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Item 17 – Population projections by age and sex and level of education

Labor Force Projections for Europe by Age, Sex, and Highest Level of Educational Attainment, 2008 to 2053

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"Article 9 : The contractor undertakes to acknowledge the source of the data by stating - European Commission, Eurostat, European Union Labour Force Survey annual averages, reference quarters or spring data accordingly - and to add a disclaimer that Eurostat has no responsibility for the results and conclusions which are those of the researcher(s) when disseminating the results of the work to which this contract relates"

1. Introduction

A lot of research has been done on the potential economic consequences of population aging. One topic that has gotten a lot of attention is the expected shrinkage (in absolute and relative terms) of the working-age population (i.e. the population between 15 and 65 years). At the same time, the share of people above the age of 65 is going to increase significantly in all European countries. If patterns of economic activity stay at current levels, a decreasing number of workers will have to produce a sufficient amount of output to support themselves and an increasing number of non-workers. Or put differently: the ratio of the number of people who are not economically active to the number of people that are is going to increase, which is seen as a threat to the sustainability of social welfare and economic growth.

The majority of existing long-term labor force projections is based on explicit assumptions about the future development of age- and sex-specific participation rates, which are then applied to age- and sex-specific population projections.[1] This allows estimating the absolute future size (quantity dimension) of the labor force as well as its composition by age and sex, but does not allow any inference about the skill composition of future workforce (quality dimension).

However, the absolute and relative size of the labor force is only one aspect when it comes to estimating future total output and economic growth. The fact that a smaller but more productive labor force might be able to alleviate some or all of the expected financial consequences of population aging is another aspect that is mentioned and quantified more and more often (Fougere, Harvey, Mercenier et al. (2009), Ludwig, Schelkle and Vogel (2008), Leibfritz and Roeger (2008), Lee and Mason (2010)). Börsch-Supan shows for Germany that higher capital intensity is unlikely to be able to compensate the expected productivity decline due to the relative decline in the labor force; he argues that "more education and training to speed up human capital formation" is needed (Börsch-Supan (2003, p. 5)). Ludwig, Schelkle and Vogel (2008) and Fougere, Harvey, Mercenier et al. (2009) demonstrate that the endogenous increase of future young generations in the investment in human capital – due to expected higher returns to education – will lead to an overall better skilled and more productive labor force: "We find that endogenous human capital formation is a quantitatively important adjustment mechanism which substantially mitigates the macroeconomic impact of population aging" (Ludwig, Schelkle and Vogel (2008, p.1)).

The goal of this paper is to show how the inclusion of education (as a proxy for the qualification of the labor force) changes the outcome of labor force projections compared to projections that do not account for educational differences. The outcome will be compared in terms of (a) total size of as well as (b) the educational composition of the labor force. The analysis covers 26 EU countries (all EU27 countries except Malta), and projects labor supply until 2053. The population as well as the

[1] There are microeconomic projection models for labor supply that do take several further characteristics of the members of the labor force into account (Houriet-Segard and Pasteels (2012)); often, these models are used to be able to predict behavioural responses to policy changes. These models are very data extensive and need to be calibrated carefully, which is why they are usually done for only one specific country at a time. Since the goal here is to project labor supply for several countries at once, the discussion about existing projections does only cover projection models on the aggregate level.

labor force are broken down in two education categories: those that hold a tertiary degree, and those that do not.

2. Labor force projections by age and sex

National statistical offices, international organizations as well as researchers have been publishing labor force projections for a single country or a whole group of countries for several decades, e.g. Flaim and Fullerton (1978) and Toossi (2009) for the US, Börsch-Supan and Wilke (2009) for Germany, ILO Department of Statistics (1971) for 168 countries in 1971 to 191 countries in 2011 (ILO Department of Statistics (2011)), Burniaux, Duval and Jaumotte (2004) for 30 OECD countries, McDonald and Kippen (2001) for 16 developed countries, Carone (2005) for 25 European countries, updated in 2011 (European Commission (2011)).

The great majority of the just cited labor force projections break down the population by age (single years or five-year age-groups) and sex. Several of these projections that cover more than one country do include all or selected European countries. CEDEFOP (2010) projects labor supply for the 27 EU member countries by qualification levels, but only until 2020. Carone does labor force projections for 25 EU countries until 2050, but the results are only disaggregated by age and sex, as are the projections by Balleer, Gómez-Salvador and Turunen (2009) for all EURO countries, Burniaux, Duval and Jaumotte (2004) for the OECD and McDonald and Kippen (2001) for 16 selected developed countries. The ILO projections do cover most countries in the world, including all EU countries, but like the projections by CEDEFOP, they are only until 2020, and they are only by age and sex.

Some labor supply projections that do include further characteristics of the population besides age and sex, e.g. the population is broken down by age, sex, German/non-German citizenship, East/West Germany in labor potential projections for Germany (Fuchs and Dörfler (2005)). However, more often than not, including these additional characteristics does serve the purpose to capture differences in labor force behavior of these subgroups and thus improve the model and not to actually illustrate changes in the composition of the projected labor force. Hence, projection results are again only presented by age and sex. A rare exception are labor force projections in the US, where data inputs as well as results are broken down by age, sex, race and ethnicity (Toossi (2009)).

Existing projections differ by a variety of characteristics: whether they are sole projections of labor supply, or estimate labor supply in a first step and, based on the results and by making specific assumptions about future labor demand, employment; whether their time-horizon is only a few years or several decades; whether the projections of labor force participation are combined with existing population projections or the necessary population projections are performed simultaneously. The main difference though is the method that is used. ILO Department of Statistics (2011) distinguishes between four different macrolevel projection approaches: first, an approach that is based on certain scenarios or benchmarks that will be reached in a specified amount of time. Second, one that uses time extrapolation models or growth functions. Third, regression models that explain labor force participation with economic, demographic and/or cultural factors, and use regression results as inputs

in the labor force projection. And fourth, an approach that is based on the analysis of cohort developments of labor force participation, where future participation is based on estimations of the probability to enter or exit the labor force at certain ages. The first two methods are methodologically and as far as data requirements are concerned easier to implement than the latter two, which is why they are ones that are most frequently used (ILO Department of Statistics (2011)).

Long-term labor force projections that cover either all or the majority of countries in the European Union have been performed by Carone (2005), Balleer, Gómez-Salvador and Turunen (2009) and Burniaux, Duval and Jaumotte (2004). They have in common that they all use methods that in one way or the other include cohort developments of labor force participation (ILO Department of Statistics (2011)), and that they identify countries with low female in comparison to male labor force participation and those with low participation of persons 50 years and older as having large potentials of labor supply.

3. The relationship between labor force participation and education

The positive correlation between education and labor force participation – which can be observed for all age-groups and for men as well as women in all developed countries – seems to be general knowledge and is more of a "stylized fact" than a thoroughly analyzed phenomenon: "It is a particularly well known fact that labor force participation and overall labor utilization increase with educational attainment" (Lutz, Cuaresma and Sanderson (2008, supplement p. 2)). „Labor force attachment strongly increases with the level of education […]. This pattern holds across all [European, author's note] countries" (Heckman and Jacobs (2010, p. 13)).

