The Impact of Technological Progress on the Labor Market: Employment Polarization in Europe

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Abstract

Following findings of recent literature, we analyze which are the main effects of the routine-bias technical change on employment. The master thesis shows evidence of employment polarization pattern for 16 European countries for the period 1995-2012. Occupations with high and low levels of earnings grow, while those with middle income occupations decline. This process accelerates during the recession period for all the studied countries (but for Italy). In a second step, we run a multinomial model to calculate the probabilities of working in three exclusive occupational categories: emerging high qualified, declining and emerging low qualified occupations. Results are computed for three model countries: Spain, Germany and Finland. We find that those with high educational level face higher probabilities on being in high paid jobs. When having low levels of education, men have higher chances of working on declining occupations, and women in low paid jobs.

Keywords: Job polarization, technological change, emerging occupations, declining occupations.

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1. Introduction

Understanding the shifts in the structure of employment has been a central topic for labor economists. There are some hypotheses about the driving forces that cause changes in the employment composition. One may think that these changes are led by a changing labor force and, thus, there is a labor supply effect. Other reason behind this phenomenon could be the impact that institutions and regulation have on the labor market. However, recent literature points out at technological change as the main hypothesis.

In the 1990s, some papers (see Autor & Katz (1999) and Autor, et al. (1998)) supported the idea that technological change was skill-biased (from now on SBTC: Skilled-bias technological change). New technical advantages raised employment for high skilled workers to the detriment of low skilled workers. In other words, changes in technology had a negative effect on low educated workers and positive effects on workers with medium and, mainly, high educational level. So, wages and employment in these last two job categories increased thanks to technological advances.

Nevertheless, more recent findings state that employment on the upper part and the lowest part of the income distribution has increased, whereas mid-income jobs have decreased. This way, the SBTC could only explain the growth of high-skilled occupations (managers, professional and technicians) and fails to explain both the decline of middle skilled occupations (clerks, craft workers and operators and assemblers) and the increase of low skilled occupations (service and sales workers). Following Goos & Manning (2003), we refer to this phenomenon as job polarization, which can be explained by the Routine Bias Technological Change (RBTC) (see Autor, et al. (2003) and Autor & Price (2013)).

Therefore, instead of considering the SBTC approach, we propose to follow the routinization hypothesis (RBTC) to analyze the impact of technology on the labor demand.[1] When developing this theory in Autor (2013), skills were differentiated from tasks. Skills are defined as a worker's endowments of capabilities for performing a set of tasks, whereas tasks are units of work activity that produce output. Considering their skills, workers choose to specialize in certain skills based on comparative advantage. So, by taking a task perspective rather than a skills perspective, the authors suggest that

[1] Also known as the ALM hypothesis for their authors.

digitalization and automation have displaced jobs that perform mostly routine and manual tasks that can be easily codified, and thus, can be substituted by machines. Among these jobs we find clerical and production positions that, as we are going to show later, are identified as medium paid jobs. On the contrary, jobs performing non-routine tasks are complementary to technological advantages. In this set of jobs, we find skilled jobs (managers, professional and technicians), but we also find low skilled jobs (sales and services). So, the demand for high- and low-income jobs increases thanks to the technological progress.

The main goal of the master thesis is to analyze the impact of technological change on employment and to assess how technology is driving the demand for jobs in the European countries. Alongside technical progress, we also want to take into account two other factors that are conditioning advanced economies: aging and the increasing participation of females in the labor force. This will allow us to study how different countries, with varying degrees of these two phenomena, are coping differently with technological change.

We will consider a group of 16 European countries for the analysis (the EU-15 countries plus Norway).[2] Our data mainly comes from European Union Labor Force Survey (EU-LFS). Firstly, we are going to test whether job polarization is indeed an empirical phenomenon in each of the studied countries. If so, the routinization hypothesis would be true. It involves lots of policy implications ranging from determining what to do with workers in declining occupations to deciding which skills will be more demanded in the future. Once some descriptive evidence is shown, we run a multinomial model to see how the probabilities of being in emerging high qualified, declining and emerging low qualified occupations depend on a set of individual (worker) characteristics.

The master thesis is divided into eight sections. Section 2 discusses the challenges faced by advanced European economies concerning aging, female labor participation rate and technology. Then, we include a section about related literature, where we comment their propositions and findings on the implication of technological progress in the labor market. Section 4 describes the data used in the master thesis. The next step is to study the changes in the occupational distribution across the sixteen European countries. So, in

[2] EU-15 countries: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden and United Kingdom.

Section 5, we test the employment polarization hypothesis. After this descriptive part, we start the empirical analysis. Section 6 describes the way we prepare the data. Firstly, we select three role models (Spain, Germany and Finland) to run the model on. Secondly, we explain why occupations are gathered into a three category classification (emerging high qualified, declining and emerging low qualified occupations). In the third place, we show some descriptive statistics of the variables used in the analysis. Lastly, the multinomial model is explained. Section 7 presents the results and a comparison between these three countries. Section 8 concludes.

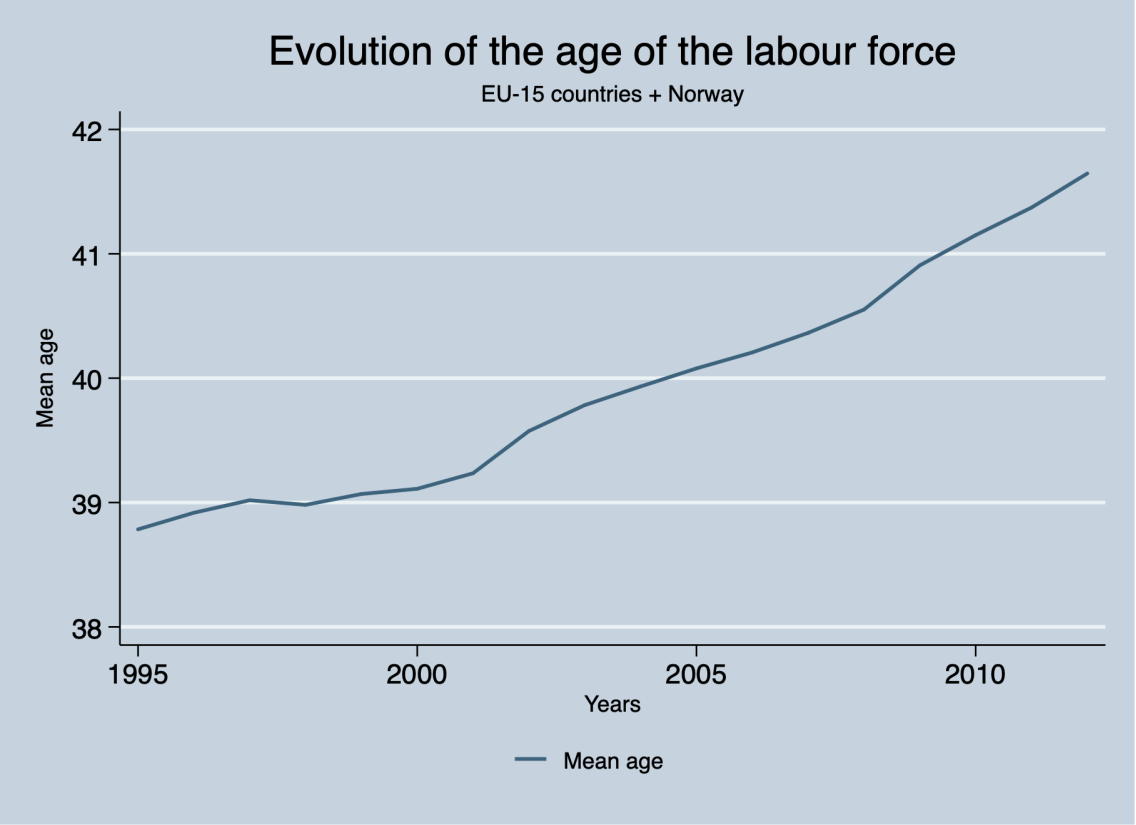
2. Which are the challenges faced by European countries?

As mentioned in the introduction, technological change is one of the biggest challenges faced by advanced economies. Still, countries nowadays have to deal with different topics such as aging and the increasing female labor force participation. In this section, that serves as motivation, we show how these three challenges have become more important over the years.

Regarding aging, it is well known that European countries are already having to and will have to continue coping with aging and hence and increasingly older labor force. There are two main reasons behind the aging problem. On the one hand, a declining birth rate is observed in advanced countries. On the other hand, life expectancy is growing thanks to scientific advances in health. This way, we observe that the mean age of the workforce across the sixteen countries that we analyze has increased from 38.78 in 1995 to 41.65 in 2012.[3] The mean age has increased almost three years in less than 20 years. Furthermore, if we look at Figure 1, there is a clear upwards trend. Additionally, we find the steepest part of the curve in the last years of the sample, which indicates that aging has sped up in the last decade.

[3] Germany is not included in the calculations for 1995, because data for this country is only available from 2002 on.

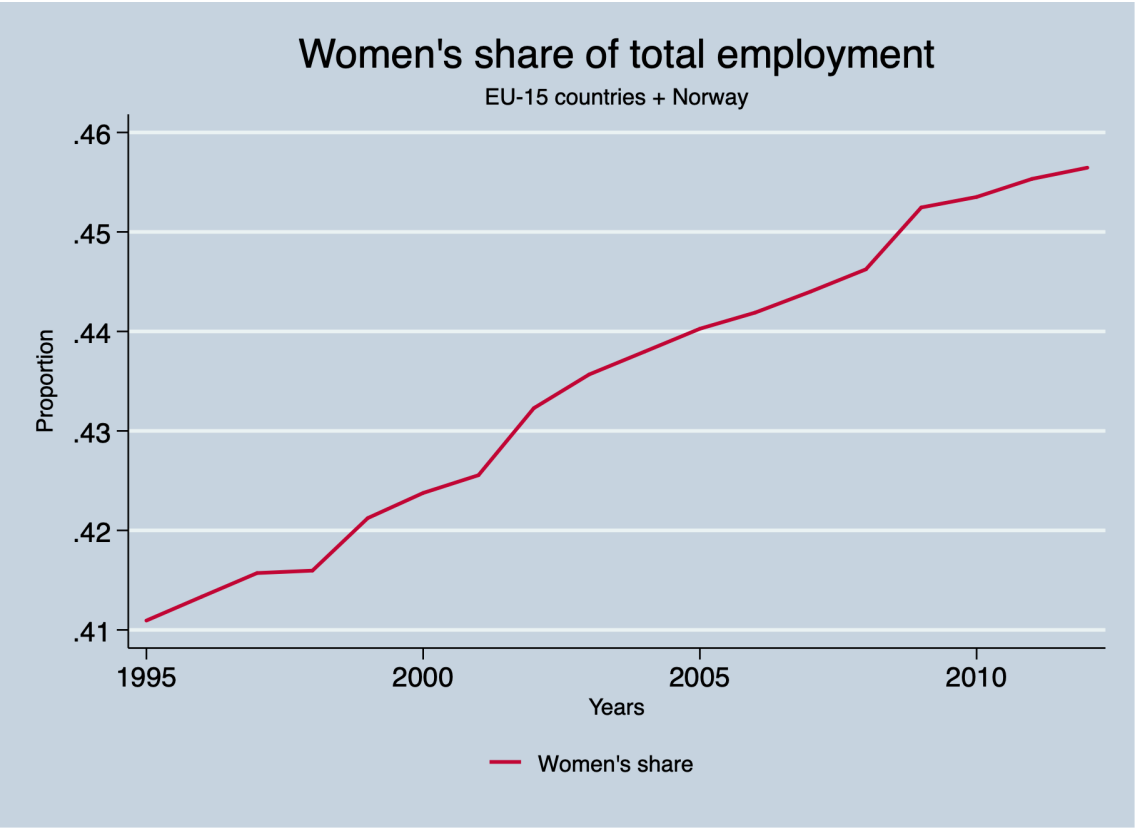
Figure 1: Evolution of the mean age of the workforce in the EU-15 countries plus Norway (1995-2012)



The mean has been calculated taking into account the yearly weighting factor. Germany is included when data is available (from 2002 on). Source: own work based on EU-LFS data.

Gender equality is another topic that European countries are working on. Although women's incorporation into the labor market has undoubtedly increase in the last two decades, there's still room from improvement when it comes to closing gender gaps in both employment and wages. Women's share in the labor force has increased in 4.55 percentage points over the sample period: while they represented 41% of the total workforce in 1995 in the analyzed group of countries, by 2012, female workers account for approximately the 46% of the labor force. Figure 2 shows the evolution of the women's share of total employment. The proportion of female workers is growing, yet there are still big country differences.

