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RAISING EMPLOYMENT: FISCAL POLICY, WAGE FORMATION, AND THEIR IMPACT ON WELFARE, INEQUALITY AND POVERTY – A GENERAL EQUILIBRIUM ANALYSIS

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Raising employment: fiscal policy, wage formation, and their impact on welfare, inequality and poverty

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Abstract

This paper studies the impact of (targeted) changes in labor taxes, unemployment benefits, and wage setting on employment in general equilibrium. Unlike existing literature, we also evaluate the effects of these changes from the perspective of welfare, inequality and poverty. Our methodological framework is an overlapping generations model that portrays two key characteristics: households differ by innate ability and there is an imperfect labor market (union wage floor) for individuals of low ability, causing unemployment. Our main findings are as follows. Unilateral fiscal actions, such as a labor tax cut financed by lower unemployment benefits, can have clear positive effects on employment of (mainly) low ability individuals and on aggregate inequality indicators, but they raise poverty among those who remain unemployed. Achieving the same progress in employment with better results in the fight against inequality and without increase in poverty requires combined efforts of fiscal authorities (labor tax cuts) and unions (wage moderation). Depending on the policy maker's priority for either employment or lower inequality, a reduction of labor taxes on employers or on employees is preferable. All our results assume employability of the unemployed, and are therefore to be seen as long-run effects, which may require complementary policies.

Key words: employment of low educated individuals, fiscal policy, heterogeneous ability, welfare inequality, poverty, overlapping generations (OLG)

JEL Classification: E62, H5, I28, J22, J24

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1 Introduction

Since the financial crisis, and because of aging and globalization, government budgets and the welfare state have come under increasing pressure in many countries. To cope with this challenge, raising employment and growth stands high on the agenda of policy makers almost everywhere. Considering that countries with weak labor market performance are lagging behind especially in terms of employment among low educated individuals (Boone and Heylen, 2019), it is mainly on that segment of the labor market that progress can be made. Increased sensitivity in society to rising inequality and poverty, however, imposes additional restrictions on the available options that policy makers have. Not only (un)employment effects but also social effects of policies are now monitored.

A huge body of academic literature has emerged that can support policy makers in developing effective employment policies. Often, the focus of this literature was on the impact of fiscal policy or the role of labor market characteristics and wage formation.

Many researchers have investigated the influence of labor taxes and non-employment benefits on aggregate employment and unemployment in econometric panel data studies (e.g. Nickell et al. 2005; Bassanini and Duval, 2006; Berger and Heylen, 2011; Nymoen and Sparrman, 2015). Overall, this work reveals unfavorable effects from higher taxes or higher benefits on labor market performance. Studying the same question in theoretical general equilibrium models, Prescott (2004), Rogerson (2007) and Dhont and Heylen (2008), among others, come up with the same conclusion. If countries want to raise aggregate employment, they should reduce labor taxes and/or non-employment benefits.

More recently, several extensions of the basic general equilibrium setup have allowed a much richer analysis of the employment effects of fiscal policy. One extension was the introduction of an education decision and endogenous human capital. As shown by e.g. Jacobs (2009), this may reinforce the impact of fiscal policy due to the possibility of (positive) feedback effects between labor supply and human capital. A second extension was the development of general equilibrium models with overlapping generations, which allow to study the impact of fiscal policy on life cycle patterns in labor supply and employment of different age groups (e.g. Rogerson and Wallenius, 2009). As a third important extension, the modeling of individuals with heterogeneous abilities made possible a theoretical analysis of fiscal policy effects on employment by education level, as for example in Heylen and Van de Kerckhove (2019)[1]. By introducing different generations and skill heterogeneity within generations, the latter two extensions also opened up important possibilities to investigate policy effects on inequality.

A weakness, however, in all the above-mentioned theoretical models is the assumption of a perfectly competitive labor market. It is therefore difficult for them to rationalize or explain (involuntary) unemployment and the huge employment gap between high and low educated individuals. The introduction of labor market imperfections in the model can address this shortcoming. A common approach in the literature has been to specify some kind of wage floor, resulting from minimum wage regulations or union involvement, that is above the market-

[1]Clearly, many studies in the overlapping generations tradition realistically assume individuals with heterogeneous ability and human capital (e.g. Cahuc and Michel, 1996; Kotlikoff et al., 2007; Buyse et al., 2017). Most of these papers also model labor supply, and/or human capital accumulation as endogenous variables. However, their focus is not on the relationship between fiscal policy and employment among the lower educated.

clearing level for low educated labor (see e.g. Cahuc and Michel, 1996; Daveri and Tabellini, 2000; Sommacal, 2006; Batyra and Sneessens, 2010; Boone and Heylen, 2019). Daveri and Tabellini (2000), Batyra and Sneessens (2010) and Boone and Heylen (2019) discuss the role of labor taxes, unemployment benefits and/or union wage setting for (un)employment in this type of theoretical model.

The above review of the literature leaves no doubt that huge progress has been made in the study of the impact of fiscal policy and wage formation on employment and unemployment, including an analysis of differences by age, by education level and between countries. To the best of our knowledge, however, no one has investigated simultaneously, i.e. within the same coherent framework, also the social effects of changes in fiscal policy and wage setting aimed at higher employment. Are these policies welfare enhancing, and if so, how is the increase in welfare distributed across the population? On the employers' side, it is often said that wage moderation is essential for job creation. But do the extra jobs outweigh lower wages when it comes to reducing inequality? Also, according to many studies, a reduction of unemployment benefits may reduce unemployment, but what happens to the income and welfare level of the individuals with the lowest ability who, despite everything, cannot find a job? What policy mix can promote employment and per capita income, while at the same time reducing income (and welfare) inequality and avoiding increased poverty among weaker groups in society? Given the intense debate on inequality in recent years, these questions can no longer be avoided.

Our objective and contribution in this paper is to try to answer these questions. To do this, we model a small open economy with four overlapping generations in which individual hours worked, education, income and welfare are endogenous. In addition to a rich specification of fiscal policy, the model portrays two key characteristics: individuals differ by innate ability and there is an imperfect labor market (union wage floor) for individuals of low ability, causing unemployment.

Within each generation, individuals have either low, medium-low, medium-high or high ability. When their ability is high(er), they not only enter the model with higher initial human capital, they are also more productive in learning and accumulating human capital through education. This will increase their labor productivity and wages during later periods[2]. While the labor market for high, medium-high and medium-low ability individuals is perfectly competitive and clears in our model, a wage floor above the market-clearing level will imply (involuntary) unemployment among the low educated[3]. This kind of modeling is similar to the approach taken in Cahuc and Michel (1996) and Daveri and Tabellini (2000) among others (cf. supra). A union wage setting framework may also best capture how wages are set in most European countries. Even in the US, there exists evidence of some form of minimum wage. To model wage setting, we follow Faia and Rossi (2013) and Boone and Heylen (2019) in assuming that unions set the wage as a function of the competitive wage and fiscal policy parameters (e.g. tax rates, unem-

[2]This set of assumptions may offer the best match to the findings of Huggett et al. (2011) and Keane and Wolpin (2007) that heterogeneity in human capital endowment at young age and learning abilities, rather than shocks to human capital, account for most of the variation in lifetime utility. Our approach also matches findings that innate learning ability and human capital at the age of 23 are strongly correlated (Huggett et al., 2011).

[3]We introduce unemployment only for households of low ability to match the main disparities that we observe in the data for (un)employment by education. Later in this paper we will take data for individuals without higher secondary education as representative for low ability individuals in our model. The data show a gap in employment (and unemployment) in particular between these individuals and those with higher education.

ployment benefits). Wage dispersion and different chances on the labor market due to different human capital levels will result in disparities in labor income and accumulated savings in our model, leading to an unequal distribution of total income and welfare.

Finally, the model includes a rich specification of fiscal policy. The government collects taxes on consumption, capital and labor, both in the form of social contributions paid by employers and in the form of progressive personal labor income taxes. It may impose different labor tax rates on workers with different ability and wage levels. Government expenditures include pensions, unemployment benefits, lump sum transfers and goods and services.

Before we can use our model to simulate fiscal policy shocks and shocks to wage formation, we calibrate it to recent data for the period 2014-2017. Moreover, we include a minimum test of the model's validity by comparing its predictions in this period to the reality of 11 individual countries, belonging to three groups: the core euro area (Belgium, the Netherlands, France, Germany), the Nordic countries (Norway, Sweden, Denmark, Finland) and the Anglo-Saxon countries (Canada, United States, United Kingdom). To derive country-specific predictions, we only allow fiscal and pension policy variables to differ by country. Technology and individual preference parameters are imposed to be the same in all countries, while a set of parameters related to institutions (e.g. wage setting) can vary by country group. Although understandably not perfect, we find that the model does succeed in explaining a large part of the cross-country variation in labor market performance and inequality in 2014-2017.

Having shown the model's empirical reliability, we then proceed by investigating (targeted) shocks in the employers' social contribution rate, labor taxes on workers, the unemployment benefit replacement rate and the level of the union wage. The main innovation in our analysis is that, next to studying the impact of these shocks on economic indicators, we also consider their effect on social indicators within the same framework. The modeling of four different ability levels in overlapping generations, with unemployment for low educated individuals, allows for a relevant amount of heterogeneity in the model. The setup is therefore well suited to study important drivers of the distribution of income and inequality. Furthermore, we consider several different indicators for welfare, inequality and poverty, allowing for a deeper and broader analysis of the social impact of policies.

Our main findings are the following. First, we confirm that fiscal policy matters for (un)employment. In line with existing literature, we find that targeted tax cuts on low educated labor (on either employees or employers) and a reduction of the generosity of the unemployment benefit system succeed in raising employment and output, and in strongly reducing unemployment among the low educated. Getting low educated people into work also raises their welfare and contributes to a reduction of overall inequality in society. A significant drawback of this policy, however, is that it raises poverty among those individuals who, despite everything, cannot find a job. Second, to achieve (at least) the same progress in employment and output with better results in the fight against inequality and without increase in poverty among the unemployed, combined efforts of fiscal policy makers (labor tax cuts) and unions (wage moderation) are required. Mutual commitment of these two key players can imply a drastic reduction of the cost of low educated labor without having to reduce unemployment benefits. If promotion of output and employment is the main goal, our results prefer to reduce the labor tax rate on employers. If the reduction of inequality is the main objective, it would be better to cut labor income taxes on

(low educated) workers. Third, even if some of the policies studied in this paper avoid greater poverty among those who remain unemployed, none of these policies succeed in reducing it. Improvement on this indicator also, requires complementary policies.

The structure of the paper is as follows. The next section describes the OLG model. Section 3 discusses the parameterization of the model and tests its empirical validity. We do this by comparing the model's predictions with the data for 11 OECD countries in 2014-17. Section 4 simulates shocks in the social contribution rate, labor taxes, the unemployment benefit, and the level of the union's wage floor for low ability workers. We combine the different policy shocks to find policy options that are politically feasible and improve both equity and efficiency. Section 5 concludes.

2 The model

Individuals enter the model at the age of 20 and live for four periods of 15 years. When young (age 20-34), middle aged (35-49) and older (50-64), they allocate their time to either work (participation on the labor market) or leisure. Young individuals can also choose to allocate time to education. During the last stage of life (age 65-79), individuals are retired and only have leisure.

In each generation individuals are born with one of four innate ability levels: low (L), medium-low (ML), medium-high (MH) and high (H). We assume each group to be of an equal size that is normalized to 1[4]. When their initial ability and human capital is higher, individuals will also be more productive in building additional human capital by studying. This will increase their labor productivity and wages during the next periods. Our assumption is that it is only worthwhile for high and medium-high ability individuals to invest time in education. Too low productivity of schooling implies that low and medium-low ability individuals will not study (after the age of 20)[5].

Households interact with firms, the government and the rest of the world in their decisions on labor supply, education, consumption and saving. Firms produce output on competitive markets and use capital and workers to do so. The labor market for high, medium-high and medium-low ability workers is assumed to be perfectly competitive. For low ability labor it is not. We assume the existence of a wage floor (minimum wage) imposed by unions for low educated employees. As this wage floor is above the competitive wage, there is (involuntary) unemployment for this ability group. The fiscal government intervenes by collecting taxes and by spending on goods and transfers. Its budget does not necessarily need to be balanced. It can borrow on domestic or foreign markets, as we model an open economy.

The next sections discuss the different parts of the model. In the equations to come, superscript t indicates the period in which a household enters the model, i.e. the generation to which

[4]This means that total population equals 16: four ability groups times four age groups.

[5]The direct link between ability, on the one hand, and time and productivity in education, on the other, allows us later in this paper (when calibrating the model and assessing its empirical relevance) to approximate the different ability levels with observed levels of educational attainment. The low ability group will be proxied by individuals who obtain below upper secondary education at best, the medium-low ability group by individuals who obtain an upper secondary degree at best. Medium-high ability individuals are assumed to have a bachelor's or equivalent degree, while the high ability group will be proxied by individuals with a master's or equivalent degree.

a household belongs. Subscript j expresses the jth period of life for the individuals belonging to a household. Subscript a will always refer to ability. Although we later apply the model to different countries, to keep notation parsimonious, we abstract from country-specific indexes.

2.1 Households

2.1.1 Preferences

In the spirit of Merz (1995) and Andolfatto (1996), we assume that individuals of the same generation and ability are grouped in households of unitary mass. They pool their income, so consumption is equalized across household members. As low ability individuals can be involuntarily unemployed, their household will consist both of a fraction of unemployed (u) and a fraction of employed members ($1-u$). Households of other ability have only employed members.

