EUROMOD WORKING PAPER SERIES

EM 1/16

Fiscal Sustainability and Demographic Change: A micro approach for 27 EU countries

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January 2016

Fiscal Sustainability and Demographic Change: A micro approach for 27 EU countries[1]

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Abstract

The effect of demographic change on the labor force and on fiscal revenues is topical in light of potential pension shortfalls. This paper evaluates the effect of demographic changes between 2010 and 2030 on labor force participation and government budgets in the EU-27. Our analysis involves the incorporation of population projections, and an explicit modeling of the supply and demand side of the labor market. Our approach overcomes a key shortcoming of most existing studies that focus only on labor supply when assessing the effects of policy reforms. Ignoring wage reactions greatly understates the increase in fiscal revenues, suggesting that fiscal strain from demographic change might be less severe than currently perceived. Finally, as a policy response to demographic change and worsening fiscal budgets, we simulate the increase in the statutory retirement age. Our policy simulations confirm that raising the statutory retirement age can balance fiscal budgets in the long run.

JEL codes: H68, J11, J21

Keywords: Demographic Change, Fiscal Effects, Labor Supply, Labor Demand, Pension Systems

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[1] We thank seminar and conference participants in Maastricht, Mannheim, Segovia and Esch-sur-Alzette for comments and suggestions. The paper is funded by the EU FP7 project `NEUJOBS' (under grant agreement 266833). The results presented here are based on EUROMOD version F6.0. EUROMOD is maintained, developed and managed by the Institute for Social and Economic Research (ISER) at the University of Essex in collaboration with national teams from the EU member states. We are indebted to the many people who have contributed to the development of EUROMOD. The process of extending and updating EUROMOD is financially supported by the European Commission [Progress grant No. VS/2011/0445]. The results and their interpretation are the authors' responsibility. We use microdata from the EU Statistics on Incomes and Living Conditions (EU-SILC) made available by Eurostat under contract EU-SILC/2011/55 and the Family Resources Survey data (for the UK) made available by the Department of Work and Pensions via the UK Data Archive. The authors alone are responsible for the analysis and interpretation of the data reported here.

1 Introduction

Ongoing long-term demographic changes are widely considered a risk to fiscal sustainability in developed countries. A shrinking labor force, combined with a growing old-age dependency ratio, is expected to negatively affect tax revenues and raise pension expenditures. This may threaten governments' capacities to fund social welfare systems and the provision of other public goods. As a consequence, pension systems in virtually all industrialized countries have been subject to recent reforms (OECD, 2013). While the expectations of growing pension expenditures have been supported by a number of studies, the case is less clear-cut for the evolution of fiscal revenues. The interlinkages between demographic transitions and labor market outcomes deserve special attention in this context. If, for example, a shrinking labor force is becoming better educated at the same time (as is projected), average wages will increase. Additionally, if there is a scarcity of labor, neoclassical economic theory predicts that wages should increase in order to stimulate labor supply. Future tax revenues may therefore increase despite population shrinkage. Hence, it is crucial to account for reactions on both sides of the labor market when assessing the effects of demographic changes on future fiscal balances. Most studies however do not systematically account for labor supply and demand responses. We study fiscal sustainability in the EU, combining population projections for 2030 with micro-based elasticities of labor supply and demand, allowing us to overcome this limitation.

Specifically, this paper outlines the extent of the challenges for public budgets from demographic changes in a four-step analysis. First, we incorporate two scenarios of projected demographic changes via a reweighting procedure into micro data sets for the EU-27 countries. In a second step, the implied wage effects are analyzed by modeling the demand and supply side of the labor market. Supply elasticities are differentiated by skill, gender and household type for each EU-27 country. On the demand side, we differentiate own-wage elasticities of demand by country and skill group, drawing on a meta-analysis approach. Next, the consequences for fiscal budgets are investigated with a tax-benefit simulation. We capture personal taxes, social insurance contributions, social transfers, public pensions, and main demography-related public expenditures. Finally, we analyze the impact of an increase in the statutory retirement age, which is an obvious and widely discussed policy response to demographic change.

Our approach is micro-driven and accounts for the full heterogeneity in populations and tax-benefit rules, required to model essential interactions between demographics, labor market behavior and fiscal systems. Unlike computable general equilibrium (CGE) approaches, the only assumptions we impose concern the elasticities of labor supply and demand or stem from the demographic projections.

Our findings contribute to a broad academic debate on the consequences of demographic change. The impact of demographic ageing and decreasing population size on long-term economic growth has been treated in a number of endogenous growth models.[1] In these models, the association between population size and economic growth is ambiguous and subject to the modeling framework. This literature regularly predicts positive growth effects from population ageing, as households seek to save more during their working life. This triggers investments and hence growth. However, there are also models implying a negative relationship between population ageing and growth. Despite its importance, there have been relatively few studies that examine population ageing with endogenous public revenues. An exception is Börsch-Supan et al. (2014), who consider a general-equilibrium model with overlapping generations and a pay-as-you-go (PAYG) pension system. Their findings imply declining consumption and GDP per capita as a consequence of higher dependency ratios in the future. The authors however demonstrate that, while sticking to a PAYG system, living standards in Europe can be maintained in spite of population ageing if total employment can be increased. A similar point is made by Ang and Madsen (2015), who show empirically, using a long-term country panel, that an ageing work force is usually more productive. This suggests that the contribution of older workers with tertiary education to national production can outweigh higher pension and health costs. Finally, Kudrna et al. (2015) explore the welfare effects from cutting pensions versus raising taxes.

Concerning the fiscal implications of demographic changes, there are a number of studies on the sustainability of pension systems. Comprehensive projections can be found in Dekkers et al. (2010), European Commission (2012) and OECD (2013). There is however little work dealing with the impact of population ageing on public *revenues*. The complexity of existing tax-benefit system calls for micro-based approaches rather than representative agent models. Notable exceptions are Decoster et al. (2014) and de Blander et al. (2013) for Belgium and Aaberge et al. (2007) for Norway.

We aim to fill this gap by a micro-founded approach for 27 EU countries, that is able to capture heterogeneous developments between population subgroups. Our treatment of the tax and contribution systems is able to capture far more detail than macro models generally can. This comes at the cost of ignoring potential general-equilibrium effects — we return to this limitation in the next section.

Our paper further extends the literature by exploring the scope of effective policy responses. Surprisingly, despite the relevance of the topic, there are only very few *ex-ante* studies investigating the effects of reforms to pension systems.[2] Leombruni and Richiardi (2006) set up an agent-based microsimulation model of labor supply to analyze the evolution of the Italian labor force, taking into account demographic

[1] See Prettner and Prskawetz (2010) for a survey.

[2] In addition there are *ex-post* studies investigating the effects of pension reforms, see e.g. Cribb et al. (2013); Staubli and Zweimüller (2013); Manoli and Weber (2012); Vestad (2013).

projections. Explicitly modeling retirement rules as well as behavior, they simulate the effects of an Italian retirement reform from the 2000s on the labor market. Mara and Narazani (2011) simulate the effects on employment and retirement behavior of a reduction in pension benefits in combination with targeted income support in Austria. They show that such a reform increases social welfare as well as the employment of middle-income males (aged 55–60). Another simulation study by Fehr et al. (2012) investigates the recent increase in the German statutory retirement age from 65 to 67 years. They show that this rise will postpone effective retirement by about one year and redistribute towards future cohorts. Yet, the reform is found to be not sufficient to offset the projected future increase in old-age poverty. None of the studies above deals with reforms of the pension system in a comparative European perspective, taking into account different country-specific fertility profiles and pension systems. Comparing the effects of pension system reforms across Europe helps to shed light on the role that systemic elements of pension policies play in shaping the fiscal budget effects.

Our results show the magnitude of fiscal strain expected from demographic change, revealing a negative outlook for the majority of countries. Taking into account labor market effects substantially improves the balance. Increasing the retirement age, as implemented in many countries, further improves fiscal outcomes, leading to mostly positive outcomes.

The paper is structured as follows. Section 2 describes our approach of modeling demographic change and the labor market in more detail. Section 3 describes our implementation of the retirement age reform. Section 4 presents results on labor market and fiscal outcomes. Section 5 contains results on the inter-generational distribution of funding public finances. Section 6 concludes.

2 Data and methodology

Microsimulation Models (MSM) have become a standard tool for the ex-ante evaluation of tax-benefit reforms (Bourguignon and Spadaro, 2006). The basic idea of MSM is to apply different sets of tax rules to the same sample of households and compare the outcomes across various dimensions such as inequality and employment. It offers a suitable framework to deal with the questions we pose due to its ability to account for the full heterogeneity within a given population. This is in contrast to approaches relying on representative agents, including CGE models. Moreover, the MSM results can be aggregated to the macro level, while this can be problematic for representative agent models due to potential biases. In the context of divergent demographic trends across EU countries, a micro-based approach is particularly useful, as we can account for the fact that the age composition, educational attainment and household composition are affected differently by demographic change across countries. In this paper, we make two main advances in MSM that may be valuable for other research and policy analyses in the future. First, past MSM studies have been focused on modeling labor supply behavior while being relatively agnostic as far as labor demand feed-back effects were concerned. By introducing a novel labor supply and labor demand link (explained in Section 2.2), we overcome this shortfall and add a more realistic (partial) equilibrium notion to MSM. Second, demographic changes are accounted for by reweighting the micro data, which allows us to not only study labor market adjustments to policy reforms in current years but also in relatively distant future (see Section 2.1). Our chosen framework proposes, therefore, a middle ground between micro and macro approaches by making MSM outcomes more plausible when accounting for labor market effects. At the same time, the method is parsimonious, straightforward to implement and does not rest on too many assumptions, avoiding a *black box*.

The main parameters we employ, apart from assumptions underlying the demographic projections, are the elasticities of labor supply and demand. Throughout the analysis, we keep these elasticities constant, even though it is unlikely to be the case in practice. Time-persistent elasticities imply that responses of supply and demand to relative scarcities in the labor market are not changing over time. While the mechanics of the labor market might change over time, it is a priori not clear in which direction they might change and how much variation there could be. For that reason, it seems more reasonable to proceed with the assumption that there are no substantial changes to labor supply or demand elasticities in this time period.

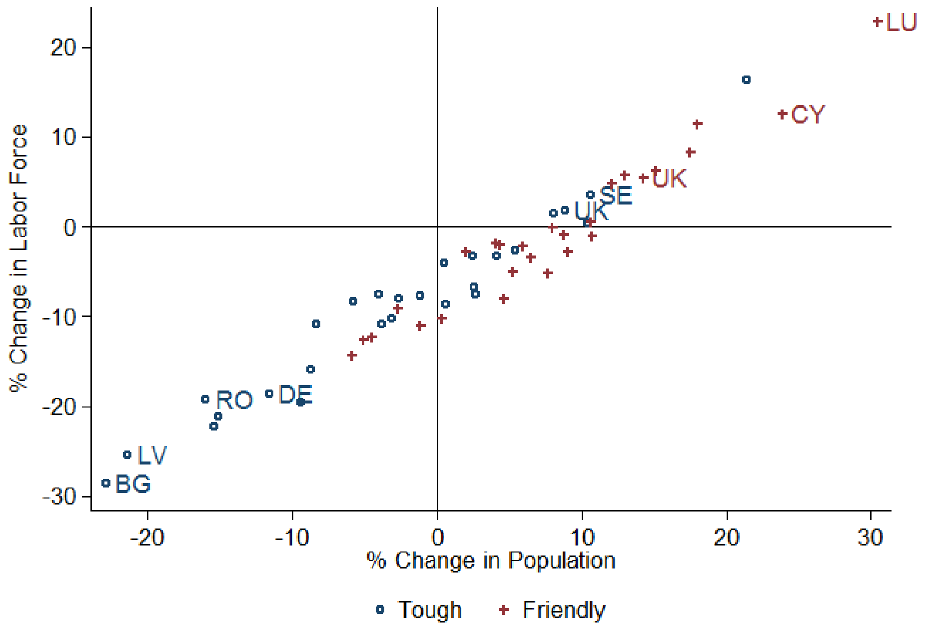
2.1 Population Projections

We draw on Huisman et al. (2013) population projections for EU-27 in 2030, which are differentiated along the dimensions of age, gender, household type and education, separately for each country. The projections start from assumptions underlying the Eurostat projections, EUROPOP2010, but allow for additional variation, captured with two scenarios — the *tough* and the *friendly* scenario. The scenarios make different assumptions about international and internal migration, educational attainment, life expectancy, fertility and GDP growth. Broadly speaking, the tough scenario implies more severe challenges for European policy makers than the friendly scenario as it assumes lower fertility, lower educational attainment, less international migration and a higher life expectancy.[3] The latter scenario is assumed to cause a strong increase in the old-age dependency ratio. In contrast, the friendly scenario assumes higher net international immigration to Europe which has a positive impact on the working-age

[3] Huisman et al. (2013) use a cohort component model to project the age and sex distribution while education projections are based on KC et al. (2010). Comparing their population projections by skill level to those of the European Centre for the Development of Vocational Training (CEDEFOP), which provides an EU-wide population projection for 2020, shows that the two are well aligned in terms of head-counts (CEDEFOP, 2012).

population as well as increasing the level of educational attainment.[4]

Figure 1: Projection change in population and labor force by 2030



Own calculations based on Huisman et al. (2013). See also Tables 3 and 4 in the Appendix.

