Cross-country differences in unemployment: fiscal policy, unions and household preferences in general equilibrium

Brecht Boone\textsuperscript{a,b} and Freddy Heylen\textsuperscript{a}

\textsuperscript{a} SHERPPA, Ghent University
\textsuperscript{b} Research Foundation – Flanders (FWO)

February 2015
2015/899
Cross-country differences in unemployment: fiscal policy, unions and household preferences in general equilibrium

Brecht Boone and Freddy Heylen
SHERPPA, Ghent University∗

February, 2015

Abstract

We develop and parameterize an overlapping generations model that explains hours worked, education, and unemployment within one coherent framework. We extend previous work in this tradition by introducing individuals with heterogeneous ability and a unionized labour market for lower ability workers. Unemployment is due to above market-clearing wages for these workers. Our calibrated model’s predictions match the facts remarkably well in a sample of continental European, Nordic and Anglo-Saxon countries. We then use the model to explain the cross-country variation in unemployment. A Shapley decomposition reveals an almost equal role for differences in fiscal policy variables and in union preferences. Both account for about half of the explained variation in unemployment rates. While it is the above market-clearing wage chosen by the unions that directly leads to unemployment, the fiscal policy variables determine most of its magnitude. As to specific fiscal variables, differences in unemployment benefit generosity play a much more important role than tax differences. Controlling for fiscal variables and union preferences, any differences in the taste for leisure of the households have no role to play in determining cross-country variation in unemployment.

∗Correspondence to: brecht.boone@ugent.be, Sherppa, Ghent University, Sint-Pietersplein 6, B-9000 Ghent, Belgium. Brecht Boone acknowledges financial support from the Research Foundation – Flanders (FWO), Brussels, Belgium. We thank Dirk Van de gaer, Tim Buyse, Stéphane Vigeant, and the participants of the 2014 Ghent-Lille Workshop in Economics for valuable suggestions and comments. Any remaining errors are ours. Paper presented at the 41th Conference of the Eastern Economic Association, New York, February 26 - March 1, 2015
1 Introduction

Labour market performance varies widely and structurally across OECD countries. In Figure 1 we document a number of important facts and regularities for 12 countries in 2001-2007. A first fact is that the cross-country variation in the aggregate employment rate is mainly due to differences in the employment rate among low educated individuals and among individuals in the older age group. While all countries show high and fairly comparable employment rates for high educated individuals and for prime age workers, reality is totally different for the low educated and for older workers. Figure 1(a) shows the best aggregate employment performance in countries like Sweden and Denmark that succeed in keeping the employment gap for the low educated small, relative to the high educated. A large gap in countries like Belgium and Germany is associated with relatively bad aggregate employment performance. Correlation in Figure 1(a) is about 0.80. Figure 1(b) shows an even stronger correlation of almost 0.92 between the aggregate employment rate and the employment rate among workers in the age group 55-64. As a second fact, Figure 1(c) reveals that cross-country differences in the employment gap between high and low educated individuals are to a large extent related to differences in unemployment between these individuals. If the objective is to get more low educated people at work, fighting unemployment among these people must be an important part of the policy programme. The message of Figure 1(d) is that this may even be the main part of any programme that aims at reducing aggregate (equilibrium) unemployment. This figure shows as a third fact that cross-country differences in aggregate unemployment mainly reflect differences in excess unemployment of low educated versus high educated individuals. Correlation in Figure 1(d) is almost 0.86. Figure 1(e) demonstrates - as a fourth fact - a wide variation in annual hours worked per employed person, ranging from about 1400 hours in the Netherlands to more than 1800 in the US. There is no clear relationship, however, between annual hours worked per employed person and the fraction of people employed.

One conclusion that we draw from the cross-country data in Figure 1 is that weak labour market performance is not an accident from nature. While some countries show poor results, others perform very well. Differences are substantial. A second conclusion is that the labour market position of low educated individuals and of older workers seems to play a crucial in these cross-country differences. In the current context of ageing, rising pressure on the welfare state, and the implied need for higher employment in many countries, this is important to know. The implied questions are obvious. Why does the labour market position of low educated workers and the position of older workers
Figure 1: Employment, unemployment and hours worked in OECD countries, 2001-07.

Notes: We compute the (un)employment rate among low educated individuals as the average of the (un)employment rates among individuals with less than upper secondary education and among individuals with upper secondary, but no tertiary degree. The (un)employment rate among individuals with higher education relates to those with a tertiary degree. Unless defined differently, all reported employment and unemployment rates concern the age group 25-64. Data sources: Eurostat (LFS series: lfsa_ergaed, lfsa_urgaed) and OECD Labour Force Statistics (Annual hours actually worked per worker – total employment).
vary so much across countries? What exactly explains the differences? Questions like these highlight the need for diverse research. Our main focus in this paper will be on the labour market position of the low educated.