Preferences are specified in a separable utility function of the class of King, Plosser and Rebelo (1988). Households gain utility from consumption c^t_{ja} and leisure l^t_{ja} in each of the four periods of life. Lifetime utility of high, medium-high and medium-low households is obtained in the following way:

$$U^t_a \;=\; \sum_{j\,=\,1}^{4} \beta^{j-1} \left(ln\; c^t_{ja} \;+\; \frac{\gamma_j}{1-\theta} \left(l^t_{ja}\right)^{1-\theta} \right) \qquad \forall\; a \;=\; H, MH, ML \quad \text{(1a)}$$

with $0 < \beta < 1, \gamma_j > 0, \theta > 0 \;\; (\theta \neq 1)$
The parameter β defines the discount factor, θ is the inverse of the intertemporal elasticity of substitution in leisure, while γ_j denotes the taste for leisure. This last parameter is assumed the same for all ability types, but is allowed to differ by age.

The utility function of low ability households is different due to the presence of unemployment on their respective labor market. The pooling of income from work and unemployment implies that each individual in a low ability household will have equal (utility from) consumption, irrespective of his or her own position on the labor market. Leisure will differ, however. We assume that leisure brings utility to those who work. In relation to this, being unemployed yields a constant utility κ. Therefore, the utility of an employed low ability individual is $ln\; c^t_{jL} \;+ \frac{\gamma_j}{1-\theta} \left(l^t_{jL}\right)^{1-\theta}$ while that of an unemployed individual is $ln\; c^t_{jL} \;+ \kappa$. Lifetime utility of the household can then be written as:

$$U^t_L = \sum_{j=1}^{4} \beta^{j-1} \left(ln\; c^t_{jL} \;+\; \frac{\gamma_j}{1-\theta} \left(l^t_{jL}\right)^{1-\theta} (1 - u_{t+j-1}) + \kappa u_{t+j-1} \right) \quad \text{(1b)}$$

Considering that unemployment is involuntary in our model, it is not unreasonable to assume that the utility of being unemployed is lower than the utility of being employed (Korpi, 1997). As we assume consumption to be equal for both employed and unemployed individuals, κ should be lower than $\frac{\gamma_j}{1-\theta} \left(l^t_{jL}\right)^{1-\theta}$, for reasonable values of l^t_{jL}. We will set $\kappa = -1$[6]

[6] After parameterization we find that $\frac{\gamma_j}{1-\theta} \left(l^t_{jL}\right)^{1-\theta}$ takes values between 0 and -1 for reasonable values of l^t_{jL}. The results presented in this paper are not influenced by the chosen value of κ.

2.1.2 Time allocation

Equations (2) to (4) show for individuals of each ability type ($\forall\ a\ =\ H, MH, ML, L$) that time is allocated to either labor, leisure or education. Total time endowment is set equal to 1 in each period.

$$l_{1a}^t = 1 - g\left(n_{1a}^t\right) - e_{1a}^t \qquad \text{with } e_{1ML}^t = e_{1L}^t = 0 \tag{2}$$

$$l_{ja}^t = 1 - g\left(n_{ja}^t\right) \qquad \forall j = 2, 3 \tag{3}$$

$$l_{4a}^t = 1 \tag{4}$$

$$\text{with } g\left(n_{ja}^t\right) = n_{ja}^t + cc \qquad \forall j = 1, 2, 3$$

Equation (2) expresses leisure time when individuals are young. Leisure falls when time is invested in education e_{1a}^t or allocated to work $g\left(n_{ja}^t\right)$. Individuals of low and medium-low ability only choose to work or have leisure, they do not study. Note that, when individuals work, they also spend a fraction of time cc commuting to and from the workplace. Individuals thus experience total labor time as $g(n_{ja}^t) = n_{ja}^t + cc$, of which only the first part is productive and rewarded by firms[7]. In the second and third period, households can allocate time only between work and leisure (eq. 3). Finally, during the last period of life, all individuals are retired: leisure is equal to 1 (eq. 4).

2.1.3 Budget Constraints

Equations (5a) - (7) describe the budget constraints for the medium-low, medium-high and high ability households for each period of life. The LHS of each equation states that households divide their disposable resources between consumption c_{ja}^t, the cost of which augmented by a consumption tax τ_c, and the accumulation of non-human wealth Ω_{ja}^t. The stock of wealth is measured at the end of each period. Households start and end life without assets.

The RHS of each equation denotes the total disposable resources of the household. During each active period of life, labor income depends on the real wage per unit of effective labor $w_{a,t+j-1}$, the stock of human capital h_{ja}^t and hours worked n_{ja}^t in that period. Given the labor tax rate $\tau_{w,ja}$, a worker earns a total after-tax income of $w_{a,t+j-1}h_{ja}^t n_{ja}^t\left(1-\tau_{w,ja}\right)$ for his labor. We assume taxes on labor to be progressive, varying over individual's income (see infra). During the last period, labor income is replaced by a pension benefit pp_a^t from the government that is further specified below. After the first period of life, individuals also earn an interest income from accumulated savings in previous periods. r_t is the exogenous world real interest rate at time t. Lastly, the household receives a lump-sum transfer (or lump-sum tax) z_{t+j-1} during each of its four lifetime stages j.

$\forall\ a\ =\ H, MH, ML$

$$\left(1+\tau_c\right)c_{1a}^t + \Omega_{1a}^t = w_{a,t}h_{1a}^t n_{1a}^t\left(1-\tau_{w,1a}\right) + z_t \tag{5a}$$

[7] We introduce a fixed commuting time to capture the non-linearity in the mapping from time spent on work related activities to productive labor services, emphasized by Rogerson and Wallenius (2009). Moreover, when testing the empirical relevance of our model in Section 3, we observe a better match with the data when we account for cross-country differences in commuting time.

$$
\begin{aligned}
(1+\tau_c)\, c^t_{ja} + \Omega^t_{ja} &= w_{a,t+j-1} h^t_{ja} n^t_{ja} \,(1-\tau_{w,ja}) \\
&\quad + (1+r_{t+j-1})\, \Omega^t_{j-1,a} \;+ z_{t+j-1} \qquad \forall\; j \;=\; 2,3
\end{aligned} \tag{6a}
$$

$$
(1+\tau_c)\, c^t_{4a} = pp^t_a + (1+r_{t+3})\, \Omega^t_{3a} + z_{t+3} \tag{7}
$$

Equations (5b) - (7) describe the budget constraints of the households of low ability ($a = L$). They differ from the equations specified above due to unemployment. Labor income is now only paid to those who work, i.e. the fraction $(1 - u_{t+j-1})$ of the low ability population. It is determined similarly to the after-tax earnings of higher ability workers. The RHS now has an extra component in each of the three active stages of life: a benefit is provided by the government to compensate those without work. This unemployment benefit is a fraction b of the after-tax wage of a worker with the same age and ability. Although the variable n^t_{jL} is part of this component, it is exogenous to the household.

$$
\begin{aligned}
(1+\tau_c)\, c^t_{1L} + \Omega^t_{1L} &= w_{L,t} h^t_{1L} n^t_{1L} \,(1-\tau_{w,1L})\,(1-u_t) \\
&\quad + b w_{L,t} h^t_{1L} n^t_{1L} \,(1-\tau_{w,1L})\, u_t \;+\; z_t
\end{aligned} \tag{5b}
$$

$$
\begin{aligned}
(1+\tau_c)\, c^t_{jL} + \Omega^t_{jL} &= w_{L,t+j-1} h^t_{jL} n^t_{jL} \,(1-\tau_{w,jL})\,(1-u_{t+j-1}) \\
&\quad + b w_{L,t+j-1} h^t_{jL} n^t_{jL} \,(1-\tau_{w,jL})\, u_{t+j-1} \\
&\quad + (1+r_{t+j-1})\, \Omega^t_{j-1,L} \;+\; z_{t+j-1} \qquad \forall\; j \;=\; 2,3
\end{aligned} \tag{6b}
$$

$$
(1+\tau_c)\, c^t_{4L} = pp^t_L \;+\; (1+r_{t+3})\, \Omega^t_{3L} + \; z_{t+3} \tag{7}
$$

2.1.4 Public pensions

To match the reality of the OECD countries studied in this paper, we assume a public Pay-As-You-Go (PAYG) pension system. Households contribute to the system and build pension rights during the active stages of their life. Their contribution is included in the labor tax rate $\tau_{w,ja}$. Consistent with this, pension expenditures will also be included in the overall government budget (cf. infra, section 2.3.). Equation (8) specifies the benefit pp^t_a that individuals receive in the fourth period of their life. It is calculated as a proportion of a worker's 'pension base', i.e. the average of revalued after-tax labor income in each of the three active periods of life. The pension base increases in hours worked n^t_{ja}, human capital h^t_{ja} and real net wages $w_{a,t+j-1}\,(1-\tau_{w,ja})$. We assume that past labor income is revalued in line with economy-wide wage growth x[8]. ρ_a is the net replacement rate applied to the pension base. It can vary by ability (income).

$$
pp^t_a = \rho_a \sum_{j=1}^{3} \left(\frac{1}{3}\right) \left(w_{a,t+j-1} h^t_{ja} n^t_{ja} \,(1-\tau_{w,ja})\,(1+x)^{4-j} \right) \qquad \forall\; a \;=\; H, MH, ML, L \tag{8}
$$

In line with practice in several OECD countries, we make no difference between the pension of employed and unemployed individuals. It is thus assumed in Equations (7) and (8) that unemployment accumulates pension rights as if the unemployed had been working.

[8]The revaluation accounts for the progress in labor productivity in the economy between the time that individuals build their pension entitlements and when they actually receive their pension. Productivity growth is equal to the rate of technical progress in steady state.

2.1.5 Human capital

Individuals enter the model at the age of 20 with a predetermined level of human capital. This level is generation-invariant, but rises in innate ability. In Equation (9) we normalize the human capital of a young individual with high ability to h_0. Young individuals with medium-high, medium-low or low ability enter the model with only a fraction ε_{MH}, ε_{ML} or ε_L of this.

$$h_{1a}^t = \varepsilon_a h_0 \qquad \forall\ a\ =\ H, MH, ML, L \tag{9}$$

$0 < \varepsilon_L < \varepsilon_{ML} < \varepsilon_{MH} < \varepsilon_H = 1$

In their first period of life, individuals with high or medium-high ability build additional human capital through (tertiary) education. We adopt in Equation (10a) a simple specification in the spirit of Lucas (1990) and Bouzahzah et al. (2002). Human capital rises with time spent on education e_{1a}^t and through higher initial human capital h_{1a}^t. σ is the elasticity of time input and φ denotes an efficiency parameter, which may depend on the quality of the education system. Both parameters are common for the two ability groups. Individuals with low or medium ability do not study (eq. 10b). Between the second and the third period of life, human capital remains constant. Learning on the job counteracts human capital depreciation.

$$h_{2a}^t = h_{1a}^t \left(1 + \varphi (e_{1a}^t)^\sigma\right) \qquad \forall\ a\ =\ H, MH \tag{10a}$$

$$h_{2a}^t = h_{1a}^t \qquad \forall\ a\ =\ ML, L \tag{10b}$$

$$h_{3a}^t = h_{2a}^t \qquad \forall\ a\ =\ H, MH, ML, L \tag{11}$$

$0 < \sigma \leq 1, \varphi > 0$

2.1.6 Optimization

Individuals will maximize their lifetime utility (eq. 1) subject to equations (2) through (11). Households will choose the optimal level of consumption, labor supply and education time (if applicable). The first order conditions are standard and can be found in Appendix B.

2.2 Firms

Firms, all identical, act competitively on output markets and maximize profits. They also face competitive markets for labor supplied by individuals of high, medium-high or medium-low ability. The labor market for low ability labor, on the other hand, is imperfectly competitive. Union involvement implies above market-clearing wages and unemployment.