We incorporate these projections into our micro data — European Union Statistics on Income and Living Conditions (EU-SILC) survey — by a reweighting procedure. The EU-SILC data are representative for the population in each country and contain rich information about socio-demographic characteristics and incomes of households, serving as input for the tax-benefit calculator (explained further below). Essentially, we adjust the respective sample weights for each observation proportionally to meet the target size in a given stratum.[5] By means of reweighting, we are able to analyze how the European labor force will change over the course of two decades. Using the implied changes in the skill and age composition, we get a projection for the future labor force and aggregate labor supply before wage adjustments. Tables 3 and 4 detail by country how the population and the labor force can be expected to change in each European country by 2030. Figure 1 contrasts country-wise changes in labor force and population for both scenarios.[6] With few exceptions, the labor force is expected to

[4] The recent influx of asylum seekers could not be incorporated. This is partly due to lack of reliable information on composition and size of the refugee influx. Moreover, there is huge uncertainty with regard to the length of stay in the host country. According to Hatton (2013), the rate of accepted asylum seekers dropped sharply in the course of the 1990s refugee inflow in the OECD due to tighter asylum policies. The effects on labor force composition in medium to long run is hence far from certain.

[5] For a similar application of sample reweighting in the context in tax-benefit microsimulation for Australia, see Cai et al. (2006).

[6] Throughout the paper, labor force (or, synonymously, work force) is understood as the total population between the age of 15 and 64.

shrink across countries in both the tough and friendly scenario – on average by 9.2% and 1.0%, respectively. The most drastic decreases are expected for Bulgaria, Romania, the Baltic countries and Germany. Although fertility rates are kept constant at the 2010 levels in the tough scenario, this assumption cannot be the main driver for the stark differences in headcounts between the two scenarios, as most new-born children will not be in the labor force in 2030. From all the different assumptions between both scenarios, migration has the most direct impact on the size of the labor force. As Table 5 shows, net migration flows are projected to be negative for the whole EU in the tough scenario. On the other hand, the friendly scenario implies a substantial overall annual inflow of 2.7 million migrants in 2030.

Figure 2: Structural changes in the work force composition

Projected Changes in percentage points between 2010 and 2030. Shares refer to total labor force. Older workers are defined as 50 years and older. High education is defined as completed tertiary education.

Apart from an overall decrease in size, the European labor force will undergo two major transitions, namely a shift towards older and higher-skill workers. The share of older workers is projected to rise in nearly all countries, most notably in the Southern European countries. This development is accompanied by increasing educational attainment, resulting in significant increases in the share of high-skilled workers in every country. This holds for both demographic scenarios and is particularly pronounced in the friendly scenario. In the tough (friendly) scenario, the share of high-skilled rises by only 0.9 ppt (8.0 ppt) in Germany, while other countries exhibit stronger increases, e. g. 10.7 ppt and 15.8 ppt respectively in Poland. The developments along both dimensions are visualized in Figure 2.

2.2 Labor Market Effects

In most countries, the total amount of hours worked, before accounting for wage adjustments, is projected to decrease as a result of demographic changes, ceteris paribus (Table 7, columns labeled **D**). It is unlikely that major transitions in the number of hours worked, as implied by our projections, would leave the behavior of labor market participants unaffected. In a neo-classical model of the labor market, greater scarcity of the production factor (labor) is expected to induce a wage increase which, in turn, may cause workers to supply more hours of work as potential disposable income rises. We model these wage adjustments by taking into account labor supply and demand elasticities as explained below.

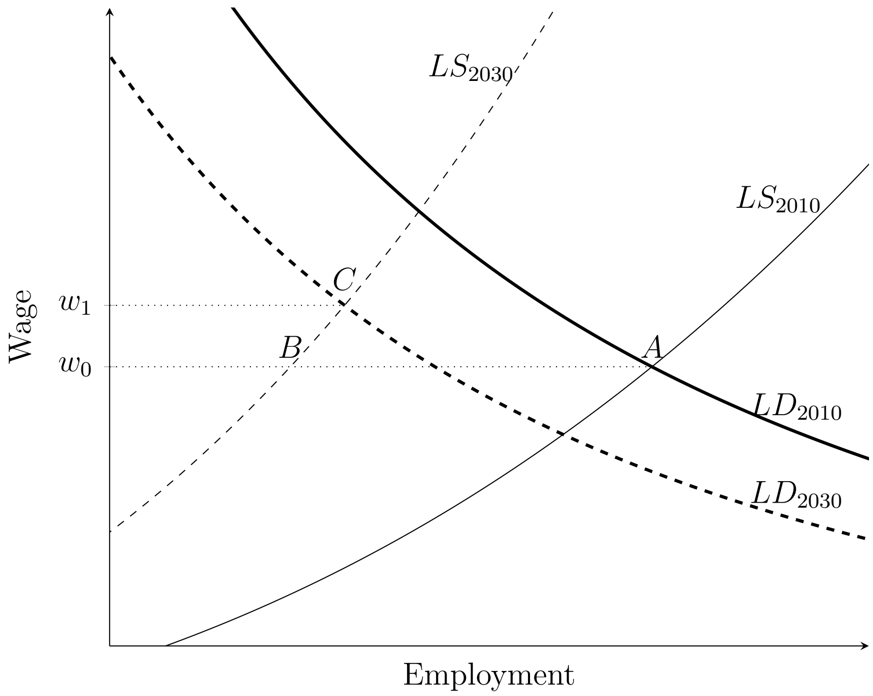
Supply Side Elasticities Our estimates of labor supply elasticities stem from the analysis of Bargain et al. (2014). While the empirical literature on own-wage labor supply elasticities is vast, Bargain et al. (2014) is the first study to carry out estimations for a multitude of countries relying on a uniform methodological framework. They apply a flexible discrete choice model where couples are assumed to maximize a joint utility function over a discrete set of working hour choices. The utility function is specified to account for fixed costs of work, labor market restrictions within countries or even states, preference heterogeneity with respect to age, the presence and number of children as well as unobserved heterogeneity components. We draw on their elasticity estimates, distinguished by sex, marital status and skill level.[7] As the study covers only 17 EU countries, we use the respective country group mean (see Table 2) if a particular country is not covered.[8]

Demand Side Elasticities To capture reactions on the demand side of the labor market, we use skill-specific demand elasticities from the meta-analysis in Lichter et al. (2015), shown at the bottom of Table 2. On the basis of empirical findings from 105 studies covering 30 years, the authors run a meta-regression of the estimated own-wage elasticity of labor demand. This allows them to obtain mean estimates for a given country, controlling for characteristics of the study, such as the time period or the estimation methods. We estimate a regression model on their dataset which follows their main specification (Lichter et al., 2015, p. 101,) but adds an interaction term between skill level and country group. We then use our specification to predict conditional mean values, setting the time trend to 2030. Due to lack of available empirical studies, the demand elasticities can only be differentiated by skill level (low-skilled vs others) and country group. The latter may not be too problematic given the convergence processes among countries in the same geographic region. The meta-study reveals negative own-wage elasticities of demand which are larger than the supply side elasticities.

[7]See the Appendix for more details.

[8] The country groups are defined as follows. Continental: AT, BE, DE, FR, LU, NL; Nordic: DK, FI, SE; Southern: CY, EL, ES, IT, MT, PT; Eastern: BG, CZ, EE, HU, LT, LV, PL, RO, SI, SK. Anglo-Saxon: UK, IE.

Figure 3: Linking Labor Supply and Demand



The graph illustrates the implied supply and demand shifts with overall decreasing labor supply and demand. While this is projected to happen in 15 countries in the tough scenario, the opposite may also occur (see Figure 1).

Labor Market Equilibrium Figure 3 visualizes the new labor market equilibrium in our approach. A formal representation is provided in the Appendix. Our implementation of the supply-demand link defines twelve distinct labor markets, differentiated by marital status, gender and three skill levels. This ensures a flexible adjustment process as it incorporates the main sources of heterogeneous labor market behavior. As we project a shrinking labor force for 18 out of 27 EU countries, even for the optimistic scenario (Figure 1), starting from the initial equilibrium A, the labor supply curve shifts to the left due to a shrinking labor force in the future.[9] Under constant wages, employment would change by the magnitude of the labor supply shock (Point B). This is the pure demographic effect. Negative elasticities on the demand side however imply higher wages due to greater scarcity of labor. We additionally take into account the demand shift that can be expected. As the total population is projected to decrease in the majority of countries, the aggregate demand for goods and services can be expected to decrease as well leading to a lower demand for labor. This is represented by a downward shift of the demand curve according to the relative population change.

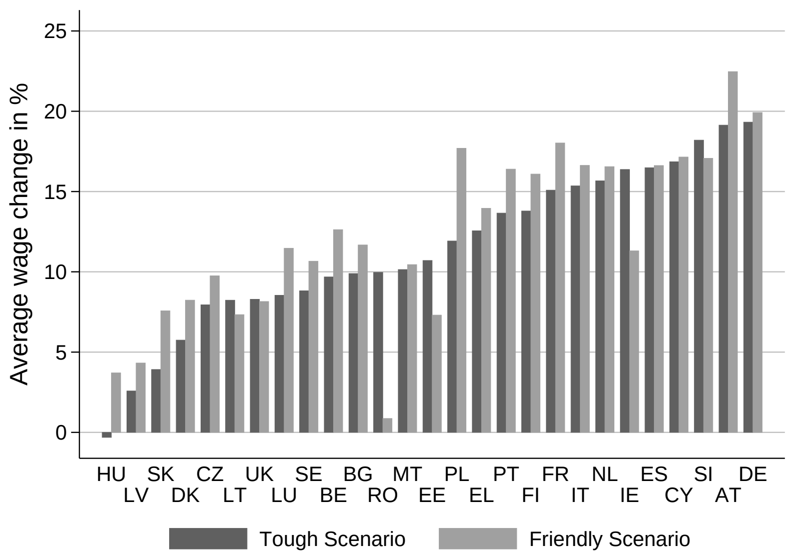
[9] Under the assumption of constant elasticities, any supply/demand curve can be fully characterized by the elasticity and a single observation of hours. This assumption is crucial for this framework. While behavioral responses might be quite stable over time, this may not hold if wage changes become substantial. Specifying supply/demand curves with non-constant elasticities is of course possible, but the empirical foundation for this assumption would be weak.

The new labor market equilibrium is hence defined by the intersection of LS_{2030} and LD_{2030} (Point C), featuring (in this example) higher employment and wages than in Point B.

Figure 4 displays the resulting average wage changes across the EU-27 for both scenarios. On average, we project wages to grow by 11.5% (12.4%) in the tough (friendly) scenario. It is crucial to note that, despite an average increase, there are many workers experiencing lower wages. With a few exceptions, wage changes in a given country are very similar across demographic scenarios.[10] The starkest changes are projected for Germany and Austria. The smallest average wage increases are projected for Hungary, Latvia and Slovakia.

Our simulated wage changes are moderate given the time horizon of 20 years. Assuming a value of 1% for the annual productivity growth of labor over the period under consideration, one would end up with a total increase in labor productivity of 22% from 2010 to 2030.[11] Such productivity effects would add to the implied wage changes. Our labor market model does not explicitly address changing skill premiums due to technological change. The educational trends in the population projections are arguably driven to some extent by an anticipated rise in skill premiums, but they are taken exogenous in our model.

Figure 4: Average wage changes



Own calculations. Countries are sorted in ascending order by the wage change in the tough scenario.

[10] For an intuition of the wage effects, see Equation 6 in the Appendix. The wage change depends on the changes in total population and supplied hours, as well as on the elasticities on labor supply and demand.

[11] Comparable studies even assume an annual productivity growth rate of 1.5%, e.g. European Commission (2012, p. 75) and Börsch-Supan et al. (2014).