Focusing on the countries of the present analysis, labor force participation by age and highest level of educational attainment follows the same profile as the profile only by age (see Figure 1): lower participation for younger and older age-groups, and an almost flat section for the middle ages. Since the majority of the European labor force has a non-tertiary degree, the overall profile is determined by the rates of those without a tertiary education. For the middle ages, the difference between educational groups is greater for women than for men. At the same time, differences between the rates of men and women are negatively correlated with the highest level of educational attainment.

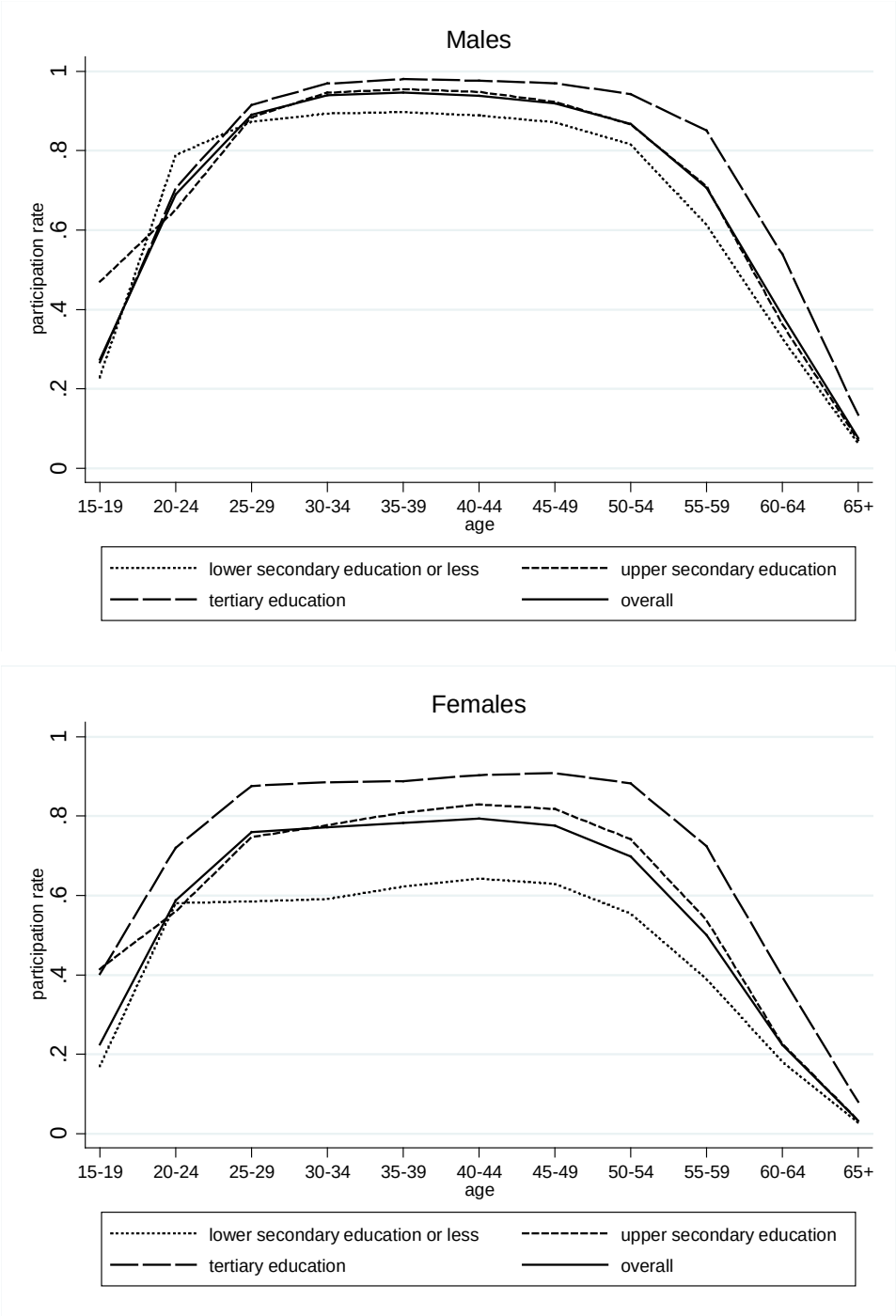

Figure 1: Labor force participation rates for all EU27 countries (except Malta) combined, by highest level of educational attainment, age and sex, average of years 2004-2008 (EU LFS, own calculations).

These differences on the aggregate level do also hold when looking at each country separately (Table 1): for men as well as women, labor force participation is higher for those with tertiary education than for those without in each country.[2] For age-groups 20 to 64, the absolute as well as relative differences between countries for higher educated males is lower (0.88 to 0.93) than for males with a non-tertiary degree (0.72 to 0.88). The respective ranges for females are (0.79 to 0.90)

[2] Since the two education categories that will be applied in the course of the projections are tertiary and non-tertiary, further descriptive statistics will be provided for only these two levels of educational attainment.

and (0.50 to 0.77), showing a lower range for tertiary-educated females as well. Overall, this means that absolute differences between countries are for men three times as high for the group with a non-tertiary degree as for the group with a tertiary degree. For women, the respective relation is approximately 2.5:1.

country	males			females		
	All	Non-Tertiary	Tertiary	All	Non-Tertiary	Tertiary
AT	0.83	0.82	0.90	0.69	0.67	0.83
BE	0.80	0.76	0.90	0.65	0.56	0.83
BG	0.77	0.74	0.89	0.66	0.61	0.83
CY	0.89	0.88	0.93	0.70	0.62	0.86
CZ	0.85	0.84	0.92	0.67	0.66	0.79
DE	0.85	0.83	0.92	0.72	0.70	0.84
DK	0.86	0.84	0.92	0.78	0.73	0.88
EE	0.84	0.81	0.92	0.75	0.69	0.85
ES	0.86	0.84	0.90	0.63	0.55	0.83
FI	0.82	0.79	0.91	0.77	0.72	0.87
FR	0.81	0.79	0.88	0.71	0.66	0.82
GR	0.85	0.83	0.92	0.59	0.52	0.85
HU	0.75	0.72	0.88	0.60	0.55	0.80
IE	0.87	0.84	0.93	0.66	0.57	0.84
IT	0.80	0.79	0.88	0.54	0.50	0.79
LT	0.81	0.78	0.92	0.73	0.66	0.89
LU	0.81	0.78	0.90	0.63	0.57	0.81
LV	0.84	0.83	0.93	0.74	0.69	0.87
NL	0.87	0.85	0.91	0.72	0.67	0.86
PL	0.78	0.76	0.90	0.63	0.58	0.85
PT	0.85	0.84	0.93	0.73	0.70	0.90
RO	0.77	0.75	0.89	0.61	0.58	0.87
SE	0.87	0.86	0.91	0.81	0.77	0.90
SI	0.80	0.78	0.91	0.71	0.66	0.90
SK	0.85	0.84	0.92	0.68	0.66	0.82
UK	0.86	0.83	0.91	0.75	0.70	0.87
EU26	0.83	0.81	0.90	0.67	0.62	0.84

Table 1: Labor force participation rates (ages 20 to 64), by sex and highest level of educational attainment (all, non-tertiary and tertiary education), average for 2004-2008. (EU LFS, own calculations).