Total domestic output Y is given by a neoclassical production function (eq. 12) with constant returns to scale, but decreasing returns to K_t and $A_t H_t$, the individual factor inputs. K_t denotes the stock of physical capital at time t while $A_t H_t$ stands for employed labor in efficiency units at time t.

$$Y_t = K_t^\alpha \left(A_t H_t\right)^{1-\alpha} \tag{12}$$

Technology A_t grows at an exogenous and constant rate x : $A_{t+1} = A_t\,(1+x)$. As for total effective labor H_t, we follow Katz and Murphy (1992) by specifying a CES function capturing the imperfect substitutability between the different types of employed labor (eq. 13). The parameter s denotes the constant elasticity of substitution while η_H, η_{MH}, η_{ML}, η_L are the input share parameters that sum to one. The latter provide information on the relative productivity of each ability type.

$$H_t = \left(\eta_H H_{H,t}^{1-\frac{1}{s}} + \eta_{MH} H_{MH,t}^{1-\frac{1}{s}} + \ \eta_{ML} H_{ML,t}^{1-\frac{1}{s}} + \eta_L H d_{L,t}^{1-\frac{1}{s}}\right)^{\frac{s}{s-1}} \tag{13}$$

Equation (14a) defines effective labor supply per ability group. Within each ability group we assume perfect substitutability of labor supplied by the different age groups. Our assumption of a competitive labor market for high, medium-high and medium-low ability individuals implies that labor demand and effective employment for these individuals will equal total supply $H_{a,t}$. The real wage cost for these workers, i.e. the real wage augmented by the social contribution rate on employers τ_p, will be equal to the marginal product of effective labor measured as $H_{a,t}$ (eq. 15a).

$$H_{a,t} \ = n_{1a}^t h_{1a}^t + n_{2a}^{t-1} h_{2a}^{t-1} + n_{3a}^{t-2} h_{3a}^{t-2} \qquad \forall\ a \ = \ H, MH, ML, L \tag{14a}$$

$$(1-\alpha)\, A_t^{1-\alpha} \left(\frac{K_t}{H_t}\right)^{\alpha} \eta_a \left(\frac{H_t}{H_{a,t}}\right)^{\frac{1}{s}} = w_{a,t}\,(1+\tau_p) \qquad \forall\ a \ = \ H, MH, ML \tag{15a}$$

For low ability labor, however, wages will be above the competitive level. A minimum wage regulation or union influence may explain the existence of a wage floor. As firms cannot adjust this wage floor, they will instead reduce their demand for labor ($H d_{L,t} < H_{L,t}$, eq. 14b). Consequently, there will be unemployment, the amount of which is determined optimally by firms in equation (15b).

$$\begin{aligned} H d_{L,t} &= \left(n_{1L}^t h_{1L}^t + n_{2L}^{t-1} h_{2L}^{t-1} + n_{3L}^{t-2} h_{3L}^{t-2}\right)(1-u_t) \\ &= H_{L,t}\,(1-u_t) \end{aligned} \tag{14b}$$

$$(1-\alpha)\, A_t^{1-\alpha} \left(\frac{K_t}{H_t}\right)^{\alpha} \eta_L \left(\frac{H_t}{H_{L,t}\,(1-u_t)}\right)^{\frac{1}{s}} = w_{L,t}\,(1+\tau_p) \tag{15b}$$

In the spirit of Boone and Heylen (2019) we model the imposed wage floor (minimum wage) as a mark-up on a weighted average of the competitive wage $w_{L,t}^c$, the average wage of the high, medium-high and medium-low ability groups $\frac{w_{ML,t}\ +\ w_{MH,t} + w_{H,t}}{3}$, and the unemployment benefit $w_{L,t} b$ (eq. 16). The competitive wage is defined as the hypothetical wage that low ability workers would receive if there were no minimum wages (and no unemployment) in the economy. The wage mark-up λ, imposed by the unions, is calibrated.

$$w_{L,t} = \left(v_1 w_{L,t}^c + v_2 \frac{w_{ML,t}\ +\ w_{MH,t} + w_{H,t}}{3} + v_3 w_{L,t} b\right)(1+\lambda) \tag{16}$$

with $v_1 + v_2 + v_3 = 1$

The order of decision making is as follows. First, unions set the wage floor. Then, households decide how many hours they want to work, while firms decide how many low ability workers to

hire. The equilibrium level of unemployment results from the interaction between households and firms.

Finally, equation (17) shows that firms will install capital up to the point where its after-tax marginal product net of depreciation is equal to the exogenous world real interest rate r_t. The physical depreciation rate is δ_k and τ_k is the capital tax rate, which is source-based. Capital is taxed in the country where it is used, regardless of the nationality of the owner.

$$\left[\alpha\left(\frac{A_t H_t}{K_t}\right)^{1-\alpha} - \delta_k\right](1-\tau_k) = r_t \tag{17}$$

2.3 Government

Equation (18) describes the government's budget constraint. Its expenditures concern goods and services G_t, benefits related to unemployment B_t, old-age pension benefits PP_t, lump sum transfers Z_t and interest payments on previous debt $r_t D_t$. We assume G_t to be a fraction g of output. Goods bought by the government do not add to the productivity of private firms, nor do they bring direct utility to households. Government spending is financed by taxes on capital $T_{k,t}$, consumption $T_{c,t}$ and labor - both in the form of a progressive income tax for employees $T_{w,t}$ as in social security contributions paid by employers $T_{p,t}$ - or by the creation of new debt $\Delta\ D_{t+1}$. D_t is defined as outstanding public debt at the beginning of period t.

$$\Delta\ D_{t+1} \ = \ D_{t+1} - D_t \ = \ G_t + B_t + PP_t + r_t D_t - T_{k,t} - T_{c,t} - T_{p,t} - T_{w,t} \ + Z_t \tag{18}$$

with $G_t = gY_t$

$$B_t \ = b \sum_{j\ =\ 1}^{3} w_{L,t} h_{jL}^{t+1-j} n_{jL}^{t+1-j} \left(1-\tau_{w,jL}\right) u_t$$

$$PP_t \ = \sum_{a=H,MH,ML,L} \left(\rho_a \sum_{j=1}^{3} \left(\frac{1}{3}\right)\left(w_{a,t+j-4} h_{ja}^{t-3} n_{ja}^{t-3} \left(1-\tau_{w,ja}\right)(1+x)^{4-j}\right)\right)$$

$$T_{w,t} = \sum_{j\ =\ 1}^{3} \left(\sum_{a=H,MH,ML} \left(\tau_{w,ja} w_{a,t} h_{ja}^{t+1-j} n_{ja}^{t+1-j}\right) + \tau_{w,jL} w_{L,t} h_{jL}^{t+1-j} n_{jL}^{t+1-j} \left(1-u_t\right)\right)$$

$$T_{p,t} \ = \tau_p \sum_{j\ =\ 1}^{3} \left(\sum_{a=H,MH,ML} \left(n_{ja}^{t+1-j} w_{a,t} h_{ja}^{t+1-j}\right) + w_{L,t} h_{jL}^{t+1-j} n_{jL}^{t+1-j} \left(1-u_t\right)\right)$$

$$T_{c,t} = \tau_c \sum_{j=1}^{4} \sum_{a=H,MH,ML,L} c_{ja}^{t+1-j}$$

$$T_{k,t} = \tau_k \left(\alpha Y_t - \delta_k K_t\right)$$

$$Z_t = 16 z_t$$

Labor income taxes paid by workers $\tau_{w,ja}$ are progressive. We model the tax function in equation (19), following Guo and Lansing (1998) and Koyuncu (2011). The average tax rate is based on the total pre-tax labor income of the household $y_{ja,t}^{lab}$ as a proportion of average pre-tax labor income $\bar{y}_t^{lab}$ in the economy. Γ and ξ are two parameters that respectively indicate the level of

the tax schedule and its slope. The marginal tax rate, i.e. the rate applied to the last euro earned, is given in equation (20). The tax system is progressive, that is $\tau^{m}_{w,ja}$ is greater than $\tau_{w,ja}$, as soon as $\xi > 0$. Note that the budget constraints of households contain average tax rates, while individuals will base their optimization decision on marginal taxes (see also Appendix B).

$$\tau_{w,ja} = \Gamma \left(\frac{y^{lab}_{ja,t}}{\bar{y}^{lab}_{t}} \right)^{\xi} \tag{19}$$

$$\tau^{m}_{w,ja} = (1 + \xi)\, \tau_{w,ja} \tag{20}$$

with $\xi \geq 0,\ 0 < \Gamma < 1$

2.4 Aggregate equilibrium and the current account

The interactions between households, firms and government lead to a certain demand for goods. Because the economy is open, domestic demand may differ from total supply and income, which generates international capital flows and an unbalanced current account. Equation (21) describes aggregate equilibrium defined for all generations living at time t. The LHS of (21) gives national income, constituted out of domestic output Y_t and net factor income from abroad $r_t F_t$. The RHS denotes aggregate domestic demand $(C_t + I_t + G_t)$ and the current account CA_t. Net foreign assets F_t are defined as the difference between the total stock of domestic wealth Ω_t, held by individuals who entered the model in $t-1$, $t-2$ and $t-3$, and the sum of the total capital stock K_t and government debt D_t.

$$Y_t + r_t F_t = C_t + I_t + G_t + CA_t \tag{21}$$

$$\text{with } F_t = \Omega_t - (K_t + D_t)$$

$$CA_t = F_{t+1} - F_t = \Delta\Omega_{t+1} - \Delta K_{t+1} - \Delta D_{t+1}$$

$$I_t = \Delta K_{t+1} + \delta_k K_t$$

3 Parameterization and empirical relevance of the model

The economic environment described above allows us to simulate the effects on employment, education, output, welfare and inequality of various changes in fiscal policy. This simulation exercise requires us first to parameterize and solve the model. Once the model is calibrated, we test its validity by comparing its predictions for several labor market and inequality indicators with the data. In our test we include 11 countries clustered in three country groups: the core euro area (Belgium, the Netherlands, France and Germany), the Nordic countries (Denmark, Finland, Norway and Sweden) and the Anglo-Saxon countries (United Kingdom, United States and Canada). To derive our predictions we impose common preference and technology parameters on all countries. For parameters that depend on institutions, such as the parameters v_1,v_2 and v_3 in the union's reference wage and the union mark-up λ (eq. 16), we follow Boone and Heylen (2019) and allow these parameters to vary by country group. We adopt the same approach for the efficiency parameter φ in the human capital production function. Finally, fiscal policy and pension policy variables are all individual country-specific.

3.1 Parameterization

Table 3.1 contains an overview of all parameters. Many have been set in line with the existing literature, while others have been calibrated to match key data.

Parameters taken from, or set in line with, existing literature. We set the annual rates of time preference, real interest and physical capital deprecation at 1.5%, 4% and 8% respectively. Considering that each period of the model lasts 15 years, this implies that $\beta = 0.8$, $\delta_k = 0.714$ and $r_t = 0.801$. These values are consistent with what is put forward in academic research (see e.g. Altig et al., 2001; Ludwig et al., 2012). So are the values of 1.5 and 0.3 that we choose for the elasticity of substitution between the different ability types of labor s, and the capital share coefficient α (Heijdra and Romp, 2009; Caselli and Coleman, 2006). Following Buyse et al. (2017), the inverse of the elasticity of substitution in leisure θ is assigned a value of 2. Although microstudies typically find lower values than the corresponding 0.5 for the elasticity of substitution, several studies suggest that these might not be relevant when focusing on the macro level (e.g. Rogerson and Wallenius, 2009). Rogerson (2007) suggests to use a value for θ between 1 and 3. Our value of 2 falls well within this range.

As to human capital and the human capital production function, we set the elasticity with respect to education time σ at 0.3. This value is quite modest in comparison to what can be found in e.g. Lucas (1990) and Glomm and Ravikumar (1992). However, with a conservative value for σ, the results from our simulations will certainly not be due to overestimating the returns from education. With a similar motivation, Bouzahzah et al. (2002) also adopt a value of 0.3. Next, we need values for the initial relative human capital levels ε_L, ε_{ML} and ε_{MH}. Buyse et al. (2017) rely on the results for 15-year old pupils from the Programme for International Student Assessment (PISA) of the OECD. They find that the ratio of scores at different percentiles of the distribution are remarkably similar across countries and can thus be seen as indicators of the cognitive capacity of individuals with different levels of ability. We assume students at the 10th percentile as representative for the low ability individuals in our model, while for the medium-low, medium-high and high ability individuals we consider respectively the students at the 37.5th percentile, the 62.5th percentile and the 90th percentile. As a proxy for ε_L, we take the score of students at the 10th percentile relative to the score of students at the 90th percentile. The other relative levels are calculated in a similar manner. When taking the average score for the total OECD, a value of 0.61 can be assigned to ε_L, 0.76 to ε_{ML} and 0.86 to ε_{MH}, while ε_H is normalized to 1.

Finally, with respect to wage setting, we rely on Boone and Heylen (2019) for the parameters v_1, v_2 and v_3 in the union's reference wage. They are the weights given to respectively the competitive wage of low educated workers, the average wage of other workers, and the unemployment benefit. Boone and Heylen acknowledge that wage formation can differ substantially between countries. Therefore, they calibrated different values for three country groups that each have distinctive institutions. For the core euro area their calculations result in respective values of 0.8, 0.05 and 0.15. Unions in the Nordic countries are found to give more weight to the competitive wage and to the unemployment benefit, resulting in the values 0.9, 0 and 0.1. The opposite seems true for unions in the Anglo-Saxon countries: they seem more influenced by the average wage of other workers in the economy, implying values of 0.9, 0.1 and 0.

Table 3.1: Parameterization

Common technology and preference parameters					
Taken from, or set in line with the literature:					
discount factor	β	0.80	inverse of the IES in leisure	θ	2
capital depreciation rate	δ_k	0.71	relative initial ability, L	ε_L	0.61
world real interest rate	r	0.80	relative initial ability, ML	ε_{ML}	0.76
capital share coefficient	α	0.3	relative initial ability, MH	ε_{MH}	0.86
elasticity of substitution in labor	s	1.5	relative initial ability, H	ε_H	1
elasticity of time input in education	σ	0.3			
Calibrated parameters:					
technology growth rate	x	0.19	input share parameter, L	η_L	0.11
taste for leisure, young	γ_1	0.04	input share parameter, ML	η_{ML}	0.17
taste for leisure, middle-aged	γ_2	0.09	input share parameter, MH	η_{MH}	0.33
taste for leisure, older	γ_3	0.28	input share parameter, H	η_H	0.38

Institutional parameters by country group:		Core euro	Nordic	Anglo-Saxon
Taken from, or set in line with the literature:				
weight, competitive wage	v_1	0.8	0.9	0.9
weight, average wages of others	v_2	0.05	0	0.1
weight, unemployment benefit	v_3	0.15	0.1	0
Calibrated parameters:				
union mark-up	λ	0.22	0.19	0.10
efficiency in human capital prod.	φ	3.42	3.87	2.17

Target values for calibration, (2014-17):					
Belgium:					
employment rate, young	$\bar{n}_1$	56.6%	relative wages, L	$\frac{w_L h_L}{w_H h_H}$	0.55
employment rate, middle-aged	$\bar{n}_2$	60.6%	relative wages, ML	$\frac{w_{ML} h_{ML}}{w_H h_H}$	0.69
employment rate, older	$\bar{n}_3$	40.8%	relative wages, MH	$\frac{w_{MH} h_{MH}}{w_H h_H}$	0.81
per capita GDP growth, annual		1.16%			

By country group:		Core euro	Nordic	Anglo-Saxon
unemployment rate	u	28.8%	24.3%	23.1%
education	e	14.5%	17.3%	12.4%

Fiscal policy parameters (2014-17, in %) for Belgium:					
government spending	g	25.8	tax on consumption	τ_c	12.1
benefit replacement rate	b	66.1	tax on capital	τ_k	34.0
pension replacement rate, L	ρ_L	69.6	tax on labor, level	Γ	40.5
pension replacement rate, ML	ρ_{ML}	66.1	tax on labor, progressivity	ξ	35.6
pension replacement rate, MH	ρ_{MH}	50.1	social contribution rate	τ_p	28.0
pension replacement rate, H	ρ_H	44.4	debt to GDP ratio	D/Y	125.4
commuting costs	cc	5.6			

For a detailed description of the target data (performance data) for the calibration and of all fiscal and pension policy parameters, we refer to Appendix A.