2.3 Tax-Benefit Calculator

Any analysis of the fiscal effects of demographic change necessarily needs to address the full heterogeneity of the population of a country, as tax-transfer rules are highly complex and the individual burden of taxation (or eligibility for transfers) depends on personal and household circumstances. The requirements for such ex ante analysis are well met by fiscal microsimulation models (see e.g. O'Donoghue, 2014), which are commonly used in the analysis of public policies (Figari et al., 2015). Given our cross-national focus and the EU-wide scope of analysis, a natural choice is to use EUROMOD, which is the only tax-benefit microsimulation model covering all EU-27 countries (Sutherland and Figari, 2013).[12] EUROMOD enables us to conduct a comparative analysis of tax and benefit systems consistently in a common framework.

EUROMOD calculates household disposable income, based on household characteristics, their market incomes and a given set of tax-benefit rules. The model covers social insurance contributions from employees, employers and self-employed, income taxes, other direct taxes as well as cash benefits. It is mainly based on nationally representative micro-data from the EU-SILC released by Eurostat, or its national counterparts where available and when they provide more detailed information. We use version F6.0 of EUROMOD with input datasets based primarily on the SILC 2008 wave.[13] The sample size for each country varies from about 10 thousand individuals for Luxembourg and Cyprus to more than 50 thousand individuals for Italy and the UK.

We define a concept of Fiscal Balance (FB) as our outcome of interest. FB encompasses the sum of all personal taxes and social insurance contributions (SIC) paid less cash benefits received, that are either simulated in EUROMOD or contained in the SILC data. We further subtract public expenditures that are closely linked to the population structure, i.e. health, old-age care, child care and educational expenditures. These are imputed into our micro-database based on Eurostat (2013), who provide age group-specific expenditures by country.[14] This definition of fiscal balance is partial as it ignores other government expenditure items such as infrastructure or defense, and non-household or indirect taxes (corporate income tax, VAT). However, it is still an informative indicator to broadly measure *changes* in public finances collected or spent in the labor market in this context as it captures the main revenue items (income taxes,

[12] As examples of recent applications, see Immervoll et al. (2007), Bargain et al. (2013) and Dolls et al. (2012).

[13] For France, the 2007 wave is used, for Malta the 2009 wave and for the UK, the Family Resources Survey 2008/09 is used.

[14] Eurostat (2013) does not provide numbers for RO, BG, CY, MT, LV and LT. Similarly to the behavioral parameters, we assume in those cases the average age-related pattern of public expenditures as found in the respective country group. Although expenditure effects for these countries should be treated with caution, this facilitates cross-country comparability.

SIC) and expenditures (public pensions, health and education) affected by changes in the population structure and by retirement age policies.[15]

In order to facilitate the comparison between governments of different size, the total balance is normalised and shown as the share of total household disposable income in 2010.[16]

3 Modeling Retirement Age reform

Our policy scenario raises the gender-specific retirement age in each country by 5 years, which roughly corresponds to the average forecasted increase in the life expectancy in the friendly scenario (see Huisman et al., 2013, Table 3).[17] The statutory retirement age varied notably in 2008 (which is the reference period for our sample), from 60 in France to 68 for males in Finland — see Table 6 in the Appendix.[18]

The first complication for implementing the reform arises from the fact that average effective retirement age is usually lower than the statutory retirement age. There are substantial fractions of the population that retire before they reach the statutory retirement age, for instance due to health related concerns and/or country-specific regulations that facilitate early retirement. This is true for current retirement ages across Europe and with all likelihood also be the case after raising the legal retirement age. As a result, employment rates tend to decrease relatively smoothly around the statutory retirement age rather than exhibiting a very clear and sharp drop. This means that we need to predict employment rates under the new policy regime not only for the group of people affected by the increase of retirement age directly, i.e. those above the current age threshold and below the new one, but for a wider group of people. In the absence of a structural model determining the retirement decision (see, e.g. Manoli et al., 2015), we base the employment rate of the target group on a 5-year younger cohort (taking the three-year moving average to obtain smoother patterns).[19] We apply this approach to four separate groups of people, distinguished

[15] For 2010, our fiscal concept covers on average around 50% of total government revenues and 61% of total expenditures

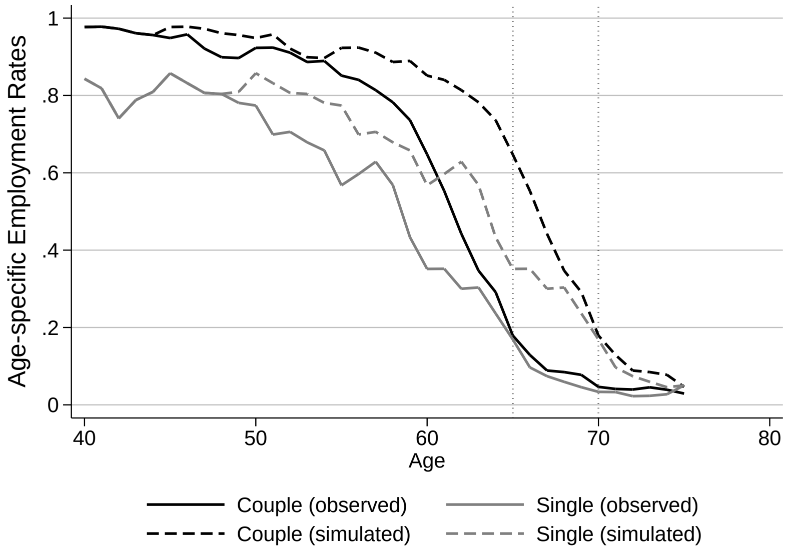
[16] A numerical example for Austria (AT) illustrates this. Here, the baseline fiscal balance amounts to €-11.2 bn and decreases to €-23.4 bn in the friendly scenario, considering demographic change only. The difference divided by the total household income in 2010 (€124.3 bn) is hence -9.82%, which is reported in Table 12.

[17] It also addresses the Barcelona target of raising the retirement age gradually by 5 years (European Council, 2002). We additionally ran a second reform scenario that introduces a universal retirement age of 70. The main conclusions are not fundamentally different and the results are available upon request.

[18] We leave aside already legislated increases in the statutory retirement age, which are scheduled to take effect between 2010 and 2030.

[19] We also rule out decreases in the employment rate by setting the minimum level equal to what is observed currently for a given cohort.

Figure 5: Age-specific employment rates



Current observed (solid line) and predicted post-reform (dashed line) age-specific employment rates for men in Germany after a shift of the statutory retirement age from 65 to 70.

by gender and singles/couples to obtain new employment rates for all age groups older than 40, which is where employment rates peak in most countries, though the largest changes occur naturally for age groups around the current statutory retirement age.[20]

Figure 5 demonstrates our approach, taking male workers in Germany as an example: the solid lines are observed employment rates by age in the status quo (2010) under the current statutory retirement age of 65 (indicated by the first dashed vertical line). We basically assume that an increase in the statutory retirement age from 65 to 70 (under the first reform) shifts the employment curve to the right (by five years as well), shown with the dashed lines. For example, as the (smoothed) employment rate of single men at the retirement age of 65 was 0.19, we assume it will also be 0.19 at a new retirement age of 70. The area between the solid and the dashed line reflects the total increase in employment.

After deriving target employment rates, we assign a corresponding number of retirees from the affected age groups back to work. As the exit into retirement before reaching the statutory age is likely to be non-random, we need to identify individuals with the highest probability to be in employment under the new retirement rules. We estimate the probability of being in work for all individuals i between 45 and 75 years using the following probit model:[21]

$$\Pr(\text{work})_i = \Phi\left(\alpha + \beta X_i + \varepsilon_i\right) \quad \text{for } age_i \in [45; 75] \tag{1}$$

[20] The age variable for Malta is grouped in 5-year intervals, hence, our retirement age related adjustments are also inevitably cruder in this case.

[21] A similar approach has been used for example by Brewer et al. (2011).

The probability of being employed is a function of individual characteristics X_i such as age (a cubic polynomial), the number of children, disability status, dummies for educational attainment, capital income, region, marital status as well as employment status and income of the partner.[22] Partner's status is crucial in couples, as the motivation to continue work might be low in the presence of a high-earning spouse. We estimate the model for each country separately for male and female workers (see Table 13 and 14 in the Appendix with the estimation results).

Having obtained the vector of coefficients β, we are able to predict the probability of being employed for those currently out of work. We then order these potential workers by the employment probability and, starting with the individuals with the highest probability, assign current retirees back to work until we meet the projected target employment rate by gender for each cohort. For those assigned into work, we assume individual labor supply to be equal to the cell-specific (defined by age, sex and education) mean value in weekly hours. The individual gross hourly wage is obtained from a regression that relates wages to observable individual characteristics and uses the standard Heckman (1979) technique to control for the unobservable factors that influence the selection into work.[23]

Once we have adjusted relevant labor market characteristics and imputed gross wage for individuals assigned back to employment, we use EUROMOD to calculate new tax liabilities and benefit entitlements. Note that we are not able to account for the effect of longer employment trajectories on pensions as public pensions are not simulated in the model, but taken from observed micro-data.[24] This is however a less serious limitation than may initially appear as additionally accumulated contributions are more likely to finance longer retirement spells, which are implicitly accounted for by the new population structure, rather than raise pension benefits.

Note that the above description of deriving the market equilibrium abstracted from any policy reaction to the projected demographic transitions. Yet, the logic of our supply-demand link can be easily extended to any additional policy reform. To see how an increase in the retirement age interacts with our labor market model, return to Figure 3. Starting from the equilibrium with no policy reform, i.e. point C, an increase in the retirement age will increase labor supply and thus lead to an additional shift of the labor supply curve to the right. The new equilibrium point yields higher employment and lower wages compared to C.

[22] Some occupations or industries might bear higher health risks, implying that workers retire earlier. In order to take this into account, we would need information on pensioners' previous occupation or industry. Unfortunately, this information is not available.

[23] The estimation results are available upon request.

[24] This is not particularly limiting when modeling employment transitions as we can simply remove old age benefits for the current retirees assigned to work (while keeping them constant for others). We may however miss out some potential interactions among non-simulated policy instruments, e.g. a switch from retirement benefits to health-related benefits.

4 Labor Market and Fiscal Results

In this section, we present our main simulation results. We focus on two outcomes (i) changes in hours worked and (ii) the effect of the fiscal balance. For both outcomes, we estimate effects at three different stages: (a) only taking into account demographic change (stage D), which isolates the external shock to labor supply for given wages; (b) after the demographic change and wage adjustments effects (stage DW), which captures interactions between labor demand and supply following initial supply shock; and (c) after the demographic change and the counterfactual policy reform of a 5-year increase in the retirement age (stage DRW), taking into account wage reactions. Results for the three different stages are shown estimated for both the tough and the friendly demographic scenario and for all countries. For clarity, we report the results by country group, roughly reflecting welfare regimes (Esping-Andersen, 1990; Ferrera, 1996). Detailed results by country are reported in Tables 7 to 12 in the Appendix.

The upper panel of Table 1 shows changes in total hours worked. The pure demographic effect (D) is -7.0% (+3.0%) in the tough (friendly) scenario for the EU-27. This represents the total labor market effect, capturing both intensive and extensive reactions. Isolating the extensive margin, i. e., the change in total employment, reveals similar effects of -7.4% and +2.5% respectively (see Table 8 in the Appendix). Eastern and Continental Europe are projected to face the largest declines, while total hours actually rise in both scenarios in the Nordic and Anglo-Saxon countries. Comparing changes in hours to changes in the labor force size (-9.2% and -1.0% for the tough and friendly scenarios respectively) suggests that focusing on head-count overestimates the reduction in effective labor and ignores differential labor supply behavior across socio-demographic groups. The change in hours partly compensates for the reduction in labor force. This suggests that demographic changes will increase the share of people with a stronger preference for working.

Wage reactions to initial shocks in labor supply and demand (columns labeled DW of Table 1) lead to additional negative effects on aggregate hours. The wage adjustments to the demographic change do not, and therefore, have a stabilising effect on employment.[25] The additional decrease in aggregate hours due to wage adjustment is particularly felt in southern European countries.

As expected, the hours effects from raising the statutory retirement age by 5 years are substantial (columns labeled DRW in Table 1) with the change in aggregate hours going from -8.5% (1.9%) to -5.5% (16.7%). The largest improvement in hours of work is seen in Continental and Southern European countries. This suggests that undertaking this reform can counterbalance the decrease in hours worked from

[25] Considering the transition in and out of employment only gives a similar, albeit slightly more positive picture. Average changes amount to -7% and +3.8% respectively.

demographic changes even in the tough scenario. There are, however, a few countries (Bulgaria, Estonia, Latvia) where the decline in total hours still exceeds 10% (Table 7).