Since about a decade many researchers have built gradually richer general equilibrium models to account for countries’ labour market performance and for cross-country differences. Initial contributions by Prescott (2004), Rogerson (2007), Dhont & Heylen (2008), Ohanian et al. (2008) and Olovsson (2009) tried to explain differences in aggregate per capita hours worked. Later work introduced a life-cycle dimension in labour supply and employment in order to explain also the huge cross-country differences in employment among persons older than 50 (see Prescott et al. (2009), Rogerson & Wallenius (2009), Erosa et al. (2012), and Alonso-Ortiz (2014)). As another advantage of introducing a life-cycle dimension, it became possible to model the time allocation of young people between labour and education, and to explain human capital formation as an endogenous variable (see e.g. Ludwig et al. (2012); Heylen & Van de Kerckhove (2013); Wallenius (2013)).

Despite the enormous progress that has been made in the literature, one clear weakness has not been dealt with. A striking observation in all the aforementioned models is their assumption of a perfectly competitive labour market. They cannot explain equilibrium unemployment, let alone the huge and persistent differences in unemployment between for example high and lower educated individuals. Yet, as demonstrated by Figures 1(c) and 1(d), these differences are important in many countries. They may explain a substantial fraction of overall cross-country differences in labour market performance.

Next to excluding a potential role for labour imperfections, the above mentioned general equilibrium literature also leaves little room for differences in individual preferences across countries to show up. Blanchard (2004) and Alesina et al. (2005) have argued that a key factor behind the lower employment in many European countries compared to the US is a higher taste for leisure. Yet, the general equilibrium literature generally imposes the same preferences upon individuals.

Our first contribution in this paper is to take the dynamic general equilibrium literature studying aggregate employment and employment over the life-cycle one step further. More precisely, we develop a five generations OLG model for a small open economy, which explains not only hours worked and human capital formation within one coherent framework, but also equilibrium unemployment among lower educated individuals. Two assumptions are key. The first one is the assumption that individuals
are heterogeneous by ability. They enter the model with different human capital stocks and have different capacity to build more human capital. This approach may offer the best match to recent findings by Huggett et al. (2006), Huggett et al. (2011) and Keane & Wolpin (1997) that heterogeneity in human capital endowment at young age and in learning abilities, rather than shocks to human capital, account for most of the variation in lifetime utility. Our second assumption and key novelty compared to previous work in this tradition is the assumption of a unionized labour market for lower ability (lower educated) individuals. Like Faia & Rossi (2013), we introduce a monopolist firm-specific trade union that determines the real pre-tax wage for these workers while taking aggregate variables and fiscal policy parameters (e.g. tax rates, unemployment benefits) as given. We specify a Stone-Geary utility function for the union with both wages and employment as arguments, albeit with a different weight. As to wages, the firm-specific union only derives utility from the difference between the after-tax wage and a reference wage. The latter is a weighted average of the after-tax wage that would prevail if the lower ability labour market were competitive, the after-tax wage of higher ability workers and the unemployment benefit. The monopoly union chooses the wage in a first stage. In the next stage, the firm will choose employment (number of workers), while the households of lower ability individuals decide on the supply of hours per employed. Both the firm and the households take the wage set by the union as given.

The union wage-setting framework in our model is motivated by the observation that in Europe union wage bargaining is still the most common way of wage determination. While union membership rates have decreased over time, the coverage of collective bargaining is still at least 80% in most continental European countries and Nordic countries (Du Caju et al. (2008)). Also, despite the fact that unions are not that powerful in the US, there exists a form of minimum wage in the US. As such, a union pushing the wage above its perfectly competitive counterpart might be a valid assumption for all countries to introduce unemployment.

Firms in our model act competitively on the goods market. Furthermore, building on earlier work in Heylen & Van de Kerckhove (2013), we introduce a government with a rich set of fiscal policy instruments. Government spending on goods and unemployment benefits are financed by taxes on labour, capital and consumption. As to labour taxes, we distinguish between taxes paid by the employer and the employees. Another novelty

\footnote{For higher ability workers we assume that wages and employment are determined in a perfectly competitive way. Several authors have provided empirical evidence that the effects of the presence of unions are much stronger for low skilled individuals than for the high skilled, e.g. through a higher union-non union wage premium among the low skilled workers. See e.g. Card (2001), Card et al. (2004), and Checci & Garcia Penalosa (2008).}
is the modelling of progressive income taxes paid by the households. We follow the approach used by Guo & Lansing (1998) and Koyuncu (2011). Lump sum transfers ensure a balanced budget.