Figure 2: Evolution of women's share of total employment in the EU-15 countries plus Norway (1995-2012)



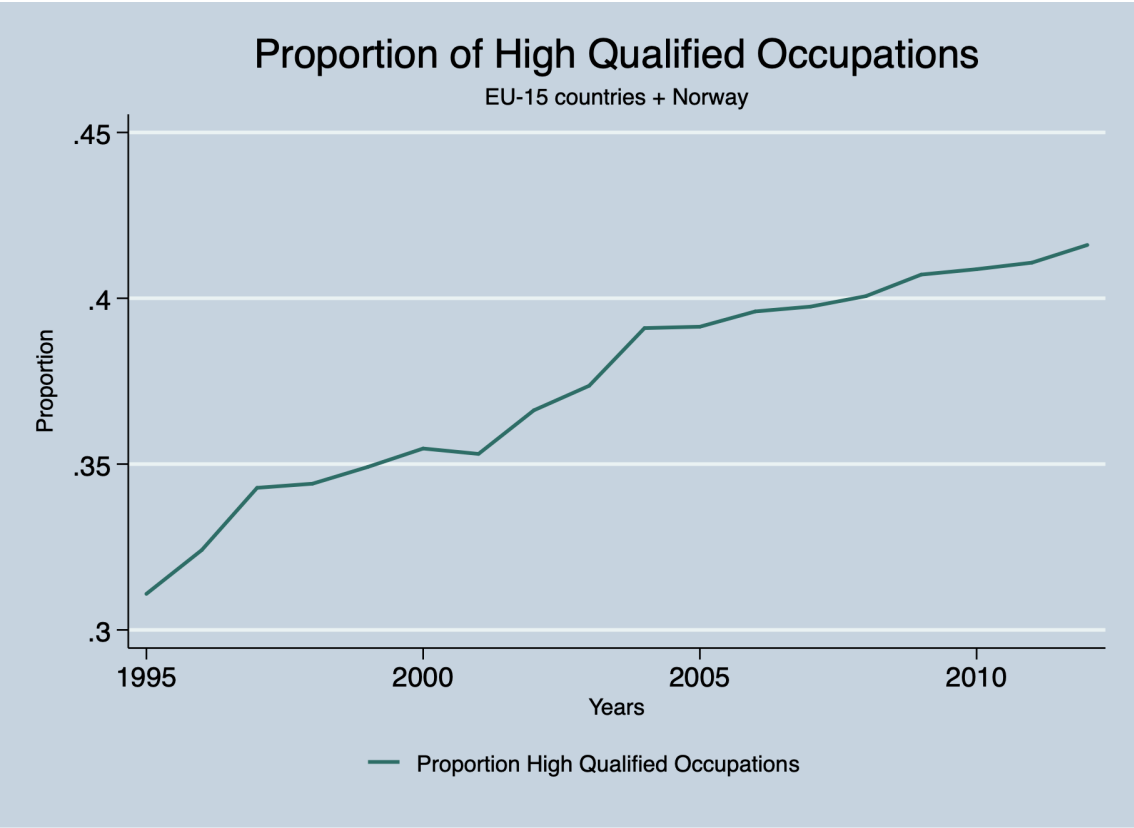
The share has been calculated considering the yearly weighting factor. Germany included when data is available (from 2002 on). Source: own work based on EU-LFS data

Finally, the last challenge that we are analyzing is technology. There is no doubt that technological progress is changing and shaping the economy, and specially, the labor market. There is a big debate about the net effect of technology on employment. However, is not clear whether the capitalization effect (the job creation caused by technological advances) will offset creative destruction (unemployment caused by new technical advances) (Arntz, et al., 2016). Nevertheless, what is true is that the share of jobs that are complementary to new technologies has increased over the years. As an approximation for technology adoption, we have calculated the high qualified employment share of total employment.[4] This kind of jobs accounted for the 31.1% of total employment in 1995;

[4] We define high qualified employment as jobs that require high levels of skills. In this job category we have included managers, professional and technicians. Later, we will explain that these jobs are the ones with the highest levels of education and seem to be complementary to technological change.

almost 20 years later, they represented 41.61%. Figure 3 displays a clear upward trend of high qualified occupations.

Figure 3: Evolution of the proportion of high qualified in the EU-15 countries plus Norway (1995-2012)



The proportion has been calculated considering the yearly weighting factor. Germany included when data is available (from 2002 on). Source: own work based on EU-LFS data.

3. Related Literature

Most of the recent literature agrees that there has been a shift in the labor market behavior related to technological change. Over the last two decades, research on labor markets has focused on studying the job polarization. This phenomenon is defined as the expansion of the share of high and low wage jobs and the decline of the share of middle wage jobs.

This trend has been found in several countries. Autor, et al. (2003) is one of the first, and yet one of the most important papers to explore the RBTC (Routinization-Biased Technical Change). They follow a task-based approach to see what the consequences of

the adoption of computer technologies are. That is, the impact of technological change on jobs and occupations will depend on the set of tasks (job content) workers perform. In order to do so, firstly, they construct a model (the ALM model) to examine how the demand for tasks changes due to the introduction of cheaper technologies. The main prediction of the model is the decline in the demand for routine tasks. Since this kind of tasks are easy to codify and computerize, labor is being substituted by machines in performing routine tasks. On the contrary, jobs involving non-routine tasks increase thanks to their complementarity to new technologies.

Autor, et al (2006) state that job polarization started in the USA in 1990. By sorting occupations into percentiles according to average years of schooling, they show that low-skill employment experimented a decline; while middle- and high- skill employment increased (the higher the level of education, the higher the rise in employment share) for the period 1980-1990. But the situation changes when the authors analyze the next decade. From 1990 to 2000, the employment growth showed a "U" shaped figure, that reflects job polarization. There was a fast increase in employment at the top of the distribution, a moderate rise in the bottom and a decrease in the middle. Nevertheless, the paper is not restricted to an occupational approach. Additionally, following the methodology of Autor, et al. (2003), they show the job polarization in the USA from a task point of view. They make a distinction in the non-routine content category and differentiate between cognitive and manual non-routine tasks. It is shown that there is a growth in employment for non-routine cognitive and non-routine manual tasks, usually performed by high-skill and low-skill jobs respectively, while middle-skill jobs performing routine tasks were declining.

The concept of employment polarization was firstly introduced by (Goos & Manning (2003). In this paper, the authors give evidence about this phenomenon in the British labor market. By taking data from Autor, et al. (2003), they assume that occupations in the US and UK have the same content of tasks. Secondly, the paper documents that non-routine jobs can be found in the upper and lowest part of the income distribution. Alternatively, those jobs in the middle of the distribution are the ones performing routine tasks, which supports the ALM hypothesis. In the third place, it is shown that job polarization happened for the period 1975-1999. Therefore, low-paid service jobs and especially high-paid positions (such as professional and managerial) grew, whereas middle-income jobs experienced a decline.

This hypothesis has also been tested for 16 Western European economies as a whole. According to Goos, et al. (2010), there is evidence of employment polarization over the period 1993-2006. In addition, they develop a model to see which is the most important underlying factor of polarization. The paper concludes that the most important determinant of polarization, and thus, the demand for different type of occupations, is technological change. Goos, et al. (2014) repeat the analysis for a longer period, from 1993 to 2010, and they draw the same conclusions.

Acemoglu & Autor (2011) also check the employment polarization from a task perspective for the US and 16 European economies. In a second step, they propose a task-based model where skills are assigned endogenously to tasks and where technical advances could cause the substitution of machines in tasks formerly carried out by labor. Following the results of Autor, et al (2003), they found that routine tasks are less demanded. At the same time, the model predicts that qualified workers will end up, in equilibrium, in jobs involving cognitive and non-routine tasks; while low qualified ones will work in jobs with high manual content due to their comparative advantage.

Anghel, et al. (2014) test for employment polarization in Spain, as well as introduce a new feature to the analysis. The paper studies the period 1997-2012, but also focuses on the expansionary period (1997-2007) and the recession period (2007-2012). Evidence supporting employment polarization in Spain is found for the expansionary, recession and whole period. However, it should be noted that polarization speeds up over the recession. It is found that the change in the composition of the workforce is not the reason behind it and that sector reallocation is only significant during the expansion of the economy. Instead, the major driving force of the polarization is the decrease in routine job content and the rise in non-routine service tasks which are characteristic of jobs on the top and bottom of the wage distribution. Moreover, the authors perform a gender analysis and conclude that males have been more affected than females by job polarization because of their concentration in jobs that require routine content. Young men tend to reallocate upwards while males over 30 years old stay in routine jobs. Sebastian (2018) also shows evidence in favor of polarization in Spain.

Finally, Autor & Dorn (2009) relate job polarization to aging in the US. Only young workers are reallocated downwards and upwards. Older workers are exiting middle

skill jobs to enter low wage jobs. Even old workers with college education are falling into low-skill nonroutine jobs.

4. Data

As we have mentioned before, the main data used in this master thesis comes from the European Union Labor Force Survey (EU-LFS). Nevertheless, data from Eurostat Database is also used to complement the former.

The EU-LFS, which is available for 31 European countries (the EU-28 plus Norway, Switzerland and Iceland), consists on a household sample survey. It provides labor status information of the population in working age. The main goal of the survey is to classify people aged 15 and over into three categories: unemployed people, employed people (both categories form the group of active people) and inactive people.

The Labor Force Survey is carried out by the national statistical institutes of each participating country and then, collected and centralized by Eurostat. Every national institute uses the same concepts and definitions, follows International Labour Organization guidelines, uses standard classifications (for example: ISCO for occupation, NACE for industries or ISCED for educational level) and reports the same individual characteristics of the subjects so that the results are comparable between countries.

EU-LFS data has been collected from 1983 onwards; however, certain information is only available for more recent years. That is why we are analyzing the period 1995-2012.[5] Even though more recent surveys have been conducted (up to 2018), the access to microdata is restrictive.[6]. Thus, we are restricted to use the data that we have, annual data up to the year 2012. We leave the period 2012 to 2018 for further research.

[5] But for Germany, Finland Norway and Sweden. The period is restricted to 2002-2012 for Germany because data is only available starting the year 2002. For the three Nordic countries there's a lack of occupational data in 1995 and 1996, so the analysis has been made from 1997 to 2012.

[6] To obtain the full sample of microdata an application is needed from a research organization. Firstly, the organization has to be recognized as a research entity. Secondly, the organization has to apply for the microdata. Both phases of the process take months, which is why we are restricted in our period of analysis.

As regards to the country sample, we have chosen the EU-15 countries (Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden and United Kingdom) and also Norway, due to its proximity to the rest of the Nordic countries. This way, we have a pool of sixteen countries.

The EU-LFS includes data related to employment status, weekly hours worked, age, gender, marital status, nationality, economic activity (one-digit industry level), occupation (three-digit occupational level), educational level, type of contract and tenure, among others. For this piece of research, we are only using the data on employment status, occupational data and some demographic variables, including age, gender, nationality and educational level; because those are the ones we consider to be the most relevant when studying the challenges, we have described and also the ones that best explain in which occupational category a worker falls.

Since we want to observe the shifts on employment, we are working with subjects that are employed during the reference week. Additionally, we have had to work on the occupational-level data because it is not comparable for the whole period. The EU-LFS use the ISCO-88 occupational classification until 2010. From that year on, occupations are reported according to the ISCO-08 categorization. Nonetheless, both classifications can be comparable by using the crosswalks at three-digit level provided by Eurostat. So, we have re-classified all the jobs according to the ISCO-88 occupational classification.

In addition to this, we also use data on monthly earnings of 2002, taken from the Eurostat database. They are reported for each country and occupation (at one-digit level).[7] We use this data in the following section, where we test for the job polarization hypothesis, in order to classify occupation according to income. We also take the old-age-dependency ratio data and employment information in high-tech sectors from the Eurostat Database. The former consists on the ratio between the number of persons aged 65 and over (age when they are generally retired) and the number of persons aged between 15 and 64. We use this statistic later to see which are the countries that will suffer most from the aging problem.

[7] Data for group 0 (armed forces) and group 6 (skilled agricultural and fishery workers) are not available.

5. Changes in the occupational distribution. Employment polarization.

In this section, we describe the impact of technological changes on employment over the 1995-2012 period for the EU-15 countries and Norway. As mentioned in the introduction and in the related literature part, there has been a shift on the effects of technical progress on the composition of employment. Previous technological changes were proven to be skill-biased Acemoglu & Autor (2011). In other words, there was a positive relationship between skills, which can be measured by earnings or education, and employment growth. In this case, high-skilled occupations (with high level of education and wages) experienced a rise in both employment share and wages.

However, new advances and cheaper technologies cause the Routine Biased Technical Change (RBTC) Autor, et al. (2003), which is the main driving force of job polarization, as seen in the previous section. This phenomenon is characterized by a surge in the share of high-skill and high-wage occupations, as well as in low-skill and low-wage occupations; at the expense of a decline in middle-skill and middle-wage jobs.

Many papers have tested this hypothesis for a specific country (for example: Goos & Manning (2003) for the UK or Anghel, et al. (2014)for Spain) or at an aggregate level in the case of Europe Goos, et al. (2010). In this master thesis, we are checking the employment polarization for a total of 16 countries.

Since we are proposing an occupational approach, our aim is to look at changes in employment shares of the different occupational groups. We take information from the EU-LFS for each country and from 1995 to 2012. In order to measure the skills of jobs, we rank the occupations by 2002 monthly mean wages. It is important to measure skills (in this case wages) at the beginning of the period (or at least no at the end) because we want to study differences with respect to the year 1995. This time, skills are fixed to the year 2002. Notice that reported wages are different for each country, so occupations do not follow the same classification in each of them.

Despite the fact that we have access to job classification at three-digit (ISCO-88) occupational level, wage information is only available at one-digit level (ISCO-88)

classification, which forces us to restrict our analysis to less than 10 categories.[8] Moreover, the Eurostat database does not report income related data for armed forces and skilled agricultural and fishery workers. Nevertheless, the weight on total employment of these two groups in rather small. Both groups represent less than 8% of total employment on aggregate level (the 16 countries minus Germany) in 1995.

Following Anghel, et al. (2014), we display the changes in the share of employment for six occupational groups. The first three groups on the ISCO-88 classification (managers, professional and technicians) have been merged into a unique category. We proceed like this because workers in this type of jobs are the ones with the highest level of income and educational level. The rest are: clerks; service workers and shop and market sales workers; craft and related trades workers; plant and machine operators and assemblers; and elementary occupations.

In an effort to disentangle the analysis, results are displayed for two periods as Anghel, et al. (2014). One for the expansionary period that goes from 1995 to 2007. And the other one for the whole period including the recession (1995-2012). This let us to know whether employment polarization is present in both periods and also whether the process accelerates or decelerates over the whole period. In addition, it allows us to observe if the change in the employment composition is structural, in spite of the recession.

In the first place, the shift in the employment structure is shown for a sole country. Figure 4 analyzes the case of France. We have chosen this country because employment polarization is very noticeable. Nevertheless, we analyze the case for the remaining 15 countries later on. The plot displays the change in employment share (in percentage points) by occupations, which are ranked according average wages of 2002 from lowest to highest.