Table 1: Labor Market and Fiscal Effects by Country Groups

	D		**DW**		**DRW**	
	tough	friendly	tough	friendly	tough	friendly
Panel A: Hours worked, relative change						
Continental	-10.0%	-2.4%	-10.6%	-2.5%	4.9%	14.4%
Nordic	1.8%	7.1%	0.3%	6.4%	7.7%	13.8%
Anglo-Saxon	3.1%	9.4%	2.8%	9.5%	14.1%	20.9%
Southern	-2.9%	8.1%	-6.7%	4.6%	12.6%	25.0%
Eastern	-14.5%	-2.8%	-16.0%	-4.1%	-3.0%	9.9%
EU-27 Average	*-7.0%*	*3.0%*	*-8.5%*	*1.9%*	*5.5%*	*16.7%*
EU-27 Labor Force Change	*-9.18%*	*-1.02%*				
Panel B: Change in Fiscal Balance						
Continental	-7.9%	-8.6%	-1.9%	-0.8%	-0.9%	-0.1%
Nordic	-4.0%	-4.8%	1.5%	8.5%	2.2%	6.8%
Anglo-Saxon	-1.9%	-2.1%	1.7%	0.0%	-0.2%	-1.9%
Southern	-3.8%	-4.5%	-2.9%	-2.8%	2.4%	2.8%
Eastern	-6.8%	-5.4%	-4.8%	-3.7%	-2.1%	-0.4%
EU-27 Average	*-5.8%*	*-5.8%*	*-2.6%*	*-1.3%*	*-0.1%*	*1.2%*

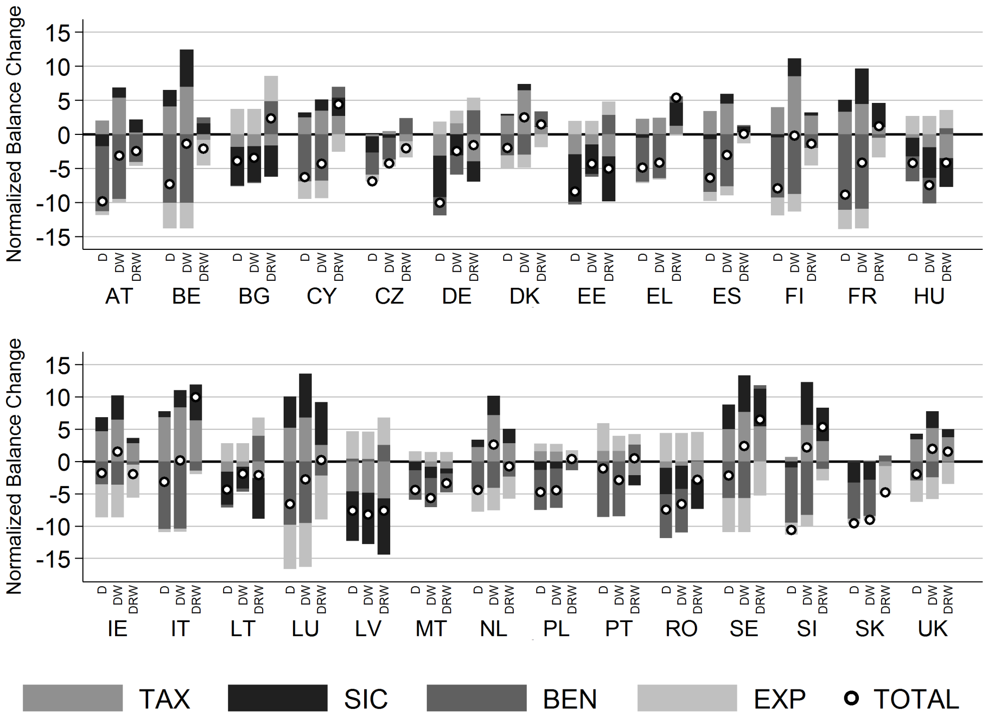
D=demographic change only; DR=Retirement Age Reform. W indicates scenarios with wage effect. Panel A shows mean percentage changes in aggregate hours by country group. Results broken down by country are provided in Tables 4 and 7 in the Appendix. Panel B refer to percentage changes in the fiscal balances, normalized to household disposable income (Equation 2).

Panel B of Table 1 shows how the changes in total hours translate into fiscal outcomes. The figures refer to relative differences in the fiscal balance, normalized by the total disposable income in 2010:

$$\frac{\Delta \text{FB}}{\sum Y_{2010}^{\text{disp}}} = \frac{\Delta \text{SIC} + \Delta \text{Tax} - \Delta \text{Benefits} - \Delta \text{Other Exp.}}{\sum Y_{2010}^{\text{disp}}} \tag{2}$$

We first quantify the scale of fiscal stress which the demographic change is likely to lead to. Under constant wages (columns labeled D in Table 1), public fiscal balances would decrease by around 6% of household disposable income in both scenarios. The negative budgetary effect in the friendly scenario occurs despite hours increasing 3% on average. Figures 6 and 7 decompose the change in fiscal balances for the tough and friendly scenarios. The components include income tax, social security contributions,

Figure 6: Decomposed balance changes by country, tough scenario



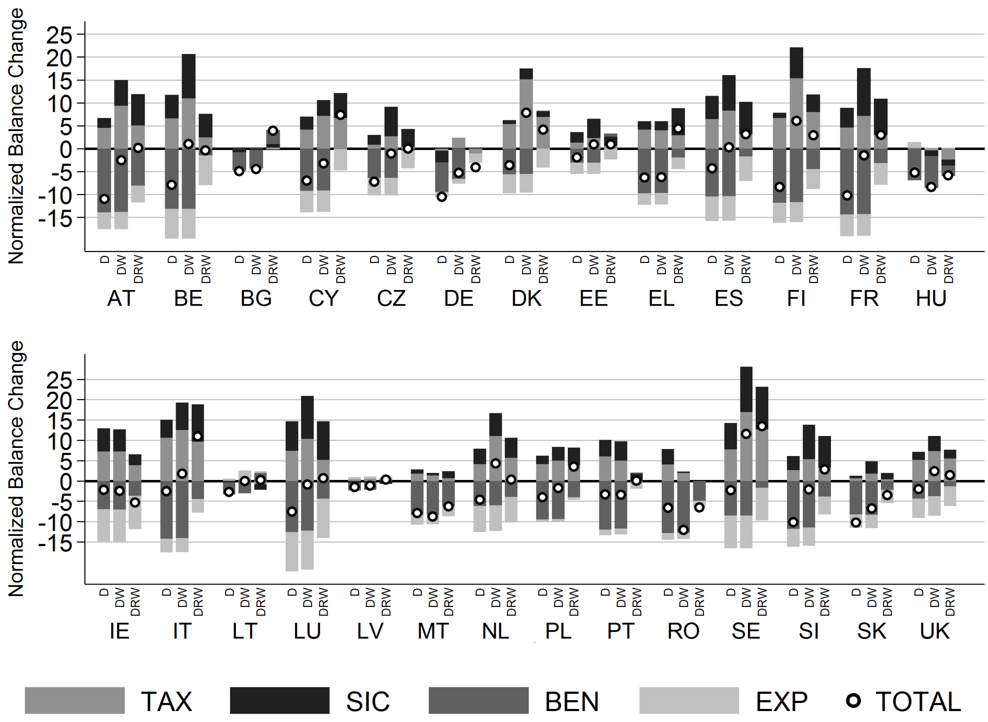
Note: The figure depicts the percentage change in the components of the normalized fiscal balance (Eq. 2) for each step, relative to 2010.

cash benefits and government expenditure (including health, old-age care, child care and educational expenditures as explained in Section 2.3). From these figures, we can see that the negative fiscal balance estimated before accounting for wage changes or introducing the retirement reform (bars labelled D in Figures 6 and 7) is driven by increased spending on (old age) cash benefits, partly counterbalanced by increased taxes and social insurance contributions though not always. The fiscal outlook is similar across countries, a few exceptions include those which are expected to face significant population growth (e.g. Sweden) or have a greater reliance on private pension schemes, such as Ireland or the UK. Another interesting finding is a positive contribution of expenditures in some Eastern European countries and Germany (tough scenario), which can be explained by large decreases in the total population.

With wage adjustments, the fiscal outlook is less bleak. The average change in fiscal balance is still negative but reduced to -3% (-1%) in the tough (friendly) scenario (columns labeled DW in Table 1). The net budget change in the Nordic and Anglo-Saxon countries becomes even positive, on average. The Continental countries also improve their position substantially, while improvements are less drastic for the Southern and Eastern countries. As can be seen in Figures 6 and 7, improvements in the fiscal balance from the wage change are mainly due to higher tax revenues (bars labeled DW compared to D). Revenues from contributions and spending on benefits vary relatively little. While the friendly scenario shows fiscal balances in nearly all EU countries close or above zero after the wage reactions, a couple of countries perform poorly in the tough demographic scenario: Hungary, Latvia, Romania and Slovakia end up with deficits above 5% of total household disposable income.

The retirement age reform brings EU average fiscal balance close to break even in both scenarios. Compared with the outcome after the demographic and wage changes (columns labeled DRW compared to DW in Table 1), fiscal balances improve most in the Southern and Eastern Europe, while we project stagnating or even falling balances for the other country groups. This is explained by the fact that there are two developments following the retirement age increase. Mechanically, cash benefits decrease and revenues increase with higher employment among the older cohorts. Additionally, there is a wage decrease due to higher labor supply, working against the positive revenue effect. The additional budget change from the retirement age reform is marked by a clear decrease in benefit payments (bars labeled DRW compared to DW in Figures 6 and 7). This positive effect on balances is offset by decreases in tax revenues, in some cases even dropping below the level with pure demographic changes (D).

Figure 7: Decomposed balance changes by country, friendly scenario

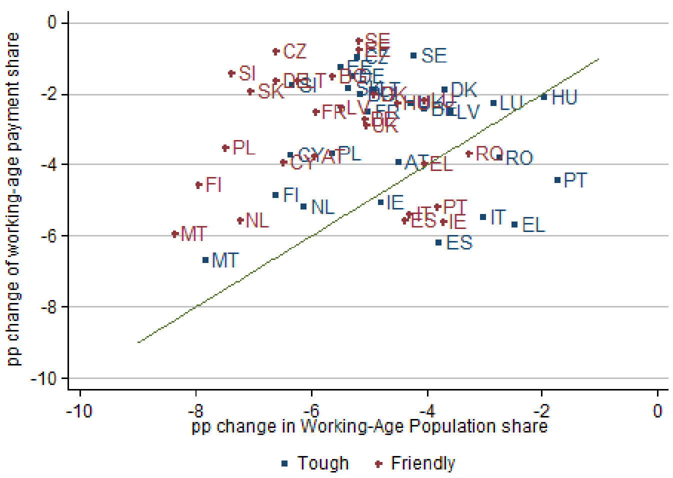


Note: The figure depicts the percentage change in the components of the normalized fiscal balance (Eq. 2) for each step, relative to 2010.

5 Distributional Impact

The previous section demonstrated fiscal strains for most countries from the expected demographic change. A related question is how the financing of public goods is going to be distributed across the population in the future. We therefore investigate the consequences of the demographic change on the intergenerational distribution of financial burden. Governments are financed to a large extent by the working-age population: the share of total taxes and contributions paid by people aged 15 to 64 amounts to 91% on average for the base year. Our demographic scenarios show that the share of working-age population, on average, decreases from 67.9% to 63.4% (tough) and 62.3% (friendly) respectively. Figure 8 plots the change in the share of the working age population between 2010 and 2030 on the horizontal axis, and the change in the share of the taxes and social security paid by the working-age population on the vertical axis (in the absence of a retirement age reform). Most of the countries (in both demographic scenarios) appear to the left of the 45-degree line. This means that, while the share of working-age people in the population is projected to decrease from 68% in average in 2010 to around 63% in 2030, the fiscal burden for this group does not decrease by the same magnitude. In other words, the working-age population pays a larger share of total tax and social security in 2030 than in 2010, relative to its share in population. The fiscal burden accrues more towards the working age population than the non-working age population. This result is intuitive on two grounds. First, it is mainly the working-age population profiting from higher average wages. Second, most income tax and contribution systems treat pension incomes preferentially (OECD, 2013).

Figure 8: Payment burden of working-age population



The graph contrasts changes in the payment share of taxes and social security contributions by the working-age population with its change in population share. The revenue amounts take wage reactions into account (DW).

6 Conclusion

It is widely believed that ageing populations in European countries will put pressure on public finances through higher spending on old age benefits and lower tax revenues. The issue has gained even more relevance in the aftermath of the Great Recession which has weakened governments' fiscal positions ahead of demographic developments. This paper assesses to what extent these concerns are justified and explores a raise in the statutory retirement age as one likely policy response.