Calibrated parameters. The values of 14 parameters have been fixed by calibration. They have been determined such that the model correctly replicates 13 moments reflecting the data in 2014-17[9] and the restriction that $\eta_L + \eta_{ML} + \eta_{MH} + \eta_H = 1$. These parameters are the exogenous technology growth rate x, the taste for leisure parameters γ_1, γ_2 and γ_3, the share parameters η_L, η_{ML}, η_{MH} and η_H, the human capital efficiency parameter φ, and the mark-up parameter λ. The last two parameters can be different in the three country groups. Table 3.1 reports all calibration targets. These targets relate to the employment rate in hours by age ($\bar{n}_j$), the unemployment rate (u), the growth rate of GDP per capita, the participation rate in education (e) and relative wages by ability (education). The reported employment rate $\bar{n}_j$ indicates the fraction of potential hours that are actually being worked by individuals in an age group (20-34, 35-49, 50-64). It rises in the fraction of working people (i.e. the employment rate in persons) in an age group and in the annual number of hours per worker. The unemployment rate has been computed as the difference between the employment rate in persons among individuals with at least a higher secondary degree and the employment rate in persons among individuals with lower secondary education at best[10]. The data for the participation rate in education indicate the fraction of individuals aged 20-34 in tertiary education, in fulltime equivalents. The reported relative wages are the wages of young workers with lower secondary education at best (L), higher secondary education (ML), or a bachelor's degree (MH), relative to the wage of young workers with a master's degree (H)[11]. For more details on the construction of these performance variables, we refer to Appendix A.

The values of the calibrated parameters result from solving the model as a system of simultaneous equations that match the target data. Given that two parameters (φ, λ) can differ by country group, we adopted a calibration procedure in three steps. First, following Buyse et al. (2017), we calibrated the model to Belgium, a small open economy whose reality fairly closely approximates the way the model is specified. The calibrated parameters were fixed such that the model correctly predicts the target data in Belgium, taking into account all other model parameters and Belgium's fiscal and pension policy data[12]. In a second step, we recalibrated the human capital efficiency parameter φ and the union mark-up λ at the level of the three considered country groups. These parameters were determined such that the model replicates the reported average participation rate in education and the reported average unemployment rate in each group. The main reason to allow group-specific parameters is that, due to institutional differences in the education system and the labor market, the quality of education and the process of (minimum or union) wage setting may differ across countries. The third step involved an iterative procedure in which we took the human capital efficiency parameter φ and the union mark-up λ that we obtained for the core euro area as starting values for Belgium, after which we recalibrated the parameters x, γ_j and η_a. Adjusted values for these parameters allowed recalibration of φ and λ for each of the three country groups. And so on. We converged on the values reported in Table 3.1.

[9] We choose this period as information for the four different education (ability) levels that are central in this paper, was only available from then on.

[10] This approach is consistent with the assumption in our model that for all individuals the states of employment and labor market participation (labor supply) coincide, except for the low ability individuals, some of whom are unemployed. The unemployment rate therefore matches the gap in employment rates.

[11] See also footnote 5.

[12] This is why we show the Belgian policy data at the bottom of Table 3.1. for illustrative purposes. Data for all other countries are in Appendix A.

Considering the calibration results, we observe a rising taste for leisure (γ) as workers grow older, in line with earlier findings by e.g. Heylen and Van de Kerckhove (2019). We find the highest efficiency in human capital formation (φ) in the Nordic countries (3.87) and the lowest in the Anglo-Saxon countries (2.17). Unsurprisingly, the union mark-up parameter λ is much higher in Europe (about 0.20) than in the Anglo-Saxon countries (about 0.10).

3.2 Evaluation and explanatory power of the model

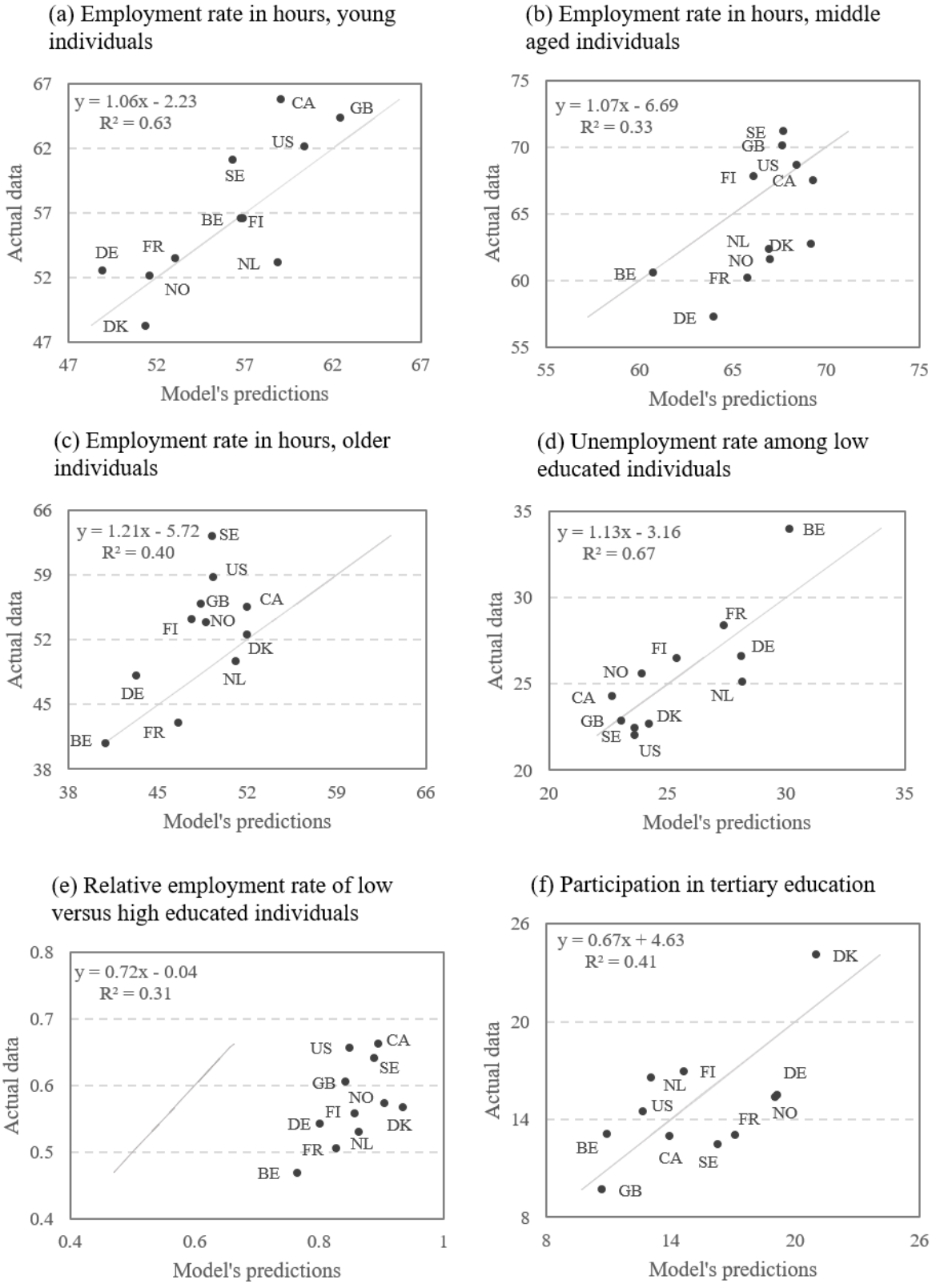
Once all parameters have been assigned a value and country-specific policy variables are plugged in, the model can predict each country's individual performance, as well as cross-country performance differences[13]. In this section we examine the validity of our model and our chosen set of parameters by comparing the predicted performance differences with the data in 2014-2017. We do this both for economic performance indicators and the Gini coefficient. Since we impose the same preference and technology parameters on each country, predicted performance differences will come from differences in fiscal policy parameters and wage setting. A reliable model should 'translate' these observed policy and wage setting differences into realistic performance differences.

Figures 3.1.a to 3.1.c compare the model's predictions of employment among young, middle aged and older individuals with their reality. The grey line in each figure is the 45°-line. In the upper left corner of each figure we also report the specification of the regression line that would provide the best fit between the model's predictions and the data, as well as the R^2. The regression line itself is not drawn. The correlation between the data and the model in the three figures is 0.79, 0.57 and 0.63 respectively. Although there are some discrepancies, our model performs relatively well in explaining the main overall cross-country differences. The core euro area has lower employment rates, while the Nordic and Anglo-Saxon countries display (much) higher values. Another reassuring result is that the slopes of the regression lines in figures 3.1.a to 3.1.c. are all close to 1. The variation in the model's predictions when actual policy parameters are introduced, is fairly close to the variation in the data. In other words, our model does not systematically overestimate the effects of policy differences (slope below 1), nor does it systematically underestimate these effects (slope above 1). Figure 3.1.d confirms this result for the unemployment rate. Correlation in this figure is 0.82, with a slope of the regression line only slightly above 1.

Figure 3.1.e considers the ratio of per capita hours worked by low ability individuals ($n_L(1-u)$) relative to hours worked by high ability individuals (n_H), accounting for the fact that a fraction of those with low ability are unemployed. Correlation stands at 0.56, while the slope equals 0.72. Excluding Denmark, these numbers rise to 0.68 and 1.03 respectively. Our model thus also explains cross-country differences in this ratio relatively well. Thinking about the reliability of the policy simulations that we execute in the next section, this is by far the most important result. The model fails, however, at predicting the right level of the ratio. The cross-country average of the predicted ratio is 0.86. In reality, this ratio stands at 0.57. Further analysis makes clear that the reason for this discrepancy can be found mainly in the model's underestimation

[13]Underlying the predictions for each country, is the assumption that lump sum transfers adjust in Equation (17) to keep the government debt to GDP ratio constant.

Figure 3.1: Aggregate Labor market performance and participation in tertiary education in individual countries, in %, 2014-2017



Note: The gray line depicts the 45 degree line

Table 3.2: Gini coefficient in three country groups, 2015-2017

	Core euro area	Nordic countries	Anglo-Saxon countries
Data	0.29	0.26	0.35
Model	0.30	0.34	0.34

Data source: Solt (2016), SWIID 7.0.
Note: to compute the model Gini we use Cowell's lower-bound index G_L.

of hours worked by the high educated group[14].

Finally, figure 3.1.f. relates our model's predictions to the data for participation in education. Correlation is 0.64, while the slope is only 0.67. However, as we do not focus in this paper on policies that influence education to a great extent, we have not seriously investigated possible extensions or improvements of the model in this respect.

Table 3.2 compares the model's predicted and actual Gini coefficients for disposable income in three country groups. The model Gini coefficient reflects inequality between 19 households. We distinguish households by (four) ability levels and in (four) age groups. Furthermore, to compute the model Gini coefficient, we consider within the group of low ability individuals those who are unemployed and those who work as separate households. To achieve this, we decompose the pooled income of low ability households. As we then work with groups of different size, we calculate the lower bound inequality measure proposed by Cowell (2011).

The model correctly predicts the highest inequality in the Anglo-Saxon countries. It also predicts a realistic a gap in the Gini coefficient between the Anglo-Saxon countries and the core euro area. However, as a weaker point, the model strongly overestimates inequality in the Nordic countries. Several elements may explain this. One is the highly stylized nature of the model. The only source of income inequality is different labor income (and its underlying determinants). For example, we do not include inheritance or intergenerational linkages, which in reality matter substantially for differences in capital income. Moreover, we assume that each of the four ability groups in the population is of equal size. This includes that 25% are expected to have obtained a lower secondary degree at best. Although some countries (Belgium, France, the Netherlands) are not too far away from this number, the Nordic countries have much lower shares of low educated (Eurostat). For the latter countries, the weight of low educated individuals in the calculation of income inequality in the model is too high in comparison with reality. Despite these concerns, we emphasize that our main research question concerns the change in inequality, not its initial level. Finally, even if we can interpret our Gini coefficient solely as an indicator of inequality out of labor, this is still of great relevance for policy makers[15].