The analysis of the development of age-, sex- and education-specific labor force participation over time shows that labor force participation increased most noticeably for women aged 30 to 54 and for men and women between 55 and 64 years (results not shown). A striking result is that the increase in participation of women was driven by an increase in the labor force participation of women with a non-tertiary degree; women with a tertiary degree have been participating on a high level all along. This decrease in the difference in participation between women with different levels of education does persist when controlling for factors that might influence this relationship (see e.g. Vlasblom and Schippers (2004) for results on 6 selected European countries). Also noticeable is the decrease in participation of tertiary-educated males (and to a lesser degree females) who are 65 years and older.

There are several mircoeconomic, sociological and psychological theories and approaches that offer can serve as explanations of the observed patterns on the macro level. Depending on the historic, cultural, social and economic circumstances in a particular country, different explanations are of differing relevance.

4. Labor force projections by age, sex and education

4.1. Data and method

Data

Estimates of labor force participation rates by age, sex, and highest level of educational attainment are based on the European Labor Force Survey (EU LFS), collected by the national statistical institutes and provided by Eurostat (European Commission (2010)). These cross-sectional data are suited particularly well for comparisons across time and space since the used concepts, definitions and classifications are harmonized by Eurostat to allow explicitly for comparative analyses. Geographically, the EU LFS covers EU member countries, EFTA member countries (except Lichtenstein) and candidate countries to the European Union (CIRCA (2012)). The scientific use files cover the years 1983 to 2008 and contain data for all 27 EU member states, except Malta. The following analyses are done for all 26 EU member countries that are contained in the data set; I will refer to this group of countries as "EU 26" whenever I present results that are aggregated across all countries. The file that is being used for the analysis of past and present labor force participation is the combination of 362 single yearly country files and comprises more than 38.1 million individual and independent observations.

The labor force is a synonym for the economically active population of a country, and is composed of everyone who is either employed or unemployed. Employment (civilian and non-civilian) is defined as any work for pay or profit for at least one hour during the reference week of the labor force survey. In addition, if someone has a formal job attachment but was temporarily not working due to e.g. illness, vacation, strike, educational training, maternity or paternity leave is counted as being employed. Persons who are not working but available for work and actively looking for a job are considered as being unemployed. These definitions are in accordance with the definitions the ILO uses for their data on economic activity (ILO (1982)). The labor force is broken down by age (5-year age-groups, from 15 to 65+), sex and educational attainment. The highest level of educational attainment is divided in two categories: those who have a tertiary degree - equivalent to ISCED 5A/B or ISCED 6 (UNESCO (2006)) - and those who do not hold such a degree. The relevant education variable, HATLEV1D ("education or training successfully completed"), has been included in the datasets since 1992, which defines the starting year of the analysis of the development of education-specific labor force participation over time (European Commission (2009)).

Age-, sex- and education-specific labor force participation rates are calculated by dividing each sub-group of the labor force by the respective sub-group of the population:

$$ {}^{j}_{i}PR^{t}_{x,x+4} = \frac{{}^{j}_{i}LF^{t}_{x,x+4}}{{}^{j}_{i}POP^{t}_{x,x+4}} \quad , $$

where ${}^{j}_{i}PR^{t}_{x,x+4}$ is the education-specific (j) and sex-specific (i) participation rate of quinquennial age groups x to x+4 at time t.[3] The youngest age-group is 15-19, the last and open age-group is 65+. In order to be able to compare the outcome of the labor force projections with and without differentiation by educational attainment, participation rates are also estimated across both education categories.

The population data are the result of population projections by age, sex and highest level of educational attainment that have been done using the specifications for fertility, mortality, migration and the education transitions as laid out in KC, Barakat, Goujon et al. (2010), the only difference being that the assumptions about the future development of fertility, mortality and migration have been updated with the latest Version of the World Population Prospects (United Nations (2011)).[4] The education transitions are those of the GET (Global Education Trend) scenario whose transitions are based on the development of historical global patterns of educational expansion. The starting populations that enter the projection by country, age, sex and highest level of educational attainment have been calculated using the EU LFS data for 2008. This means that the estimates of the total population and the labor force participation rates are coming from the same source, ensuring that differences between the labor force projections with and without educational attainment are solely attributable to changes in the educational composition of the population, not due to differences originating from sample differences due to differing data sources.

Figure 2 shows the population composition in 2010 and 2050 by age, sex and highest level of educational attainment for all 26 countries combined. The share of the population 15 years and older who finished at primary education is projected to decrease from 13.2 % in 2010 to 4.5 % in 2050. At the same time, the share of the population with a secondary degree will decrease from 66.7 % to 59.7 %. This reduction in the share of the population that holds a non-tertiary degree is naturally accompanied by an equivalent increase in the share with a tertiary degree: In 2010, 20.1 % of persons ages 15+ had a tertiary degree. Until 2050, this is expected to change significantly: the average share of higher-educated persons ages 15+ will increase by 78.0 %, meaning that 35.8 % will have a tertiary degree. This change in the educational composition of the population in Europe is due to the fact that younger, better educated cohorts are replacing older cohorts, a phenomenon also referred to as “educational upgrading” (AARP Foundation (2011)). There are and will be stark differences between countries: the lowest share of people with a tertiary degree in 2010 was found in Romania, Italy, Portugal and Slovakia (10.4 %, 11.2 %, 11.5 % and 12.2 %, respectively), and the highest share in Estonia, Finland, Cyprus and Ireland (29.1 %, 28.8 %, 28.3 % and 28.1 %, respectively). The relative between-country differences are projected to decrease: given the assumptions about future development of educational attainment, the lowest share of people with a tertiary degree in 2050 will be found in Italy, the Czech Republic, Romania and Slovakia (23.4 %, 23.8 %, 25.2 % and 25.2 %, respectively), and the highest share in Cyprus, Lithuania, Denmark and Ireland (46.6 %, 45.2 %, 44.1 % and 43.6 %, respectively).

[3] Strictly speaking, this is a ratio and not a rate, but it is conventionally referred to as a rate (O'Hare, Pollard and Ritualo (2004)).

[4] I am very grateful to Samir KC at IIASA that I could use his R code and for his and Erich Striessnig’s assistance in running it.