Linking EU-27 demographic projections for 2030 with rich household-level data and employing microsimulation methods, we simulate the fiscal effects of demographic change, accounting for substantial population heterogeneity and the complexity of tax-benefit systems. Using the EU tax-benefit model EUROMOD, our analysis covers 27 EU countries in a consistent way in a common framework. This is complemented by a partial equilibrium model of the labor market, relying on recent micro-based empirical evidence.

We quantify the scale of fiscal stress which the demographic change is likely to incur. Assuming constant real wages, public fiscal balances would decrease by around 6% of household disposable income on average — less than the drastic fiscal adjustments carried out in European countries following the recent crisis but of a comparable magnitude.[26] This is driven by increased spending on (old age) cash benefits, in most countries partly counterbalanced by increased taxes and social insurance contributions due to the older and better educated labor force. The fiscal outlook is broadly similar across countries, a few exceptions include those which are expected to face more favorable demographic developments and have a greater reliance on private pension schemes. Overall, the results are not particularly sensitive to the underlying demographic scenarios. Under flexible wage conditions, however, labor scarcity leads to a strong wage growth and small employment increases which, together, notably reduce the worsening in fiscal balances though are not sufficient to withstand it entirely.

We also consider a retirement age reform which increases the current (gender-specific) statutory retirement age by 5 years — roughly corresponding to the projected increase in life expectancy. We model effective retirement ages by extrapolating current employment profiles. Our results demonstrate that such reforms could more than offset the impact of demographic processes on fiscal balances. This is due to increased taxes as there is a strong correlation between the increase in the number of people in work and improvement in the fiscal balance, though the reduction of the welfare bill also matters. These effects are, however, moderated and sometimes even reversed, by lower wages due to higher labor supply. As a result, the likely wage reaction to the demographic

[26] Replicating our fiscal balance concept with revenue statistics, EU-27 balances worsened during the Great Recession, on average, by 7.4% of disposable income.

change, coupled with a retirement age reform are sufficient to avoid worsening in fiscal balances in nearly all countries. An analysis of the change of the fiscal burden reveals that under the existing tax-benefit systems, the working-age population will assume even a greater role in financing the government. Their share of payments relative to the population share is projected to rise. Overall, our results paint a less worrying outlook on the fiscal implications of the demographic change. This is line with previous findings on the country level (de Blander et al., 2013; Aaberge et al., 2007).[27]

We conclude that wage dynamics are highly relevant for the analysis as dramatic demographic shifts may engender important wage adjustments. This highlights the importance of taking interactions between the demand and supply sides of the labor market into account when evaluating retirement reforms — it can be highly misleading to look at static effects only. Nevertheless, our results should be considered in light of some limitations. Extensions to our work could address broader general equilibrium effects by considering the role of technological change and associated changes in labor productivity and returns to education. A more comprehensive concept of fiscal balance, taking e.g. indirect taxes into account, could be useful. Further work can also explore alternative policy options available such as reducing public pensions and increasing the tax burden for those currently employed. Another option to counterbalance decreasing labor force is pursuing policies which encourage higher migration. Even though migrants are likely to be net fiscal contributors (see e.g. Dustmann et al., 2010), this topic remains politically highly sensitive. Lastly, this paper examined the effect of demographic change on labor supply, wages and fiscal revenue. Other margins of interest include inequality and poverty levels and we leave this for future research.

[27] See also recent OECD projections on pension payments, which are projected to increase from 9.2% of GDP to 11.7% up to 2050 (OECD, 2013, pp. 174ff).

References

Aaberge, R., U. Colombino, E. Holmøy, B. Strøm, and T. Wennemo (2007). Population Ageing and Fiscal Sustainability: Integrating Detailed Labour Supply Models with CGE Models. In A. Harding and A. Gupta (Eds.), *Modelling Our Future: Social Security and Taxation*, Volume I, Amsterdam, pp. 259–290. Elsevier.

Ang, J. B. and J. B. Madsen (2015). Imitation versus innovation in an aging society: international evidence since 1870. *Journal of Population Economics 28*(2), 299–327.

Bargain, O., M. Dolls, C. Fuest, D. Neumann, A. Peichl, N. Pestel, and S. Siegloch (2013). Fiscal union in Europe? Redistributive and stabilizing effects of a European tax-benefit system and fiscal equalization mechanism. *Economic Policy 28*(75), 375–422.

Bargain, O., K. Orsini, and A. Peichl (2014). Comparing Labor Supply Elasticities in Europe and the US: New Results. *Journal of Human Resources 49*(3), 723 – 838.

Börsch-Supan, A., K. Härtel, and A. Ludwig (2014). Aging in Europe: Reforms, international diversicification and behavioral reactions. *American Economic Review: Papers and Proceedings 104*(5), 224–29.

Bourguignon, F. and A. Spadaro (2006). Microsimulation as a tool for evaluating redistribution policies. *Journal of Economic Inequality 4*(1), 77–106.

Brewer, M., J. Browne, R. Joyce, and J. Payne (2011). *Child and working-age poverty from 2010 to 2020.* Institute for Fiscal Studies London.

Cai, L., J. Creedy, and G. Kalb (2006). Accounting for Population Ageing in Tax Microsimulation Modelling by Survey Reweighting. *Australian Economic Papers 45*(1), 18–37.

CEDEFOP (2012). Future skills supply and demand in Europe: Forecast 2012. European Centre for the Development of Vocational Training Research Paper No. 26.

Cribb, J., C. Emmerson, and G. Tetlow (2013). Incentives, shocks or signals: labour supply effects of increasing the female state pension age in the UK. IFS Working Paper.

de Blander, R., I. Schockaert, A. Decoster, and P. Deboosre (2013). The Impact of Demographic Change on Policy Indicators and Reforms. FLEMOSI Discussion Paper No. 25.

Decoster, A., X. Flawinne, and P. Vanleenhove (2014). Generational accounts for Belgium: fiscal sustainability at a glance. *Empirica 14*, 663–686.

Dekkers, G., H. Buslei, M. Cozzolino, R. Desmet, J. Geyer, D. Hofmann, M. Raitano, V. Steiner, and F. Verschueren (2010). The Flip Side of the Coin: The Consequences of the European Budgetary Projections on the Adequacy of Social Security Pensions. *European Journal of Social Security 12*(1), 94–120.

Dolls, M., C. Fuest, and A. Peichl (2012). Automatic stabilizers and economic crisis: US vs. Europe. *Journal of Public Economics 96*(3-4), 279–294.

Dustmann, C., T. Frattini, and C. Halls (2010). Assessing the fiscal costs and benefits of A8 migration to the UK. *Fiscal Studies 31*(1), 1–41.

Esping-Andersen, G. (1990). *The Three Worlds of Welfare Capitalism*. Princeton University Press.

European Commission (2012). The 2012 Ageing Report: Economic and budgetary projections for the 27 EU Member States (2010-2060). European Union.

European Council (2002). Barcelona European Council: Presidency Conclusions. 15 and 16 March.

Eurostat (2013). The distributional impact of public services in European countries. Eurostat Methodologies and Working Papers.

Fehr, H., M. Kallweit, and F. Kindermann (2012). Pension reform with variable retirement age: a simulation analysis for Germany. *Journal of Pension Economics and Finance 11*, 389–417.

Ferrera, M. (1996). The 'Southern Model' of Welfare in Social Europe. *Journal of European Social Policy 6 (1)*, 17–37.

Figari, F., A. Paulus, and H. Sutherland (2015). Microsimulation and policy analysis. In A. B. Atkinson and F. Bourguignon (Eds.), *Handbook of Income Distribution*, Volume 2, Chapter 25, pp. 2141–2221. Elsevier-North Holland.

Hatton, T. J. (2013). Refugee and Asylum Migration: A Short Overview. In A. Constant and K. F. Zimmermann (Eds.), *International Handbook on the Economics of Migration*. Edward Elgar.

Heckman, J. (1979). Sample Selection Bias as a Specification Error. *Econometrica 47*(1), 153–161.

Huisman, C., J. de Beer, R. van der Erf, N. van der Gaag, and D. Kupiszewska (2013). Demographic scenarios 2010 - 2030. NEUJOBS Working Paper D 10.1. http://www.neujobs.eu/publications/working-papers/demographic-scenarios-2010-2030.

Immervoll, H., H. J. Kleven, C. T. Kreiner, and E. Saez (2007). Welfare reform in European countries: a microsimulation analysis. *The Economic Journal 117*(516), 1–44.

KC, S., B. Barakat, A. Goujon, V. Skirbekk, W. Sanderson, and W. Lutz (2010). Projection of populations by level of educational attainment, age, and sex for 120 countries for 2005-2050. *Demographic Research 22*, 383–472.

Kudrna, G., C. Tran, and A. Woodland (2015). Facing demographic challenges: Pension cuts or tax hikes. ANU Working Papers in Economics and Econometrics No. 626.

Leombruni, R. and M. Richiardi (2006, November). Laborsim: An agent-based microsimulation of labour supply. An application to Italy. *Computational Economics 27*, 63–88.

Lichter, A., A. Peichl, and S. Siegloch (2015). The Own-Wage Elasticity of Labor Demand: A Meta-Regression Analysis. *European Economic Review 80*, 94–119.

Manoli, D., K. J. Mullen, and M. Wagner (2015). Policy variation, labor supply elasticities, and a structural model of retirement. *Economic Inquiry 53*(4), 1702–1717.

Manoli, D. and A. Weber (2012). Labor market effects of the early retirement age. mimeo.

Mara, I. and E. Narazani (2011). Labour-incentive reforms at preretirement age in Austria. *Empirica 38*, 481–510.

O'Donoghue, C. (Ed.) (2014). *Handbook of Microsimulation Modelling*. Emerald.

OECD (2013). *Pensions at a Glance 2013*. OECD.

Prettner, K. and A. Prskawetz (2010). Demographic change in models of endogenous economic growth. A survey. *Central European Journal of Operations Research 18*(4), 593–608.

Staubli, S. and J. Zweimüller (2013). Does raising the early retirement age increase employment of older workers? *Journal of Public Economics 108*, 17–32.

Sutherland, H. and F. Figari (2013). EUROMOD: the European Union tax-benefit microsimulation model. *International Journal of Microsimulation 6*(1), 4–26.

Vestad, O. L. (2013). Labour supply effects of early retirement provision. *Labour Economics 25*, 98 – 108.

Appendix

Labor supply elasticities

The total supply elasticity for subgroup $g \in [1, \ldots, 12]$ in country c is defined as a percentage change in total hours in relation to the percentage change in wages: $\varepsilon^S_{gc} = \frac{\partial H_{gc}}{\partial w_{gc}} \frac{w_{gc}}{H_{gc}}$. The intensive elasticity is this ratio conditional on working at least one hour. The extensive elasticity is defined as the relative change of the employment rate E_{gc}: $\varepsilon^{S,ext}_{gc} = \frac{\partial E_{gc}}{\partial w} \frac{w}{E_{gc}}$. This corresponds to the *extensive margin (participation)* in the result tables of Bargain et al. (2014).

Looking first at single females in Table 2, we see that the labor supply elasticity of low skilled single females ranges from 0.1 in the Eastern European countries to just over 0.3 in the British Isles. In the medium skilled category, it is the Southern European countries which display the highest labor supply elasticity for single females (at around 0.3) while the same figure for the British Isles is almost unchanged compared to the low skilled category. The Nordic and Continental countries show a similarly low labor supply elasticity for this group of medium skilled single women. The labor supply elasticities of high skilled single women are much higher than those of low or medium skilled, ranging from 0.25 in Eastern Europe to 0.5 in the Southern European countries and in the UK and Ireland.

In general, women in couples display higher labor supply elasticities than their single counterparts (except for the high skilled category). Once again, there are discrepancies by country groups although the labor supply elasticity of women in couples displays less variability by skill group than that of single women. Eastern European women in couples have the lowest labor supply elasticity, regardless of skill type, at around 0.1. Non-single southern European women have the largest labor supply elasticities which range from 0.35 among the high skilled to 0.5 among the medium skilled. The labor supply elasticity of continental European women is fairly constant across skill groups at around 0.3 while the Nordic countries and the British Isles also have stable elasticities of around 0.2 across skill groups.

Among single men, the highest labor supply elasticities are to be found among the high and low skilled with the group of medium skilled single men displaying reasonably stable labor supply elasticities across countries of between 0.1 (in the Continental countries) and 0.2 (in the Nordic countries). Among the low-skilled single men, the British Isles have the largest labor supply elasticity of around 0.45. The smallest, of 0.15, are to be found in the Continental and Eastern European countries. Meanwhile the Nordic and Southern European low skilled single men have labor supply elasticities of around 0.25. Similar cross-country grouping patterns are found for the high-skilled with the highest elasticities found in the British Isles (0.65), followed by the Nordic (0.35) and Southern European (0.3) countries.