[14] One way to solve this could be to allow for bequests as a luxury good (cf. De Nardi, 2004). Another possibility is a change in the specification of the utility function. In our model, individuals derive utility from work only through the consumption possibilities that it provides. However, individuals may derive utility from labor in many different ways. The 'joy of work' is related to identity, responsibility, satisfaction and variation of jobs, all things that are assumed to be higher for jobs that demand a high level of education. It can explain why individuals occupying such jobs work more than individuals with repetitive and less challenging jobs (see e.g. Avent, 2016).

[15] Labor income can be saved over time, thus also playing a role for the accumulation and distribution of wealth.

4 Policy reform: economic and inequality effects

In this section, we implement a change in several fiscal policy variables to see their impact on economic and social indicators in general equilibrium. We evaluate policies according to three criteria: 1) increase employment, especially among low ability individuals, 2) decrease income and welfare inequality, and 3) be politically feasible, i.e. that a clear majority of individuals in the economy need to gain welfare, such that the population will support the policy changes as a whole.

4.1 Setup

Each shock is implemented within a benchmark model, which is the average of the four core euro area countries. The imposed changes in the policy variables have an ex-ante budgetary effect of 0.375% of GDP (i.e. the budgetary effect computed before anyone has changed behavior). Ex-post, the tax rate on consumption adjusts endogenously to keep the ratio of government debt to GDP constant. We examine shocks in the level of labor taxes, the employers' social contribution rate, the unemployment benefit replacement rate and the level of the union's wage floor (minimum wage), all targeted at low ability workers. The results of single shocks, financed by a change in the consumption tax rate, can be found in Appendix C[16]. In general, single policy shocks have relatively weak employment and output effects. Moreover, they tend to have opposite effects on the welfare of households with low ability versus households with higher abilities, compromising political feasibility. Here, we continue with combinations of shocks in these different policy variables.

In the next sections, several aspects of the policy reforms will be analyzed. On the one hand, we want to see the impact on economic indicators such as hours worked, unemployment, education and output. We report changes from the benchmark case in percentage points in table 4.1. On the other hand, we ask the question whether these policies are welfare enhancing and what their impact is on inequality and poverty. We report a measure for the change in welfare of successive generations with different ability in figure 4.1. The results for the medium-high ability households are not shown. They are about the same as for the high ability households. The welfare effect is reported on the vertical axis. It is defined as the constant percentage change in benchmark consumption in each period of remaining life that households should get to attain the same lifetime utility in the benchmark as after the policy shock (see also King and Rebelo, 1990). When computing this percentage change, we keep employment rates at the benchmark. The horizontal axis of each panel of figure 4.1. indicates the different current and future generations by period of birth. More precisely, we report results for generations born (and entering the model) at time $t + k$ where the number on the horizontal axis indicates k and t is when the policy is implemented. For example, the data reported for $k = -1$ concern individuals at middle age at the moment of implementation of the policy. Data for $k = -3$ refer to the retired at that moment. All data for $k > 0$ concern future generations. Next to

[16] We do not present results of general (untargeted) reductions in labor taxes, social contributions or other variables. However, we have simulated these policy shocks and found them much less effective in raising employment and welfare than targeted policies. These results are in line with Batrya and Sneessens (2010) and Heylen and Van de Kerckhove (2019), and available upon request.

effects by individual cohort, we report an aggregate summary welfare measure in table 4.2. It is the present discounted value of the net aggregate consumption gain of all winners after having compensated the losers, in percent of initial GDP.

However, we are not only interested in welfare gains, we also care about its distribution. We show two aggregate inequality measures in table 4.2. First, we compute the Gini coefficient for household disposable income. Again, we consider within the group of low ability individuals those who are unemployed and those who work as separate households[17]. Even though income is an incomplete indicator of welfare, the attention that income inequality receives in policy making, makes it relevant to report it. However, we prefer the second inequality measure, which is the Atkinson measure of inequality in lifetime utility[18].

A last indicator we monitor, is poverty (risk). We do this in table 4.3, which only focuses on low ability households. In the model, employed and unemployed household members pool their disposable income. In table 4.3. (first data column) we report this pooled income as a fraction of average per capita disposable income in the economy. Furthermore, we split up this household income into the part earned by the unemployed household members and the part earned by the employed members (second and third columns). Both parts are rescaled, such that they indicate the household's disposable income if everybody had been employed or if everybody had been unemployed[19]. Table 4.3 also shows these results for the benchmark case. As can be seen, pooled disposable income of low ability households in the benchmark is below 65% of the aggregate average in the economy. If we take this 65% as our proxy for the international risk-of-poverty threshold, the incidence of poverty in our benchmark economy is serious, especially among unemployed households. Table 4.3 reveals a substantial gap between the income of the employed in comparison with the unemployed, although this gap decreases over individuals' lifetime.

4.2 Reductions in the unemployment benefit rate

The first policy we consider combines a reduction in the benefit replacement rate with a reduction of the level of labor taxes (Γ) targeted at low educated workers. The shock is ex ante budget neutral as the change in both benefits and taxes is equal to 0.375% of GDP in the initial benchmark. The unemployment benefit rate drops with 28.8 percentage points, which is similar to moving from the rate of the core euro area to the rate of the United states. Lower government expenditures allow to cut the labor tax rate for low educated workers from 34.5% to 20.6%. Table 4.1 reports the economic steady state effects of this policy change. We see a rise in employment for all age groups. Distinguished by ability, it is mainly the low educated group that increases its labor supply. Moreover, we observe a strong decrease in unemployment and positive effects for education and output. In the end, the consumption tax can fall. The underlying mechanism

[17] We calculate the lower bound inequality measure proposed by Cowell (2011).

[18] We prefer the Atkinson measure for several reasons: for one, as it is calculated over the lifetime, it respects the individuals' optimization decision. Moreover, it takes as its argument utility, not income. This is allowed when we assume cardinality and every household has the same utility function. Finally, contrary to the Gini coefficient, the weighting of the different arguments in the welfare function is not arbitrary.

[19] We do not show numbers for the retired households. First, there is no unemployment in these households. Second, in line with our assumption in Equation (8) that unemployment accumulates pension rights as if the unemployed had been working, there is no difference in the pension benefit between former employed and former unemployed household members.

Table 4.1: Economic effects[1]

	Policy 1 $\Delta b : -28.84$ $\Delta\Gamma : -13.85$	Policy 2 $\Delta b : -28.84$ $\Delta\tau_{p,L} : -8.94$	Policy 3 $\Delta\lambda : -0.062$ $\Delta\Gamma : -13.85$	Policy 4 $\Delta\lambda : -0.071$ $\Delta\tau_{p,L} : -8.94$
$\Delta\tau_c$[2]	-0.26	-0.58	0.17	-0.28
$\Delta\bar{n}_1$[3]	1.55	1.53	1.62	1.83
$\Delta\bar{n}_2$	1.47	1.45	1.50	1.67
$\Delta\bar{n}_3$	1.06	0.97	0.96	0.98
$\Delta\bar{n}$[4]	1.36	1.32	1.36	1.50
Δn_L	0.89	-0.03	0.33	-0.74
Δn_{ML}	0.02	0.03	0.02	0.04
Δn_{MH}	0.00	-0.01	0.00	0.00
Δn_H	0.00	0.00	0.00	0.00
Δu	-7.42	-8.28	-8.11	-10.34
$\Delta \mathrm{w}_L(1+\tau_{p,L})$[5]	-6.67	-6.43	-6.67	-7.24
$\Delta \mathrm{w}_L$[5]	-6.67	0.87	-6.67	0.00
$\Delta \mathrm{w}_L(1-\tau_{w,1L})$[5]	4.71	-0.33	4.68	-1.32
Δe	0.03	0.07	0.03	0.08
ΔY[5]	0.91	0.96	0.91	1.08

The effects are for a benchmark of 4 core euro area countries (Belgium, France, The Netherlands and Germany). Initial policy variables in %: $\tau_c = 12.2$, $\tau_k = 31.9$, $\tau_p = 23.5$, $\xi = 36.9$, $\Gamma = 34.5$, $D/Y = 99.4$, $b = 63.5$, $g = 25.7$, $\rho_{wL} = 75.3$, $\rho_{wML} = 72.9$, $\rho_{wMH} = 67.6$, $\rho_{wH} = 64.3$, $cc = 5.5$

[1] Difference in percentage points between the new steady state and the benchmark, except for output Y and wages.

[2] Change in consumption tax rate in percentage points to keep the ratio of debt to GDP constant.

[3] $\bar{n}_j$ indicates the employment rate in hours by age (see also figure 3.1.a-c). It is computed as $n_j(1-u)$ with n_j hours per employed worker and $(1-u)$ the employment rate in persons. By analogy, n_a is hours per employed worker by ability.

[4] Change in (weighted) aggregate employment rate in hours, in percentage points.

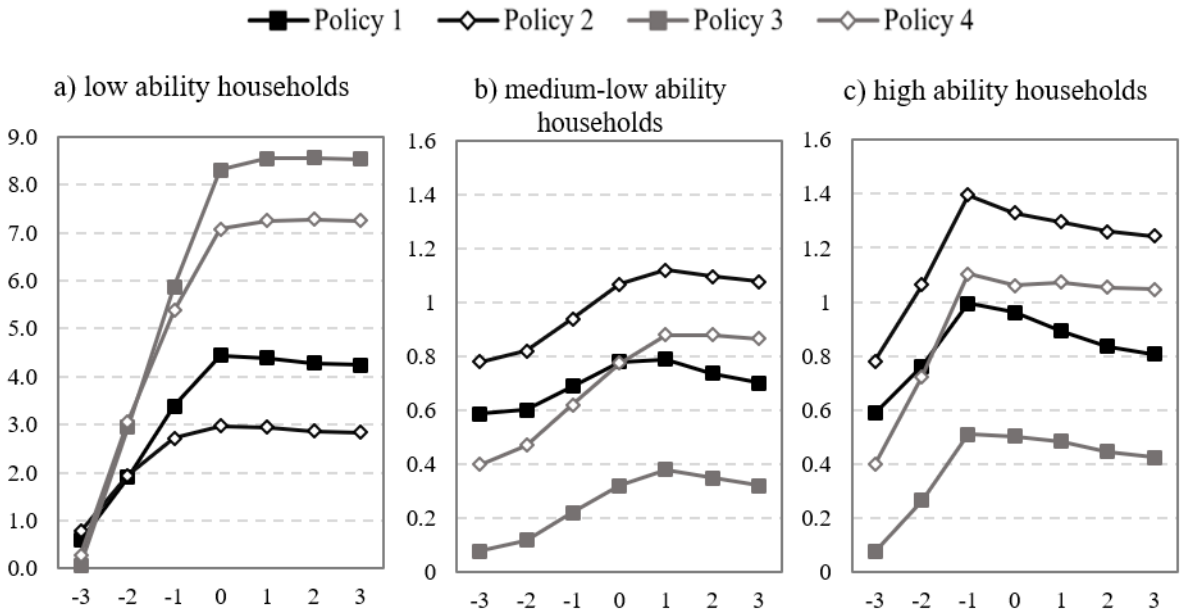
[5] Difference in percent between the new steady state and the benchmark.

is as follows. The union wage w_L falls by 6.67% due to the large drop in the unemployment benefit replacement rate and a drop in the competitive gross wage for low educated workers[20]. This induces firms to increase their demand for low ability labor. Despite the drop in their gross wage w_L, low ability workers experience a rise in their net wage $w_L(1-\tau_w)$, which makes them supply more labor (n_L)[21]. The substitution effect trumps the income effect of higher net wages. Moreover, the large drop in the unemployment benefit implies a decrease in income for low educated households, which will also incentivize the workers of these households to supply more labor. In summary, labor supply increases, though less than labor demand. As a result, firms hire previously unemployed individuals to fill the remaining gap. The positive effect on household income that follows from this, will somewhat offset, but not reverse the increase in

[20] The competitive wage falls following a shift in the labor supply curve to the right (which is induced by the lower taxes). Note that in equation (16), there also occurs a slight increase in other wages. As the low educated supply more labor and demand for labor rises, demand for other labor types rises as well. This is translated into higher wages for these groups. The drop in the competitive wage and the unemployment benefit offsets the increase in the wages of higher educated workers and in sum, the union wage decreases.

[21] Because of its progressivity, the labor tax rate may differ between generations of the same ability if they work different hours and earn different income levels. This also implies a different net wage $w_L(1-\tau_w)$. In table 4.1. we report the net wage effect of the different policy shocks for the youngest generation. The data for the older working generations are highly similar.

Figure 4.1: Welfare effects for households belonging to current and future generations



The vertical axis indicates the welfare effect for the generation born in $t + k$, where t is when the fiscal policy change is introduced. The horizontal axis indicates k. Our welfare measure is the (constant) percentage change in benchmark consumption in each period of remaining life that individuals should get to attain the same lifetime utility in the benchmark as after the policy shock.

labor supply of the household's working members. In the end, labor is supplied by workers who want to perform more hours and by unemployed who are now hired.

