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Changes in Economic Activity: The Role of Age and Education

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Abstract

The aim of the paper is to understand to which extent developments of labor force participation rates in selected European countries between 2000 and 2010 can be explained by age- and education-specific changes in participation rates as compared to changes in populations' structural composition by age and education. We apply a decomposition methodology that allows us to disentangle changes in age- and education-specific labor force participation rates from changes in the age and educational structure of the population.

Our results show that labor force participation rates of adult women would have increased even more, had it not been for the downward pressure from the shift in the age composition towards older age-groups with relatively lower levels of participation. This downward pressure also depressed male participation. The increase in participation among older persons is mainly explained by participation increases among those with non-tertiary education and reinforced by a general shift towards higher levels of educational attainment. Our results indicate that labor supply may not decrease to the extent expected due to population aging, given educational expansion and education-specific patterns of economic activity.

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1 Introduction

Developments of labor supply and labor force participation in Europe have been widely analyzed recently, not least because of the expected decline in the number of workers in the future due to the shift in populations' age composition towards older ages (see e.g. Carone 2005; and Balleer et al. 2009). If economic activity levels stayed at current levels, significant increases in the share of the non-working population were to be anticipated during the next decades, posing problems particularly for social security systems that rely on pay-as-you-go schemes.

Potential to increase labor supply is mainly argued to come from women and older persons, since their labor market involvement is lower than that of adult men (European Commission & Economic Policy Committee 2014). It is precisely these two groups where increases in participation could be observed in the last decade: Whereas participation of men of prime ages was predominantly constant at high levels in all countries or decreased slightly, participation of adult women continued to increase in most countries. The forerunners when it comes to female labor force participation are the Scandinavian and Baltic countries, Iceland, as well as most Eastern European countries, where larger shares of women were part of the labor force significantly earlier than in other parts of Europe. Participation rates of persons close to normal retirement ages, on the other hand, have been on the rise in every country since around the year 2000, with very few exceptions (cf. Figure A1 in the Appendix). These developments entail that countries' labor forces contain higher shares of women than in the past and that they are slowly growing older.

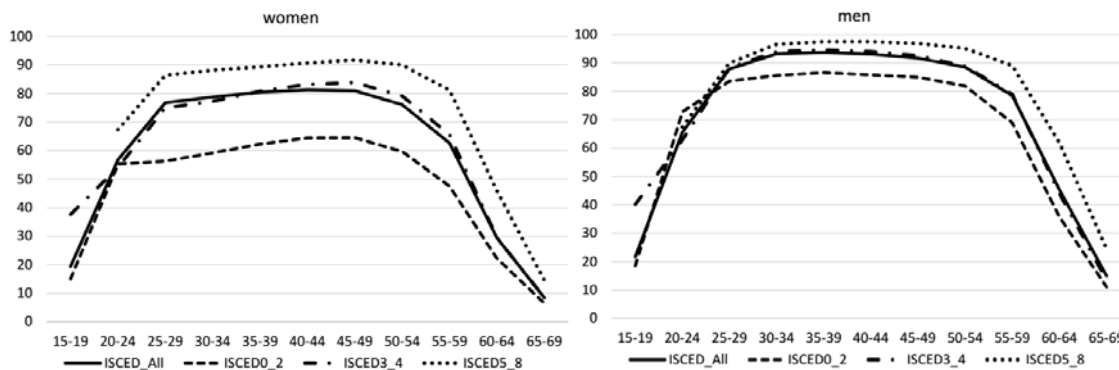
Much less attention has been given to the fact that – besides changes in the sex and age composition of the labor force – the education composition of the active population has changed as well. As increasing shares of persons within each birth cohort have been attaining higher education levels than the previous cohort, the education composition of the adult population has shifted towards higher degrees (Heckman & Jacobs 2010). The difference in percentage points in the proportion of younger (25-34 years) and older (55-64 years) adults with a tertiary degree amounts, for example in France, to 19.6% for men and 29.0% for women.

The respective values are in the Slovak Republic 5.3% and 18.2%, in Denmark 5.1% and 16.8%, and 5.1% and 15.2% in Italy (OECD 2013).

Another not much covered fact is that the level of educational attainment and labor force participation are positively correlated in Europe. This effect is stronger for women than for men and larger among those aged 50+ than for middle-aged workers (cf. Figure 1). Also, the higher the education level, the smaller the differences between male and

female participation rates (Loichinger 2015). Employment rates are highest for persons with tertiary education whereas their unemployment rates are consistently lower than of those with less educational attainment (OECD 2013), which is an indicator for the continued demand for workers with higher education and special skills.

Figure 1: Education-specific labor force participation rates (in %), EU28, by age-groups and sex, 2013



Note: ISCED0_2: pre-primary, primary and lower secondary education; ISCED3_4: upper secondary and post-secondary non-tertiary education; ISCED5_8: first and second stage of tertiary education. Source: Eurostat Database, LFS based

Against this backdrop – changes in the education structure of the population and the existence of education-specific differentials in economic activity – the question arises how much each of the observed past changes in labor force participation are due to the fact that the educational composition has changed – i.e. to the shift towards educational groups with higher labor force participation rates – versus the change in education specific labor force participation rates themselves. Disentangling these two effects is the focus of this paper. Burtless (2013) has shown for the US that slightly more than half of the observed increase in participation of 60- to 74-year-old men between 1985 and 2010 was due to increases in educational attainment, and only a third due to the increases in participation rates.¹

Our approach is in the spirit of Prskawetz et al. (2005) who quantified for selected countries how much of the change in the crude labor force participation rate between the mid-1980s and 2000 was due to changes in the age composition of populations and how much to changes of age-specific activity rates. They found that for men as well as women, the observed participation changes were predominantly due to changes in age-specific participation rates as opposed to shifts in populations’ age composition.

Our analysis will cover selected European countries and be done separately for women and men. We start out by describing the methodological foundation of our approach. Next, we describe our data and explain the selection of countries and age-groups that enter the analysis. In the results section, we first apply the decomposition presented in Prskawetz et al. (2005) to a larger number of EU countries and a more recent

¹ The remainder was explained by a shift towards younger ages – meaning on average higher participation rates – within the age-group 60- to 74 between 1985 and 2010.

time-period than in the original publication. This allows us to select the age-groups that contributed the most to observed changes in crude labor force participation between 2000 and 2010. In a next step, we disentangle the change in labor force participation for these age groups in the contribution of changes in education-specific participation and in the educational composition of the population. Additionally, we split up both effects by educational level. Finally, we discuss our findings and evaluate the implications for future developments of labor force participation.

2 Method

Standardization is a common tool in demography to eliminate the role of compositional effects when comparing demographic indicators between countries or over time. However, the choice of a standard population is not clear cut. As an alternative a decomposition methodology can be applied which decomposes the change of a demographic indicator over time into a direct change of the characteristic of interest and a change due to the changing composition or structure of a population (see Canudas-Romo 2003 for an excellent review).