Finally, we observe very low labor supply elasticities for men in couples, regardless of their skill level. These range from 0.06 to 0.14 with the largest values observed for high skilled men, followed by low skilled and then medium skilled men. The Nordic countries display the largest elasticities across country groups for men in couples, regardless of the skill group.

Table 2: Supply and Demand Elasticities

	Skill Level		
	High	Medium	Low
(Total) Labor supply elasticities			
Single Male			
Continental	0.15	0.11	0.23
Nordic	0.27	0.21	0.34
Anglo-Saxon	0.46	0.14	0.65
Southern	0.27	0.18	0.27
Eastern	0.15	0.17	0.24
Single Female			
Continental	0.23	0.14	0.38
Nordic	0.19	0.11	0.36
Anglo-Saxon	0.32	0.20	0.51
Southern	0.26	0.29	0.48
Eastern	0.09	0.10	0.48
Married Male			
Continental	0.09	0.08	0.10
Nordic	0.11	0.09	0.14
Anglo-Saxon	0.09	0.06	0.11
Southern	0.06	0.08	0.07
Eastern	0.08	0.08	0.08
Married Female			
Continental	0.28	0.30	0.27
Nordic	0.18	0.17	0.22
Anglo-Saxon	0.20	0.23	0.19
Southern	0.40	0.49	0.36
Eastern	0.11	0.12	0.11
Labor demand elasticities			
Continental	-0.53		-0.62
Nordic	-0.48		-0.54
Anglo-Saxon	-0.66		-0.91
Southern		-0.58	
Eastern		-0.66	

Note: Supply elasticities based on estimations from Bargain et al. (2014). The values refer to mean value by country group. Where possible, elasticities are country-specific. If a specific country was not covered in the initial study, it was assigned the mean value within the country group. Demand elasticities are from Lichter et al. (2015), by adding an interaction between skill and country group to the main specification and setting the time trend to 2030. Due to insufficient empirical estimates, we had to partly aggregate skill levels for the demand side.

Analytical derivation of new labor market equilibrium

Denoting total hours worked with H and the average wage w, the labor demand elasticity η with respect to wage is defined by $\eta = \frac{\partial H}{\partial w}\frac{w}{H} = H'(w)\frac{w}{H}$. We assume an isoelastic demand curve of the form $H_D(w) = cw^{\eta}$, where c is derived from the observed combination of hours and (average) wages.

$$H_D(w) = c_0^{LD} w^\eta = \frac{H_0}{w_0^\eta} w^\eta. \tag{3}$$

Assuming an equilibrium state initially, both the supply and the demand curve go through this point. Defining the wage elasticity of labor supply ε analogously[28], the analytical labor supply curve looks as

$$H_S(w) = c_0^{LS} w^\varepsilon = \frac{H_0}{w_0^\varepsilon} w^\varepsilon \tag{4}$$

Now suppose a labor supply shock due to demographic change, i. e. $H_1^S = \lambda H_0$. This shifts the labor supply curve (4) by manipulating c_0, i. e. $c_1 = \lambda \frac{H_0}{w_0^\varepsilon}$.

At the same time, we mimic general equilibrium effects from demographic change on the labor demand side by scaling c_0^{LD} in Eq. 3 in proportion to the population change π . The new labor market equilibrium is found at the intersection of both equations

$$\underbrace{\frac{\pi H_0}{w_0^\eta} w^\eta}_{\text{new LD curve}} \stackrel{!}{=} \underbrace{\frac{\lambda H_0}{w_0^\varepsilon} w^\varepsilon}_{\text{new LS curve}} \tag{5}$$

This yields the new equilibrium wage

$$w^* = \left(\frac{\lambda}{\pi}\right)^{\frac{1}{\eta - \varepsilon}} w_0 \tag{6}$$

The relative wage effect $\frac{w^*}{w_0} = \left(\frac{\lambda}{\pi}\right)^{\frac{1}{\eta-\varepsilon}}$ for the respective population subgroup can then be fed into the tax-benefit calculator to compute labor market reactions on the individual level, and, finally, fiscal effects. Note that measurement error in the individual wage does not constitute a problem here, as $\frac{w^*}{w_0}$ is independent of w_0. We distinguish individual reactions by extensive and intensive labor supply elasticities. First, people in work adjust their number of hours according to the intensive elasticity. In a next step, the number of people in work is adjusted such that the employment rate changes according to the extensive elasticity.

[28] At this stage, the total labor supply elasticities are used.

Table 3: Projected Total Population in 2010 and 2030

	Million People			% Change	
	Base	tough	friendly	tough	friendly
AT	8.4	8.3	9.1	-1.2	8.7
BE	10.8	11.7	12.5	8.1	15.1
BG	7.6	5.8	7.2	-22.9	-4.5
CY	0.8	0.9	1.0	10.4	23.9
CZ	10.5	10.1	11.2	-3.8	6.5
DE	81.8	72.3	80.8	-11.6	-1.2
DK	5.5	5.7	6.0	2.5	7.9
EE	1.3	1.1	1.4	-15.4	5.9
EL	11.3	10.9	11.8	-4.0	4.4
ES	46.0	44.8	52.0	-2.6	13.0
FI	5.4	5.5	5.8	2.6	7.6
FR	62.8	66.2	69.5	5.4	10.6
HU	10.0	9.2	9.7	-8.3	-2.7
IE	4.5	4.7	5.3	4.2	18.0
IT	60.3	60.6	67.6	0.5	12.1
LT	3.3	2.8	3.1	-15.2	-5.9
LU	0.5	0.6	0.7	21.4	30.4
LV	2.2	1.8	2.1	-21.4	-5.1
MT	0.4	0.4	0.4	-9.5	4.6
NL	16.6	17.0	18.1	2.6	9.0
PL	38.2	34.8	38.3	-8.8	0.3
PT	10.6	10.0	11.1	-5.8	4.0
RO	21.5	18.0	21.9	-16.0	2.0
SE	9.3	10.3	11.0	10.6	17.5
SI	2.0	2.1	2.3	0.6	10.8
SK	5.4	5.3	5.7	-3.2	5.2
UK	62.0	67.5	70.8	8.8	14.2

Own calculations based on projections in Huisman et al. (2013) applied to EU-SILC data for the EU-27.

Table 4: Projected Total Labor Force in 2010 and 2030

	Million Workers			% Change	
	Base	tough	friendly	tough	friendly
AT	5.7	5.2	5.6	-7.7	-0.9
BE	7.1	7.3	7.6	1.5	6.3
BG	5.2	3.7	4.6	-28.6	-12.3
CY	0.6	0.6	0.6	0.4	12.4
CZ	7.4	6.6	7.2	-10.9	-3.5
DE	53.9	43.8	47.9	-18.7	-11.1
DK	3.6	3.5	3.6	-3.3	-0.1
EE	0.9	0.7	0.9	-22.3	-2.2
EL	7.5	7.0	7.4	-7.6	-2.0
ES	31.4	28.9	33.2	-8.0	5.8
FI	3.6	3.3	3.4	-7.6	-5.2
FR	40.7	39.6	40.9	-2.7	0.5
HU	6.9	6.1	6.2	-10.9	-9.1
IE	3.0	2.9	3.4	-3.2	11.5
IT	39.7	38.0	41.5	-4.1	4.8
LT	2.3	1.8	2.0	-21.2	-14.4
LU	0.3	0.4	0.4	16.3	22.7
LV	1.5	1.2	1.4	-25.5	-12.6
MT	0.3	0.2	0.3	-19.6	-8.0
NL	11.1	10.4	10.8	-6.8	-2.8
PL	27.2	22.9	24.5	-16.0	-10.2
PT	7.1	6.5	7.0	-8.3	-1.9
RO	15.0	12.1	14.6	-19.3	-2.8
SE	6.1	6.3	6.6	3.4	8.2
SI	1.4	1.3	1.4	-8.6	-1.0
SK	3.9	3.5	3.7	-10.3	-5.1
UK	41.0	41.7	43.2	1.8	5.5

Own calculations based on Huisman et al. (2013). applied to EU-SILC data for the EU-27. Labor force is defined by the population aged between 15 and 64.

Table 5: Assumed annual net migration flows in 2030

Country	last observed net flow	projected net flows	
		tough	friendly
	in 1000		
AT	21.1	12.9	58.4
BE	64.1	23.3	62.0
BG	-15.7	-57.4	50.8
CY	1.8	1.8	9.2
CZ	28.3	-5.6	56.7
DE	-10.7	-100.3	366.2
DK	15.3	5.9	18.0
EE	0.0	-11.8	11.2
EL	35.1	11.2	60.3
ES	50.3	-5.8	513.8
FI	14.6	5.6	13.9
FR	70.0	5.0	169.0
IE	-27.6	-3.9	45.4
IT	311.6	128.2	549.1
HU	17.3	18.4	25.9
LT	-15.5	-9.5	7.4
LV	-4.7	-12.6	13.5
LU	6.6	2.1	4.7
MT	-0.2	-1.7	2.4
NL	38.5	-13.4	37.0
PL	-1.2	-85.3	91.7
PT	15.4	10.1	64.4
RO	-1.6	-144.2	150.6
SE	62.6	9.0	43.0
SI	11.5	-0.6	11.9
SK	4.4	-2.6	18.9
UK	201.3	100.8	255.5
EU-27	*892.6*	*-120.4*	*2710.9*

Source: Huisman et al. (2013), Table 4.

Table 6: Overview: Pension Systems in the EU

Country	Public Pension System	Occup. Pension System	Private Pension System	Statutory Retirement Age (2010)		recent RA reforms	Share workers/pensioners	Fertility Rate
				Men	Women		2012	2012
AT	ER	M		65	60	RA+5(w)	3.77	1.44
BE	ER	V		65	65		3.76	1.79
BG	ER	V	M (*after 1959&SP)	63	60	RA+2(m);RA+3(w)	3.60	1.50
CY	ER	M (Publ); V (Priv)		65	65		5.22	1.39
CZ	ER			62y2m	58y8m	RA+:2m/birth coh.(m/w)	4.17	1.45
DE	ER	V		65	65	RA+2(m/w)	3.14	1.38
DK	FR and MTS	QM		65	65	RA+2(m/w)	3.68	1.73
EE	ER since 1999	M (*after 1982)		63	61	RA+2(m); RA+4(w)	3.74	1.56
EL	ER			65	60	RA+2(m);RA+7(w)	3.29	1.34
ES	ER (Priv); FRw (Publ)	M (Publ);V (Priv)		65	65	RA+2(m/w)	3.83	1.32
FI	ER	V		63	63		3.53	1.80
FR	ER	V		65	65	RA+2(m/w)	3.65	2.01
HU	ER		V	62	62	RA+3(m/w)	4.02	1.34
IE	FR	M (Publ); V (Priv)		66	66	RA+2(m/w)	5.54	2.01
IT	ER	V		65y4m	60y40	RA+1y8m(m);RA+6y8m(w)	3.09	1.43
LV	ER			62	62		3.62	1.44
LT	ER			62y6m	60	RA+1.5(m);RA+3(w)	3.72	1.60
LU	ER	V		65	65		4.94	1.57
NL	FR	m		65	65	RA+2(m/w)	4.01	1.72
PL	ER	V	M(*after 1969);V	65	60	RA+2(m);RA+7(w)	5.06	1.30
PT	ER	mostly V		65	65		3.43	1.28
RO	ER		M	64	59	RA+1(m);RA+2(w)	4.22	1.53
SE	ER	QM	M	61	61		3.39	1.91
SI	ER	mostly V		63	61		4.05	1.58
SK	ER		M; V for NLME	62	57y11m	RA+4.1(w)	5.53	1.34
UK	ER (V)	V		65	60	RA+3(m);RA+8(w)	3.84	1.92

Source: European Commission (2012), OECD (2013); With regard to the private pension, a voluntary scheme exists in all countries. RA+ = Increase Retirement age by number of given years for women (w) and/or men (m); no entry: does not exist; ER = earnings-related; FR = flat rate; FRw = flat rate by wage categories; MTS = means tested supplement; S = Supplement; Priv = Private Sector Employees; Publ = Public Sector Employees; V = Voluntary Participation; M = Mandatory Participation; QM = Quasi-mandatory; SP = selected professions; NLME = new labor market entrants.