The second policy shock combines the same reduction in the unemployment benefit replacement rate with targeted reductions in the social contribution rate. The employer tax rate for low ability workers drops from 23.5% to less than 15%. The aggregate employment ($\bar{n}$) and output (Y) effects of policy 2 are comparable to those of policy 1. The composition of the increase in employment is different, however. Under policy 2 higher employment is reached only through the impact of the policy change on the unemployment rate, which decreases much more than under policy 1. The employed, however, do not raise their supply of hours. Better fiscal results, mainly thanks to the stronger reduction in unemployment, also allow a somewhat stronger drop in the consumption tax rate under policy 2 (-0.58 percentage points). The behavioral changes underlying these results are the following: although competitive gross wages rise due to the cut in social contributions, the lower benefits keep the union's wage nearly constant; there is only a slight increase. Accounting for taxes on labor income paid by workers, the net wage even shows a marginal decline. The only factor which would thus encourage low ability households to supply more labor is the drop in income due to lower unemployment benefits. For firms, the cost to hire low educated workers falls due to the cut in the contribution rate. Demand for labor rises. Moreover, this rise is greater than the extra labor that individuals want to supply. Because of that, the extra demand can be filled by people who previously found themselves in unemployment. As individuals pool their incomes, this increases the number of employed individuals in the household and the income they bring in. This extra income counteracts the

Table 4.2: Aggregate welfare and inequality measures

Steady state	Policy 1	Policy 2	Policy 3	Policy 4
Δ income inequality measure[1]	-0.017	-0.015	-0.021	-0.021
Δ lifetime utility inequality measure[2]	-0.024	-0.009	-0.059	-0.047
Dynamic	Policy 1	Policy 2	Policy 3	Policy 4
Welfare measure all current generations	1.28	1.47	1.21	1.63
Welfare measure all current + 3 future generations	2.23	2.49	2.38	3.06

See the main text for a description of the calculation of the measures.
[1] Change in the Gini coefficient.
[2] Change in the Atkinson inequality index.

higher willingness to supply labor induced by the reduced unemployment benefits. In contrast to policy 1 (where after-tax wages increased), labor supply of the working individuals decreases marginally.

We now turn to the impact of the two policy changes on welfare, inequality and poverty. Looking at figure 4.1, we find that welfare increases for all individuals of current and future generations of all ability types for both policy 1 and policy 2. Unsurprisingly, the gains are by far the largest for the low ability households. They are much smaller, but still positive, for the other households. We find that policy 1 performs better in terms of welfare gains for the low ability households, but has less good results for other households. Added up, the aggregate welfare indicator in table 4.2. turns out better for policy 2, both when we consider only living generations and when we also include three future generations. This result is mostly due to the different impact of the two policies on the consumption tax, which decreases more for the second policy, implying more gains for the other households who also pay this tax.

Finally, in line with their very positive welfare effects for low ability households, policies 1 and 2 also contribute to a reduction in inequality. Getting more people into work and earning a higher income is a key factor behind this improvement. Policy 1 performs better: it alleviates inequality more strongly both in terms of income inequality and in terms of utility inequality (table 4.2). The main reason is that it also brings an increase in after-tax labor income for all low educated workers.

Based on all these results, one would find both policy measures very favorable. They raise employment and output, and reduce unemployment and inequality in society. The results for labor market performance are also fully in line with existing general equilibrium studies (e.g. Prescott, 2004; Rogerson, 2007; Heylen and Van de Kerckhove, 2019) and econometric work (e.g. Nickell et al., 2005; Bassanani and Duval, 2006; Berger and Heylen, 2011; Nymoen and Sparrman, 2015) on the effects of reductions in labor taxes and unemployment benefits. For policy makers the choice seems simple. If one is more concerned with unemployment and political feasibility, one should opt for policy 2, while if the government is more concerned with inequality, it should opt for policy 1.

There is one big problem, though. While unemployment is reduced strongly, those who still find themselves in unemployment after the implementation of the new policy are very

Table 4.3: Decomposition of pooled disposable income of low ability households between their employed $(1-u)$ and unemployed (u) members – Income relative to average disposable income in the economy

	Benchmark			Policy 1			Policy 2		
	pooled	u	$(1-u)$	*pooled*	u	$(1-u)$	*pooled*	u	$(1-u)$
young	0.62	0.49	0.67	0.62	0.33	0.69	0.60	0.34	0.66
middle	0.68	0.57	0.73	0.68	0.43	0.75	0.66	0.43	0.72
older	0.64	0.55	0.67	0.63	0.46	0.68	0.62	0.46	0.66
	Benchmark			Policy 3			Policy 4		
	pooled	u	$(1-u)$	*pooled*	u	$(1-u)$	*pooled*	u	$(1-u)$
young	0.62	0.49	0.67	0.64	0.46	0.69	0.62	0.48	0.65
middle	0.68	0.57	0.73	0.71	0.55	0.75	0.69	0.56	0.72
older	0.64	0.55	0.67	0.65	0.55	0.68	0.64	0.55	0.66

See the main text for a description of the calculation of the measure.

bad off. To see this, we refer to table 4.3. The gap between employed and unemployed low educated individuals' income increases substantially in policies 1 and 2, and the unemployed find themselves with only around 40% of average income in the economy. Poverty rises. Mainly, this is due to the reduction of unemployment benefits. This result is not uncommon. Many authors in literature have asserted the advantages of unemployment benefit schemes as they work as an insurance against involuntary unemployment and poverty (see e.g. Moffitt, 2014).

The favorable consequences of the two policies mainly come from their impact on demand for labor and unemployment. If we assume that the government can affect union wage formation to arrive at gross wages at levels equivalent to those in policies 1 and 2, combined with the same changes in labor taxes and social contribution rates in these policies, this could bring about similar favorable effects on employment, inequality and welfare, but would not cause increased poverty among the unemployed. This is what we analyze in the next section. Basically, what we have in mind is a social contract or mutual commitment in which unions accept gross wage moderation in return for labor tax cuts by the government.

4.3 Changing the wage floor

Policy 3 combines the labor tax cut implemented in policy 1 with a decrease in the union wage, implemented by a reduction in the mark-up λ. The same wage is set as that which is formed ex-post in policy 1, but now the unemployment benefit rate stays constant. More specifically, the gross wage decreases with 6.67% for low ability workers while the level of labor taxes they pay is reduced with 13.85 percentage points. Policy 4 allows the same change in the employers' social contribution rate for low ability labor as in policy 2, while unions renounce any gross wage increase.

Table 4.1 shows the economic effects, which are very similar to policies 1 and 2. The impact of policy 3 on aggregate employment, education and output is the same as in policy 1. As the same gross wage is set, the same labor demand comes about[22]. However, households do not

[22] As long as there are involuntary unemployed individuals on the labor market, aggregate employment is completely determined by labor demand.

experience the income loss from the reduced unemployment benefits, leading them to supply fewer hours than in the previous case (n_L increases less under policy 3 than under policy 1). This makes firms hire more previously unemployed individuals to match labor demand. In the end, the same aggregate employment is achieved by more workers that work fewer hours than was the case in policy 1. The outcome of policy 4 is the best among all considered policies when it comes to raising employment and output, and reducing unemployment. Firms in policy 4 experience the strongest reduction of labor costs for low educated workers, which implies the strongest increase in labor demand and hiring of unemployed individuals. Again, the induced increase in household income encourages the employed household members to cut labor hours, which creates even more room for additional hirings.

While policies 3 and 4 preserve the positive effects on employment and output, their results are much more favorable for welfare, inequality and poverty. Aggregate welfare gains in table 4.2. are of similar order (policy 3) or larger (policy 4). Moreover, we see in figure 4.1. that they accrue more to low educated households than before, while the other households gain a little less. Both inequality indicators in table 4.2. are alleviated to a greater extent than under policies 1 and 2. Looking at poverty risk, we find that policies 3 and 4 raise low ability households' pooled income relative to average income in the economy, something policies 1 and 2 could not achieve. Still, however, compared to the benchmark, there is no progress for those individuals who remain unemployed. Achieving improvement also on this indicator will require complementary policies. The fact that in figure 4.1. neither policy 3 nor policy 4 imply welfare losses for higher educated households, may leave some room for maneuver.

Finally, from a comparison of policies 3 and 4, it is clear that they also present the government with a trade-off. If promotion of output and employment is the main goal, our results prefer policy 4. If the reduction of inequality is the main objective, policy 3 would be better. Unlike policy 4, it does not impose a reduction in after-tax wages for low educated workers.

5 Conclusions and policy recommendation

Increasing employment, in particular among low educated individuals, stands high on the agenda of policy makers. A huge body of academic literature using either general equilibrium models or econometric methods may guide governments to develop effective policies. However, the impact of employment policies on welfare, inequality and poverty has rarely been studied within the same framework. Our contribution in this paper is to analyze the effect of employment policies most often put forward in the literature on both economic and social indicators. More specifically, we study the impact of a change in employers' social security contributions, labor taxes to be paid by employees, unemployment benefits, and union wages on employment, output and education on the one hand, and on welfare, poverty and inequality on the other hand.

Our framework is a four-period OLG model for a small open economy in which agents optimize their decisions on labor supply, consumption and education. Households face a budget constraint in which income includes labor income, interest income and, if applicable, transfers from the government. The model has two distinct characteristics: individuals differ by innate ability and there is an imperfect labor market (union wage floor) for individuals of low ability, causing

unemployment. For workers of higher ability, we assume perfect competition on the labor market. After parameterizing the model, we show its empirical reliability in a group of 11 OECD countries and then use it for of fiscal policy simulations. The benchmark from which we start is an average of four core euro area countries: Belgium, France, Germany and the Netherlands. The former three countries in particular are among the worst performers when it comes to employment of low educated individuals.

The conclusions and policy implications of our work are as follows. Above all, we find that fiscal policies targeted at the low educated can make a substantial difference. Our results confirm the effectiveness of targeted reductions in taxes on low educated labor (both on employees and employers), financed by a decrease of unemployment benefits. In line with existing literature, this combination succeeds in raising employment and output, and in strongly reducing unemployment among the low educated. Getting low educated people into work also raises their welfare and contributes to a reduction of overall inequality in society. Moreover, because its beneficial macroeconomic effects imply an ex-post improvement of the government budget, which would allow for example to reduce consumption taxes, higher educated individuals benefit as well. A significant drawback of this policy, however, which has received much less attention in general equilibrium models and econometric studies, is that it exacerbates the income gap between employed and unemployed individuals. Low educated individuals who, despite everything, cannot find a job end up in (deeper) poverty.

Achieving higher employment and lower aggregate inequality without increasing poverty requires combined efforts of fiscal policy makers (labor tax cuts on either employers or workers) and unions (wage moderation). Mutual commitment of these two key players can imply a drastic reduction of the cost of low educated labor without having to reduce unemployment benefits. The induced increase in employment and the drastic fall in unemployment make it possible to finance (most of) the labor tax cut. Aggregate inequality falls to a greater extent, compared with policies based on benefit cuts: neither the income gap between employed and unemployed individuals, nor poverty among the unemployed increase. Depending on government preferences for either employment or reduced inequality, different policy reforms within this type are possible. If promotion of output and employment is the main goal, our results prefer to reduce the labor tax rate on employers. If the reduction of inequality is the main objective, it would be better to cut labor income taxes to be paid by the (low educated) workers.

The observation that the welfare of other, higher educated households increases for all considered policies, although to a lesser extent, insures the political feasibility and the support for these policy measures throughout all layers of society.

For a correct interpretation of our conclusions we emphasize two major underlying assumptions. One is that we assume all unemployment to be involuntary. The second is that all unemployed are directly employable. Our results are therefore to be seen as long-run effects, the realization of which may require complementary policies, such as active labor market policies. Furthermore, we emphasize that while the policies discussed in this paper are successful in reducing unemployment and inequality, they do not succeed in reducing poverty among those who, despite everything, remain unemployed. Achieving improvement on this indicator as well will also require complementary policies.

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Appendix

A Data, construction and sources

In this appendix we provide more detail on the construction of the performance data and the policy variables in 11 OECD countries. We use similar calculation methods as used in Buyse et al. (2017) and Boone and Heylen (2019) but apply them to data from a more recent period.

A.1 Performance variables

$\bar{n}_1$, $\bar{n}_2$, $\bar{n}_3$: Employment rate in hours (in one of three age groups, 2014-2016)

Definition: actual hours worked per person in the age group / potential hours worked.
Actual hours worked per person = employment rate in persons x average hours worked per employed per week x average number of weeks worked per year
Potential hours = 2080 (where 2080 = 52 weeks per year x 40 hours per week)
Data sources:
* Employment rate in persons by age : OECD Stat; Education at a Glance; Educational attainment and outcomes; Employment, unemployment and inactivity rate of 25-64 year-olds, by educational attainment. The data are taken for all levels of educational attainment and are constructed for the three age groups as weighted averages of the available age subgroups: 25-34, 35-44, 45-54, 55-64.
* Average hours worked per employed per week: OECD Stat; Labour Force Statistics; Average usual weekly hours worked on the main job. These data are available only for age groups 15-24, 25-54, 55-64.
* Average number of weeks worked per year: Due to lack of further detail, the same data is used for each age group. The average number of weeks worked per year has been approximated by dividing average annual hours actually worked per worker (total employment) by average usual weekly hours worked on the main job by all workers (total employment). Data source: OECD Stat; Labour Force Statistics; Hours worked.

Ability and education

The OECD provides data for individuals with different levels of education. We consider 'below upper secondary education' as representative for the low ability group in our model and 'upper secondary or post-secondary non-tertiary education' as representative for the medium-low ability group. Furthermore, we calculated a weighted average of data for 'short-cycle tertiary education' and 'bachelor's or equivalent education' as representative for the medium-high ability group. Last, we use data for 'master's or equivalent education' as a proxy for the high ability group.

u : unemployment rate, low ability group (2014-2016)

Definition: In line with our assumptions that (i) all individuals of active age in our model participate on the labor market, and (ii) that all those with at least medium-low ability have a job, while some of those with low ability do not, we calculate the unemployment rate among

the low ability group (u) as the difference in the data between the employment rate of the average of the three highest educational groups and the employment rate of those with the lowest education.
Data Source: OECD stat; Education at a Glance; Educational attainment and outcomes; Employment, unemployment and inactivity rate of 25-64 year-olds, by educational attainment.