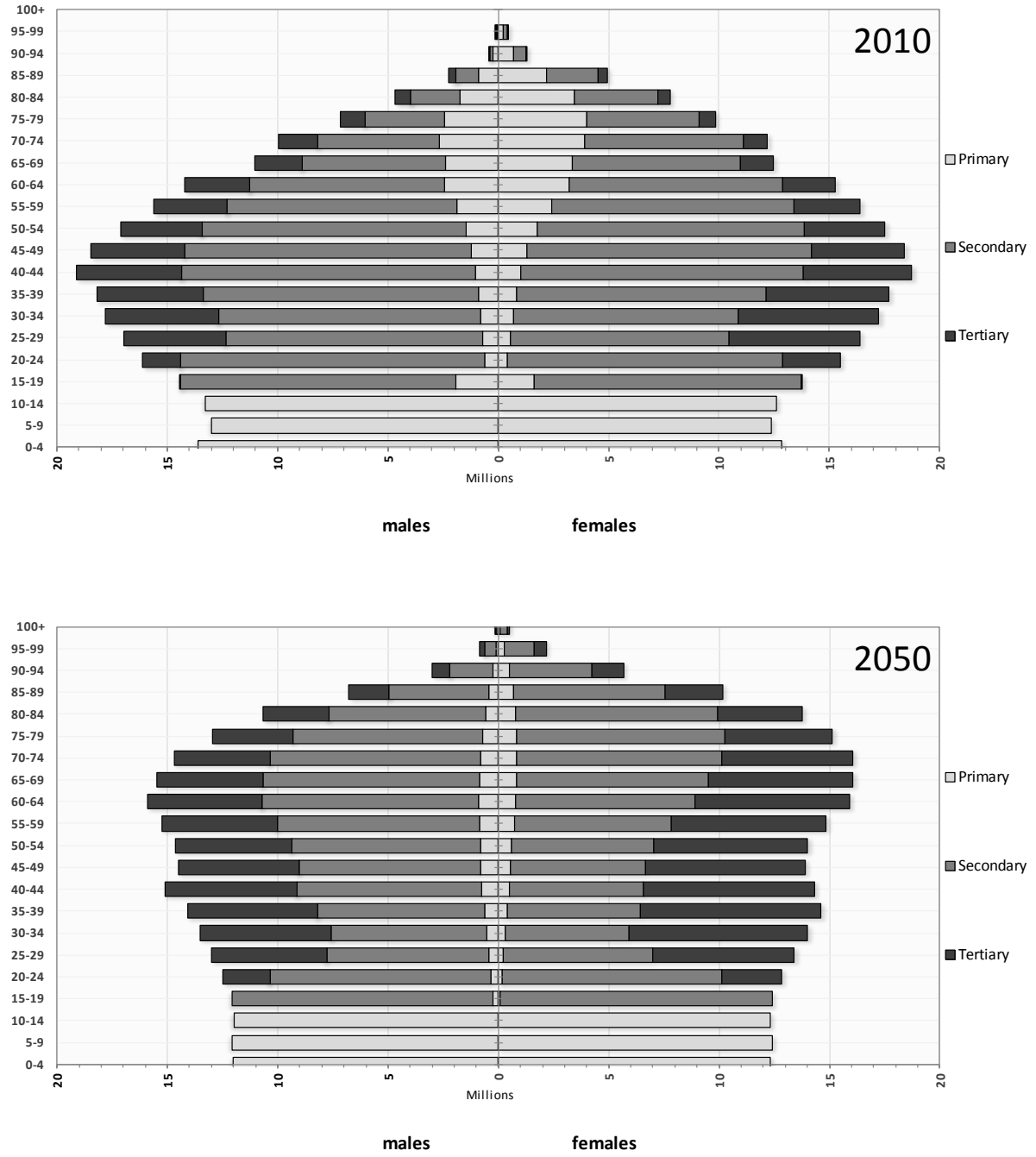

Figure 2: Population pyramid for ages 15+, all EU27 countries combined (except Malta), 2010 and 2050. Education categories: lower secondary (ISCED levels 0 and 1), secondary (ISCED levels 2,3 and 4), and tertiary (ISCED levels 5 and 6) (EU LFS, own calculations).

A further expected change in the distribution of higher education concerns the attainment differences between men and women: already today, young women are better educated than their male counterparts in many countries. Until 2050, this shift will mean that in each country, the female population 15+ will on average be better educated than the male population 15+.

Method

The described population projections are combined with six scenarios of the future development of labor force participation. For each scenario, age-, sex- and education specific sub-groups of the labor force at time t+5 is estimated by

$$ {}^{j}_{i}LF^{t+5}_{x,x+4} = {}^{j}_{i}PR^{t+5}_{x,x+4} * {}^{j}_{i}POP^{t+5}_{x,x+4} , $$

where t ranges from 2008 to 2048, which means the final year labor force participation is projected for is 2053. At any point in time, the total size of the labor force – taking into account the heterogeneity by highest level of educational attainment – is the sum of all sub-groups:

$$ LF^{t+5} = \sum_{i=1}^{2} \sum_{j=1}^{2} \sum_{x=15}^{65} {}^{j}_{i}LF^{t+5}_{x,x+4} $$

The size of the total labor force is also estimated across both education categories and the results with and without differentiation by education are compared.

The six scenarios of labor force participation are:

(1) **Constant scenario**. Labor force participation rates will be kept at the average level that was observed in 2008.
(2) **Cohort scenario**. In this scenario, cohort developments in participation between 2003 and 2008 are analyzed and enter the projection.
(3) **Benchmark scenario**. Participation is modeled towards a given distribution.
(4) **Equalization scenario**. Female participation in 2053 reaches the levels that are observed for males in 2008.
(5) **Retirement scenario**. In this scenario, labor force participation of older workers (aged 55+) is assumed to increase by a certain percentage each 5-year period between 2008 and 2053.
(6) **Combination scenario**. This scenario combines the assumptions in scenario 4 and 5.

The **constant scenario** is not a likely outcome but serves the purpose of a reference scenario: the resulting labor force size and composition is purely driven by changes in the composition of the population, not by changes in participation. In order to not project labor force participation that is based on only one year of observation and thus potentially biased by cyclical effects, the weighted five-year average of the years 2004 to 2008 is used.

The **cohort scenario** takes into account that labor market attachment can have a cohort component. It has been shown that the observed increase in age-specific labor force participation of women has been shaped by changes in the labor force participation of different birth-cohorts, whereas cohort effects are very small or even slightly negative for men (Burniaux, Duval and Jaumotte (2004)). Using the cohort approach method, differences in participation at two or more points in time are analyzed by birth-cohorts. This analysis can be done in a static or a dynamic way,

where the dynamic one is an advancement to the static approach. In a static approach, the comparison is done cross-sectionally by age-groups. The dynamic approach does take the observed cohort component in labor force participation into account, since synthetic cohorts are compared over time and cohort behavior enters the projection. Consequently, the observed increase in participation of women is projected to continue, as younger cohorts are gradually replacing older cohorts.

Cohort developments enter the projections by way of entry and exit rates (Burniaux, Duval and Jaumotte (2004); Australian Government Productivity Commision (2005); Carone (2005); BC Stats (2010)). Age-, sex- and education-specific entry and exit rates are calculated for each country, based on the participation rate of the years 2003 and 2008.The design of the calculation of these rates entails that when one of them is positive, the other one is negative. In a next step, future participation rates are calculated based on the last observed participation rates and the calculated entry- and exitrates. Entry and exit rates were kept constant during the whole projection period. The fact that education information has only been included in the EU LFS since 1992 and that age-data is only available in 5-year age-groups, it is not possible to calculate any time-series data about the long-term development of entry- and exit rates, and thus impractical to modify the entry and exit rates based on past trends.