We apply the decomposition methodology by Vaupel and Canudas-Romo (2002) in several steps. First we decompose the change in overall labor force participation into an effect of changing age-specific labor force participation rates versus changes in the age composition of the population in order to quantify the magnitude of both effects. Next, we apply the same decomposition by five year age groups to determine for which age group the labor force participation changed the most. For this specific age group, we disentangle in our third step the change in the labor force participation into an education specific change in labor force participation versus a compositional effect of changing educational distributions. In a final step we apply the decomposition by level of education to determine for which educational category the labor force participation changed the most.

2.1 Decomposing the change in the overall labor force participation

We restrict our analysis of changes in economic activity to ages 15 to 74 and call the corresponding rate the crude labor force rate defined as (cf. Fürnkranz-Prskawetz et al. 2005, p.171):

$$\bar{l}(t) = \frac{\int_{15}^{75} l(a,t)N(a,t)da}{\int_{15}^{75} N(a,t)da} \quad (1)$$

where $l(a, t)$ denotes the fraction of people aged a at time t in the labor force, $N(a, t)$ denotes the number of people aged a at time t in. The crude labor force rate gives the expected value of the age-specific labor force participation rate $l(a, t)$ with the weighting function $\frac{N(a,t)}{\int_{15}^{75} N(a,t)da}$.

We can apply the formula by Canudas-Romo (2003) which gives the change of the average over time as a sum of the direct (level 1) and compositional (level 2) effect:

$$\dot{\bar{l}} = \bar{\dot{l}} + Cov_N(l, \dot{N}) \quad (2)$$

The subscript N denotes the weighting function and \dot{N} denotes the age-specific population growth rate (relative change): $\dot{N} = \frac{\partial N(e,t)}{N(e,t)}$. The first term on the right hand side of equation (2) $\bar{\dot{l}}$ captures the direct effect, i.e. the average change in age-specific labor force participation rates. This term may be positive or negative depending on whether the labor force participation rates in specific age groups have increased or decreased over time. The sign of the first term (the average of the time derivative) will depend on the changes in the involved age groups and also on the size of the involved age groups. The second term relates to the compositional change, i.e. changes in the age composition of the population over time.

2.2 Decomposing the change in age-specific labor force participation

While in the previous section we decomposed the labor force participation rate by age, we are now focusing on a decomposition of the labor force by education. In order not to mix up the age and educational compositional effect we will investigate the role of educational changes for age-specific labor force participation rates.

We therefore apply the same decomposition methodology as in the previous section to disentangle in a second step the change in age-specific labor force participation into the direct effect that captures how far the education specific labor force participation rates have shifted over time versus the fact that the educational distribution has shifted towards educational groups with lower or higher participation rates. We are therefore not just controlling for the educational distribution as done in standardization methods, but are interested to what extent a change in the educational distribution versus a change in education-specific labor force participation can explain observed changes in age-specific labor force participation.

We define age-specific labor force participation rates as the number of persons of a specific age-group belonging to the labor force divided by the population for the same age-group:

$$\bar{l}(a, t) = \frac{\int_{e_l}^{e_u} l(a, e, t) N(a, e, t) de}{\int_{e_l}^{e_u} N(a, e, t) de} \quad (3)$$

where $l(a, e, t)$ denotes the fraction of people in age group a , education group e at time t who participate in the labor force, the variable $N(a, e, t)$ denotes the number of people in age group a , education group e at time t and e_l, e_u are the lowest and highest level of education of the labor force. The labor force participation rate at age a is therefore the mean of the education-specific labor force participation rate with $N(a, e, t) / \int_{e_l}^{e_u} N(a, e, t) de$ being the weighting function.

Similar as in the previous section we can decompose the change in the age specific labor force into the direct (level 1) and compositional (level 2) effect:

$$l(\dot{a}) = \bar{l} + Cov_N(l, \dot{N}) \quad (4)$$

The subscript N denotes the weighting function and \dot{N} denotes the education specific growth rate (relative change): $\dot{N} = \frac{\partial N(e,t)}{N(e,t)}$. The first term \bar{l} captures the direct effect, i.e. the average change in education specific labor force participation rates. This education specific term may be positive or negative depending on whether the labor force participation rates in specific educational groups have increased or decreased over time. The sign of the first term (the average of the time derivative) will depend on the changes in the involved educational groups. The second term relates to the compositional change, i.e. changes in the educational composition over time.

We can decompose our formula in equation (4) into education specific components (assuming e.g. three levels of education):

$$\dot{l} = [\bar{l} + Cov_N(l, \dot{N})]_{e_1} + [\bar{l} + Cov_N(l, \dot{N})]_{e_2} + [\bar{l} + Cov_N(l, \dot{N})]_{e_3} \quad (5)$$

Such a decomposition by educational level allows to quantify the role of each educational group in explaining the overall change in age-specific labor force participation rates. The education specific compositional effect is however rather difficult to explain since the covariance will depend on the mean of the labor force participation rates and mean of the education specific growth rates and therefore depends on all education groups.

3 Data

Country-specific data for labor force participation and population composition – by age, sex and highest level of educational attainment – are based on the European Labor Force Survey (EU LFS) and are available for 33 countries.² The selection of countries, years as well as age-groups of analysis is driven by methodological considerations (as explained in the next section), the availability of data and the results of each step of our analysis.

The definition of labor force participation is based on the definition of the ILO and comprises the employed and unemployed (International Labour Organization 1982). Data by educational attainment based on the ISCED1997 classification have been part of the EU LFS since 1998 and thus define the earliest point in time for any education-specific analysis. The three categories that the highest level of completed educational attainment is provided by are 1) pre-primary, primary and lower secondary education (ISCED levels 0, 1 and 2) 2) upper secondary and post-secondary non-tertiary education (ISCED levels 3 and 4) and 3) first and second stage of tertiary education (ISCED levels 5 and 6).³ There are, however, sometimes severe breaks in time series of labor force as well as education

² All data are available online at <http://ec.europa.eu/eurostat/data/database>

³ https://circabc.europa.eu/sd/a/3b3f4939-5e18-478d-b954-42e112f8ed05/SECTION1_EA.htm

data due to countries' changes in the translation of the guidelines for economic activity and educational attainment or changes in the overall sampling procedure.⁴ In those instances where these breaks introduced noticeable jumps in countries' time-series trajectories, countries got excluded completely from the analysis.

A general consideration is the width of age-groups that we analyze. On the one hand, participation patterns over time are more stable for broader age-groups. On the other hand, changes in the age-structure within broader age-groups – e.g. ages 60 to 74 – will also have an effect on the aggregate participation rates of these age-groups over time. Burtless (2013) points this out and quantifies this non-negligible effect for the US. We opted therefore for the analysis of 5-year age-groups being aware that this decision restricts the pool of possible countries further since labor force participation by educational attainment and 5-year age-groups is not continuously available in all countries, particularly for women in older age-groups.

4 Results

We show results for our two decomposition analyses, each one involving two steps: First, we repeat the analysis in Prskawetz et al. (2005) including more countries and covering a more recent time period. Besides decomposing changes in crude labor force participation in a participation and age composition effect this analysis returns the 5-year age group that contributed on average the most to the observed change in overall participation.