[8] Getting access to EU-SES (European Union Structure of Earnings Survey) would mean that we could have wages from 1995 at a three-digit level. However, the procedure to obtain this dataset is the same as the EU-LFS LFS and was therefore beyond the timeline of this master thesis.

Figure 4: Change in employment share by occupational group in percentage points

The data include all employed people on working age during the reference week. Skilled agricultural and fishery workers and workers in armed forces are not included. Occupations follow the ISCO-88 one-digit level classification and are ranked by 2002 mean wages. Source: own work based on EU-LFS data and Eurostat Database.

Let us start by analyzing the expansionary period (1995-2007). Here we can see an obvious pattern of job polarization. Over the 12-year period, occupations in the upper part of the wage distribution (managers, professional and technicians) expanded in 5 percentage points (or pp). On the opposite side of the income distribution, we find that service and sales occupations increased in less than 1 pp, but the expansion of elementary occupations surpassed the 2.5 pp. The rest of the occupations, that are characterized by middle-wages, declined. All of the three occupational groups (clerks, operators and assemblers and craft and trade workers) experienced a decrease close to 2.5 pp. Thus, it is proven that lowest- and highest-paying occupations underwent a rise in the employment share.

If we focus on the entire period, including the recession, the evolution of employment remains the same. Top paid occupations' expansion reached 10 pp. This means that in the five-year period (2007-2012) occupations including managers,

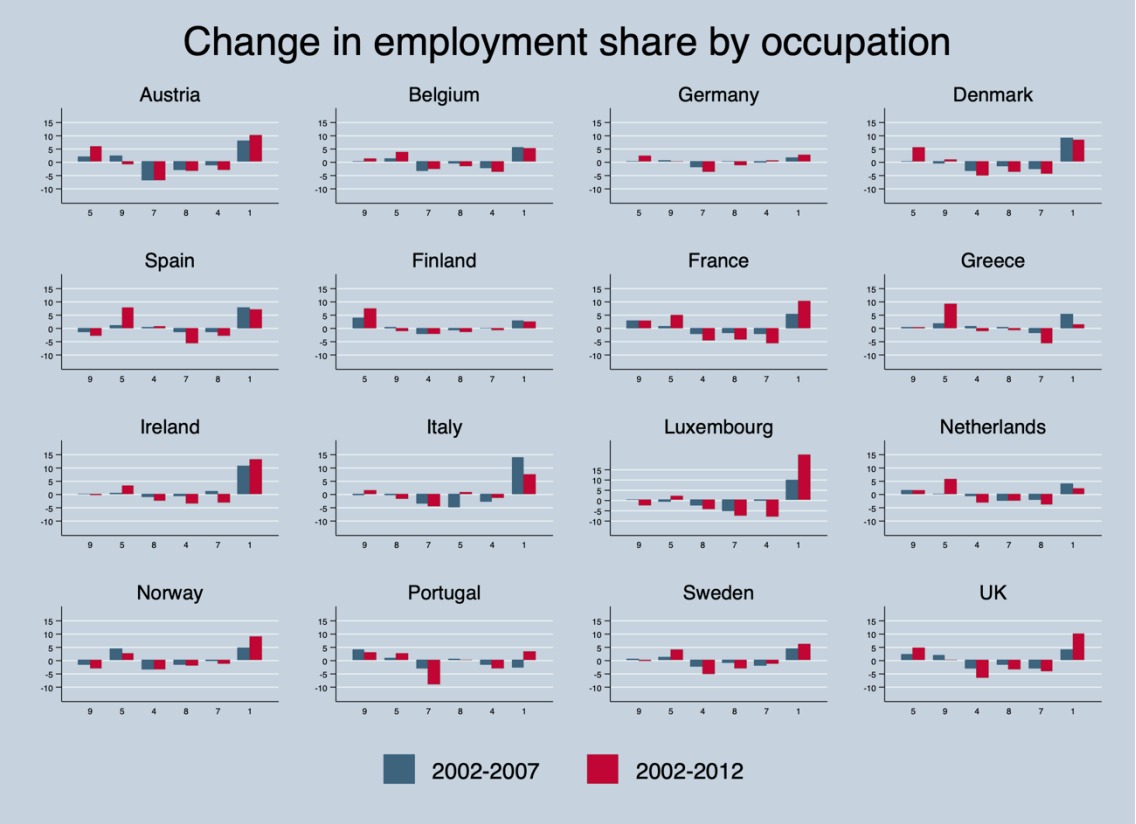
professional and technicians grew the same as in the economic expansion. As regards to elementary occupations, the growth was the same as in the restricted period. However, occupations related to service and sales experienced a big boom reaching an increase of 5 pp. Additionally, mid-skill jobs suffered a greater decline over the whole period. In the case of clerks, the employment proportion decreased in almost 5 pp. As for operators and assemblers, the drop (4.5 pp) also doubled in the recession years with respect to the 1997-2007 period. Finally, craft and trade workers faced the biggest fall surpassing 5 pp.

With regards to France, the employment polarization happened for both the expansionary and recession periods. These results are in line with those reported in the recent literature; the share of jobs in low- and especially high-skill occupations associated with nonroutine (service and abstract, respectively) task has grown, whereas mid-skill jobs, mostly performing routine tasks, have declined. We can even confirm that this process has deepened in the recession years. This evidence gives us a sense that the labor market in France has experienced a structural change.

Now that we have presented the case for a specific country, which has served as an example, we show the results for the whole pool of 16 countries. Figure 5 displays the change in employment level from 1995 to 2012.[9] As in the previous case, results are depicted for two periods (up to the recession and including the recession).

[9] 2002-2012 for Germany; and 1997-2012 for Finland, Norway and Sweden.

Figure 5: Change in employment share by occupational group in percentage points



The data include all employed people on working age during the reference week. Occupations follow the ISCO-88 one-digit level classification and are ranked by 2002 mean wages. Groups are classified as follows: group 1: managers, professionals and technicians; group 4: clerks; group 5: service and sales workers; group 7: craft and related trades workers; group 8: operators and assemblers; group 9: elementary occupations. Skilled agricultural and fishery workers (group 6) and workers in armed forces (group 0) are not included. Source: own work based on EU-LFS data and Eurostat Database.

At a glance, we can observe that each country follows the "U" shape pattern that is characteristic of job polarization. However, we proceed case by case to see whether there are differences across countries.

On the one hand, we have countries where the phenomenon is crystal clear. We are referring to Belgium, Netherlands, Sweden and the UK. In this set of economies, the share of occupations related to managers, professionals and technicians experienced the biggest increase; followed by the two-low paid service occupations. For Netherlands, the most pronounced rise was for the service and sales workers from 1995 to 2012. The employment share of middle-skill occupations falls considerably. Moreover, it is observed that polarization has accelerated during the recession years.

On the other hand, there is a handful of countries (Austria, Denmark, Finland and Ireland) where elementary occupation does not show a big increase, and sometimes an insignificant decrease. Nevertheless, the share of low and high paying jobs is growing, while middle ones decrease. As for the previously mentioned countries, changes are more pronounced when including recession years.

There are also countries like Spain, Norway and Luxembourg in which the decline of elementary occupations, those in the lowest part of the income distribution, is more noticeable. This could be due to the composition of the elementary occupations group, which is a mixture of service and primary sector jobs. The decrease in the share of the latter could have offset the rise in the former. Still, employment polarization is obvious if we aggregate both low-wage occupations and it seems that it has sped up during the recession period. With regards to Luxembourg and Norway, the biggest increase is detected in the best paid jobs (particularly in Luxembourg with a rise of 20 pp; in Norway there is an expansion of 10 pp). In Spain, service and sales occupations experience the highest jump with an increase of 10 pp. It should also be noted that the share of clerks does not decline.

Finally, we want to make some comments for a few specific countries. For Greece, the job polarization process is a fact, but there is little increase in the share of jobs in top paid occupations and the only middle paid occupation declining (the rest remain with a constant share) is craft and trade workers. In the case of Portugal, the "U" shaped curve is seen when considering the whole period. Italy is the only country where polarization is not fully seen; it looks like the crisis period has stopped it. Lastly, Germany is the country with the least pronounced "U" shaped curve, with changes under 5 pp. Recession appears to deepen the polarization process.

To sum up, the demand in European countries is shifting to the extremes of the income distribution, being low paid service jobs and high paid positions the ones that have grown more from 1995 to 2012. Moreover, the trend is more pronounced when taking into account the recession period.

6. Empirical specification

In the previous section, the master thesis displays descriptive evidence that supports the job polarization hypothesis caused by the technological change, which has shown that those workers in emerging occupations (Managers, professionals, technicians, service and sales workers and elementary occupations) have benefitted from technical advances, whereas those workers in declining occupations (clerks, operators and assemblers and craft and related trade workers) have ended up losing out. Once it is shown which are the real winners and losers of the change in the employment structure across 16 European countries, we proceed to start the empirical analysis.

The aim of this section is to establish a relationship between the changes in the demand for labor caused by technical advances, and the individual characteristics of workers, such as age, gender and educational level. Therefore, we propose to estimate a multinomial logit model to calculate the probabilities of being on each of the occupational categories depending on age, gender and education. However, since we want to examine the evolution of the probabilities over the period 1995-2012 for different countries, we propose to estimate the model for each year and each country.

Repeating this process for 16 countries would produce a huge output, difficult to analyze. That is why we restrict the exercise for a limited number of countries. Based on evidence related to aging, female participation of the labor force and technology we choose three countries: Spain, Germany and Finland. These results will not only give us information on the population groups in the growing and declining occupations, but also differences across countries.

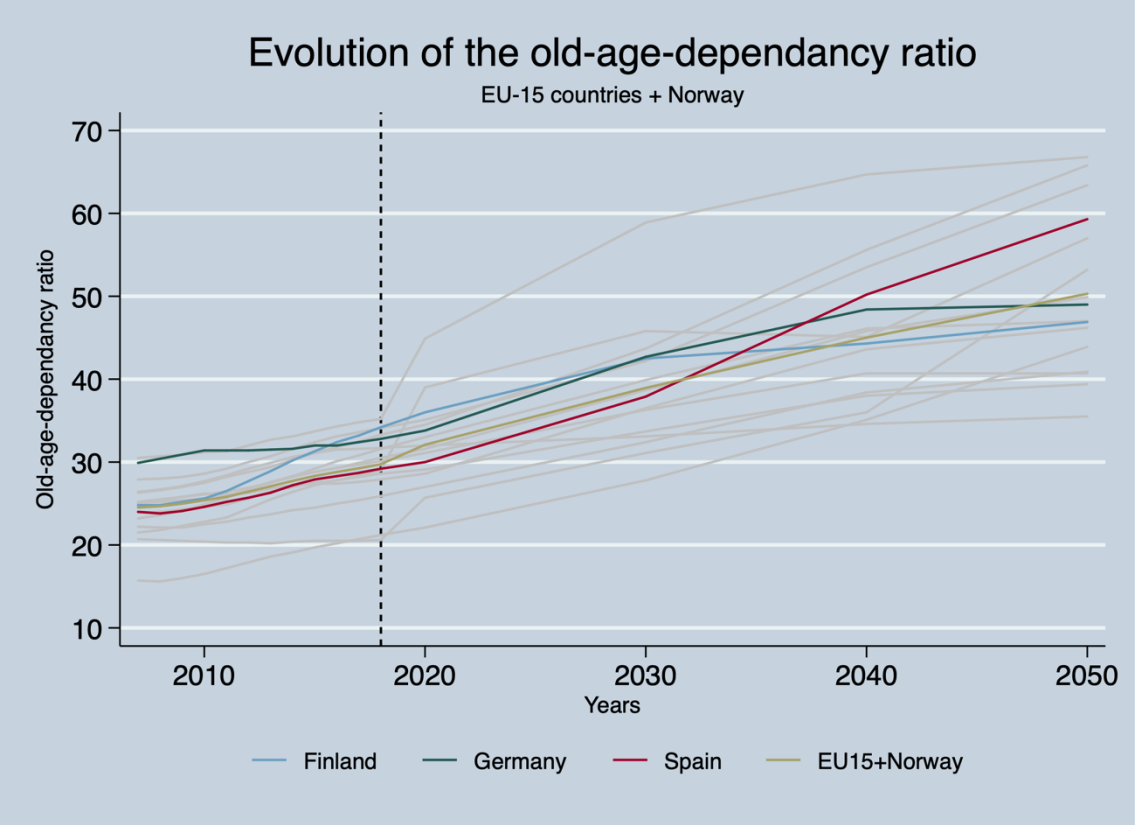
6.1. Choosing the country role models

As noted above, we want to restrict our analysis a bit more in order to simplify the outcomes. One way to interpret easily the results is to take three countries as role models: Spain, Germany and Finland. The choice has been made according to country specific characteristics about gender, aging and technology.

First of all, we are going to represent the aging phenomenon across European countries. We initially considered showing the mean age of the labor force for each

country and selecting one country among the oldest ones, other among the youngest and another on an intermediate level. However, the mean age of the labor force does not completely define this issue. Instead, we use the old age dependency ratio provided by Eurostat. The indicator is the ratio between the number of persons aged 65 and over and the number of persons whose age ranged from 15 to 64 years. It is a more reliable statistic than the mean age of the workforce, since it also includes inactive people (who generally are older than 65).