Contrary to the cohort method, where actual age-, sex- and education-specific developments of labor force participation are the basis for future participation, the **benchmark approach** is based on the deliberate selection of a future age- and sex- specific target participation distribution. Often, this distribution is one that has been observed in another country that is similar in several respects (culture, history, political system) but considered to be more advanced economically or when it comes to e.g. gender equality or labor market involvement of persons 50+ (Houriet-Segard and Pasteels (2012)).

The target distribution in the benchmark scenario in 2053 is the average labor force distribution observed in Sweden in the years 2004 to 2008. Comparing all countries during this time period, Sweden is the one that is leading for the most education-, sex- and age-specific values of labor force participation. The country-specific developments are interpolated in five-year steps, between the observed averages for 2004 to 2008 and the target distribution in 2053. In those few cases where certain participation rates are already higher in the than the ones in the target scenario, these participation rates are not modified but kept constant during the whole period. Since the difference in labor force participation between men and women is smaller in Sweden than in any other country, this scenario implicitly models a reduction of the gender disparity.

In the **equalization scenario**, it is assumed that for all age-groups, female participation in 2053 reaches the levels that are observed for males today. Female labor force participation in Europe has been increasing constantly for several decades, leading to a reduction in the gender differences in participation (see e.g. Balleer, Gómez-Salvador and Turunen (2009)). At the same time, male participation remains unmodified during the whole projection period in this scenario.

The **retirement scenario** is based on the fact that labor force participation among the population 55+ has been increasing during recent years (Balleer, Gómez-Salvador and Turunen (2009);

Heckman and Jacobs (2010)). This increase has been mainly attributed in changes in retirement regulations and access to different pension schemes (European Commission (2011)). Many countries have passed legislation that entails increases in normal retirement ages beyond current ages and further restrictions on the access to invalidity pensions and early retirement schemes. Thus, further increases in the labor force participation of the elderly are likely. The analysis of increases in labor force participation of the 55- to 64-year olds between 1998 and 2008 leads to the assumption of an average projected increase of 2 % in labor force participation in this age-group during each five-year interval until 2053. For ages 65 and over, the assumed future increase in participation is 1 %.

Finally, the **combination scenario** assumes both, the harmonization of male and female participation and the increase in participation of those aged 55+. This scenario resembles the benchmark scenario insofar as the attainment of Swedish conditions requires in many countries an increase in female participation and in participation of the elderly.

Differences in labor force participation between the two education categories have not been modified explicitly. However, they do change implicitly in the cohort, benchmark and equalization scenario. In the cohort scenario, they do decrease if a decrease between consecutive cohorts was picked up. Since educational differences in participation are for men as well as women smallest in Sweden compared to all other EU countries, the benchmark scenario does also imply a reduction. And finally, educational differences in participation decrease for women in the equalization scenario, since the observed differences are generally smaller for men.

The six labor force scenarios are multiplied with the previously described population projections. For each of the four scenarios, labor force projections are calculated twice: once only with age- and sex-specific participation rates, and once where participation is additionally differentiated by the two educational attainment categories.

4.2. Results

The goal of this analysis is to demonstrate the effect of adding the highest level of educational attainment to projections of the labor force. This is done by comparing the absolute size of the labor force as well as the educational composition of several sub-groups of the population (men and women, different age-groups).

Labor force size and economic dependency

The labor force of the 26 countries considered comprises 237.8 million persons in 2008. Figure 3 illustrates for the period 2008 to 2053 the effect of adding the highest level of educational attainment on the total size of the labor force. For each scenario, i.e. irrespective of the method and assumptions used, adding the education dimension leads to a larger projected labor force than without it. The biggest education effect, namely 4.1 %, occurs in the case of the constant scenario (204.1 versus 212.5 million). The constant scenario leads to the lowest projected size of the labor force. Due to population aging, there will be more and more people in age-groups that are associated with low labor force participation rates, and the constant scenario is the only scenario that unmodified captures this demographic effect. The only two scenarios that project a clear increase in the labor force are the

benchmark and the combination scenario. The trajectories of these two scenarios are very similar, with the benchmark scenario resulting in the largest labor force in 2053 of all scenarios considered (251.3 million with education differentiation). The assumption that female participation reaches male levels (equalization scenario) and the assumed increase of participation of older workers (retirement scenario) have an almost identical effect on the total size of the labor force.

The results on the aggregate level are largely replicated on the country level. Every scenario leads to a reduction in the size of the labor force in the majority of the 26 countries, whether participation is differentiated by education or not. The only exception is the benchmark scenario with education differentiation which anticipates a decrease in only 12 out of 26 countries.

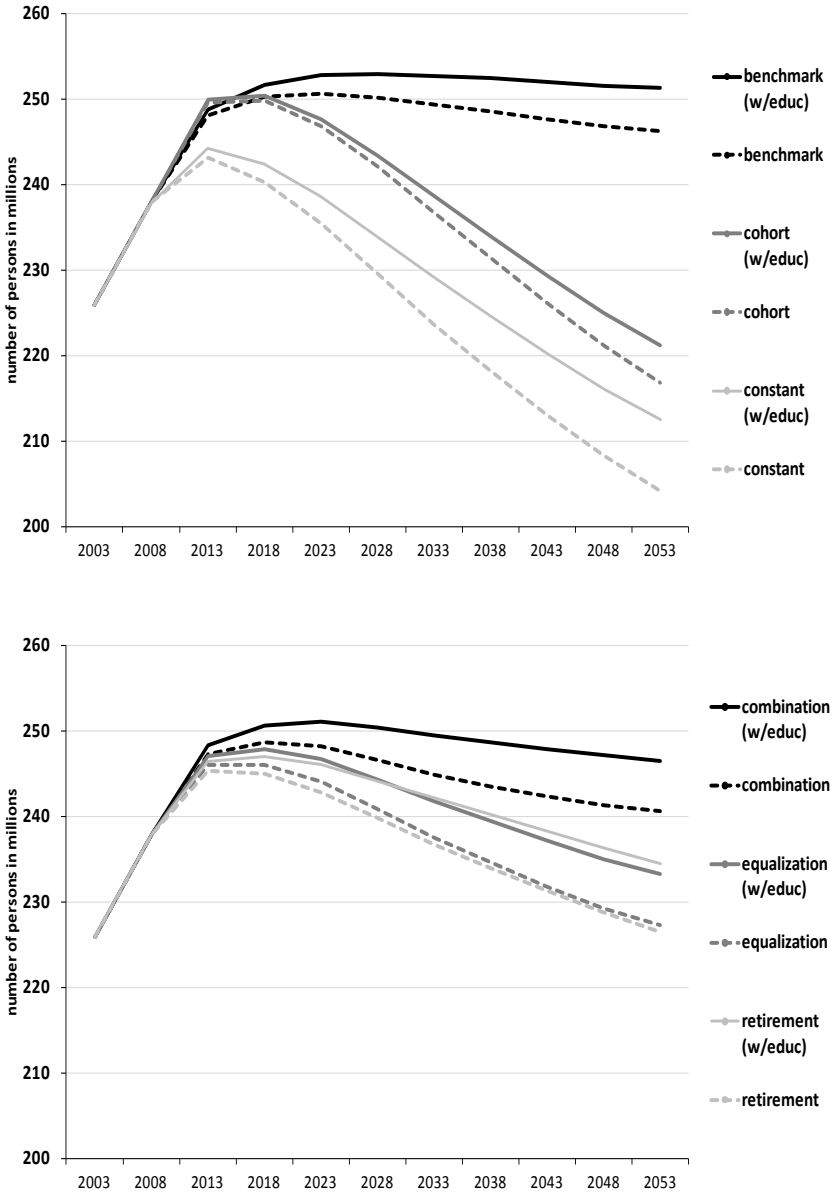

Figure 3: Total labor force (ages 15+), 2008 to 2053, by scenario, projecting with (solid lines) and without (dotted lines) differentiation by educational attainment.