$\bar{n}_L$, n_{ML}, n_{ML}, n_H: employment rate in hours by ability (2014-2016)

Definition: actual hours worked per person in the ability group / potential hours worked.
Actual hours worked per person = employment rate in persons x average hours worked per employed per week x average number of weeks worked per year
Potential hours = 2080 (where 2080 = 52 weeks per year x 40 hours per week)
Data sources:
* Employment rate in persons by ability: OECD Stat; Education at a Glance; Educational attainment and outcomes; Employment, unemployment and inactivity rate of 25-64 year-olds, by educational attainment. For a description of the relationship between ability levels in the model and education levels in the data, cf. supra.
* Average hours worked per employed per week: ILO (2012, International standard classification of occupations, structure, group definitions and correspondence tables) links professions categorized in ISCO-08 groups to ISCED-97 levels of education. As the low ability group corresponds to ISCED-97 groups 1 to 2 (primary and lower secondary education), the medium-low group to groups 3 and 4 (upper secondary or post-secondary, non-tertiary education), the medium-high ability group to ISCED-97 group 5a (tertiary education, short or medium duration) and the high ability level to ISCED-97 groups 5b and 6 (first stage, medium duration and second stage tertiary education) the professions of low, medium-low, medium-high and high ability are composed as follows: Low ability individuals can be found among clerical support workers, service and sales workers, craft and related trades workers, plant and machine operators and assemblers, workers in elementary occupations). Medium-low ability workers can be found in the same occupations, but not in elementary occupations. Medium-high ability individuals are expected to be ISCO-08 technicians and associate professionals and managers. The high ability group corresponds to the ISCO-08 groups of professionals and managers.
EUROSTAT provides the data on hours worked per week by profession (Average number of usual weekly hours of work in the main job, by sex, professional status, full- time/part-time and occupation, lfsq-ewhuis). The data concern dependent employees. Due to a lack of data for the United States and Canada, Average Usual Weekly Hours Worked on the main job (OECD Stat) are used to replace average hours worked per week.
* Average number of weeks worked per year: Due to lack of further detail, the same data is used for each ability group. The average number of weeks worked per year has been approximated by dividing average annual hours actually worked per worker (total employment) by average usual weekly hours worked on the main job by all workers (total employment). Data source: OECD Stat; Labour Force Statistics; Hours worked.

e: Education rate of the young (age group 20-34, 2013-2015)

Definition: total hours studied by individuals of age 20-34 / potential hours studied
Hours studied are approximated by the fraction of the age group 20-34 in education, in full time equivalent. Calculation:

Table A.1: Employment rate in hours by age 20-34 ($\bar{n}_1$), 35-49 ($\bar{n}_2$) and 50-64 ($\bar{n}_3$), and by ability level: primary or lower secondary ($\bar{n}_L$), upper secondary (n_{ML}), bachelor (n_{MH}) and master (n_H), the unemployment rate in persons (u), education rate in hours (e) and per capita growth rate (x)[1]

	$\bar{n}_1$	$\bar{n}_2$	$\bar{n}_3$	$\bar{n}_L$	n_{ML}	n_{MH}	n_H	u	e	x
Belgium	56.6	60.6	40.8	33.6	54.2	69.6	71.6	34.0	13.1	1.16
France	53.5	60.2	43.0	36.1	51.9	66.3	71.4	28.4	13.1	1.14
Germany	52.5	57.2	48.1	36.3	52.6	66.0	66.8	26.6	15.4	0.93
Netherlands	53.2	62.3	49.7	38.9	55.4	69.4	73.3	25.1	16.6	1.48
Core average	53.9	60.1	45.4	36.2	53.5	67.8	70.8	28.5	14.5	1.18
Denmark	48.3	62.7	52.6	40.6	55.1	67.5	71.6	22.7	24.1	0.75
Finland	56.6	67.8	54.3	41.3	58.2	70.4	73.8	26.5	17.0	1.08
Norway	52.2	61.6	53.9	39.4	53.7	65.2	68.6	25.6	15.5	1.17
Sweden	61.1	71.2	63.3	49.5	66.0	73.1	77.2	22.5	12.5	1.46
Nordic average	54.5	65.8	56.0	42.7	58.2	69.0	72.8	24.3	17.3	1.11
United Kingdom	64.4	70.1	55.9	47.0	64.3	74.0	77.6	22.9	9.7	1.23
United States	62.1	68.7	58.8	47.5	58.7	68.1	72.3	22.0	14.5	1.18
Canada	65.8	67.5	55.6	45.3	60.5	66.9	68.4	24.3	13.0	1.32
Anglo-Saxon average	64.1	68.8	56.7	46.6	61.1	69.7	72.7	23.1	12.4	1.24
Overall average	56.9	64.5	52.4	41.4	57.3	68.8	72.0	25.5	15.0	1.17

[1] For employment, n indicates labor hours supplied by individuals, in line with the specification in our model. For individuals of high, medium-high or medium-low ability, these hours are also actually being worked (labor market clearing). $\bar{n}$ indicates hours worked corrected for the fact that a fraction of the concerned population (low ability individuals) is unemployed.

$(fts_{20-34} + 0.5\ pts_{20-24} + 0.25\ pts_{25-34})\ /\ pop_{20-34}$

with fts the number of full-time students in the age group 20-34

pts the number of part-time students in the age groups 20-24 and 25-34

pop total population of age 20-34

Full-time students are assumed to spend all their time studying. For part-time students of age 20-24 the assumption is made (for all countries) that they spend 50% of their time studying, part-time students of age 25-34 are assumed to spend 25% of their time studying. Due to the limited number of part-time students, these specific weights matter very little.

Data sources:

* Full-time students in age groups 20-24, 25-29, 30-34: OECD Stat; Education and Training; Students enrolled by age (total tertiary education, all educational programmes, full-time)

* Part-time students in age groups 20-24, 25-29, 30-34: OECD Stat; Education and Training; Students enrolled by age (total tertiary education, all educational programmes, part time).

For those countries where data for specific years are missing, period averages are computed on the basis of all available annual data.

x: Annual real potential per capita GDP growth rate (aggregate, 2015-2017)

Definition: Average annual growth rate of real potential GDP per person of working age

Data sources:

* real potential GDP: OECD Statistical Compendium; Economic Outlook; supply block; Potential output of total economy, volume.

* population at working age: OECD Stat; Labour Force Statistics; LFS by Sex and Age.

A.2 Policy variables

τ_c: Tax rate on consumption (2015-2017)

Definition: taxes less subsidies on products divided by domestic demand corrected for taxes less subsidies on products. We assume the same tax rate on investment goods as on consumption goods.

Data source: OECD stat; National Accounts; Annual National Accounts; Main Aggregates; Gross Domestic Product (GDP); 1. Gross Domestic Product (GDP); 'D21-D31: Taxes less subsidies on products' and 'P3-P5: Domestic demand'.

τ_k: Tax rate on capital returns (2015-2017)

Definition: Statutory corporate income tax rate

Data Source: OECD Stat; Public Sector, Taxation and Market regulation; Taxation; Table II.1: Statutory corporate income tax rate.

τ_p:Social security contribution rate, employers (2017)

Definition: The data cover employer social security contributions and payroll taxes as a % of the gross wage. OECD provides data in monetary terms for all taxes, contributions and the gross wage.

Data Source: OECD Stat; Public sector, taxation and market regulation; Taxation; Taxing wages; Marginal tax wedge decomposition.

* The OECD publishes data on the gross wage earnings and labor income taxes for 4 family types and several income situations. We calculate the average over each family situation for the following income levels: 75%, 100%, 150% and 175% of average earnings.

ξ: progressivity parameter of labor taxes (2015-2017)

Definition: the ratio (minus 1) of the marginal tax rate on workers' gross wage to the average tax rate

Data sources:

*Marginal personal income tax and social security contribution rates on gross labour income: OECD Stat, Public sector, Taxation and Market Regulation; Taxation; Tax Database; Table I.4

*Average personal income tax and social security contribution rates on gross labour income: OECD Stat, Public sector, Taxation and Market Regulation; Taxation; Tax Database; Table I.5

The OECD provides data on 4 levels of average income: 67%, 100%, 133% and 167%. The data is calculated taking the average of these 4 income levels.

Γ*: level parameter of labor taxes (2015-2017)*

Definition: The OECD provides data for the average personal income tax and social security contribution rates on gross labour income at 67%, 100%, 133% and 167% of the average income. Function values for Γ are averaged over these four levels of income.

Data source: OECD Stat, Public sector, Taxation and Market Regulation; Tax database; Table I.5

D/Y: Government debt (% of GDP) (2015-2017)

Definition: General government gross financial liabilities, as a percentage of GDP.

Data source: OECD Statistical Compendium, Economic Outlook, N°102, Government Accounts.

Table A.2: Fiscal policy: tax rates and government debt

	Tax rate on consumption (in %)	Tax rate on capital income (in %)	Social contribution rate (in %)	progressivity of labor taxes	level of labor taxes (in %)	Public debt (in % of GDP)
Proxy for:	τ_c	τ_k	τ_p	ξ	Γ	D/Y
Belgium	12.1	34.0	28.0	35.6	40.5	125.9
France	11.9	39.0	38.9	39.4	29.0	121.9
Germany	12.1	29.8	17.6	22.1	39.2	75.8
Netherlands	12.8	25.0	9.5	50.3	29.4	73.8
Core average	12.2	31.9	23.5	36.9	34.5	99.4
Denmark	16.6	22.5	0.7	28.7	36.4	52.2
Finland	15.9	20.0	22.3	47.9	29.8	74.6
Norway	13.1	25.3	13.0	39.9	28.4	41.3
Sweden	13.8	22.0	31.4	50.9	26.6	52.3
Nordic average	14.8	22.5	16.9	41.9	30.3	55.1
United Kingdom	11.9	19.7	11.2	49.1	23.3	117.1
United States	3.1	38.9	8.3	34.8	26.2	105.8
Canada	6.9	26.7	10.4	32.8	22.4	96.3
Anglo-Saxon av.	7.3	28.4	9.9	38.9	24.0	106.4
Overall average	11.8	27.5	17.4	39.2	30.1	85.2

Table A.3: Fiscal policy: unemployment benefit and pension replacement rates, government spending and commuting costs

	Earnings-related pension (replacement rate in % of average earned net labor income)				Non-employment benefit (net replacement rate in % of previous earnings)	total expenditure on goods and services (% of GDP)	commuting costs (% of total time)
Proxy for:	ρ_{wL}	ρ_{wML}	ρ_{wMH}	ρ_{wH}	b	g	cc
Belgium	69.6	66.1	50.1	44.4	66.1	25.8	5.6
France	77.1	74.5	70.3	67.8	59.6	27.1	4.7
Germany	51.1	50.5	49.8	44.3	61.7	21.6	5.6
Netherlands	103.4	100.6	100.2	100.7	66.5	28.2	5.8
Core average	75.3	72.9	67.6	64.3	63.5	25.7	5.5
Denmark	89.2	80.2	76.2	74.3	71.1	29.0	4.8
Finland	64.4	65.0	65.1	64.8	74.2	27.7	4.4
Norway	50.7	48.8	41.3	37.4	66.9	29.1	6.1
Sweden	55.7	54.9	67.6	70.7	63.7	30.4	3.8
Nordic average	65.0	62.2	62.6	61.8	69.0	29.1	4.8
United Kingdom	37.2	29.0	20.7	18.2	63.8	21.4	4.6
United States	52.5	49.1	42.4	38.9	36.4	17.5	4.4
Canada	53.8	53.4	38.5	33.6	56.2	24.7	6.3
Anglo-Saxon av.	47.8	43.8	33.9	30.2	52.1	21.2	5.1
Overall average	64.1	61.1	56.6	54.1	62.4	25.7	5.1

b: Net non-employment benefit replacement rate (2014-2016)

Definition: The data concern net transfers received by long-term unemployed people and include unemployment benefits, social assistance, family and housing benefits in the 60th month of benefit receipt. Supplements are assumed to be included.
Data Source: OECD Stat; Social protection and Well-being; Benefits, Taxes and Wages; Key indicators; Net replacement rate, Long term after 5 years of unemployment;
* The OECD provides net replacement rates for six family situations and three earnings levels. The average is calculated over the six family types at 67% of average earnings.

ρ_a: Net pension replacement rates (2016)

Definition: OECD (2017) presents net pension replacement rates for individuals at various multiples of average individual earnings in the economy. We consider the data for individuals at 75% of average earnings as representative for the low ability group, individuals with 100% of average earnings as representative for the medium-low ability group, individuals with 150% of average earnings as representative for the medium-high ability group and individuals with 175% average earnings as representative for the high ability group.
Data source: Country studies in OECD (2017) show the values of the net replacement rates at these specific levels of average earnings.

g: government spending on goods and services (2015-2017)

Definition: Sum of government final consumption expenditure and government fixed capital formation, as a percentage of GDP.
Data source: OECD Stat; Economic Outlook N°103; Government Accounts and Expenditure and GDP.

cc: commuting costs (1995-2014)

Definition: Time spent travelling to and from work as a fraction of the total time endowment (2080 = 52 weeks x 40 hours per week) of individuals.
Data source: The OECD family Database; Table LMF 2.6.