Our second contribution in this paper is to use our model to investigate the main drivers of the differences in labour market performance across OECD countries, in particular unemployment. A large range of variables play a role in the model: the labour tax rates imposed on employers and employees, the unemployment benefit replacement rate, the tax rates on capital and consumption, the size of government spending, the taste for leisure of the households, and union preferences. The latter include the relative weight of employment versus wages in the unions’ utility function, and the determinants of the reference wage of the unions. To find out which of these variables matter most, our procedure is as follows. First, we calibrate our model and show its empirical relevance for twelve countries belonging to three groups (five continental European countries, four Nordic countries and three Anglo-Saxon countries). More precisely, we simulate our calibrated model for each country imposing common technology on all countries, but country-specific fiscal policy parameters and country group-specific household and union preferences. We find that the predictions of our model match the main facts in most countries. These facts concern hours worked per employed person in different age groups and the unemployment rate. Having established its empirical reliability, we then use the model to find out what policy or preference parameters account for the cross-country differences in the aggregate unemployment rate. Our objective is similar to the one of Dhont & Heylen (2008), Wallenius (2013) and Alonso-Ortiz (2014) in earlier work. We make progress by also explicitly testing the potential explanatory power of labour market imperfections, different union preferences in particular, and different tastes for leisure of the households. Performing a Shapley decomposition, we find an almost equal role for differences in fiscal policy variables and in union preferences. Both account for about half of the explained variation in unemployment rates across countries. By contrast, any differences in the households’ taste for leisure play no role. Our story will then be that the above market-clearing wage chosen by the unions is the source of unemployment, while the fiscal policy variables explain a significant part of the magnitude of unemployment. Going into greater detail on the fiscal side, we find that the key variable driving cross-country differences in unemployment of lower ability individuals is the unemployment benefit replacement rate. In the Nordic countries and (even more) the continental European countries, this has a significant impact on the reference wage of the union. The second most important fiscal policy variable is government spending on
goods. We find no role, however, for differences in labour taxes to explain cross-country unemployment variation.

Several earlier contributions have made an attempt to introduce unemployment in OLG models. Daveri & Tabellini (2000), Corneo & Marquardt (2000), and Ono (2010) among others developed OLG models with a unionized labour market, while Ravn & Sørensen (1999) and Sommacal (2006) introduced minimum wages. Other authors embed a search and matching setup in a life-cycle model, e.g. Bean & Pissarides (1993) and de la Croix et al. (2013). Many of these contributions also model growth endogenously (e.g. Bean & Pissarides (1993), Cahuc & Michel (1996), Corneo & Marquardt (2000), Bräuninger (2005), and Ono (2010)). We make progress compared to this literature along two dimensions. First, most of the models incorporating unions or studying the relationship between equilibrium unemployment and long-run growth in a life-cycle model, leave the intensive margin of employment (i.e. hours worked) unexplored. Individuals supply one unit of labour inelastically. However, as we have already shown in Figure 1(e), hours of work per employed person are substantially lower in most European countries than in the Anglo-Saxon countries. Therefore, in the search for a realistic setting, models resembling the European labour markets should be such that both the extensive and intensive margin of employment are endogenous. Second, to the best of our knowledge, all the existing OLG models where unions are present are populated by only two generations, which means that they lack a life-cycle dimension of labour supply.

The structure of this paper is as follows. In Section 2, we describe the basic setup of our model. Section 3 discusses optimal behaviour of unions, households and firms, and how this drives hours worked, unemployment and real output. Section 4 presents our calibration procedure and data on all exogenous parameters. In Section 5 we test and show the empirical validity of our model for 12 OECD countries as described above. Finally, in Section 6 we investigate the relative importance of institutional and (household and union) preference related variables versus several fiscal policy variables to explain differences across countries in the unemployment rate. Section 7 concludes.

2 The model: setup, preferences and constraints

Time is discrete and runs from 0 to infinity. We assume a small open economy populated by five overlapping generations of households, firms, unions and a fiscal government. Individual members of the household enter the model at the age of 18 and live for five periods j of 12 years. Individuals have either high or low innate ability. Those with
higher ability enter the model with high human capital and also have the capacity to pursue tertiary education. Those with lower ability enter with low human capital. They will not spend time in further education. We assume that households have only higher or lower ability members, but not both. Both the goods market and the labour market for higher ability individuals are competitive, whereas the labour market for lower ability individuals is unionized. In every period t, wages for lower ability workers are set by a monopoly union at the firm level. The government in our model disposes of a rich set of fiscal policy instruments. Government spending on goods and unemployment benefits are financed by (non-)linear taxes on capital, labour and consumption. There is no uncertainty.