Second, we present the contribution of education-specific changes in participation and in the educational composition of the population on changes in labor force participation for the age group identified in the first step. Finally, we show how much of the overall observed change in age-specific labor force participation is due to changes of labor force participation in each of the three educational levels.

4.1 Decomposition of the overall labor force participation

Prskawetz et al. (2005) showed for France, West-Germany, Spain, the UK and the US that observed increases in the female crude labor force participation rates between the year 1985 and 2000 can be explained by increases in age-specific participation rates. Changes in the age composition of these countries' populations played only a very minor role, and the effect these changes did have was positive and reinforced the overall increase. Similarly, the observed decline in male participation during the same period was also mainly due to changes in age-specific labor force participation rates. Here, the overall decline would have been even larger for Spain, the UK and the US if the growth rate of the population in age-groups with high participation had not been positive.

As explained in Vaupel and Canudas-Romo (2002) and also discussed in the Appendix of Prskawetz et al. (2005), we assume that the rate of change is more or less constant over the time interval we choose for the analysis of our labor force indicators. We therefore start out with visually inspecting the development of crude labor force rates by sex, starting in 1998 and only include countries and time periods where the assumption

⁴ For details see http://ec.europa.eu/eurostat/statistics-explained/index.php/EU_labour_force_survey_-_methodology

of a linear change is valid for both, men and women. This reduces the period of analysis to the years 2000 to 2010 and the number of countries to 14: Belgium, Czech Republic, Denmark, Finland, France, Greece, Hungary, Italy, Netherlands, Portugal, Slovakia, Slovenia, Switzerland and the United Kingdom.

Figures A3 and A4 in the Appendix show the development of the labor force participation rate of 15- to 74-year old women and men between 1998 and 2013. With the exception of the Czech Republic, Denmark, Finland and Slovakia – where participation stayed about constant – the trend of increasing female participation continued between 1998 and 2013, and differences in participation levels in the 14 analyzed countries declined. The picture of male participation is more diverse: whereas participation remained pretty stable in 9 out of the 14 countries, it decreased slightly in Denmark, Finland and Switzerland and increased marginally in Hungary and Slovenia.

The results in Table 1 confirm the visual inspection: female labor force participation increased in 9 out of 14 countries between 2000 and 2010, and in those cases where it declined the decrease was small.⁵ The question is to what degree these observed patterns are the result of changes in age-specific participation (column 6 in Tables 1 and 2) or in the age composition of populations (column 7). With the exception of Greece, the age-structure effect has turned negative for women. Still, the overall observed increase in participation was only relatively little attenuated by the negative effect of changes in the age composition, which means that the overall change in participation is still dominated by the development of age-specific participation. Only in 4 countries – the Czech Republic, Denmark, Finland and Portugal – is the relative size of the age-structure effect larger than the participation effect. Furthermore, in Denmark and Finland, the participation effect is positive but due to the larger age-structure effect, the overall change in participation is negative. It has to be kept in mind though that these are the two countries where female labor force participation is among the highest of all 14 countries.

⁵ Column 5 in Tables 1 and 2 represents the change in crude labor force rate at mid-year (2005). We use the formula presented in the Appendix in Prskawetz et al. (2005) to apply the continuous formulas from section 2 to discrete data, based on the assumption that changes occur continuously over time. The validity of this assumption can be tested by comparing the values in column 5 and 8, i.e. by comparing the calculated change at mid-year with the summation of the two separate effects.

Table 1: Crude labor force participation rate for women, ages 15 to 74, per thousand, and the decomposition of the change over time from 2000 to 2010

Country	$\bar{i}(2010)$	$\bar{i}(2000)$	$\bar{i}(2005)$	$\dot{\bar{i}}(2005)$	\bar{j}	$\text{Cov}_N(\mathbf{l}, \dot{\mathbf{N}})$	$\dot{\bar{I}} = \dot{\bar{i}} + \text{Cov}_N(\mathbf{l}, \dot{\mathbf{N}})$
Belgium	487.4	545.7	511.1	5.8	6.0	-0.5	5.5
Czech Republic	559.1	543.3	546.4	-1.6	-0.4	-1.2	-1.6
Denmark	672.6	666.7	667.8	-0.6	2.1	-2.9	-0.8
Finland	650.8	637.2	638.0	-1.4	0.9	-2.6	-1.6
France	545.0	587.7	564.2	4.3	5.0	-0.8	4.2
Greece	439.0	502.2	466.3	6.3	5.1	1.2	6.3
Hungary	455.6	488.3	465.2	3.3	4.1	-1.0	3.1
Italy	399.7	441.1	415.1	4.1	4.2	-0.1	4.1
Netherlands	589.0	663.3	621.0	8.2	10.9	-2.8	8.1
Portugal	539.4	525.6	531.5	-1.4	0.0	-1.3	-1.4
Slovakia	560.5	551.8	545.3	-0.9	-1.0	-0.1	-1.1
Slovenia	555.6	593.8	571.0	3.8	3.9	-0.2	3.7
Switzerland	641.1	681.2	660.0	4.0	4.6	-0.6	4.0
United Kingdom	603.3	623.4	611.9	2.0	2.6	-0.6	2.0

Source: Eurostat database, own calculations.

Table 2: Crude labor force participation rate for men, ages 15 to 74, per thousand, and the decomposition of the change over time from 2000 to 2010

Country	$\bar{i}(2010)$	$\bar{i}(2000)$	$\bar{i}(2005)$	$\dot{\bar{i}}(2005)$	\bar{j}	$\text{Cov}_N(\mathbf{l}, \dot{\mathbf{N}})$	$\dot{\bar{I}} = \dot{\bar{i}} + \text{Cov}_N(\mathbf{l}, \dot{\mathbf{N}})$
Belgium	654.4	660.5	654.7	0.6	1.3	-0.8	0.4
Czech Republic	725.1	719.5	719.2	-0.6	-0.1	-0.5	-0.6
Denmark	762.9	742.1	749.4	-2.1	0.7	-3.3	-2.6
Finland	722.3	690.6	701.5	-3.2	0.0	-3.3	-3.2
France	672.4	675.7	672.5	0.3	2.0	-1.7	0.3
Greece	691.9	700.5	694.8	0.9	-1.9	2.8	0.9
Hungary	614.6	613.7	609.8	-0.1	0.5	-0.5	0.0
Italy	659.2	648.1	651.6	-1.1	-0.8	-0.3	-1.1
Netherlands	768.7	778.9	769.3	1.1	4.5	-3.5	1.0
Portugal	666.8	671.5	667.4	0.5	0.6	-0.2	0.4
Slovakia	706.3	707.0	701.1	0.1	-1.0	1.0	0.0
Slovenia	658.2	691.3	673.5	3.3	2.9	0.4	3.3
Switzerland	829.2	811.6	820.0	-1.8	-0.5	-1.3	-1.8
United Kingdom	750.3	743.9	745.8	-0.6	0.4	-1.0	-0.7

Source: Eurostat database, own calculations.