B First order conditions of the households

Equation (22) describes the Euler equation for consumption. It is the same for all individuals, irrespective of ability. Consumption in the next period relative to the current period will be higher if there is a high interest rate and the rate of time preference is low (high β).

$$\frac{c^t_{j+1,a}}{c^t_{ja}} = \beta(1 + r_{t+j}) \qquad \forall j = 1,2,3 \quad \forall a = H, MH, ML,\ L \quad (22)$$

Equation (23) describes optimal labor supply for each of the three active periods in life. Equation (23.a) does this for individuals of high, medium-high or medium-low ability, while equation (23.b) expresses the first order condition of low ability individuals.

Households supply labor hours up to the point where the marginal gain for the household is equal to its marginal cost. The LHS of each equation shows the marginal cost: the utility loss of having one less hour of leisure. The RHS denotes the gains of working more. These are

twofold: first of all, it is possible to consume more while still on the labor market. Secondly, the individual also builds pension entitlements and thus possibilities to consume once retired. The gains of working rise in higher human capital h_{ja}^t, lower marginal axes on labor τ_w^m, lower consumption taxes τ_c and when the marginal utility of consumption $\left(1/c_{ja}^t\right)$ is high. The policy parameter ρ_a also directly affects the leisure-labor decision.

The only difference between the low educated and the other households is that the unemployment rate needs to be taken into account when looking at the marginal utility cost and the gains from work. Only a fraction $(1-u)$ of household members are at work and can adjust their labor hours. Unemployment and unemployment benefits are assumed exogenous to the individuals. The benefit component of income does not appear in these equations.

$$\forall\ j\ =\ 1,2,3 \qquad \forall\ a\ =\ H, MH, ML$$

$$\frac{\gamma_j}{\left(l_{ja}^t\right)^\theta} = \frac{w_{a,t+j-1} h_{ja}^t \left(1-\tau_{w,ja}^m\right)}{c_{ja}^t \left(1+\tau_c\right)} + \beta^j \frac{1}{3} \frac{\rho_a w_{a,t+j-1} h_{ja}^t \left(1-\tau_{w,ja}^m\right)(1+x)^j}{c_{4a}^t \left(1+\tau_c\right)} \tag{23a}$$

$$\forall\ j\ =\ 1,2,3 \qquad For\ a\ =\ L$$

$$\begin{aligned}\frac{\gamma_j \left(1-u_{t+j-1}\right)}{\left(l_{jL}^t\right)^\theta} &= \frac{w_{L,t+j-1} h_{jL}^t \left(1-\tau_{w,jL}^m\right)\left(1-u_{t+j-1}\right)}{c_{jL}^t \left(1+\tau_c\right)} \\ &\quad + \beta^j \frac{1}{3} \frac{\rho_L w_{L,t+j-1} h_{jL}^t \left(1-\tau_{w,jL}^m\right)(1+x)^j}{c_{4L}^t \left(1+\tau_c\right)}\end{aligned} \tag{23b}$$

Finally, Equation (24) describes the first order condition for the high and medium-high ability individuals in deciding their optimal education level. It imposes that the total discounted marginal utility gain of studying one more hour is equal to its marginal cost. There is a marginal cost because the individual has less time for leisure or labor. The gains can be seen as a higher labor income in the next periods of life, enlarging consumption possibilities. Investment in human capital will rise in initial human capital h_{1a}^t, hours worked n_{ja}^t, low marginal taxes on labor τ_w^m, low consumption taxes τ_c and the underlying determinants of the human capital production function. Policy also has a role to play: in addition to tax rates, the net pension replacement rate ρ_a can influence the education decision directly.

$$\frac{\gamma_1}{(l_{1a}^t)^\theta} \frac{-\partial l_{1a}^t}{\partial e_{1a}^t} = \beta \frac{1}{c_{2a}^t} \frac{\partial c_{2a}^t}{\partial e_{1a}^t} + \beta^2 \frac{1}{c_{3a}^t} \frac{\partial c_{3a}^t}{\partial e_{1a}^t} + \beta^3 \frac{1}{c_{4a}^t} \frac{\partial c_{4a}^t}{\partial e_{1a}^t} \qquad \forall\ a\ =\ H, MH \tag{24}$$

$$\begin{aligned} with\ \frac{\partial c_{2a}^t}{\partial e_{1a}^t} &= \sigma\varphi (e_{1a}^t)^{\sigma-1} \frac{w_{a,t+1} h_{1a}^t (1-\tau_{w,ja}^m) n_{2a}^t}{1+\tau_c} \\ \frac{\partial c_{3a}^t}{\partial e_{1a}^t} &= \sigma\varphi (e_{1a}^t)^{\sigma-1} \frac{w_{a,t+2} h_{1a}^t (1-\tau_{w,ja}^m) n_{3a}^t}{1+\tau_c} \\ \frac{\partial c_{4a}^t}{\partial e_{1a}^t} &= \rho_a \sigma\varphi \left(e_{1a}^t\right)^{\sigma-1} \frac{1}{3} \frac{\sum_{j=2}^3 \left(w_{a,t+j-1} h_{1a}^t \left(1-\tau_{w,ja}^m\right) n_{ja}^t (1+x)^{4-j}\right)}{1+\tau_c} \end{aligned}$$

C Singular policy changes

This appendix analyses the effects of a single policy shock in fiscal policy parameters and wage setting for low educated households. More specifically, a change in the level parameter of labor taxes (policy C.1), the employers' social contribution rate (policy C.2), the unemployment benefit replacement rate (policy C.3) and the union wage (policy C.4). Each shock equals 0.375% of GDP ex-ante, while for the 4th policy, we set the union wage at the same level as is reached in policy C.3. The consumption tax rate adjusts endogenously to keep the government debt-to-output-ratio at its benchmark level. Table C.1 shows the economic effects, while tables C.2 and C.3 and figures C.a to C.d show the impact on welfare and its distribution.

Concerning economic effects, we find that changes in the labor tax rate on workers or the employers' social contribution rate have similar favorable effects for aggregate employment. However, while the second policy decreases unemployment, the first policy implies a marginal increase. Moreover, the effects on employment and output are small in comparison with the results realized by a decrease in the unemployment benefit rate or an equivalent change in the union wage. The latter two policies also allow for a strong decrease in the consumption tax rate, while this rate has to rise for the first two policies.

Looking at the impact on welfare, we find that policy C.1 has the most favorable effects for low educated workers of all ages, while it has a negative impact for the other three household categories. The increase in the consumption tax rate plays a major role here. Moreover, the overall change in welfare is negative when we look at the aggregate level in table C.2. Only when accounting for future generations, aggregate welfare rises marginally. This finding can be generalized for the other policies: if a policy performs well in raising welfare for low educated households it performs worse in terms of welfare changes for other households. In result it also performs worse in terms of aggregate welfare. The political feasibility of single policy measures aimed at improving employment and welfare among low educated households is therefore highly questionable.

Finally, we also want to know more about inequality and poverty. Even though all policies alleviate income inequality, we find that a decrease in the benefit rate (policy C.3) increases utility inequality. Moreover, this policy performs very badly when looking at poverty. The income gap between the employed and the unemployed enlarges greatly. The gap also increases for the other policies, but to a lesser extent.

Table C.1: Economic effects[1]

	Policy C.1 $\Delta\Gamma : -13.85$	Policy C.2 $\Delta\tau_{p,L} : -8.94$	Policy C.3 $\Delta b : -28.84$	Policy C.4 $\Delta\lambda : -0.062$
$\Delta{\tau_c}^2$	1.00	0.72	-1.26	-0.85
$\Delta\bar{n}_1$ [3]	0.14	0.11	1.40	1.48
$\Delta\bar{n}_2$	0.19	0.17	1.26	1.29
$\Delta\bar{n}_3$	0.24	0.15	0.81	0.71
$\Delta\bar{n}$ [4]	0.19	0.14	1.16	1.16
Δn_L	1.11	0.13	-0.16	-0.77
Δn_{ML}	0.00	0.01	0.02	0.02
Δn_{MH}	0.00	-0.01	0.00	0.00
Δn_H	0.00	-0.01	0.00	0.00
Δu	0.06	-0.76	-7.45	-8.22
$\Delta \mathrm{w}_L(1+\tau_{p,L})^5$	-1.01	-5.60	-5.75	-5.75
$\Delta {\mathrm{w}_L}^5$	-1.01	7.02	-5.75	-5.75
$\Delta \mathrm{w}_L(1-\tau_{w,1L})^5$	11.28	6.13	-6.09	-6.14
Δe	0.00	0.05	0.02	0.02
$\Delta \mathrm{Y}^5$	0.13	0.18	0.78	0.78

The effects are for a benchmark of 4 core euro area countries (Belgium, France, The Netherlands and Germany). Initial policy variables in %: $\tau_c = 12.2$, $\tau_k = 31.9$, $\tau_p = 23.5$, $\xi = 36.9$, $\Gamma = 34.5$, $D/Y = 99.4$, $b = 63.5$, $g = 25.7$, $\rho_{wL} = 75.3$, $\rho_{wML} = 72.9$, $\rho_{wMH} = 67.6$, $\rho_{wH} = 64.3$, $cc = 5.5$

[1] Difference in percentage points between the new steady state and the benchmark, except for output Y and wages.

[2] Change in consumption tax rate in percentage points to keep the ratio of debt to GDP constant.

[3] $\bar{n}_j$ indicates the employment rate in hours by age (see also figure 3.1.a-c). It is computed as $n_j(1-u)$ with n_j hours per employed worker and $(1-u)$ the employment rate in persons. By analogy, n_a is hours per employed worker by ability.

[4] Change in (weighted) aggregate employment rate in hours, in percentage points.

[5] Difference in percent between the new steady state and the benchmark.

Table C.2: Aggregate welfare and inequality measures

Steady state	Policy C.1	Policy C.2	Policy C.3	Policy C.4
Δ income inequality measure[1]	-0.018	-0.007	-0.007	-0.011
Δ lifetime utility inequality measure [2]	-0.048	-0.038	0.031	-0.009
Dynamic	Policy C.1	Policy C.2	Policy C.3	Policy C.4
Welfare measure all current generations	-0.075	0.090	1.353	1.346
Welfare measure all current + 3 future generations	0.055	0.325	2.123	2.352

See the main text for a description of the calculation of the measures.

[1] Change in the Gini coefficient.

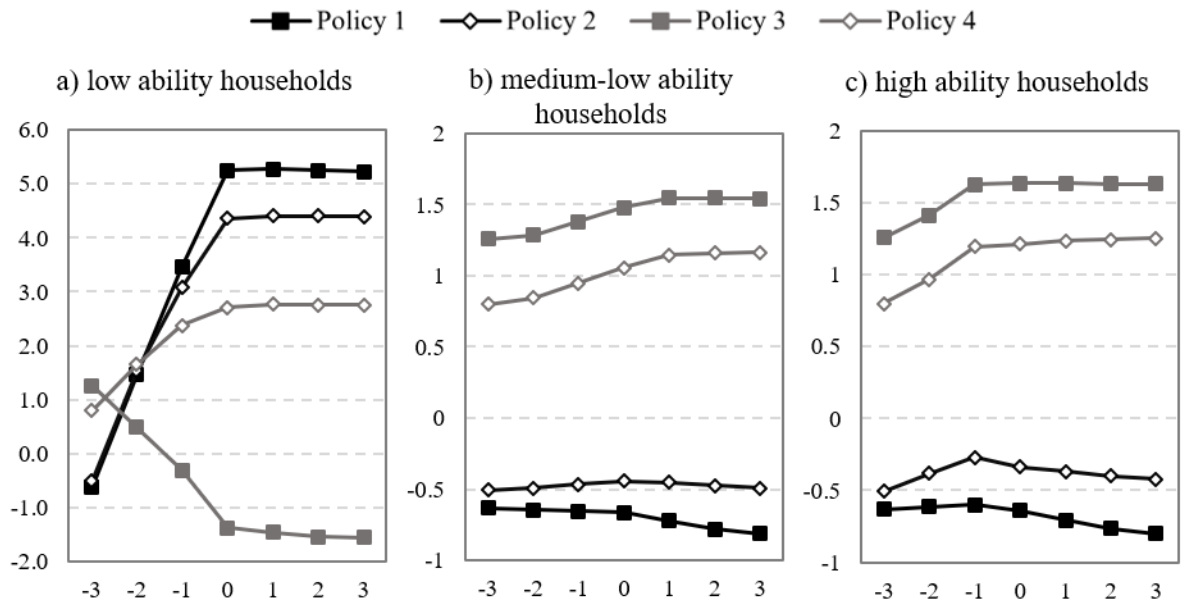
[2] Change in the Atkinson inequality index.

Table C.3: Decomposition of pooled disposable income of low ability households between their employed $(1-u)$ and unemployed (u) members – Income relative to average disposable income in the economy

	Policy C.1			Policy C.2			Policy C.3			Policy C.4		
	pool	u	$(1-u)$	*pool*	u	$(1-u)$	*pool*	u	$(1-u)$	*pool*	u	$(1-u)$
young	0.65	0.48	0.72	0.64	0.51	0.70	0.58	0.33	0.64	0.60	0.47	0.63
middle	0.72	0.57	0.78	0.71	0.59	0.76	0.64	0.42	0.70	0.67	0.55	0.70
older	0.67	0.56	0.71	0.66	0.58	0.70	0.60	0.44	0.64	0.62	0.54	0.64

See the main text for a description of the calculation of the measure.

Figure C.1: Welfare effects for households belonging to current and future generations



The vertical axis indicates the welfare effect for the generation born in $t+k$, where t is when the fiscal policy change is introduced. The horizontal axis indicates k. Our welfare measure is the (constant) percentage change in benchmark consumption in each period of remaining life that individuals should get to attain the same lifetime utility in the benchmark as after the policy shock.