Figure 6: Evolution of the old-age-dependency ratio for the EU-15 countries and Norway



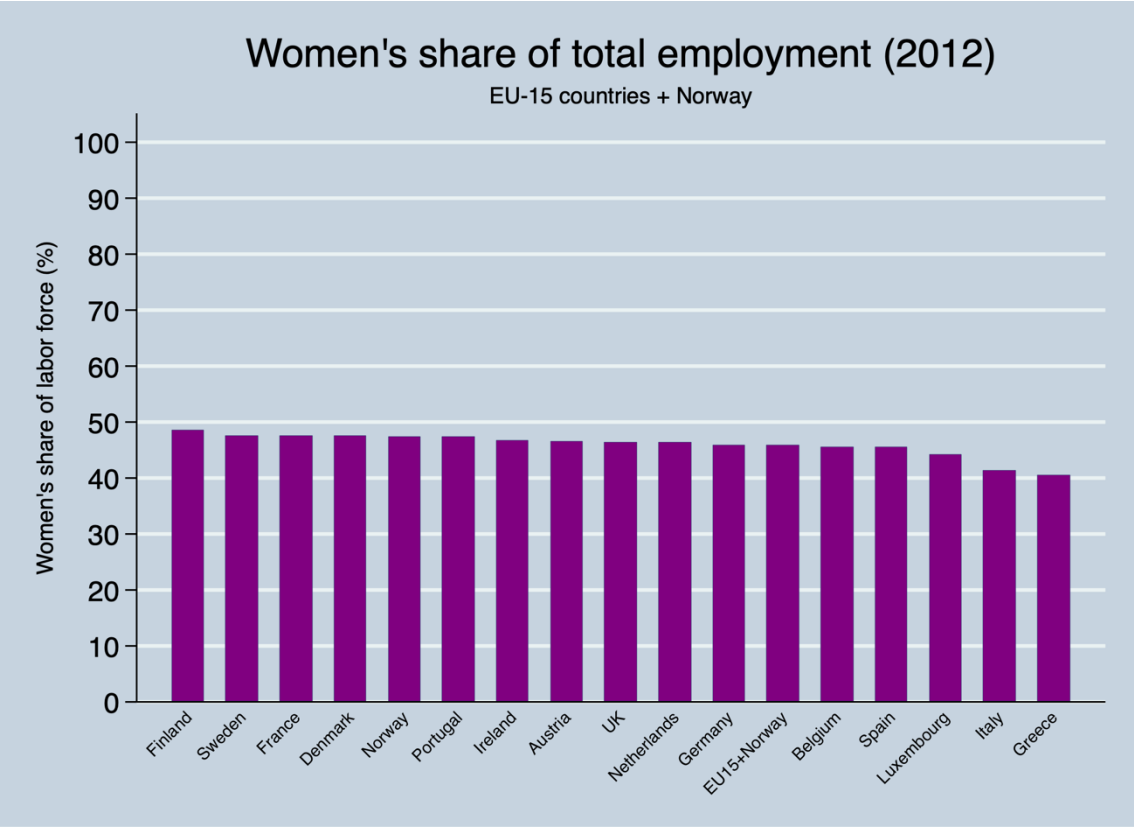
The mean for this group of countries is also included as "EU15+Norway". This indicator is the ratio between the number of persons aged 65 and over (age when they are generally economically inactive) and the number of persons aged between 15 and 64. The ratio is expressed in per 100 persons of working age (15-64). The dashed vertical line denotes the year 2018; from this year on the projected old-age-dependency ratio is represented. Source: own work based on Eurostat Database.

Figure 6 shows the evolution of the statistic for the selected group of countries. As we can see in the graph, Spain is one of the countries with the worst projections. Although its figures are below the European mean nowadays, the dependency ratio skyrockets from 2030 on. Thus, we chose Spain as a country that will have to deal with a serious aging problem. Then, Germany is selected as country that will stay around the

mean in the long term. Lastly, we have Finland that will have a ratio lower than the mean, so it is picked as a country whose aging problem is not that big. Notice that Germany and Finland hold high numbers during the last decade. Nevertheless, the upward trend softens in the long-term projections, maybe due to the parental leaves, policies to boost birthrates and immigration.

In the second place we look at female labor force participation issues. One way to approximate it examination the women's share of total employment. Figure 7 shows us the proportion of the workforce that are female for the year 2012. As we did before, we are taking one leading country, one that is close to the mean and another that is in the bottom of the ranking. In this case, the leader is Finland, where the 48.7% of workers are women. On the opposite side, we have Spain. The proportion of women (45.4%) is below but close to the European mean. Then, we have countries like Germany which are on the European mean, with women representing the 45.9% of workers in the labor market. It is ahead of Spain but far away from Finland.

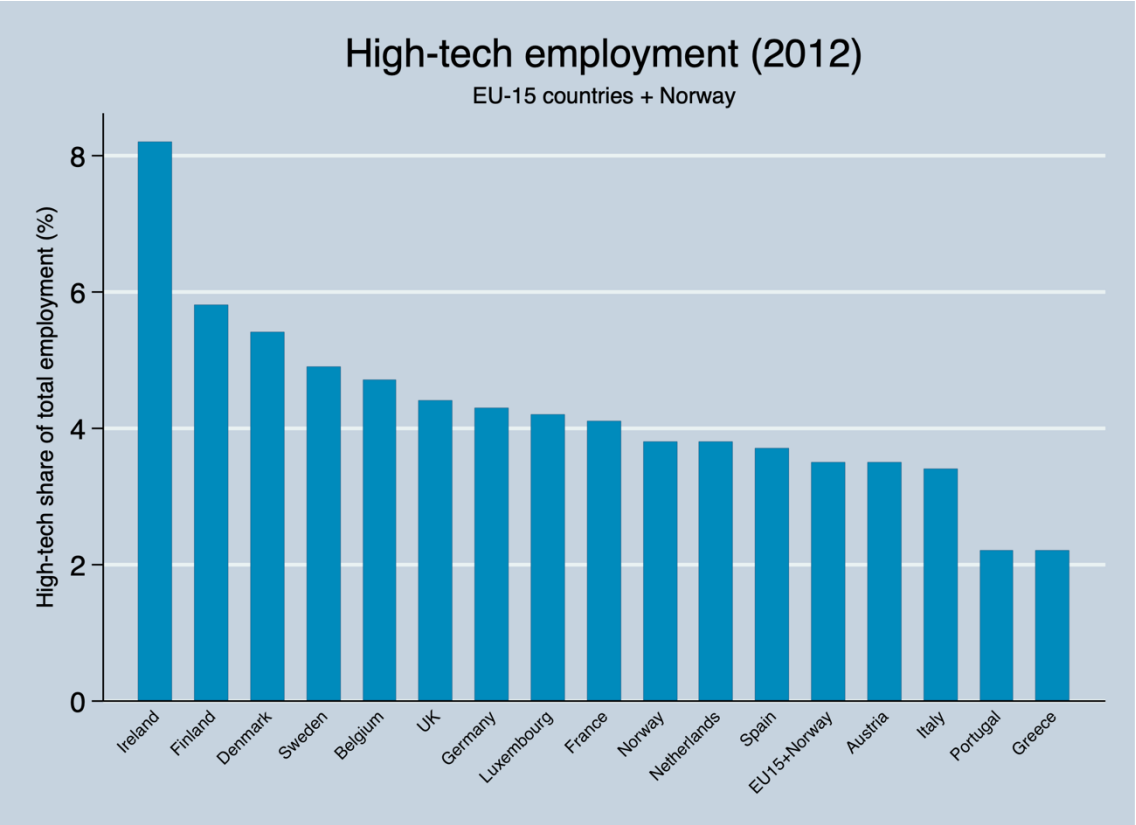
Figure 7: Women's share of total employment in 2012 for the EU-15 countries plus Norway



The mean this group of countries is also included as "EU15+Norway". Source: own work based on EU-LFS Data.

Lastly, we focus on technological change. We propose to approach the technological penetration in each of the economies by measuring high-tech employment. As we can see in figure 8, there are noticeable differences between European economies. Again, three countries are chosen: one leading country, one that is close to the mean and one that is in the bottom of the ranking. Finland holds the second position in this classification, where the 5.8% of the jobs are considered high-tech. Germany is around the middle of the ranking; the share of total employment is close 4.3%. Spain is the chosen economy to represent those with low level high-tech employment (with 3.7%). However, it is above the European mean because countries like Portugal and Greece are far behind the rest with levels close to 2%.

Figure 8: High-tech employment share of total employment in 2012 for the EU-15 countries plus Norway



It is measured by computing the Employment in technology and knowledge-intensive sectors at the national level. Source: own work based on Eurostat Database.

In summary, we select Spain as a country with an important aging problem, with room for improvement in regards to women's participation in the labor force and with low levels of technology implementation when compared to the leaders. Germany is the

role model for countries in the middle. In these three topics, Germany sits around the mean. And Finland is taken as a leader in aging, gender and technology.

6.2. Creating a broader occupational classification

The dependent variable considered for the analysis is the occupational classification that, following the previous section, is divided into six exclusive categories: elementary occupations; service and sales; clerks; operators and assemblers; craft and related trades works; and managers, professionals and technicians. This variable is a nominal one which means that categories cannot be ordered. Therefore, a multinomial model is considered.

However, we want the occupational classification to be more extensive. On the one hand, we will relate this broader classification to the "winners" and "losers" previously mentioned, which is what mostly interests us when analyzing the impact of technological change. However, we also make a distinction among those occupations that emerge, separating those high-paid emerging occupations from the low-paying ones. On the other hand, a multinomial logit with three categories instead of six simplifies the interpretation of the results.

Thus, the occupations gathered into three groups based on evidence and literature. In the first place, we include managers, professionals and technicians into a category called **emerging high qualified occupations**. They are emerging because their employment share has increased over the last two decades in European Western countries, as verified in Section 5. We identify them as high qualified occupations because Acemoglu & Autor (2011) determine that workers in these jobs mostly perform abstract nonroutine cognitive tasks.

In the second place, we group together those occupations that lose employment share over the period 1995-2012. According to the results of the previous part, declining occupations are not the same for the 16 countries. Nevertheless, we observe, in general, that operators and assemblers, craft and trade workers and clerks are the ones suffering from the effects of technological change on aggregate level. These three middle-skill occupations are introduced into a group called **declining occupations**. Another similarity between this type of jobs, enabling us to classify them together, is that workers are

specialized in routine tasks (but there's a distinction between clerks and those working in manufacturing: the former are used to carry out routine cognitive tasks while the latter perform routine manual ones) Acemoglu & Autor (2011).

Lastly, service and sales workers and elementary occupations as well are arranged into **emerging low qualified occupations**. These typically low paid jobs are characterized by low educational level requirements and a high increase in employment share. Additionally, trying to identify occupations by tasks, these jobs demand, generally, non-routine manual and service tasks Acemoglu & Autor (2011).

The relationship between occupations and tasks is shown in Table 5a in Acemoglu & Autor (2011). They create five variables (non-routine cognitive analytic, non-routine cognitive interpersonal, routine cognitive, routine manual and non-routine manual) that reflect the task measure for different occupations. These have been constructed using O*NET occupational classification scheme and have zero mean and standard deviation one. Managers, professionals and technicians have the highest score in non-routine cognitive tasks (the abstract ones) and non-routine interpersonal; service and production occupations have the lowest. The table shows that the routine tasks are highest in clerical and production jobs.[10] Non-routine manual tasks are the highest for production and service occupations.

Therefore, we have a categorical dependent variable with three different outcomes: being in emerging high qualified occupations, emerging low qualified occupations and declining occupations.

6.3. Descriptive statistics

Table 1 contains the summary statistics displayed according to the three occupational categories (emerging high qualified, declining and emerging low qualified). The statistics have been calculated taking mean over the period 1995-2012 across the 16 European countries; individual weights for each observation have been used.

All of the variables are dummy variables (either take value 1 if the subject has that characteristic or 0 if not) and, consequently, the mean represents the proportion of

[10] Notice that Acemoglu & Autor (2011) include in just one category clerical and service occupations.

individual with that characteristic. The first two variables are related to gender. Regarding age, one individual is considered young if s/he is aged from 16 to 30; in his middle age if aged between 31 and 45; and old if 46 or older. With respect to education, if an individual has lower educational level than lower secondary, it is considered that s/he is low educated (digit 0,1 and 2 according to ISCED 2011 classification). When the highest educational attainment level is upper secondary, the subject has medium educational level (digit 3 and 4 according to ISCED 2011 classification). If the person has achieved tertiary education, s/he is treated as high educated.

Table 1: Summary statistics of explanatory variables

Emerging High Qualified Occupation		
Variable	*Mean*	*Std. Dev.*
Man	0.5556263	0.4968961
Woman	0.4443737	0.4968961
Young	0.1661194	0.3721878
Middle aged	0.4366627	0.4959722
Old	0.3972179	0.4893219
Low educational level	0.1087977	0.3113853
Medium educational level	0.3506093	0.4771608
High educational level	0.5405929	0.4983495
Declining Occupations		
Variable	*Mean*	*Std. Dev.*
Man	0.6746366	0.4685105
Woman	0.3253634	0.4685105
Young	0.2411426	0.4277767
Middle aged	0.4099113	0.4918171
Old	0.3489461	0.4766369

Low educational level	0.3903251	0.4878232
Medium educational level	0.5074676	0.4999443
High educational level	0.1022074	0.3029208
Emerging Low Qualified Occupation		
Variable	*Mean*	*Std. Dev.*
Man	0.3901057	0.4877738
Woman	0.6098943	0.4877738
Young	0.2909668	0.4542083
Middle aged	0.3687071	0.4824544
Old	0.3403261	0.4738189
Low educational level	0.4731611	0.4992792
Medium educational level	0.4477269	0.4972601
High educational level	0.079112	0.2699135

Among workers in high qualified occupations, we find that men represent 55% of the total. There is a low presence of young people in top paid jobs. About 83% of individuals in this category are older than 30 years. More than half (55%) have tertiary education, which reflect that managers, professionals and technicians are high skilled workers. Declining occupations are more segregated. Men represent almost 70% of workers in these jobs, which are mainly production ones (except clerks). The majority of them have a medium level of education (51%), followed by low educational level (40%), and are middle aged (41%) or old (35%). However, there are more young workers in these occupations than in emerging high qualified ones. With respect to emerging low qualified occupations, we can confirm that they are mostly occupied by women. We have workers from all the ages in low-paid jobs (29% the young; 37% the middle aged; 34% the old) and the majority of them are either low educated or have medium educational level (47% and 45% respectively).