The results for men warrant a more nuanced interpretation. In contrast to the female case, the participation effect dominates in only 6 out of 14 countries. This means that the negative population growth in age-groups with high participation entails an on average lower increase in overall participation than in the absence of these structural changes. For Hungary and Slovakia, the flat profile of males in Figure A4 is the combination of a participation effect and a population-structure effect that cancel each other out. Both effects are small though. In the Czech Republic, Italy and Switzerland, the observed decline in overall participation was a combination of both, a decrease in age-specific participation and a shift of the population structure towards age-groups with lower levels of economic activity. In Denmark, the small but positive participation effect is outweighed by a relatively large negative age effect. In the Netherlands, on the other hand, a large negative age effect is more than compensated by the largest positive

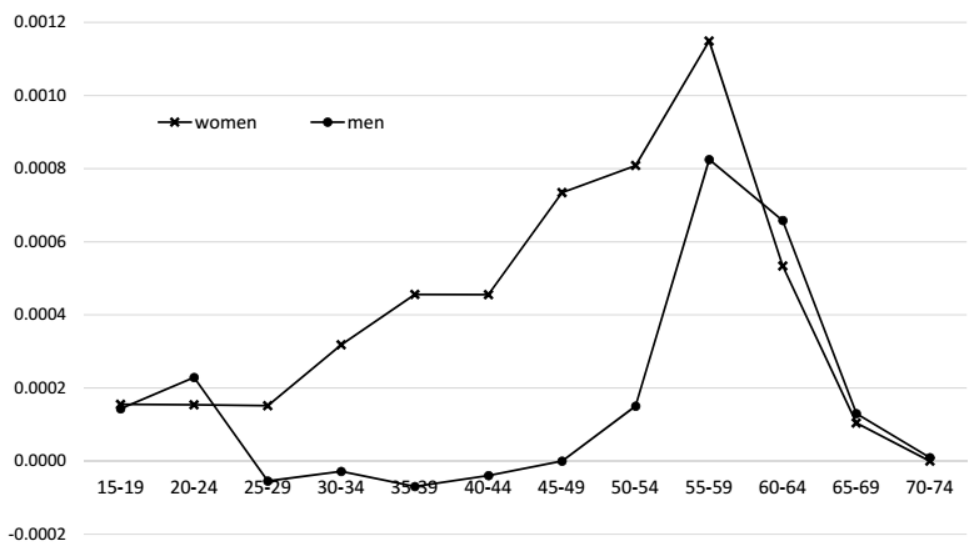
participation effect observed from men in any country. At a lower level, the same applies to Belgium and France. Slovenia is the only country where both effects are positive.

What should come as no surprise is that the country-specific age effect is much more similar between men and women than the participation effect. On the one hand, female and male populations of working age are for the most part of about equal size and structure in the countries under consideration, unless migration differs noticeably by sex. On the other hand, economic activity is more volatile compared to population development per se and differences in patterns of economic activity between men and women add to that as well.

Identification of age-groups with largest participation effect

As described in the methods section, the decomposition into participation and age-structure effects can be broken down further into age-group specific components. Applying this decomposition to the 14 countries of our analysis reveals that for women, change in participation between 2000 and 2010 was largest for ages 55-59 in 7 countries, followed by 4 countries where it peaked at age-group 50-54. The lowest age-group with the maximum change was observed in Greece (45-59), whereas the highest peak age-group was in Finland and Switzerland (60-64). For men, peak change occurred among 55-59 year-olds in 7 countries and for 60-64 year-olds in 6 countries. In the UK, 65-69 year-olds had the largest change.⁶ As an example, Figure 2 shows the age- and sex-specific results for France.⁷ For the subsequent analysis of education effects, we will be using each countries' age-group with the maximum change.

Figure 2: France: age-group specific contribution to participation effect, by sex, between 2000 and 2010



Source: Eurostat database, own calculations.

⁶ Country-specific information about which age-group showed the maximum change is included after each country name in Table 4 and Table 5.

⁷ Figures for all other countries are available upon request.

4.2 Decomposition of age-specific labor force participation

Denmark and the UK are dropped from the pool of 14 countries from the previous analysis, due to methodological changes in their LFS that bias the analysis over time of their education data. We chose to show results for the development of educational attainment of the 55-59 year-old population, since this is the age-group where the greatest change in the labor force participation took place in the majority of countries. For men as well as women, educational attainment clearly shifted towards higher degrees since 2000 (cf. Figure A2 in the Appendix).

Changes in the education structure are happening more rapidly among women than among men, as the steeper slope for all three education groups indicates. Female advancement is especially pronounced for the tertiary education group, from 10.3% in 2000 to 16.5% in 2010, representing a relative increase of more than 50%. In 2010, among men, those with at most lower secondary education (ISCED0_2) are no longer representing the largest education group but instead those with upper secondary and post-secondary non-tertiary education (ISCED3_4) hold the largest share, a transition that has yet to happen for women.

Table 3: Educational composition (%) of population age 55-59 for 12 selected European countries, by sex, 2000 and 2010

Country	Year	Men			Women		
		ISCED012	ISCED34	ISCED56	ISCED01	ISCED34	ISCED56
Belgium	2000	54.8	22.2	23.0	63.8	20.2	16.0
	2010	41.8	30.0	28.3	43.6	30.4	26.0
Czech Republic	2000	12.2	75.6	12.2	31.2	60.0	8.9
	2010	6.9	78.5	14.6	21.1	69.6	9.3
Finland	2000	45.3	25.7	29.0	44.2	29.8	26.0
	2010	27.2	42.8	30.0	23.2	43.1	33.6
France	2000	47.1	37.1	15.8	56.7	28.9	14.4
	2010	37.0	43.9	19.1	45.7	35.3	19.0
Greece	2000	66.1	21.1	12.8	75.4	19.2	5.4
	2010	50.9	27.8	21.3	55.2	30.5	14.3
Hungary	2000	48.0	36.3	15.7	59.5	29.2	11.3
	2010	17.5	65.9	16.6	29.3	54.4	16.3
Italy	2000	69.3	23.1	7.6	77.5	16.9	5.6
	2010	54.4	33.4	12.2	58.6	29.9	11.5
Netherlands	2000	34.7	40.6	24.7	55.3	30.3	14.4
	2010	30.6	37.1	32.3	43.7	34.1	22.1
Portugal	2000	89.4	5.2	5.4	94.1	-	5.9
	2010	82.4	8.4	9.2	82.8	6.4	10.8
Slovakia	2000	20.3	69.1	10.6	43.8	48.5	7.6
	2010	10.6	74.1	15.4	21.2	66.8	12.0
Slovenia	2000	25.4	59.4	15.3	41.7	46.3	11.9
	2010	20.7	66.0	13.3	33.0	49.8	17.2
Switzerland	2000	16.8	49.6	33.6	33.5	57.3	9.1
	2010	12.3	48.3	39.4	24.4	54.7	20.9

Source: Eurostat database, LFS based.