The development of the labor force alone does not say much about the economic consequences of population aging. It is the ratio of the number of persons that are not economically active (i.e. those that are not in the labor force) to those who are (i.e. those that are in the labor force) that is of crucial interest, since it gives an estimate of the economic burden on those that are economically active. Strictly speaking, his ratio underestimates actual economic dependency, since the economically active comprise those working and those that are looking for work. However, since the focus here is on labor supply and not employment, the measure of choice is what could be called the "potential economic dependency ratio".[5]

Potential economic dependency (PED) on the EU level was 1.02 in 2008, meaning there was already then more than one inactive person for every active person. PED increases initially in all scenarios, but starts to level off or even decline half-way through the projection period in every but the constant and the cohort scenario. The trajectories of economic dependency of these latter two scenarios are driven by a constant decline in the number of active persons and a simultaneous constant increase in the number of inactive persons that only starts to reverse towards the end of the projection period. In contrast, this reversal in the development of the size of the inactive population starts in the other four scenarios already half-way through the projection period. Only in the benchmark and in the combination scenarios that do include educational heterogeneity is economic dependency at a lower level in 2053 than it was in 2008, all other specifications lead to higher dependency throughout the projection period than the level observed in 2008.

On the country level, potential economic dependency is projected to increase for the great majority of countries in every scenario. This means that the projected increase on the European level is not the result that is driven by a few large countries but is expected to occur across the board.

Labor force by education

As far as the educational composition of the labor force is concerned, there will be a shift toward higher degrees.[6] As shown in 4.1, the share of the population that holds a tertiary degree will increase in each of the 26 countries during the next decades. This fact, in combination with higher participation rates of the higher educated, leads to an overall better educated labor force: in all 26 countries combined, the share of 20- to 64- year old workers that possess a tertiary degree is going to increase from 27 % in 2008 to 46 % in 2053 (Figure 4). Given that countries differ greatly in the educational composition of the population as well as education-specific labor force participation, is it not surprising that there are large differences between countries.

[5] There are several definitions of economic dependency that are being used in the literature. The definition here is based on the one suggested by Mc Morrow and Roeger (1999) which is a blending of the demographic and the economic approach to dependency: their numerator is composed of the population under 14 or above 65 years of age and the denominator is made up of the labor force. As a slight modification, I add those between ages 15 and 64 that are economically inactive to the numerator, so that potential economic dependency ratio= (population not in the labor force)/(population in the labor force).

[6] The separate scenarios do not differ much when it comes to differences in the educational composition of the labor force, which is why the country-specific shares of the labor force with a tertiary degree are only shown for the combination scenario.

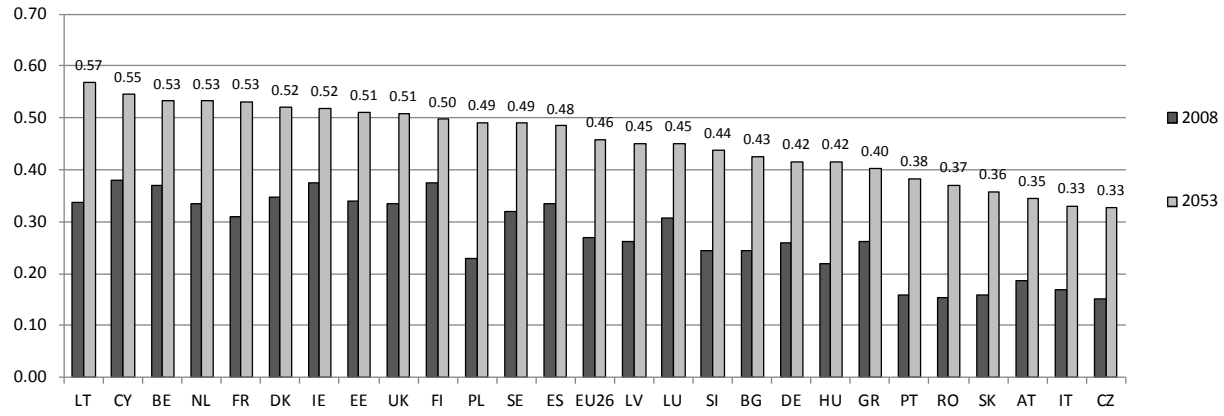

Figure 4: Share of the labor force with tertiary education, ages 20-64, by country, 2008 and 2053 (combination scenario).

What has been demonstrated up to now – that the labor force is projected to decrease in a large number of countries and that the educational composition is going to shift to a higher level – will now be combined to explicitly point out the country differences in both characteristics at the same (change in absolute size and the educational composition). Under the assumptions of the combination scenario, the size of the labor force going to decline in Austria, Belgium, the Czech Republic, Estonia, Germany, Hungary, Italy, Lithuania, Latvia, Poland, Portugal, Romania, Slovenia, Slovakia, and Spain (cf. Figure 5 and Figure 6). However, since the decline is accompanied by an expected „upgrading" of the labor forces' human capital, the decrease might not hit the economy as hard as it potentially would if the educational composition did not change. In Germany, the biggest economy in Europe in terms of GDP, the labor force is projected to decline from 42.6 to 34.6 million (combination scenario). All of the decline will be attributable to a decrease in the size of the labor force that is composed of persons with a non-tertiary degree (from 31.9 to 20.6 million), whereas the group of those who have a tertiary degree will increase from 10.7 to 13.7 million. The countries with a projected increase in their labor force are double-winners, because their labor supply of workers with tertiary education increases in absolute and relative terms. In the UK, for example, the total size of the labor force between 2008 and 2053 increases from 30.2 to 43.6 million persons, and 11.2 million of these additional workers will have a tertiary degree.