6.4. The model

As mentioned before, the proposed model is a multinomial logit, where the dependent variable occupational category is regressed on a set of explanatory variables. The dependent variable contains three options that are mutually exclusive: emerging high qualified occupations, declining occupations and emerging low qualified occupations. The independent variables entering the regression are dummy variables. The model can be represented as:

$$Occupational\ groups^{*}_{ijt} = \beta_0 + \beta_1 woman_{ijt} + \beta_2 young_{ijt} + \beta_3 old_{ijt} + \beta_4 loweducation_{ijt} + \beta_5 higheducation_{ijt} + \beta_6 immigrant_{ijt} + \epsilon_{ijt}$$

where $Occupational\ groups^{*}_{ijt}$ is the latent variable associated to the true categorical dependent variable. The base subject is a middle-aged man with medium level of education and who is native. The subscript *i* denotes each individual observation; *j* stands for country; and *t* refers to years.

Models for nominal outcomes can be thought as binary logits that are estimated simultaneously for all the possible comparison among the outcome categories (Long, 1997). The estimation method is maximum likelihood.

Concerning the interpretation, we are not going through neither the estimated parameters nor the marginal effects. On the one hand, because even with this simple model (with three outcomes and five explanatory variables), there are 12 different parameters or marginals to interpret. On the other hand, the value of the marginal effect, depends not only on the value of the estimated coefficients, but also on the value of the independent variables. Therefore, the sign of the estimated parameters may not be the same as the marginal effects making it difficult to interpret them. For these reasons, we are computing the predicted probabilities on being on each of the categories depending on different individual characteristics, instead. This makes the comparison across different groups a lot easier. Notice that we are repeating this process for each year (from 1995 to 2012), so we observe the evolution of the predicted probabilities.

7. Results

In this section, results from the multinomial estimations are presented. We show the estimated probabilities on being on each of the three occupational categories for six population groups and for each role model country. The population groups are designed according to individual characteristics and are the following ones: old and young people as a way to analyze the aging phenomenon; men and women, to look at gender differences; and high educated and low educated people.[11]

We expect to find higher differences between old and young in those countries where aging is a more noticeable (in our case, Spain). We also anticipate to find more possibilities of being in top paid occupations in countries in which advanced technologies are implemented (the case for Finland). Finally, we suspect that differences between men and women arise in countries with lower women's share in the workforce.

The way we proceed is as follows: in the first place, we look whether polarization is visible in Spain by looking at probabilities on being on each of the occupational categories; secondly, we study the situation for the low and high educated workers; in the third place, we compare the situation of the young and old; lastly, we look at differences between men and women in each of the categories. Then, we repeat this exercise for Germany and Finland, but including a comparison with respect to Spain.

7.1. Spain

Figures 9, 10, 11 and 12 plot the evolution of probabilities in Spain for each population group. Firstly, we can confirm a pattern of employment polarization in the estimated probabilities. Regarding the emerging high qualified occupations, they tend to increase or maintain over the 1995-2012 period. The rise of the emerging low qualified occupations is much more obvious. Nevertheless, the increase occurs on the recession period. For previous years, the probabilities remain at levels similar to the ones in 1995. On the contrary, probabilities on working in declining occupations decrease. As it happened with low skill jobs, the fall in the probabilities takes place from the year 2007. This gives us evidence on employment polarization, which accelerated on the recession

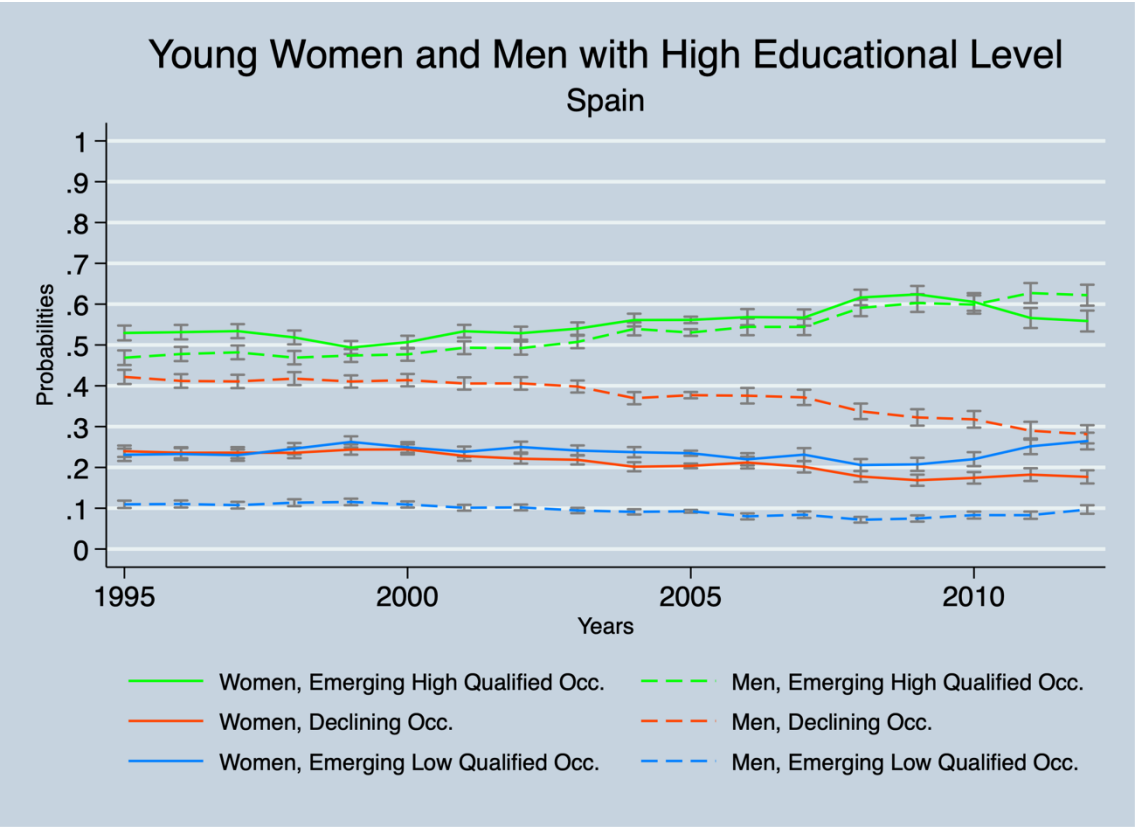
[11] Medium aged and middle-education groups are included in the model, but are excluded out of the interpretation.

years. The results fit perfectly with what is seen in the changes in the occupational distribution (Section 5).

Next, we look at differences between workers with high and low levels of education. Individuals with tertiary education have higher probabilities of being in emerging high qualified occupations, whereas people with educational below lower secondary face higher probabilities of being in emerging low qualified occupations. When comparing young and old, we see a similar evolution between these two groups if both are equally educated. However, young are more exposed (deal with higher probabilities) to low-paid emerging jobs, while the possibilities on being in high- and medium-income jobs are greater for the old.

Let us analyze the situation case by case. With regards to young people with tertiary education, they show a high probability of being in emerging high qualified occupations (around 60%). Therefore, there is a match between jobs and qualifications. For both men and women, the probabilities have increased over the period. However, they were higher for the latter group until the year 2010. From this year on, men have higher probabilities of working in this type of occupations than females. At the beginning of the period, the probability of being in declining occupations (close to 45%) were close to the ones of emerging high qualified jobs in the case of men. The situation changes for recent years; the probability has fallen from 45% to 30%. On the other hand, chances of being in emerging low qualified occupations hasn't changed over the years (around 10%). The situation is rather different for women. In 1995, women faced a low probability (only slightly above 20%) of being in declining and emerging low qualified occupations; but both job categories don't experience the same evolution: probabilities for decreasing medium income jobs decline, while the ones for the emerging low paid jobs grows, reaching 30%.

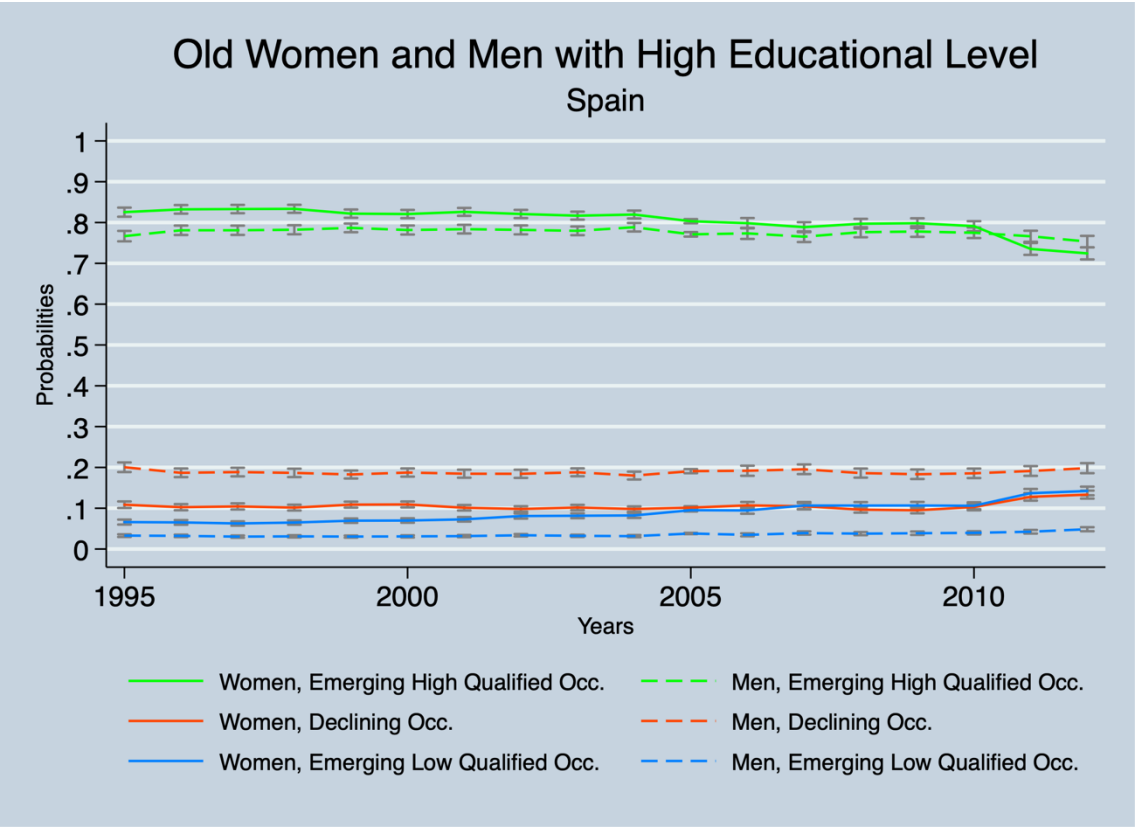
Figure 9:Evolution of estimated probabilities for young workers with high educational level in Spain (1995-2012)



The plot also includes 95% confidence intervals. Source: own work based on EU-LFS data.

In the case of high educated workers aged 45 years or more the situation is a bit different. As it happened with the young, this group face the highest chances (around 80%) of being in emerging high qualified occupations for both male and females. However, the evolution is downwards (70% at the end of the period). For women, the probability of working in declining (opposite to young women) and emerging low qualified occupations has increased, reaching the 15%. In the case of men, the likelihood of being in declining occupations is steady (20%), unlike young high educated workers that faced greater probabilities. The same happens when referring to emerging low qualified occupations.

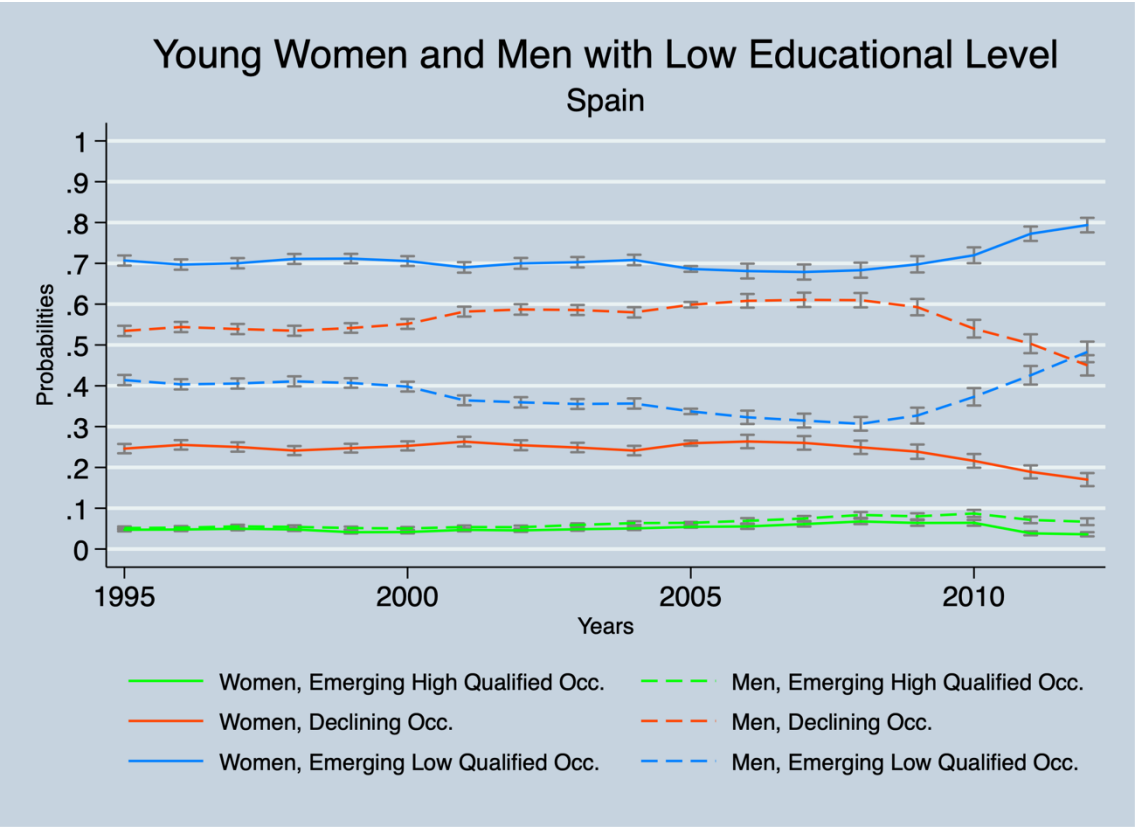
Figure 10: Evolution of estimated probabilities case for old workers with high educational level in Spain (1995-2012)



The plot also includes 95% confidence intervals. Source: own work based on EU-LFS data.