There are of course significant differences among countries when it comes to the educational attainment structure of their older population (cf. Table 3). The share of 55-

59-year-old men and women with at most lower secondary education decreased in all countries, and the shares in the two higher education groups increased almost universally. The largest relative reduction in the share of persons with ISCED0_2 occurred in Hungary and Slovakia (for men and women), whereas the largest relative increase in the share of persons with ISCED5_6 took place in Portugal (men) and Greece (women).

The question we ultimately want to answer is in how far these changes in the educational composition contributed to the observed developments in labor force participation. With the exception of Greece and Slovenia (minuscule negative composition effect for men), the education effect is positive in all instances for women as well as men (column 7 in Table 4 and Table 5)⁸. This means that the positive participation effect that appears for every country (column 6 in Table 4 and Table 5) is “enhanced” by the compositional change in the education, leading to an increase in participation rates that would have been smaller in the absence of changes in the educational composition.

For women, the participation effect dominates significantly over the education effect (cf. Table 4). In Belgium, Greece, Hungary, Italy and Switzerland, the education effect is responsible for 20% or more of the overall observed increase in female participation. As with women, the participation effect dominates also for men (cf. Table 5). The relative importance of the education effect is smaller though than for women, which is in line with the presented changes in educational composition in Figure A2 and in Table 3. The exception is Hungary where over 50% of the increase in participation between 2000 and 2010 is due to the change in the education composition of 55-59 year old men.

Table 4: Labor force participation rate for women for specified age-group, per thousand, and the decomposition of the change over time from 2000 to 2010 for 12 European countries

Country	$\bar{i}(2010)$	$\bar{i}(2000)$	$\bar{i}(2005)$	$\dot{\bar{i}}(2005)$	\bar{i}	$\text{CovN}(\mathbf{I}, \dot{\mathbf{N}})$	$\dot{\bar{i}} = \bar{i} + \text{CovN}(\mathbf{I}, \dot{\mathbf{N}})$
Belgium (50-54)	698.5	488.5	590.6	20.9	15.6	5.5	21.1
Czech Rep. (55-59)	602.1	322.0	442.7	27.6	25.4	2.3	27.7
Finland (60-64)	418.8	225.1	306.4	19.1	16.2	2.9	19.1
France (55-59)	613.9	462.0	532.7	15.1	13.7	1.5	15.1
Greece (45-49)	700.2	546.2	620.7	15.4	11.1	4.4	15.5
Hungary (55-59)	508.6	201.0	329.7	29.7	24.0	6.5	30.5
Italy (50-54)	577.6	412.2	490.5	16.5	10.8	5.8	16.6
Netherlands (55-59)	611.4	392.4	492.3	21.7	18.6	3.2	21.9
Portugal (50-54)	750.3	618.6	681.3	13.1	10.9	2.3	13.2
Slovakia (55-59)	511.3	184.0	315.0	31.3	26.1	6.0	32.1
Slovenia (50-54)	776.5	599.0	660.6	21.7	18.3	3.4	21.7
Switzerland (60-64)	463.0	339.1	396.7	12.3	9.8	2.6	12.4

Source: Eurostat database, own calculations.

Table 5: Labor force participation rate for men for specified age-group, per thousand, and the decomposition of the change over time from 2000 to 2010 for 12 European countries

⁸ Note that for the decomposition of age specific labor force rates in Table 4 and Table 5 we use different age groups for different countries. The choice of the age groups is based on the criteria of the greatest change in labor force participation, cf. last paragraph in section 4.1.

Country	$\bar{l}(2010)$	$\bar{l}(2000)$	$\bar{l}(2005)$	$\dot{\bar{l}}(2005)$	\bar{j}	$Cov_N(l, \dot{N})$	$\dot{\bar{l}} = \bar{j} + Cov_N(l, \dot{N})$
Belgium (55-59)	661.5	537.7	596.0	12.4	9.8	2.6	12.4
Czech Rep. (60-64)	381.7	245.0	307.0	13.6	12.0	1.6	13.6
Finland (60-64)	443.7	278.7	352.4	16.4	14.7	1.7	16.4
France (55-59)	692.6	584.9	637.3	10.8	9.4	1.4	10.8
Greece (55-59)	749.3	720.6	732.7	2.9	3.2	-0.3	2.8
Hungary (55-59)	631.9	523.0	584.3	10.9	4.7	6.3	11.0
Italy (55-59)	683.2	533.6	603.8	14.9	12.3	2.6	14.9
Netherlands (60-64)	497.8	268.8	366.8	22.5	21.4	1.2	22.6
Portugal (60-64)	NA	NA	NA	NA	NA	NA	NA
Slovakia (55-59)	810.2	655.5	733.7	15.4	13.3	2.2	15.5
Slovenia (55-59)	617.2	445.0	522.6	17.2	17.5	-0.4	17.1
Switzerland (60-64)	696.8	641.1	663.7	5.6	4.5	1.0	5.5

Source: Eurostat database, own calculations.

Sensitivity analyses showed that the level 1 effect (i.e. the direct effect, \bar{l}) is significantly more affected by the selection of starting and ending years of the analysis than the level 2 effect (i.e. the compositional effect, $Cov_N(l, \dot{N})$). The explanation is simple: labor force participation rates are more volatile over time than the educational attainment structure. Whereas changes in the starting or ending year of the analysis can have non-negligible effects on the average change in participation rates over time, educational attainment within each education group does not show any sudden jumps.

Contribution of each education level to changes in labor force participation

The previous analysis has identified the extent to which education-specific changes in participation on the one hand and changes in the educational composition of the population on the other hand were responsible for observed changes in participation for the selected age-groups. Now, we take the decomposition one step further by analyzing how the observed change in participation (i.e. the level 1 effect) for these specific age-groups can be allotted to participation changes in each of the three education levels (i.e. we apply the decomposition as shown in equation (5) and show only the education specific change in the labor force participation rates in the following tables).

As Table 6 and Table 7 illustrate, increases in overall participation were on average over all countries mostly driven by increases in the middle education category, followed by increases in the lowest education group. However there are country as well as gender specific differences.

Table 6: Contribution (%) of each education level to changes in female labor force participation, for specified age-groups, between 2000 and 2010

Age-group	Country	ISCED0_2	ISCED3_4	ISCED5_6
50-54	Belgium	57%	22%	21%
55-59	Czech	24%	66%	10%
60-64	Finland	33%	37%	30%
55-59	France	47%	43%	11%
45-49	Greece	48%	46%	6%
55-59	Hungary	44%	46%	10%
50-54	Italy	61%	32%	7%
55-59	Netherlands	49%	37%	14%
50-54	Portugal	88%	9%	3%
55-59	Slovakia	26%	65%	9%
50-54	Slovenia	30%	64%	7%
60-64	Switzerland	38%	55%	7%

Source: Eurostat database, own calculations.

For females in Finland we observe an equal contribution to the change in the labor force participation rate across all three educational levels. In four countries (Belgium, Italy, Netherlands and Portugal) the increase in the labor force participation was driven to a large extent by the contribution of the lowest educational group. For three countries, France, Greece and Hungary, the contribution of the lowest and middle education group was very similar.