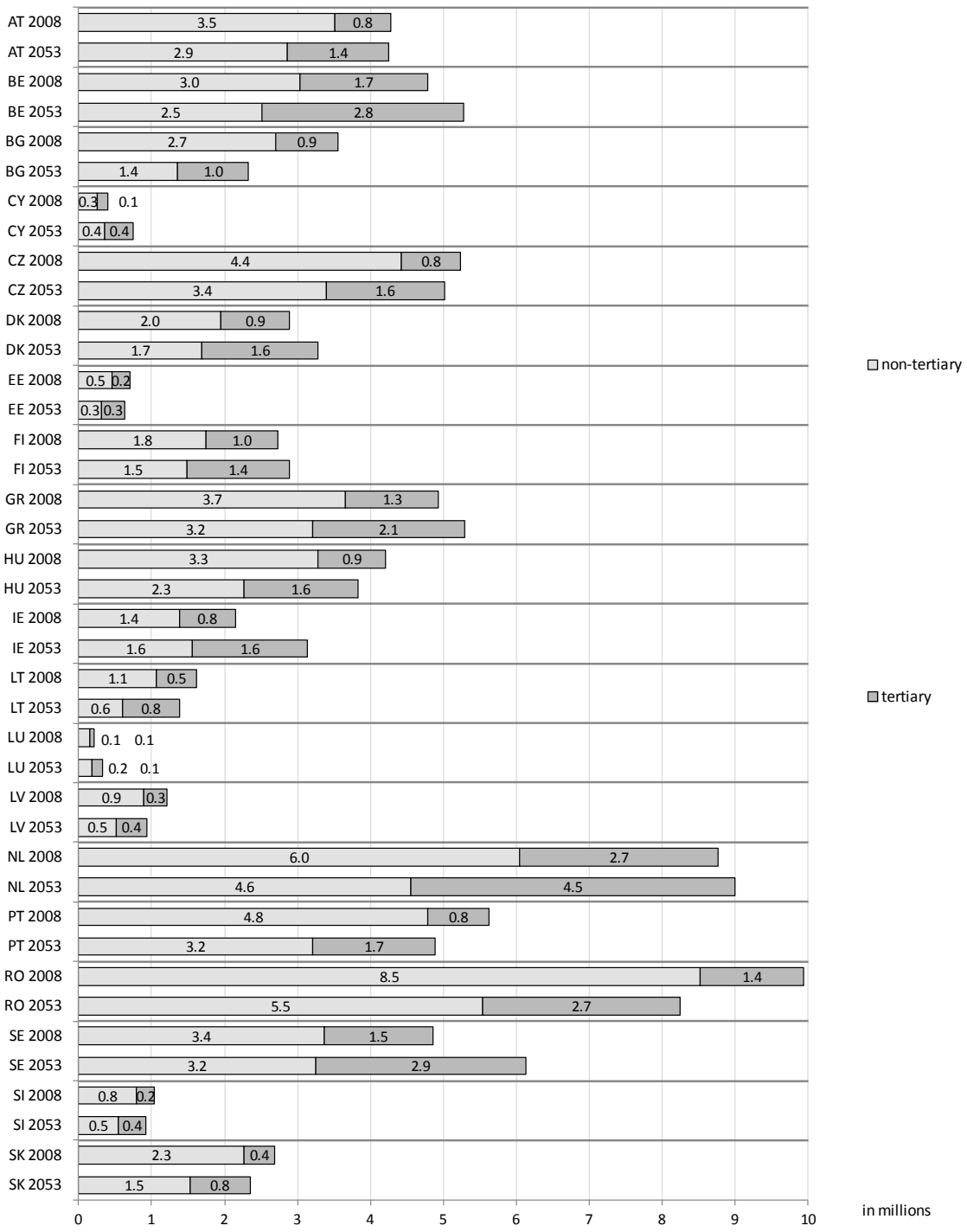

Figure 5: Absolute size of the labor force (ages 15+), by highest level of educational attainment (combination scenario, small and medium-sized labor forces).

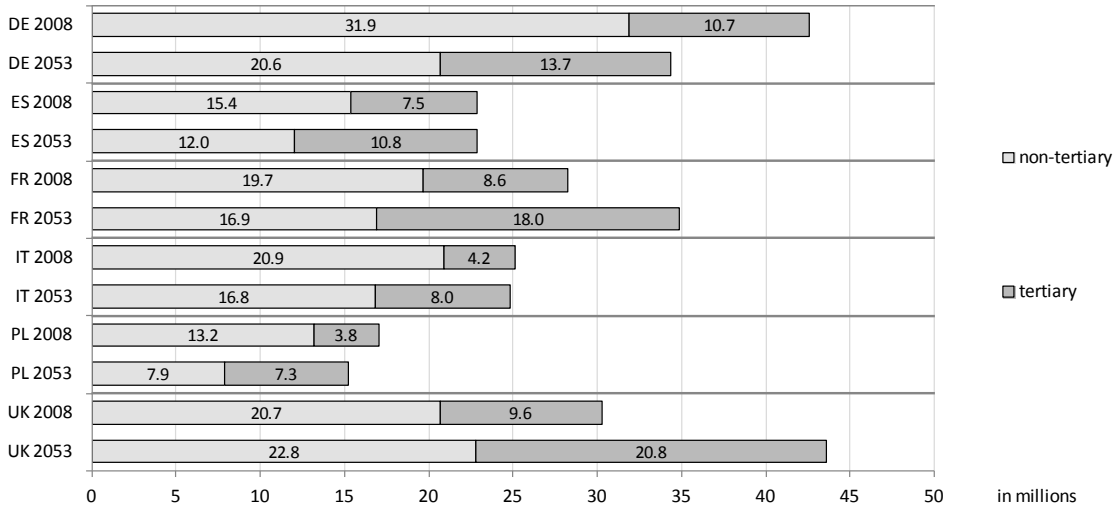

Figure 6: Absolute size of the labor force (ages 15+), by highest level of educational attainment (combination scenario, six largest labor forces).

Labor force by education and gender[7]

Already today, the female labor force is equally or higher educated than their male counterpart (the only exceptions being Austria and Germany). Figure 7 shows the share of the labor force with a tertiary degree by gender in 2008 and 2053.[8] By 2053, a higher share of female than male workers will be holding a tertiary degree in every country. This development is driven by both: the fact that young women have been catching up to and even surpassing men when it comes to the share of them obtaining a tertiary degree; and the fact that female labor force participation shows larger differences between women with tertiary and non-tertiary education than it is the case for male labor force participation.

What has been demonstrated for the overall labor force in each country in Figure 6 – that the labor force decreases in size in the majority of countries but experiences an shift in its composition towards persons with higher degrees – does happen in a more complex way within the male and the female fraction of the labor force. In countries like e.g. Austria and the Netherlands, the male labor force is projected to decrease in size whereas the female one will increase. Both labor forces are projected to increase in e.g. Sweden, Ireland and the UK. A universal decrease is anticipated in e.g. Portugal, Bulgaria, Romania and Germany.

[7] From now on, whenever results are presented by scenario, these are the results when disaggregating labor force participation and population by age, sex, and highest level of educational attainment.

[8] Again, the results for the combination scenario are shown in the text. The differences between the scenarios when it comes to the composition of the labor force by sex and highest level of educational attainment vary between countries and are generally larger for men than for women.