For young individuals with low educational level, the likelihood of being in emerging high qualified occupations has increased, but stays lower than 10% in 2012. Women face higher probability of being in emerging low qualified occupations. The tendency over the analyzed period is upwards, reaching probabilities close to 80% in the end of the period. On the other hand, the likelihood of working in declining jobs stays below 30% and decreases over the years. For men, the probability of being in declining occupations is higher. In spite of the increase during the beginning of the period, it has fallen from 2008 on, up to the point of being below the probability of being in emerging low qualified occupations. Chances of being in this last category have considerably grown from the start of the recession.

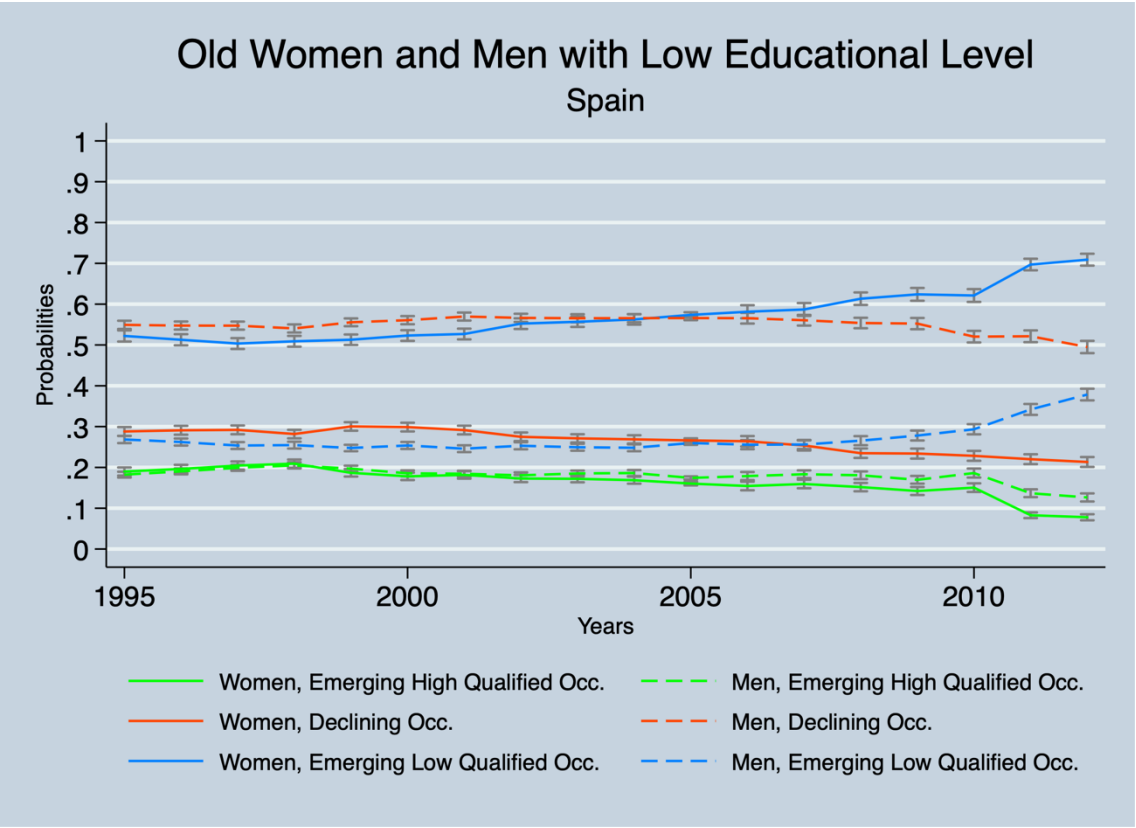
Figure 11: Evolution of estimated probabilities for young workers with low educational level in Spain (1995-2012)



The plot also includes 95% confidence intervals. Source: own work based on EU-LFS data.

Lastly, we look at low educated old workers. The situation is similar to the young individuals with low educational level. Still, they have higher probabilities of being in higher paid jobs (declining and emerging high qualified occupations). Old women face higher chances of working in emerging low qualified occupations; the evolution is upwards, going from 50% to 70%. When talking about declining occupations, the likelihood decreases, reaching the 20%. Men find themselves in declining occupations, even though the possibilities have decreased (no that much as young worker with the same educational attainment). They also see how the probability of entering low paid jobs increase, especially in the last 5 years of the period. Chances of working in top occupations is low and declines over the years for old men and women; however, probabilities are higher than for the young.

Figure 12: Evolution of estimated probabilities for old workers with low educational level in Spain (1995-2012)



The plot also includes 95% confidence intervals. Source: own work based on EU-LFS data.

To sum up, high educated people stay in emerging high qualified occupations. Having tertiary education guarantees a high-skilled job for older workers (with probability close to 0.8), but the situation is rather different for the young. When highly educated, young workers are more exposed to declining and emerging low qualified occupations. This evidence shows a mismatch between jobs and qualifications, especially for women who face a relatively high probability (30%) of working in low qualified occupations. Therefore, being old, that is associated with tenure, is significant to explain differences in probabilities. For workers with low educational level, the situation is similar between old and young. They exit emerging high qualified and declining occupations to enter emerging low qualified occupations.

7.2. Germany

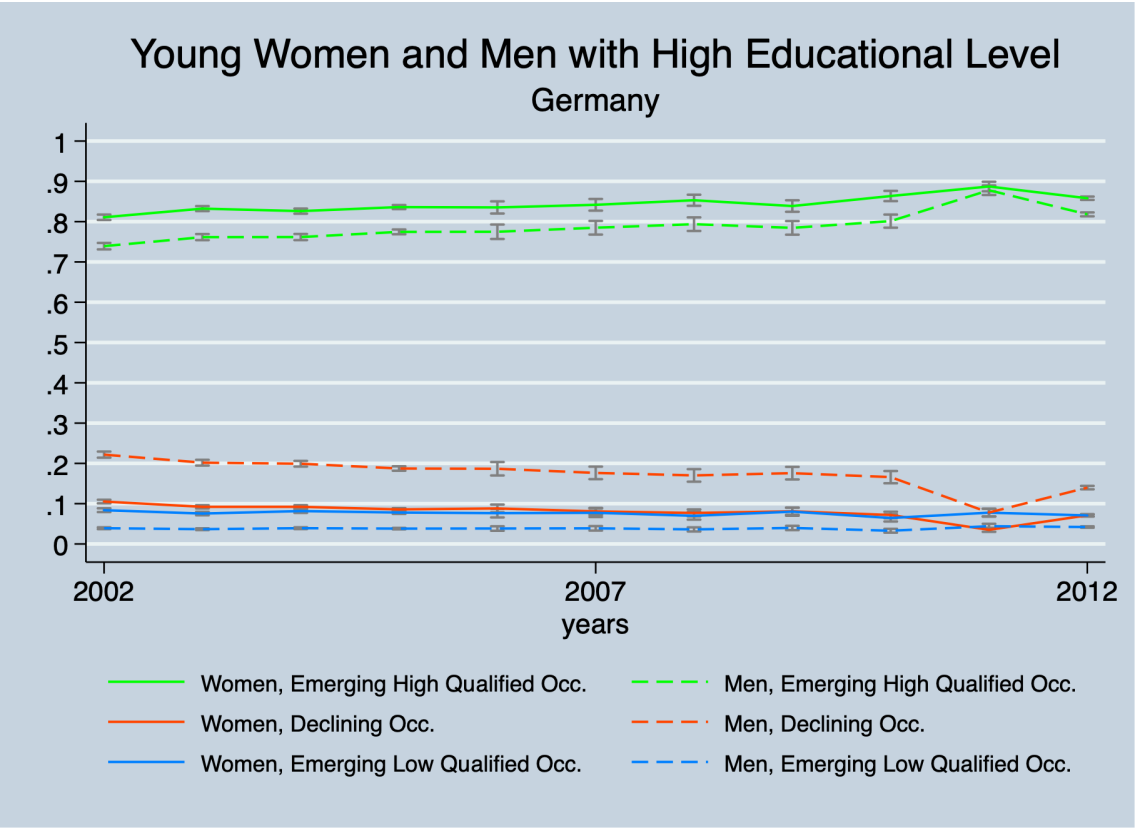
By looking at Figures 13, 14, 15 and 16, we can observe the results for Germany. The first conclusion that we draw is that the employment polarization is not as visible in Germany. On an aggregate level, the likelihood increases for emerging high qualified and emerging low qualified occupations and, consequently, it decreases for declining occupations. Even so the changes are smooth and less pronounced than in Spain; but it is no surprise. Results of section 5 pointed out that employment polarization in Germany was happening but at a slower pace, maybe because of the industrial composition of Germany. The biggest variations occurred in the recession period (2007-2012), as in Spain.

Differences between workers with high and low education are really pronounced. The former work in emerging high qualified occupations with an 80% probability while the latter work, mainly, in the other two occupational groups depending on gender. If we look at population groups conditional on age, we observe that there are no differences between the old and young. This is a major finding that is telling us that working on one occupational group or another depends exclusively on education when comparing workers of the same gender. Unlike in Spain, where there was sort of a "premium" for being old; young and old face the same probabilities in Germany.

Once a general analysis has been made, we focus on group differences with respect to Spain. Workers with tertiary education and aged from 16 to 30 years have probabilities close to 85% of working in emerging high qualified occupations. If we want to examine the evolution over the period, we confirm that the trend is upwards. Chances on being in low income and medium income remain below 10% in the case of females. For men, the likelihood of being in declining occupations drops below the 20%; while probabilities of working in emerging low qualified occupations do not vary and stay close the 5%.

Young high educated individuals in Germany exhibit higher probabilities of being in emerging high qualified occupations than their Spanish counterparts. Moreover, chances of entering low qualified and declining jobs are higher for the Spanish young workers. Therefore, we can perceive a mismatch between education and occupations (in Spain).

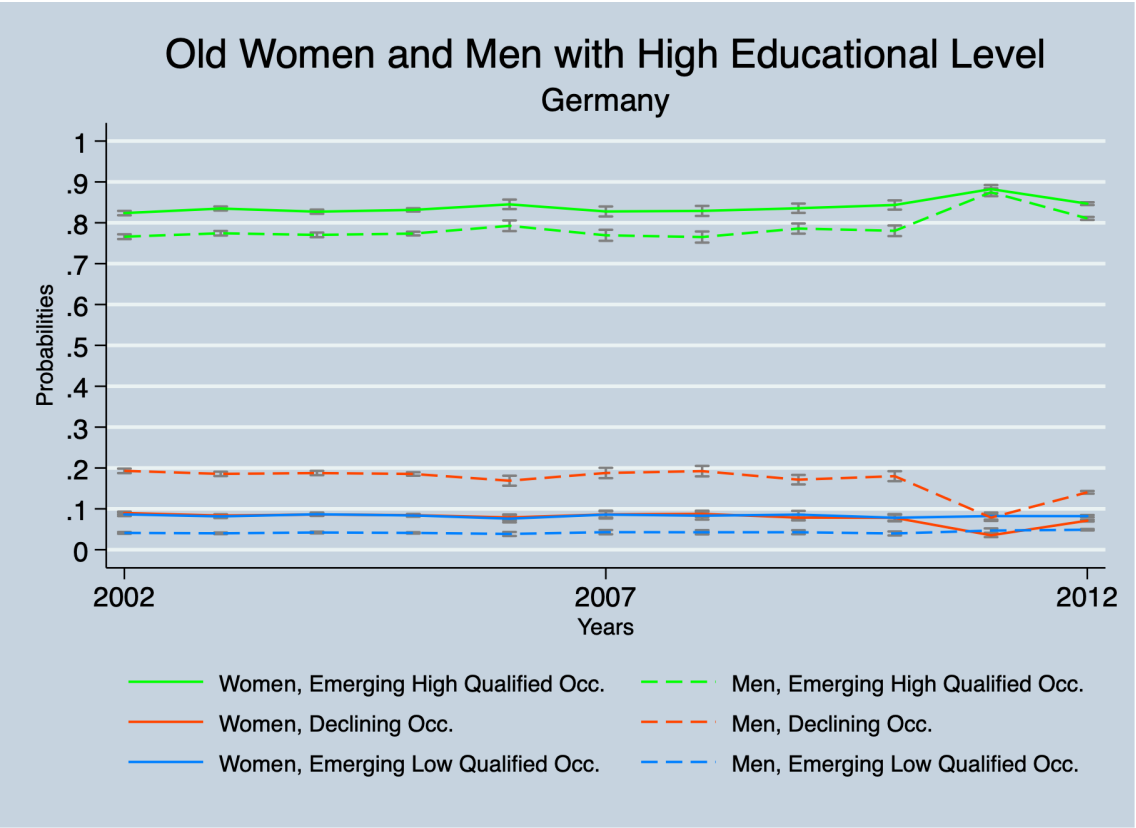
Figure 13: Evolution of estimated probabilities for young workers with high educational level in Germany (2002-2012)



The plot also includes 95% confidence intervals. Source: Source: own work based on EU-LFS data.

Results are the same as for the young qualified workers: old workers see how the probability of being in high qualified occupations increase from 1995 to 2012; but on the contrary, the evolution was downwards in the case of Spain. In Germany workers in this group exit declining occupations; at the same time, probabilities remain almost constant for Spain. Regarding emerging low qualified occupations, the situation does not vary in Germany. In Spain it does for women (the probabilities increase). Results are much more similar between old high educated workers than young workers with tertiary education between these two countries.