Table 7: Hours worked in 2010 and 2030

	Base	D		DW		DRW	
		to	fr	to	fr	to	fr
	Mill. Hours	% change					
AT	148.0	-11.1	-3.1	-9.4	0.1	2.4	14.1
BE	177.9	4.7	11.8	3.5	11.3	24.0	32.4
BG	179.0	-27.4	-8.6	-30.7	-12.1	-17.4	2.1
CY	17.0	2.5	16.7	2.5	16.6	18.7	34.0
CZ	221.4	-8.6	1.0	-8.9	1.8	3.2	14.3
DE	1442.5	-20.3	-10.1	-19.8	-9.4	-7.4	4.8
DK	109.4	-0.3	3.9	0.1	5.2	5.4	10.8
EE	29.8	-20.9	2.3	-23.1	-0.6	-12.4	11.7
EL	218.1	-9.0	-2.9	-10.0	-3.2	4.8	11.6
ES	910.5	-6.2	9.5	-8.0	7.7	10.5	27.7
FI	110.2	-4.4	-0.3	-5.9	-1.0	3.9	8.8
FR	1080.2	-0.2	4.5	-2.6	2.6	18.5	25.0
HU	188.5	-8.2	-5.0	-14.0	-9.9	-1.6	2.9
IE	82.1	2.0	19.0	-0.4	15.2	11.9	28.3
IT	1169.6	1.1	10.3	-5.0	4.6	16.6	27.1
LT	69.6	-17.6	-7.5	-19.6	-9.1	-1.3	9.8
LU	9.5	17.3	24.7	17.4	26.1	48.9	56.9
LV	51.6	-22.6	-6.5	-25.6	-9.9	-17.4	-0.7
MT	6.7	-12.5	2.1	-13.7	1.6	-7.7	8.0
NL	270.6	-4.6	0.9	-4.1	2.2	4.0	10.9
PL	745.3	-11.1	-3.2	-12.3	-3.9	-1.3	7.8
PT	206.5	-4.4	0.5	-7.1	-1.7	8.2	15.1
RO	376.3	-22.3	-0.5	-22.2	-1.3	-5.9	17.8
SE	177.9	7.0	13.7	4.3	11.8	11.6	18.8
SI	40.3	-8.8	-0.0	-10.4	-1.2	6.8	17.0
SK	119.5	-7.3	-0.8	-8.1	-0.8	7.5	14.7
UK	1033.9	3.1	8.6	3.1	9.1	14.3	20.3
Mean		*-7.0*	*3.0*	*-8.5*	*1.9*	*5.5*	*16.7*

Own calculations based on EM input datasets reweighted for 2010 and 2030 and labor demand and labor supply elasticities. Notes: Hours refer to total hours worked per week. D=demographic change only; DR=Retirement Age Reform. W indicates scenarios with wage effect.

Table 8: Employment in 2010 and 2030

	Base	D		DW		DRW	
		to	fr	to	fr	to	fr
	Millions	% change					
AT	3.6	-11.3	-3.7	-9.9	-0.5	4.8	17.7
BE	4.5	3.8	10.1	4.8	12.8	29.2	37.7
BG	3.9	-27.5	-8.6	-30.1	-10.9	-14.6	5.0
CY	0.4	1.7	15.7	5.0	19.6	27.8	44.5
CZ	4.7	-8.5	0.9	-3.8	7.4	12.7	24.7
DE	35.2	-20.2	-10.9	-18.0	-7.4	-3.0	13.3
DK	3.0	0.3	4.7	0.9	5.8	11.3	17.1
EE	0.7	-20.9	1.7	-21.7	1.1	-8.1	16.8
EL	4.7	-8.9	-2.5	-6.8	0.8	11.5	18.1
ES	21.5	-6.3	9.5	-5.4	11.7	18.2	36.6
FI	2.7	-4.5	-0.6	-4.7	0.0	9.2	14.3
FR	27.5	-1.3	2.9	-1.8	3.1	22.5	28.8
HU	4.5	-9.1	-6.3	-12.9	-9.0	2.1	6.6
IE	2.1	1.8	18.8	0.8	17.7	18.1	35.9
IT	26.8	0.2	9.4	-2.5	7.7	20.5	30.7
LT	1.7	-17.7	-7.9	-19.0	-8.4	-0.6	11.0
LU	0.2	15.2	21.6	20.3	28.7	48.7	57.6
LV	1.2	-22.1	-6.9	-23.5	-7.7	-12.6	4.4
MT	0.2	-13.8	0.1	-13.8	1.9	-5.9	9.4
NL	7.8	-5.0	0.2	-4.5	1.9	8.4	16.1
PL	16.2	-10.6	-2.4	-8.9	-0.1	5.1	14.9
PT	4.9	-6.0	-0.3	-5.6	-0.6	12.9	19.7
RO	8.5	-22.1	0.3	-19.7	3.0	-0.4	25.8
SE	5.3	6.8	13.2	3.7	10.9	13.0	20.1
SI	0.9	-9.7	-1.1	-9.5	-0.3	7.6	18.2
SK	2.7	-7.5	-0.7	-8.3	1.7	8.7	16.2
UK	28.7	3.5	8.9	4.5	10.6	22.3	28.8
Mean		*-7.4*	*2.5*	*-7.0*	*3.8*	*10.0*	*21.9*

Employment is defined by working a positive amount of hours. Own calculations based on EM input datasets reweighted for 2010 and 2030 and labor demand and labor supply elasticities. Notes: Hours refer to total hours worked per week. D=demographic change only; DR=Retirement Age Reform. W indicates scenarios with wage effect.

Table 9: Tax revenues in 2010 and 2030

	Base	D		DW		DRW	
		to	fr	to	fr	to	fr
	€ bn. per year	% change					
AT	21.6	11.6	26.1	30.8	53.9	1.6	29.2
BE	37.0	15.3	24.6	26.0	40.9	-3.1	9.1
BG	1.2	-24.1	-0.9	-23.0	0.7	-21.7	3.1
CY	1.0	28.3	47.0	39.9	81.8	30.8	76.1
CZ	4.4	-3.7	11.1	5.8	34.8	-17.7	4.3
DE	221.0	-16.3	-2.4	8.4	12.4	-20.6	-15.4
DK	45.7	6.8	13.4	16.0	37.5	2.6	17.2
EE	1.0	-18.9	8.4	-9.7	14.7	-20.8	3.6
EL	11.8	18.0	32.6	19.2	31.4	9.8	22.6
ES	65.0	23.5	44.8	31.2	57.6	1.7	21.9
FI	29.6	11.9	20.0	25.7	46.2	8.2	24.0
FR	129.0	21.5	29.8	28.9	46.3	6.9	19.6
HU	3.7	-3.8	8.2	-13.7	-2.9	-25.2	-17.0
IE	10.9	29.2	45.7	40.6	45.2	17.8	24.1
IT	218.2	25.0	38.8	30.7	45.9	23.4	35.3
LT	1.5	-12.3	1.2	-6.4	7.6	-20.1	-6.6
LU	2.2	32.1	45.6	41.9	64.1	15.8	32.1
LV	2.1	-19.4	1.7	-20.2	2.4	-23.8	-0.2
MT	0.2	2.0	25.4	-11.9	20.3	-16.4	9.4
NL	58.9	9.9	18.1	31.7	48.5	12.4	25.0
PL	28.4	8.4	22.4	8.1	26.9	2.7	20.6
PT	10.1	33.5	45.8	21.3	38.0	-16.5	-4.4
RO	6.2	-5.8	23.5	-4.0	11.2	-16.2	-0.1
SE	47.0	15.9	24.7	24.3	53.8	17.3	40.5
SI	2.3	5.2	19.6	42.6	39.9	23.5	24.4
SK	1.2	-1.0	12.0	2.4	33.7	-21.2	7.0
UK	243.4	13.5	20.7	20.5	29.0	14.9	21.8

Own calculations based on EM input datasets reweighted for 2010 and 2030 and labor demand and labor supply elasticities. Notes: D=demographic change only; DR=Retirement Age Reform. W indicates scenarios with wage effect.

Table 10: SSC revenues in 2010 and 2030

	Base	D		DW		DRW	
		to	fr	to	fr	to	fr
	€ bn. per year	% change					
AT	42.9	-5.1	6.2	4.4	16.2	5.4	19.7
BE	47.2	7.1	15.0	16.0	28.2	4.7	15.0
BG	3.6	-26.3	-3.2	-24.2	-1.3	-21.2	3.6
CY	1.5	5.4	21.4	12.1	26.1	19.9	41.3
CZ	20.6	-6.6	5.9	-1.4	17.9	-5.7	11.1
DE	357.7	-19.6	-8.1	-10.0	-0.1	-9.7	-0.5
DK	11.3	2.6	7.9	9.1	23.9	1.4	12.2
EE	2.3	-20.0	6.5	-12.4	12.0	-18.9	5.9
EL	23.9	-2.1	7.0	-0.2	7.7	13.3	23.2
ES	140.0	-2.4	16.4	4.7	25.1	2.9	22.7
FI	25.5	-1.6	4.2	9.1	23.9	1.6	13.4
FR	357.2	4.2	10.2	12.2	24.6	8.3	18.4
HU	9.2	-8.0	0.8	-13.1	-3.7	-12.4	-4.0
IE	14.1	10.6	27.6	18.2	26.9	3.9	13.0
IT	239.0	3.2	14.9	8.9	22.4	18.5	30.7
LT	4.4	-13.6	-1.0	-9.0	4.2	-16.8	-3.6
LU	3.1	20.6	31.3	29.1	45.1	28.3	40.5
LV	3.1	-22.1	-1.4	-23.0	-0.8	-25.1	-1.9
MT	0.4	-9.2	7.3	-11.6	3.6	-5.0	11.4
NL	99.1	2.9	10.0	7.8	14.8	5.8	12.9
PL	41.6	-4.9	7.6	-4.0	12.3	-0.5	16.1
PT	21.5	5.6	14.9	4.3	17.2	-5.7	6.5
RO	9.6	-15.1	14.1	-13.3	1.4	-17.1	-0.0
SE	54.8	10.4	17.7	15.6	30.5	15.8	28.6
SI	6.2	-2.6	9.7	18.2	23.4	14.2	21.5
SK	8.9	-8.2	1.5	-7.2	7.9	-10.0	4.2
UK	151.3	5.7	12.6	16.6	23.9	8.0	13.9

Own calculations based on EM input datasets reweighted for 2010 and 2030 and labor demand and labor supply elasticities. Notes: D=demographic change only; DR=Retirement Age Reform. W indicates scenarios with wage effect.

Table 11: Benefit payments in 2010 and 2030

	Base	D		DW		DRW	
		to	fr	to	fr	to	fr
	€ bn. per year	% change					
AT	40.1	29.5	43.1	29.3	42.8	12.6	24.9
BE	33.1	41.9	54.7	41.8	54.7	-3.7	6.1
BG	3.3	0.5	20.1	0.6	20.3	-24.4	-15.3
CY	1.8	42.7	57.1	42.3	56.7	-10.0	0.6
CZ	13.9	13.5	26.5	13.4	26.5	-9.8	2.0
DE	370.1	8.3	20.2	8.7	20.5	-10.9	-0.3
DK	30.5	11.5	21.0	11.1	20.5	-8.0	-0.4
EE	1.0	2.7	20.8	2.8	21.0	-19.2	-4.6
EL	20.3	29.5	44.6	29.2	44.3	-4.3	8.9
ES	70.2	49.8	67.3	49.3	66.7	-1.3	10.8
FI	23.7	33.2	44.5	33.0	44.0	7.5	17.0
FR	263.0	35.3	45.8	34.9	45.7	1.7	10.1
HU	9.1	10.8	20.5	11.2	20.7	-2.6	6.8
IE	17.7	13.8	27.0	13.9	27.2	2.0	14.3
IT	200.6	41.7	56.6	41.4	56.1	5.7	17.6
LT	2.3	2.4	14.8	2.7	15.4	-20.2	-10.1
LU	3.0	43.7	55.9	42.4	54.2	9.7	19.4
LV	1.2	-3.2	14.7	-2.8	14.7	-19.6	-4.0
MT	0.6	19.6	35.8	19.4	35.7	12.5	27.0
NL	47.1	23.9	34.2	22.7	33.0	13.0	21.6
PL	38.1	24.8	38.2	24.6	37.8	5.0	16.1
PT	18.2	36.8	51.2	36.3	50.2	-11.1	-1.0
RO	11.6	21.1	39.6	20.8	39.2	-0.5	14.9
SE	35.4	24.0	36.0	23.9	36.0	-2.3	7.2
SI	4.1	35.6	49.1	34.4	47.8	4.7	15.8
SK	5.0	25.3	37.2	25.5	37.8	-4.2	10.0
UK	175.7	16.2	23.9	13.6	20.8	0.9	7.4

Own calculations based on EM input datasets reweighted for 2010 and 2030 and labor demand and labor supply elasticities. Notes: D=demographic change only; DR=Retirement Age Reform. W indicates scenarios with wage effect.