For men we also find some heterogeneity in the role of the three educational groups in explaining changes in the labor force participation. For Finland, Greece and the Netherlands we find that all three educational groups contributed to a large extent to the change in age specific labor force participation. In France and Hungary, the lowest and middle educational group contribute a similar share to the change in the age specific labor force participation while in Italy the lowest educational group had the highest contribution. For Switzerland our results indicate that the increase in male labor force participation can solely be explained by higher labor force participation rates in the highest educational group.

Table 7: Contribution (%) of each education level to changes in male labor force participation, for specified age-groups, between 2000 and 2010

Age-group	Country	ISCED0_2	ISCED3_4	ISCED5_6
60-64	Czech	10%	86%	3%
60-64	Finland	38%	26%	36%
55-59	France	46%	42%	12%
55-59	Greece	24%	40%	36%
55-59	Hungary	45%	51%	4%
55-59	Italy	58%	33%	9%
60-64	Netherlands	38%	38%	24%
60-64	Portugal	NA	NA	NA
55-59	Slovakia	29%	62%	9%
55-59	Slovenia	34%	60%	6%
60-64	Switzerland	-4%	-2%	107%

Source: Eurostat database, own calculations.

5 Discussion and conclusion

The aim of the paper was to understand to which extent changes in the labor force participation in European countries over the period from 2000 to 2010 can be explained by age and education specific changes in the labor force participation rates as compared to changes in the composition of age and educational groups. We conducted our study in four steps. First, we disentangled the relative contribution of age specific (level 1) as compared to age structure (level 2) effects to changes in the crude labor force participation rate between 2000 and 2010. Based on these results in the first step we identified which age-groups contributed most to the overall level 1 effect in each country. For the selected age groups we applied in the third step a decomposition of the change in the labor force participation rate by education. I.e. we investigated to what degree changes in education specific labor force participation rates as compared to the educational composition were responsible for increases in participation in these age-groups. In a final step we investigated which education groups contributed how much to the age specific change in the labor force participation rate.

Between 2000 and 2010, the participation effect is the driving force behind the observed increases in crude female labor force participation rates that happened in the majority of countries. The negative age compositional effect, however, did start to attenuate the increase already, meaning that crude female labor force participation rates would have been even larger without shifts in population's composition towards older age-groups with relatively lower participation levels. For men, the picture is more mixed, but also here did structural changes in the age composition start to put downward pressure on crude labor force participation rates. For men as well as women, the age-groups where the largest increase in participation took place was among the 55- to 59- and the 60- to 64-year-olds. Our result of the decomposition by education indicates that changes in education specific labor force participation rates were, for those age groups which contributed the most to the overall labor force change, mainly explaining the increase in the labor force participation. The change in the educational composition towards higher educational levels reinforced these trends.⁹ A final decomposition by the level of the education showed that changes in participation rates of those with non-tertiary education contributed considerably more to the observed increases in participation than those with tertiary education.

Putting our results in perspective, what can be expected for the future? Since younger, higher educated cohorts will continue to replace older cohorts with lower levels of education, a positive education effect will – *ceteris paribus* – persist. This continuous shift to higher levels of education will happen with large certainty during the next 20 years, since the cohorts causing this upgrading in skill levels – i.e. those aged between 25 and 45 years today – have for the most part already finished their educational attainment. Hence, we may expect that the negative age compositional effect that depresses the overall labor force may be counteracted by higher labor force participation rates among females, elderly and most importantly also by those of higher education.

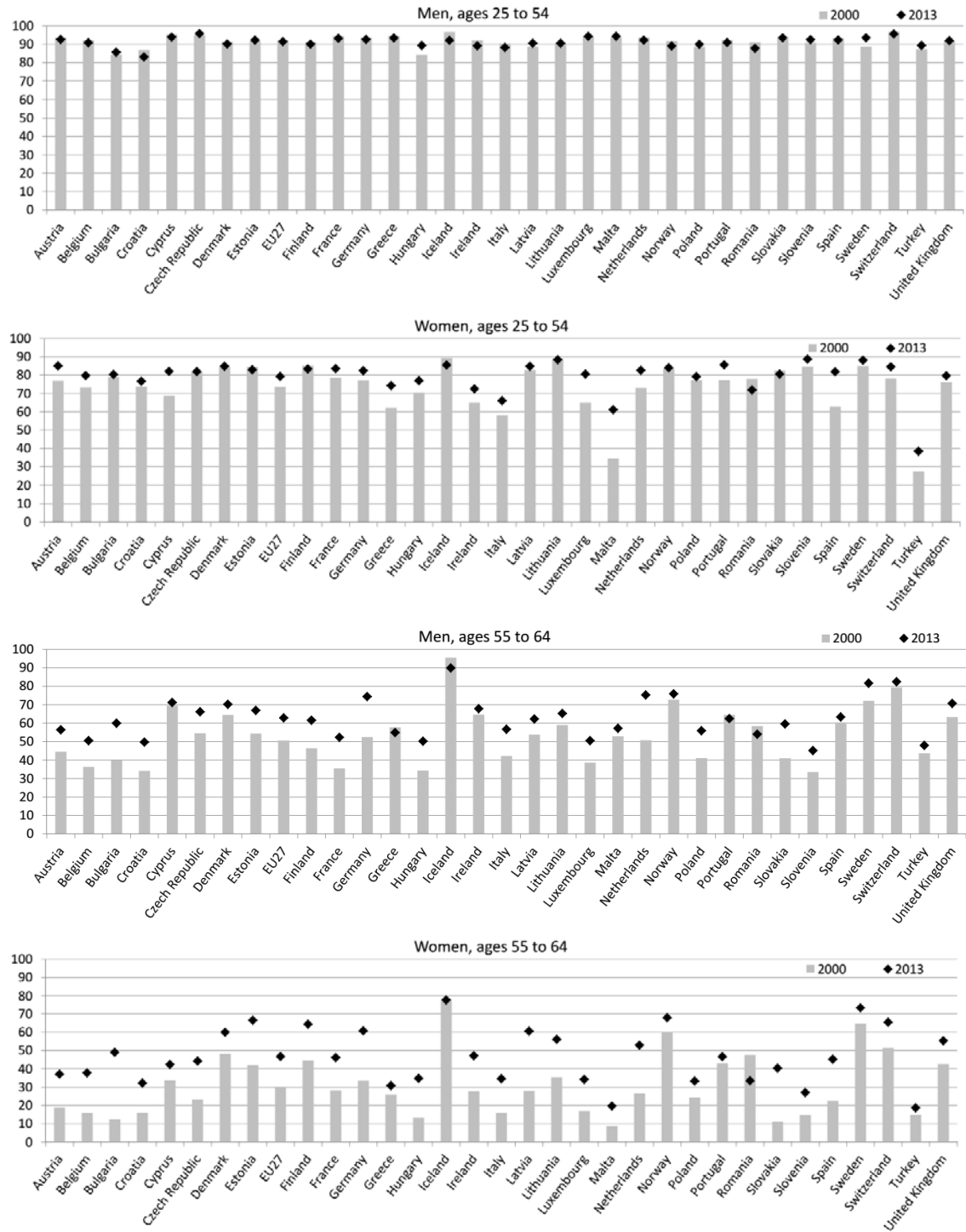
⁹ The overall effect of the educational composition might however be underestimated since we combined the educational levels in three categories. Any shift in the distribution within categories will therefore not be accounted for.