Figure 14: Evolution of estimated probabilities case for old workers with high educational level in Germany (2002-2012)

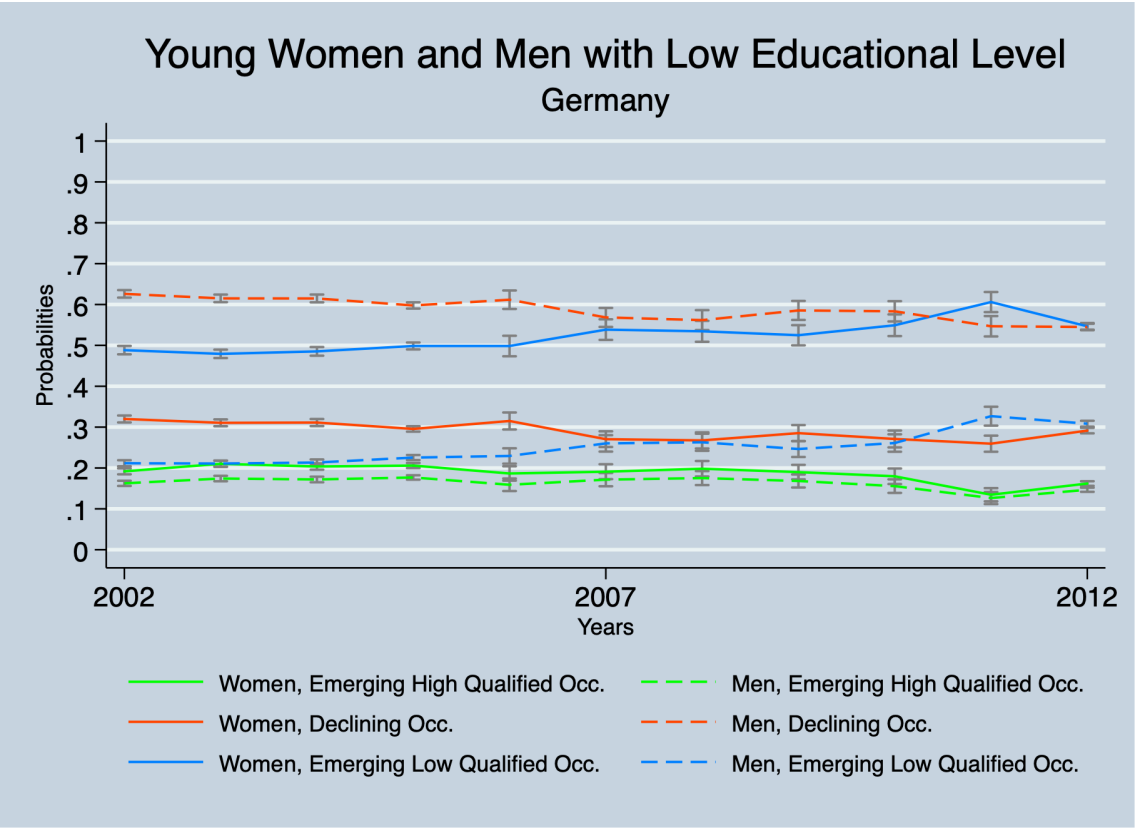


The plot also includes 95% confidence intervals. Source: Source: own work based on EU-LFS data.

For low educated young women, chances on being in emerging low qualified job are the highest (around 55%) whereas in declining occupations remain at the same level as in the beginning of the period (30%). Men face higher probability of working in declining occupations, but it decreases as time goes by. The likelihood for emerging low qualified occupations raises and stays close to 30% in 2012. With respect to emerging high qualified occupations, the probability stays below 20% and decreases both for men and women.

When compared to Spain, we conclude that: (i) the growth of emerging low qualified occupations is lower; (ii) declining occupations do not suffer as much as in Spain, maybe due to the strong German industrial fabric; and (iii) probabilities of being in top paid occupations are low but higher than for the Spanish counterparts.

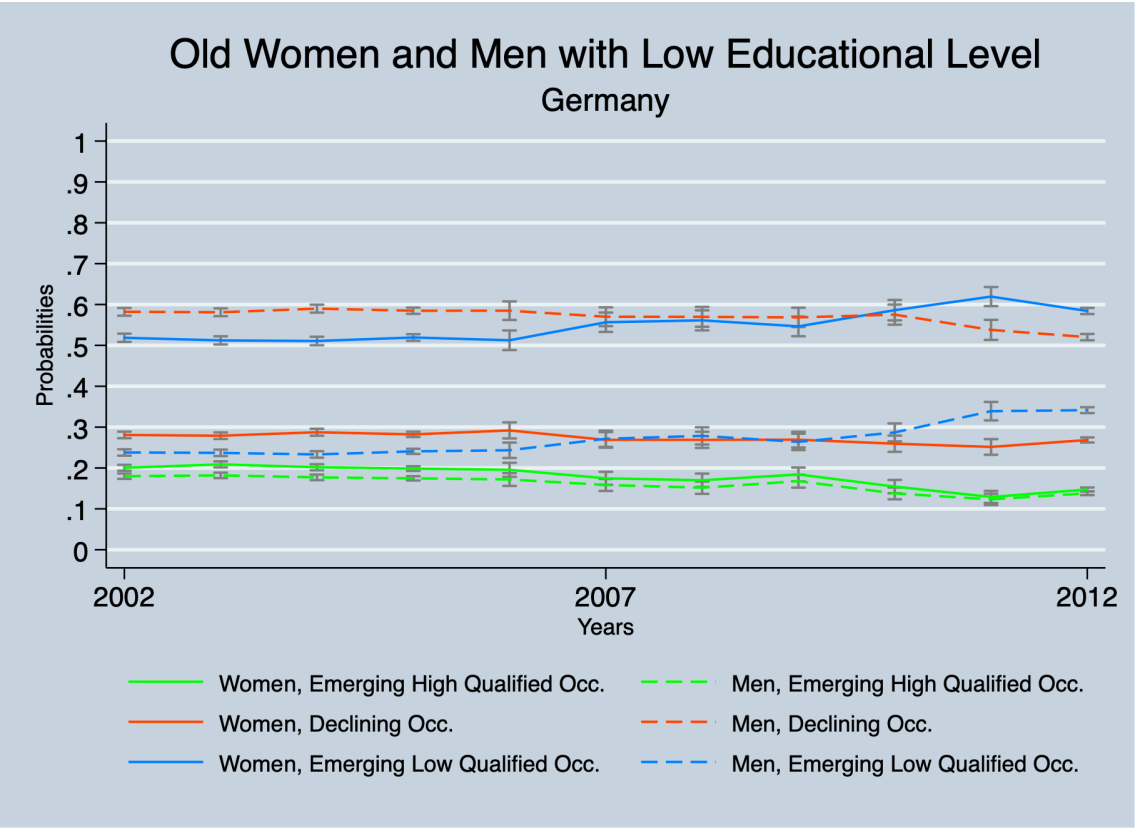
Figure 15: Evolution of estimated probabilities for young workers with low educational level in Germany (2002-2012)



The plot also includes 95% confidence intervals. Source: own work based on EU-LFS data.

The evolution for low educated workers aged 45 or more is quite the same as for the young ones. Nevertheless, the declines and increases are a little bit more pronounced. As it happened with the low qualified young, the evolution is quite similar in both countries. However, the growth in low skill jobs is more moderate and the fall in declining jobs is lower in Germany. Once more, this groups find a higher decline of being in top paid occupations in Spain.

Figure 16: Evolution of estimated probabilities case for old workers with low educational level in Germany (2002-2012)



The plot also includes 95% confidence intervals. Source: own work based on EU-LFS data.

7.3. Finland

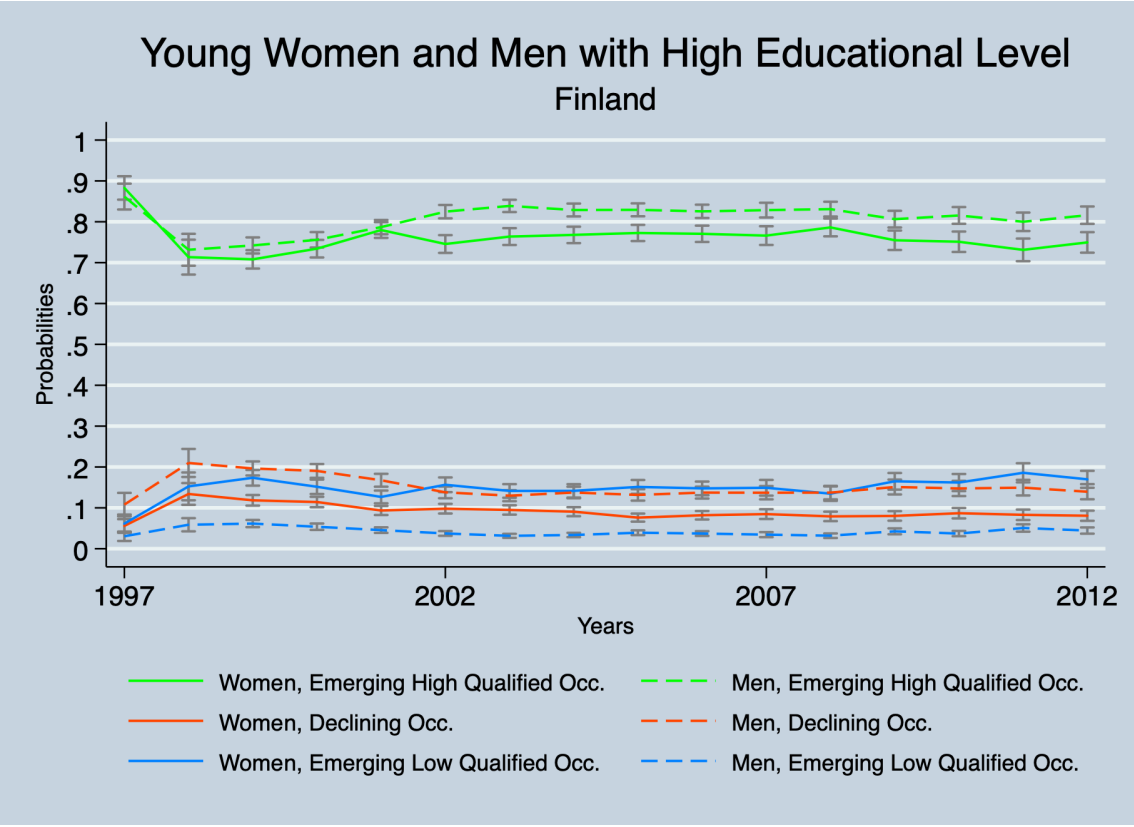
Figures 17, 18, 19 and 20 depict the picture for Finland. At a glance, we can confirm that the situation is closer to Germany than to Spain. The best paid occupations seem to maintain their probability over the period on aggregate level. The same can be said about declining occupations, for which some groups the likelihood increases. Low paid occupations are growing from 1995 to 2012. This resembles to what it is observed in Figure 5. Jobs experiencing major changes were emerging low qualified occupations and the fall in the declining occupations wasn't that high. Notice that we are not seeing the whole picture since we are not including the results for middle aged workers. Still, employment polarization is perceived.

If we focus on education, it is clear that it really is a determining factor in Finland. Those with tertiary education are employed in emerging high qualified occupations. Chances of working in the other two job categories are low. On the other hand, individuals

with low educational level are mainly concentrated in declining and emerging low qualified occupations depending on gender. Regarding age, there are no differences between old and young when high educational level is attained; age is not significant to explain differences in probabilities. The situation is close to the one in Germany and different from the one in Spain. The situation differs a bit when treating low educated workers.

Regarding young high educated workers, they are more likely to work in emerging high qualified occupations for both men and women. The probability is higher for the former (around 80% and 70%, respectively). Chances of working in declining and emerging low qualified jobs are low and stay below the 20%. Men are more exposed to declining jobs and women to low paid ones. Mid income jobs decline over the period while low income positions increase for women. This group faces a higher probability of being in emerging high qualified occupations than the Spanish. Chances of being in the rest of the occupational categories are higher for the Spanish counterparts.

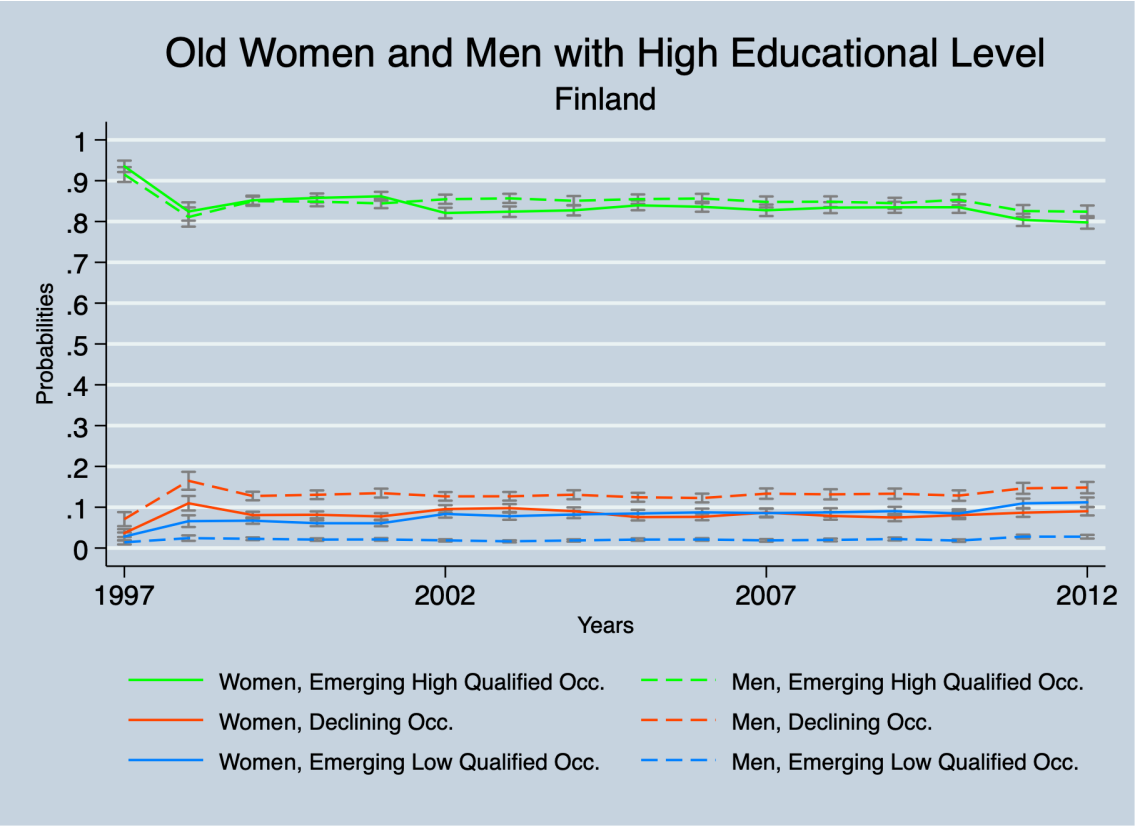
Figure 17: Evolution of estimated probabilities for young workers with high educational level in Finland (1997-2012)



The plot also includes 95% confidence intervals. Source: own work based on EU-LFS data.