Table 12: Changes in normalized budgets between 2010 and 2030

	D		DW		DRW	
	to	fr	to	fr	to	fr
AT	-9.82%	-10.96%	-3.15%	-2.58%	-2.47%	0.11%
BE	-7.30%	-7.94%	-1.38%	0.99%	-2.11%	-0.39%
BG	-3.92%	-4.92%	-3.43%	-4.43%	2.33%	3.92%
CY	-6.30%	-6.98%	-4.32%	-3.25%	4.38%	7.35%
CZ	-6.93%	-7.25%	-4.29%	-1.09%	-2.05%	0.01%
DE	-10.06%	-10.55%	-2.46%	-5.32%	-1.61%	-4.09%
DK	-2.03%	-3.61%	2.47%	7.84%	1.42%	4.11%
EE	-8.38%	-1.94%	-4.32%	0.94%	-5.05%	0.90%
EL	-4.89%	-6.32%	-4.20%	-6.23%	5.39%	4.38%
ES	-6.40%	-4.31%	-3.04%	0.33%	0.03%	3.13%
FI	-7.93%	-8.36%	-0.23%	6.07%	-1.41%	2.91%
FR	-8.87%	-10.18%	-4.18%	-1.45%	1.20%	2.96%
HU	-4.21%	-5.26%	-7.47%	-8.41%	-4.19%	-5.81%
IE	-1.83%	-2.19%	1.54%	-2.48%	-1.97%	-5.34%
IT	-3.17%	-2.55%	0.14%	1.76%	9.95%	10.97%
LT	-4.34%	-2.69%	-1.90%	-0.06%	-2.14%	0.23%
LU	-6.61%	-7.53%	-2.77%	-0.91%	0.18%	0.64%
LV	-7.65%	-1.47%	-8.20%	-1.13%	-7.62%	0.33%
MT	-4.40%	-7.89%	-5.66%	-8.76%	-3.36%	-6.30%
NL	-4.45%	-4.64%	2.58%	4.30%	-0.78%	0.31%
PL	-4.74%	-3.98%	-4.49%	-1.75%	0.35%	3.49%
PT	-1.10%	-3.29%	-2.92%	-3.43%	0.48%	0.05%
RO	-7.49%	-6.60%	-6.58%	-12.02%	-2.82%	-6.48%
SE	-2.18%	-2.32%	2.38%	11.54%	6.48%	13.43%
SI	-10.63%	-10.11%	2.17%	-2.12%	5.31%	2.82%
SK	-9.57%	-10.27%	-9.04%	-6.77%	-4.79%	-3.48%
UK	-1.99%	-1.99%	1.94%	2.43%	1.50%	1.48%
Mean	-5.82%	-5.78%	-2.62%	-1.33%	-0.13%	1.17%

Balance change to 2010 according to Equation 2. Own calculations based on EM input datasets reweighted for 2010 and 2030 and labor demand and labor supply elasticities. Notes: D=demographic change only; DR=Retirement Age Reform; 2. W indicates scenarios with wage effect.

Table 13: Probit estimations for entering employment: Men

Country	AT	BE	BG	CY	CZ	DE	DK	EE	EL	ES	FI	FR	HU
Age	-1.218*	0.684*	0.342*	-3.310*	-5.801*	-1.664*	-2.013*	-3.780*	2.888*	-1.187*	-1.033*	-3.489*	-5.354*
Age^2	0.0285*	-0.00968*	-0.00395*	0.0651*	0.119*	0.0356*	0.0452*	0.0779*	-0.0531*	0.0261*	0.0244*	0.0783*	0.109*
Age^3	-0.000*	0.000*	0.000	-0.000*	-0.000*	-0.000*	-0.000*	-0.000*	0.000*	-0.000*	-0.000*	-0.000*	-0.000*
Disabled	0	-1.603*	-1.943*	-2.986*	-2.691*	-1.983*	-2.009*	-1.966*	-2.584*	-2.468*	-1.420*	-3.046*	-1.992*
MedSkilled	0.369*	0.428*	0.342*	-0.317*	0.875*	0.233*	0.223*	0.357*	-0.224*	0.121*	0.174*	0.300*	0.335*
HighSkilled	0.826*	0.825*	0.838*	-0.009	1.136*	0.591*	0.334*	0.791*	0.206*	0.375*	0.278*	0.419*	0.564*
# of Children	0.115*	0.0655*	-0.0221*	0.0871*	0.0945*	0.276*	0.0667*	0.0574*	0.170*	0.112*	0.0548*	0.0178*	0.00596*
CapIncome	0.769*	0.478*	()	-0.724*	-0.0748*	1.196*	0.0000226*	0.899*	0.568*	0.297*	0.749*	0.359*	-0.599*
Spouse Empl.	0.548*	0.704*	0.180*	0.412*	0.542*	0.904*	0.715*	0.436*	0.441*	0.587*	0.598*	0.409*	0.508*
Spouse Not Empl.	-0.211*	-0.331*	0.0164*	-0.176*	-0.505*	-0.519*	-0.540*	-0.212*	-0.313*	-0.265*	-0.238*	-0.199*	-0.468*
Constant	18.36*	-13.18*	-6.194*	58.20*	94.12*	26.40*	30.77*	61.68*	-49.35*	19.04*	15.00*	52.64*	88.29*
Pseudo R^2	0.375	0.365	0.242	0.342	0.425	0.398	0.42	0.37	0.277	0.333	0.304	0.306	0.435

Country	IE	IT	LT	LU	LV	MT	NL	PL	PT	RO	SE	SI	SK	UK
Age	-1.149*	2.515*	-3.845*	3.168*	-4.665*	0.679	-3.471*	-0.353*	0.386*	-1.564*	-2.380*	-2.826*	-3.220*	-0.140*
Age^2	0.025*	-0.045*	0.077*	-0.057*	0.091*	-0.013	0.072*	0.010*	-0.006*	0.032*	0.049*	0.057*	0.068*	0.005*
Age^3	-0.000*	0.000*	-0.001*	0.000*	-0.001*	0	-0.000*	-0.000*	0.000*	-0.000*	-0.000*	-0.000*	-0.000*	-0.000*
Disabled	-2.166*	-1.856*	-2.347*	-3.146*	-1.560*	-3.572*	-2.256*	-1.201*	-2.104*	-2.167*	-2.159*	-1.985*	-2.708*	0
MedSkilled	0.390*	0.318*	0.256*	0.160*	0.079*	0.580*	-0.015*	0.147*	0.151*	0.116*	0.266*	0.037*	0.356*	-0.180*
HighSkilled	0.447*	0.699*	0.571*	0.643*	0.296*	0.996*	0.239*	0.678*	0.474*	0.745*	0.404*	0.659*	0.525*	-0.039*
# of Children	0.033*	0.139*	0.043*	0.218*	0.108*	0.050*	0.280*	0.070*	0.035*	0.016*	0.085*	0.094*	-0.047*	-0.002*
CapIncome	0.276*	0.383*	0.167*	0.735*		-0.250*	0.443*	0.119*	0.239*	-0.443*	0.919*	0.390*	0.535*	0.412*
Spouse Empl.	0.725*	0.375*	0.709*	0.131*	0.386*	0.473*	0.773*	0.723*	0.819*	0.330*	0.276*	0.423*	0.809*	0.766*
Spouse Not Empl.	-0.316*	-0.181*	-0.137*	0.113*	-0.336*	0.109*	-0.408*	-0.585*	-0.204*	-0.317*	-0.432*	-0.226*	-0.508*	-0.582*
Constant	18.373*	-44.021*	64.738*	-55.058*	80.334*	-9.767	56.943*	5.067*	-6.522*	27.620*	39.639*	48.005*	51.518*	1.944*
Pseudo R^2	0.35	0.328	0.411	0.546	0.172	0.439	0.466	0.303	0.238	0.284	0.335	0.283	0.312	0.176

Dependent Variable: Employment Dummy. Sample is restricted to workers between 40 and 70 years. Significance levels: (*) = 0.01 level, (#) = 0.05 level, (+) = 0.1 level.

Table 14: Probit estimations for entering employment: Women

Country	AT	BE	BG	CY	CZ	DE	DK	EE	EL	ES	FI	FR	HU
Age	-1.149*	2.515*	-3.845*	3.168*	-4.665*	0.679	-3.471*	-0.353*	0.386*	-1.564*	-2.380*	-2.826*	-3.220*
Age^2	0.025*	-0.045*	0.077*	-0.057*	0.091*	-0.013	0.072*	0.010*	-0.006*	0.032*	0.049*	0.057*	0.068*
Age^3	-0.000*	0.000*	-0.001*	0.000*	-0.001*	0	-0.000*	-0.000*	0.000*	-0.000*	-0.000*	-0.000*	-0.000*
Disabled	-2.166*	-1.856*	-2.347*	-3.146*	-1.560*	-3.572*	-2.256*	-1.201*	-2.104*	-2.167*	-2.159*	-1.985*	-2.708*
MedSkilled	0.390*	0.318*	0.256*	0.160*	0.079*	0.580*	-0.015*	0.147*	0.151*	0.116*	0.266*	0.037*	0.356*
HighSkilled	0.447*	0.699*	0.571*	0.643*	0.296*	0.996*	0.239*	0.678*	0.474*	0.745*	0.404*	0.659*	0.525*
# of Children	0.033*	0.139*	0.043*	0.218*	0.108*	0.050*	0.280*	0.070*	0.035*	0.016*	0.085*	0.094*	-0.047*
CapIncome	0.276*	0.383*	0.167*	0.735*		-0.250*	0.443*	0.119*	0.239*	-0.443*	0.919*	0.390*	0.535*
Spouse Empl.	0.725*	0.375*	0.709*	0.131*	0.386*	0.473*	0.773*	0.723*	0.819*	0.330*	0.276*	0.423*	0.809*
Spouse Not Empl.	-0.316*	-0.181*	-0.137*	0.113*	-0.336*	0.109*	-0.408*	-0.585*	-0.204*	-0.317*	-0.432*	-0.226*	-0.508*
Constant	18.373*	-44.021*	64.738*	-55.058*	80.334*	-9.767	56.943*	5.067*	-6.522*	27.620*	39.639*	48.005*	51.518*
Pseudo R^2	0.35	0.328	0.411	0.546	0.172	0.439	0.466	0.303	0.238	0.284	0.335	0.283	0.312

Country	IE	IT	LT	LU	LV	MT	NL	PL	PT	RO	SE	SI	SK	UK
Age	-0.140*	-1.149*	2.515*	-3.845*	3.168*	-4.665*	0.679	-3.471*	-0.353*	0.386*	-1.564*	-2.380*	-2.826*	-3.220*
Age^2	0.005*	0.025*	-0.045*	0.077*	-0.057*	0.091*	-0.013	0.072*	0.010*	-0.006*	0.032*	0.049*	0.057*	0.068*
Age^3	-0.000*	-0.000*	0.000*	-0.001*	0.000*	-0.001*	0	-0.000*	-0.000*	0.000*	-0.000*	-0.000*	-0.000*	-0.000*
Disabled	0	-2.166*	-1.856*	-2.347*	-3.146*	-1.560*	-3.572*	-2.256*	-1.201*	-2.104*	-2.167*	-2.159*	-1.985*	-2.708*
MedSkilled	-0.180*	0.390*	0.318*	0.256*	0.160*	0.079*	0.580*	-0.015*	0.147*	0.151*	0.116*	0.266*	0.037*	0.356*
HighSkilled	-0.039*	0.447*	0.699*	0.571*	0.643*	0.296*	0.996*	0.239*	0.678*	0.474*	0.745*	0.404*	0.659*	0.525*
# of Children	-0.002+	0.033*	0.139*	0.043*	0.218*	0.108*	0.050*	0.280*	0.070*	0.035*	0.016*	0.085*	0.094*	-0.047*
CapIncome	0.412*	0.276*	0.383*	0.167*	0.735*		-0.250*	0.443*	0.119*	0.239*	-0.443*	0.919*	0.390*	0.535*
Spouse Empl.	0.766*	0.725*	0.375*	0.709*	0.131*	0.386*	0.473*	0.773*	0.723*	0.819*	0.330*	0.276*	0.423*	0.809*
Spouse Not Empl.	-0.582*	-0.316*	-0.181*	-0.137*	0.113*	-0.336*	0.109*	-0.408*	-0.585*	-0.204*	-0.317*	-0.432*	-0.226*	-0.508*
Constant	1.944*	18.373*	-44.021*	64.738*	-55.058*	80.334*	-9.767	56.943*	5.067*	-6.522*	27.620*	39.639*	48.005*	51.518*
Pseudo R^2	0.176	0.35	0.328	0.411	0.546	0.172	0.439	0.466	0.303	0.238	0.284	0.335	0.283	0.312

Dependent Variable: Employment Dummy. Sample is restricted to workers between 40 and 70 years. Significance levels: (*) = 0.01 level, (#) = 0.05 level, (+) = 0.1 level.