6 References

- Balleer, A., R. Gomez-Salvador, and J. Turunen. 2009. *Labour Force Participation in the Euro Area. A Cohort Based Analysis*. Frankfurt/Main: European Central Bank.
- Burtless, G. 2013. *Can Educational Attainment Explain the Rise in Labor Force Participation at Older Ages?*. Chestnut Hill, MA: Center for Retirement Research at Boston College.
- Canudas-Romo, V. 2003. *Decomposition Methods in Demography*. Dissertation. Rijksuniversiteit Groningen.
- Carone, G. 2005. *Long-Term Labour Force Projections for the 25 EU Member States: A Set of Data for Assessing the Economic Impact of Ageing*. Brussels: European Commission.
- European Commission and Economic Policy Committee. 2014. *The 2015 Ageing Report: Underlying Assumptions and Projection Methodologies*. Brussels: European Commission.
- Fürnkranz-Prskawetz, A. et al. 2005. Decomposing the change in labour force indicators over time. *Demographic Research* 13(7): 163–188.
- Heckman, J.J. and B. Jacobs. 2010. *Policies to Create and Destroy Human Capital in Europe*. Cambridge, MA: National Bureau of Economic Research.
- International Labour Organization. 1982. Resolution Concerning Statistics of the Economically Active Population, Employment, Unemployment and Underemployment. in *Adopted by the Thirteenth Inter-National Conference of Labour Statisticians*.
- Loichinger, E. 2015. Labor force projections up to 2053 for 26 EU countries, by age, sex, and highest level of educational attainment. *Demographic Research* 32(15): 443–486.
- OECD. 2013. *Education at a Glance*. Paris: Organisation for Economic Co-operation and Development.
- Vaupel, J. and V. Canudas-Romo. 2002. Decomposing demographic change into direct vs. compositional components. *Demographic Research* 7(1): 1–14.

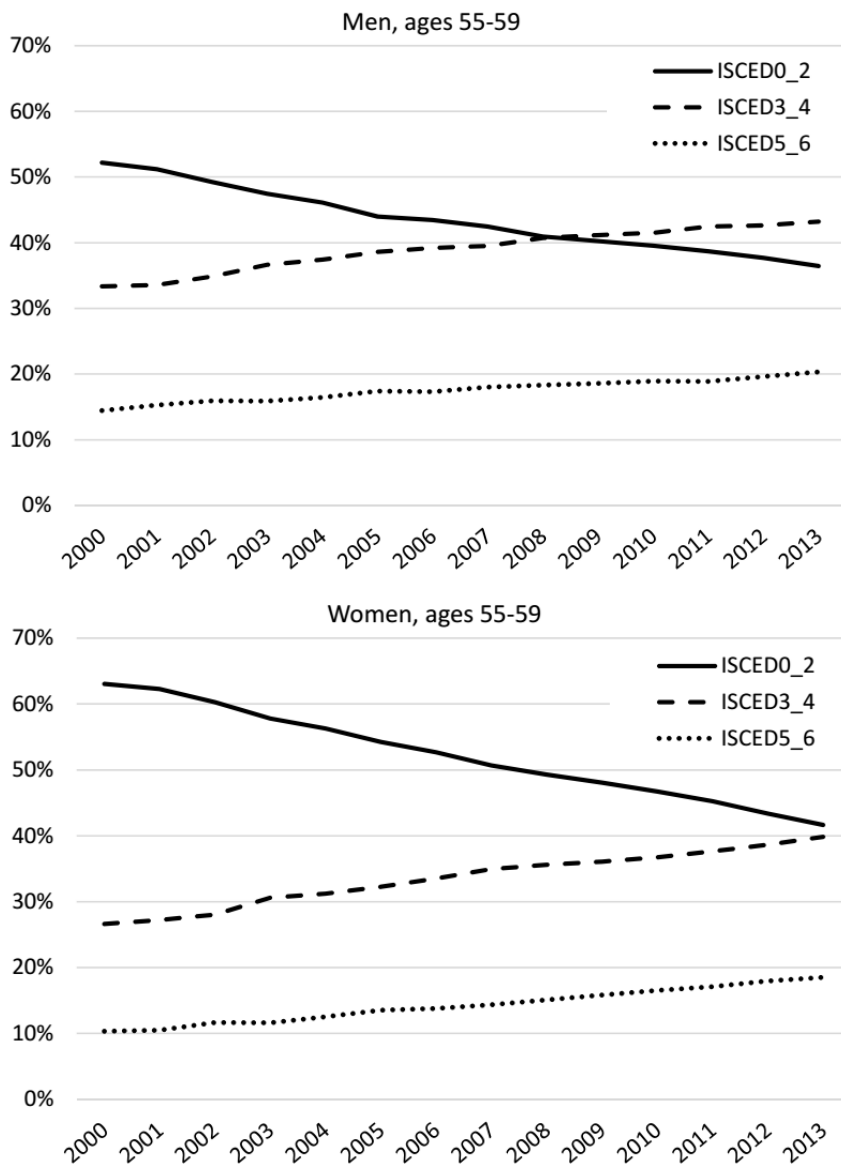
7 Appendix

Figure A1: Country-specific labor force participation, by age-groups and sex, 2000 and 2013