The evolution is quite similar for old worker with tertiary education. The only difference we can stand out is that there is a decrease in the probability of being in emerging high qualified occupations (still, the probability is high and close to 80%) and that the increase in emerging low qualified occupations is not that high for women. Compared to Spain, we confirm that the evolution is quite similar.

Figure 18: Evolution of estimated probabilities for old workers with high educational level in Finland (1997-2012)

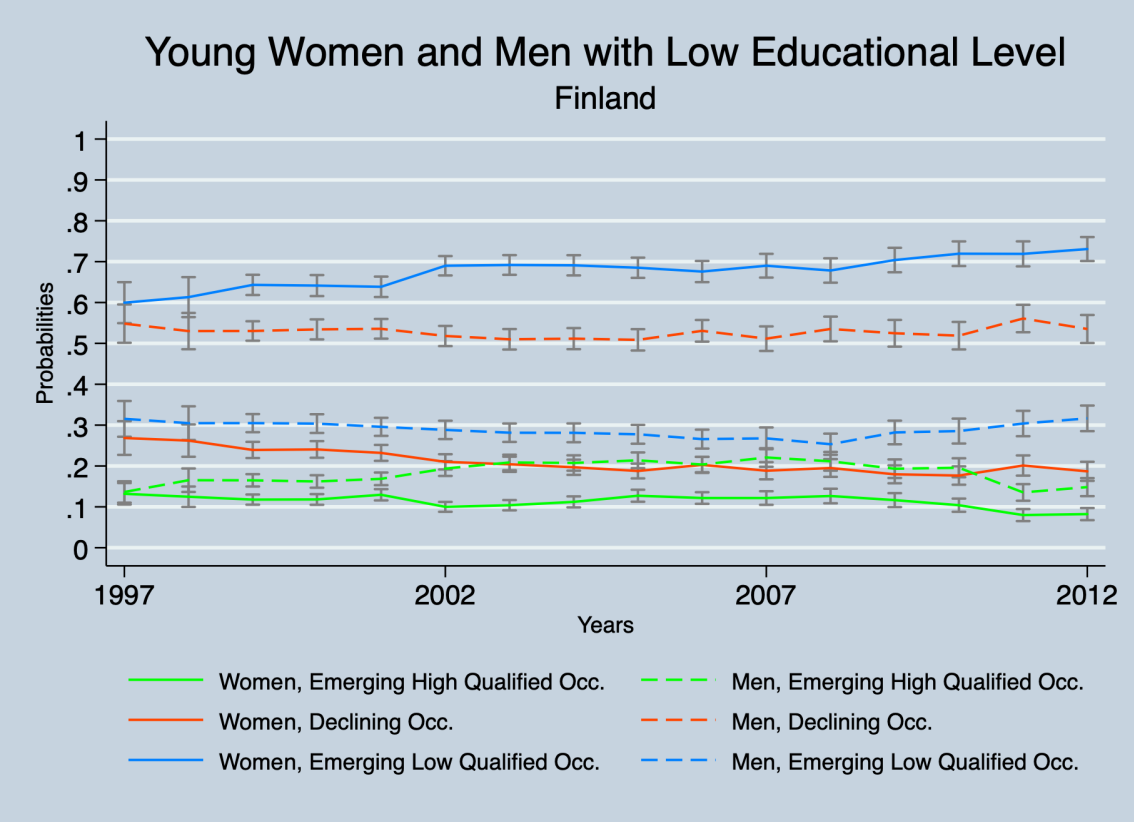


The plot also includes 95% confidence intervals. Source: own work based on EU-LFS data.

Now we look at the state of low skilled aged between 16 and 30 years. The likelihood of working in declining occupations are increasing. However, women are entering in this kind of this jobs with a probability of 73%; for men it reaches the 30%. Declining jobs are declining for females (a decrease of 10 pp over the period), but the level stays the same as in the beginning of the period for men. Chances of being in high qualified occupations fall over the 17-year period.

The main difference with the Spanish case is that employment polarization is more noticeable than in Finland. In the southern country the increase in emerging low qualified and the drop in declining occupations are far more pronounced.

Figure 19: Evolution of estimated probabilities for young workers with low educational level in Finland (1997-2012)

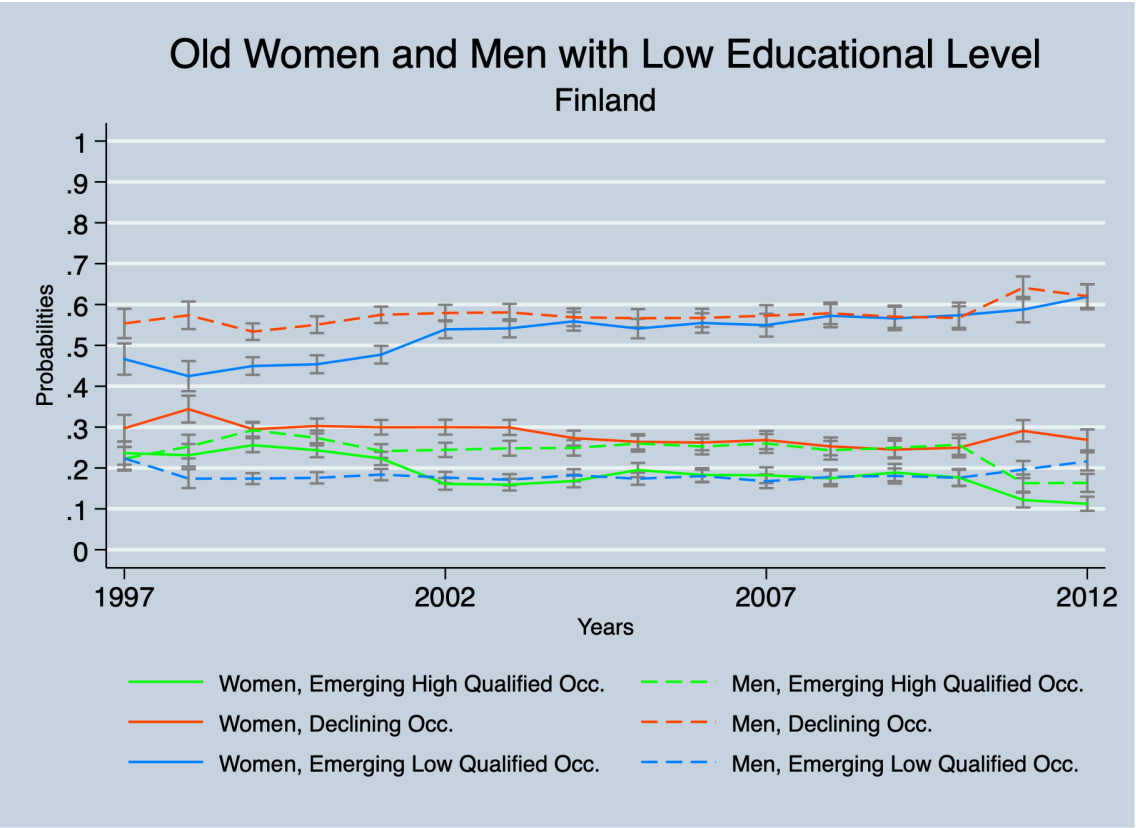


The plot also includes 95% confidence intervals. Source: own work based on EU-LFS data.

Finally, we analyze old workers with lower secondary level of education or less. The probability of working in low skilled jobs surges for women (reaching 60%) and stays below the 30% in the case of middle skilled occupations. Chances of being in high skilled jobs decrease and sits close to 10% in 2012. On the contrary, men are more likely to work in declining occupations in 2012 than in 1995. They face similar probabilities of being in emerging low qualified and emerging high qualified jobs.

Old women with low education deal with the same evolution in Finland and in Spain. Nevertheless, men don't face employment polarization in Finland as they do their Spanish counterparts.

Figure 20: Evolution of estimated probabilities for old workers with low educational level in Finland (1997-2012)



The plot also includes 95% confidence intervals. Source: own work based on EU-LFS data.

What we can see in the three role model countries is that technological changes are forcing the decline in medium paid occupations (substitute of machines) and the increase of top and low paid occupations (complementary or at least neutral to technological advances). The increase in emerging high qualified occupations affects positively both men and women, when their education is high. Men are the ones suffering from the decline in medium skilled jobs and women are the ones who get benefit from the rise in emerging low qualified occupations, which reflects the increasing female labor force participation. Finally, the evolution for old and young workers is quite similar if the attained educational level is the same. Nevertheless, young workers seem to be more exposed to low qualified jobs than old workers, even when they are high qualified.

8. Conclusions

This master thesis studies the effect of technological progress on employment for 16 advanced European economies for the period 1995-2012. In order to do so, we propose to follow a two-step analysis. Firstly, we perform a descriptive analysis and, then, an empirical one, using a multinomial logit model.

On the one hand, the descriptive analysis consists on an examination of the changes in employment. Since we follow an occupational approach, we look at changes in the distribution of occupations. We rank six occupational categories according to 2002 average wages and test whether employment polarization is happening in European countries. Effectively, we conclude that occupations in the lowest part and highest part of the wage distribution grew relative to the ones in the middle part. Those middle skilled jobs' share on employment decreased over the period. However, we have distinguished two periods: the expansionary period (1995-2007) and the whole period including the recession period (1995-2012). In general terms, job polarization is seen for both year spans. Moreover, this phenomenon deepened during the recession years for all the countries (but Italy).

Secondly, the main contribution of this master thesis is to stablish the relationship between the three challenges faced by advanced European: aging, closing the gender gap in the labor market participation and the uncertainty caused by technological progress. We estimated a multinomial model to calculate the probabilities of being in an emerging high qualified, declining or emerging low qualified occupational category depending on age, gender and education. The analysis is made for the whole 1995-2012 period, so we have estimated the model for each year in order to obtain changes in the probabilities of work in each category. However, we decided to broaden the classification used in the descriptive part. Still, we had to limit our analysis more because estimation the model for the 16 would produce a huge output. Three role models have been selected for the study based on the challenges discussed above. In concrete, Spain is a country with relatively low technology implementation (when compared to the leaders), a long-term aging problem and room for improvement in gender equality. The second country is Germany. It sits in the European mean level in the different measurement for technology, gender and aging. The last country is Finland, that is considered a leader. It is placed at top in

technological rankings, is the European country with the highest share of women in the labor market and does not face that big aging phenomenon.

Employment polarization is seen when analyzing the probabilities of working in emerging and declining occupations. However, this pattern is more noticeable for the least advanced country (Spain). Men, mainly those with low educational level are exiting declining jobs to enter into low paid service and sales positions. Still, the increase in emerging low qualified occupations is absorbed by women (generally the low educated ones). This mean that technological change is affecting negatively men (specially the low educated ones) and positively women. This way women have opportunities of keeping entering the labor market. This makes sense with what we have seen in the descriptive statistics. The 67% of workers in declining occupations (at European level) are men, so it is reasonable that the ones suffering the decline are males. The same happens to emerging low qualified occupations, where the 60% of workers are females. This way, women are benefitted from the shift in the labor market demand. Nevertheless, high educated women face a more noticeable mismatch because they are more exposed to low qualified jobs than men. Finally, there are no major differences between men and women in emerging high qualified occupations.

Nevertheless, we observe country differences. In the case of a country with an aging phenomenon (Spain) there are differences between young and old workers with the same educational level. Older workers (aged 45 years or more) have higher probabilities of being in better jobs. Therefore, there is a "premium" for being old. It is also remarkable that young high qualified workers, have relatively high probability of being in low paid job. Particularly, women that have 30% likelihood of working in these positions. Young Spanish individuals seem to start at low skill jobs before aiming for better jobs. In general, the trend of the probabilities for high- and low-skilled occupations is upwards over the period, while the trend for the declining jobs is downwards.

In Germany and Finland (countries where the aging phenomenon started before, and thus, with better predictions about aging) there is no mismatch for young workers with tertiary education. The evolution for old workers is similar for the three economies. We also can say that employment polarization is smoother. It is also seen, that high educated women are not likely to work in low paid occupations. In the case of Germany, the probabilities of being on a category depend entirely on education when comparing

people of the same gender. As regards Finland, differences are not as big as in Spain and the situation is closer to the one in Germany.

This evidence reflects that in countries that are better prepared to face future challenges there is a better match between workers' qualifications and occupations. However, it also gives rise to questions concerning public policy regarding what to do with workers exiting declining occupations and also about the high concentration of women in low paid jobs. As mentioned before, due to the impossibility of obtaining data for 2012 onwards, we leave the period 2012-2018 for further research, but we expect the results to be even more noticeable.

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