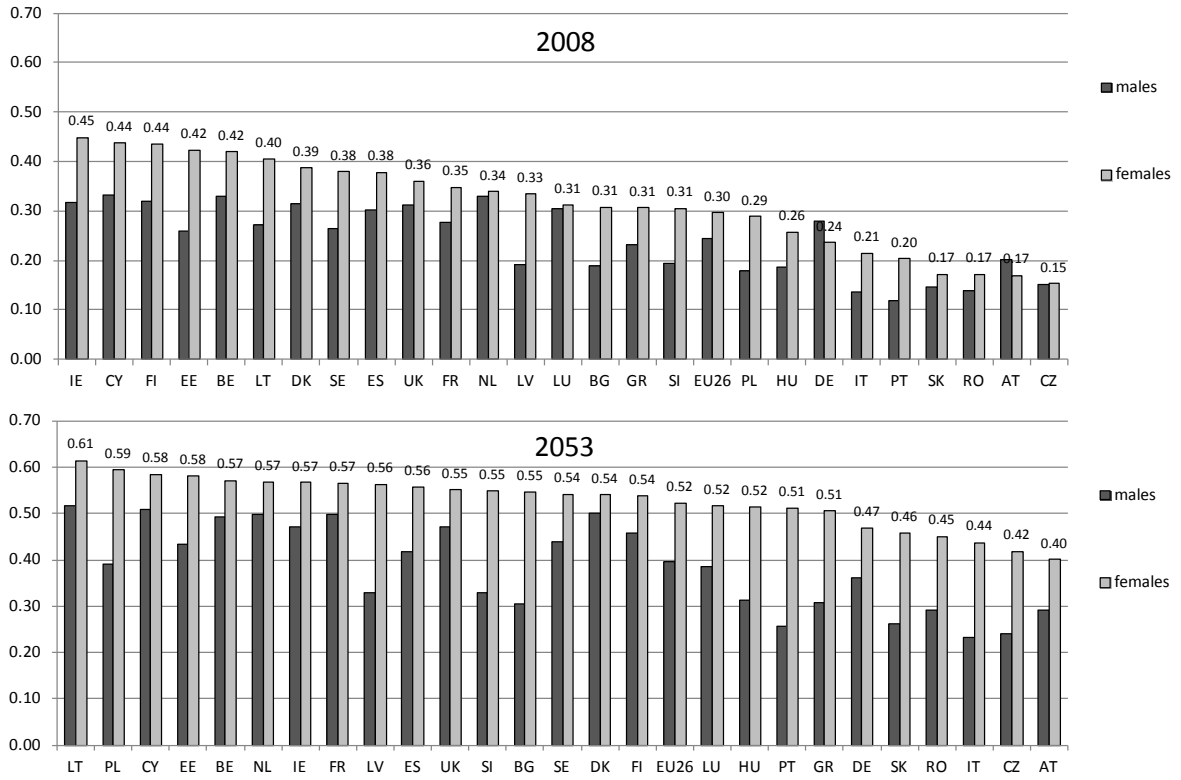

Figure 7: Share of the labor force with tertiary education, ages 20 to 64, by country and sex, 2008 and 2053 (combination scenario).

Labor force by education and age

Looking at the age-composition of the projected European labor force, there is a clear shift towards older age-groups. Besides these changes in the age-distribution, there are expected shifts in the composition by highest educational attainment: the share of the labor force that holds a tertiary degree is estimated to increase in every age-group and for every scenario between 2008 and 2053, and the differences between the individual scenarios are relatively small for every but the oldest age-group. The at first view surprising result that members of the oldest age-group are in four out of six scenarios better educated than members of younger age-groups is due to selection: although the population 65+ is lower educated than younger cohorts (compare Figure 2), the greater relative educational differences in labor force participation (compare Figure 1) lead to a higher predicted share of tertiary educated persons in the oldest age-group than in the younger ones.

5. Summary and discussion

Compared to existing labor force projections, the projections here include information about the highest level of educational attainment, which means another level of heterogeneity in labor force participation besides age and sex is being considered. This heterogeneity is relevant in two ways: (1) it enters the projection methodology since the fundamental parameters (population and labor force

participation) are decomposed in three instead of two dimensions, and (2) it adds a further dimension of information about the future composition of the labor force.

When talking about the effect of adding educational attainment to the dimensions that labor force participation is disaggregated by, one has to distinguish between the effect on the absolute size and the consequences it has on the composition of the labor force. For each scenario, i.e. irrespective of the assumptions about future development of the labor force and the method used, adding the education dimension leads to a larger projected labor force than without it. The effect, though, is moderate if not small. The magnitude of the effect varies across countries and scenarios and increases over time, but does in 2053 in no case exceed 8 % (the average across countries and scenarios in 2053 is 3 %). The general development of the size of the labor force is driven by the specification of the scenario, not whether the scenario is estimated with or without education differentiation of participation.

The six scenarios do not differ much when it comes to the composition of the labor force in each country by highest level of educational attainment. However, there is a significant shift in human capital towards higher degrees between 2008 and 2053. This educational upgrading of the European labor force is not driven by the development in a few large countries but can be expected to take place in each of the 26 analyzed countries. This result of a better educated labor force is robust in the sense that it holds for the overall labor force, irrespective of the scenario, and also for the analyzed subgroups (gender and age-groups).

Summing up, the labor force in Europe is likely to be older, contain a higher share of women, and will overall be composed of people that are on average higher educated than today. Whether the labor force will be smaller depends on how participation of those aged 55+ years and older will evolve.

The size and the composition of the labor force during the next four decades depends on two components: the course of populations development, and the evolution of age-, sex- and education-specific labor force participation. As far as the reliability of the results of the population projection is concerned, the most uncertainty does come from migration. It is impossible to anticipate what future European and global migration patterns will look like. The volume of migration flows and the human capital of migrants have the potential to shape the educational composition of Europe's population. Based on past development and the experience in countries that are fore-runners when it comes to gender equality in the labor market a further increase in female labor force participation can be reasonably expected (cf. McDonald and Kippen (2001)). Similarly, it is well justified to anticipate further increases in the labor market attachment of the population 55+, due to likely future restrictions on early retirement schemes and increases in statutory retirement ages. Hence, the benchmark and the combination scenario are equally reasonable.

A strong case can be made that labor supply does not evolve independently of labor demand, since there is the hidden labor reserve and feedback-effects including the discouraged worker effect and the additional worker effect (Houriet-Segard and Pasteels (2012)). None of these issues has been taken into account in current estimations, partly because they are due to cyclical factors. However, the general understanding seems to be that there has been a shift in labor demand towards skilled

labor (see e.g. Heckman and Jacobs (2010, p. 10)) and that there will be a continued demand for high-skilled labor (see e.g. Judy and D'Amico (1997) for the US and CEDEFOP (2010, p. 68) for Europe). “Many explanations have been put forward for these labor demand shifts but skill-biased technical changes appears to be the most important one” (Heckman and Jacobs (2010, p. 10)).

External shocks, like for example the current financial crisis, cannot be anticipated and are therefore not considered in this kind of projections; they can only try to factor in structural changes, not short-term cyclical changes (cf. Houriet-Segard and Pasteels (2012, p. 7)). Cyclical changes like the current crisis have the potential to influence the decision to invest in human capital: rather than facing unemployment, particularly young people might opt to stay in or re-enter the education system. Of course, unforeseeable events and subsequent changes in behavior of educational activity can have an effect on the educational composition of the labor force for several decades.

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