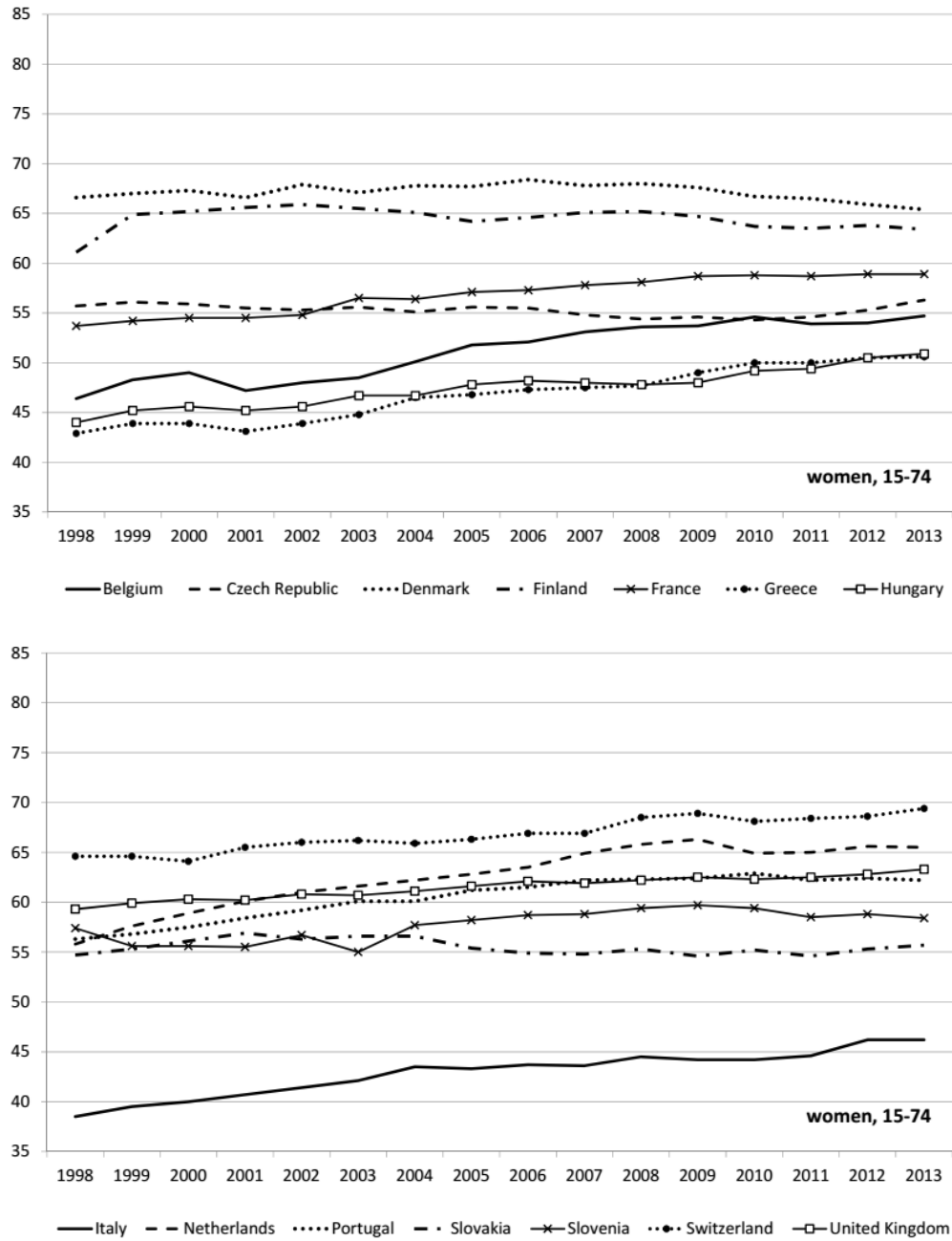
Source: Eurostat database, LFS based.

Figure A2: Population by highest level of educational attainment, ages 55-59, by sex, 2000 to 2013



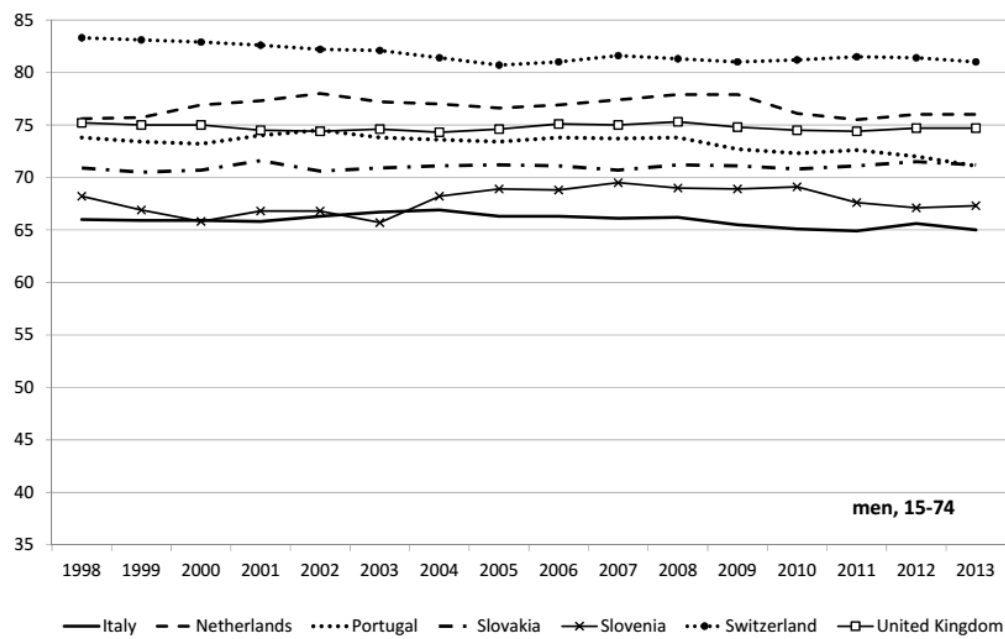
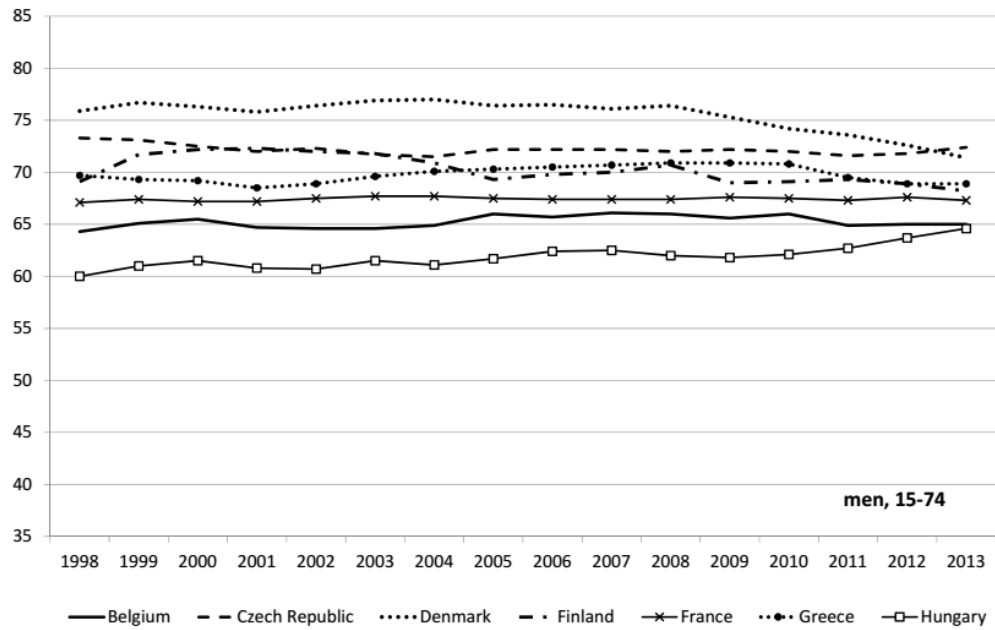
Source: Eurostat database, LFS based. Countries included (unweighted average): Belgium, Czech Republic, Finland, France Greece, Hungary, Italy, Netherlands, Portugal, Slovakia, Slovenia, Switzerland.

Figure A3: Female crude labor force participation rates for 14 selected countries, 1998 to 2013



Source: Eurostat database.

Figure A4: Male crude labor force participation rates for 14 selected countries, 1998 to 2013



Source: Eurostat database.