In the following sections, we discuss preferences and constraints of households (2.1), firms (2.2), unions (2.3) and the government (2.4).

2.1 Households

In our framework, most individuals will be employed, while some will be involuntarily unemployed. Therefore, differences in consumption and saving levels can be observed. In the spirit of Merz (1995) and Andolfatto (1996), we assume a large number of households each consisting of a continuum of members of the same age. Each household has unitary mass. All members pool their income, meaning that consumption across household members is the same. As such there is perfect insurance within the household against the risk of unemployment, which implies that we can study the representative household. A household that enters the model in period t (a household of generation t) is denoted with a superscript t. Subscripts are reserved for the age $j \in (1,2,3,4,5)$ and the ability level $a \in (H,L)$. Hence, $n_{2H}^{t+1}$ denotes the fraction of time devoted to labour services by a member of a higher ability family who is in the second period of life and who started active life in period t+1. As a short introduction, we present here a short overview of the model structure with respect to the households:

1. Table 1 represents the detailed life-cycle of a member of a representative higher ability household of generation t. Members of this household enter the model with a human capital stock $h_{1H}^{t}$. They have a time endowment of one in each period which they can devote to work, education when young, or leisure. During four active periods (age $j = 1,2,3,4$), all these individuals are employed on a perfectly competitive labour market. During the fifth period ($j=5$), they are retired. The household chooses an optimal consumption path, the optimal amount of non-human wealth, the time each individual devotes to education when young and the
Table 1: Life-cycle of a member of a higher ability household of generation t

<table>
<thead>
<tr>
<th>Time</th>
<th>t</th>
<th>t + 1</th>
<th>t + 2</th>
<th>t + 3</th>
<th>t + 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hours worked</td>
<td>$n^t_{1H}$</td>
<td>$n^t_{2H}$</td>
<td>$n^t_{3H}$</td>
<td>$n^t_{4H}$</td>
<td>0</td>
</tr>
<tr>
<td>Education</td>
<td>$e^t_{1H}$</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Participation rate</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Unemployment rate</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Employment rate</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Leisure time</td>
<td>$1 - n^t_{1H} - e^t_{1H}$</td>
<td>$1 - n^t_{2H}$</td>
<td>$1 - n^t_{3H}$</td>
<td>$1 - n^t_{4H}$</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 2: Life-cycle of a member of a lower ability household of generation t

<table>
<thead>
<tr>
<th>Time</th>
<th>t</th>
<th>t + 1</th>
<th>t + 2</th>
<th>t + 3</th>
<th>t + 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hours worked when employed</td>
<td>$n^t_{1L}$</td>
<td>$n^t_{2L}$</td>
<td>$n^t_{3L}$</td>
<td>$n^t_{4L}$</td>
<td>0</td>
</tr>
<tr>
<td>Education</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Participation rate</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Unemployment rate</td>
<td>$u_{1,t}$</td>
<td>$u_{2,t+1}$</td>
<td>$u_{3,t+2}$</td>
<td>$u_{4,t+3}$</td>
<td>0</td>
</tr>
<tr>
<td>Employment rate</td>
<td>$1 - u_{1,t}$</td>
<td>$1 - u_{2,t+1}$</td>
<td>$1 - u_{3,t+2}$</td>
<td>$1 - u_{4,t+3}$</td>
<td>0</td>
</tr>
<tr>
<td>Leisure time when employed</td>
<td>$1 - n^t_{1L}$</td>
<td>$1 - n^t_{2L}$</td>
<td>$1 - n^t_{3L}$</td>
<td>$1 - n^t_{4L}$</td>
<td>1</td>
</tr>
</tbody>
</table>

2. Table 2 represents the detailed life-cycle of a member of a representative lower ability household of generation t. Members of this household enter with a human capital stock $h^t_{1L} < h^t_{1H}$. Just like their higher ability counterparts, they have a time endowment of one. A fraction $1 - u_{j,t+j-1}$ of all lower ability individuals of generation t at age $j$ will be employed in period $t+j-1$, the others are unemployed. Lower ability individuals do not pursue tertiary education. Employed members devote time to either work or leisure, unemployed members only have leisure. The household chooses an optimal consumption path, the optimal amount of non-human wealth and the amount of time the employed members supply labour.

2.1.1 Higher ability households

Lifetime utility of the representative higher ability household of generation t is given by

$$u^t_H = \sum_{j=1}^{5} \beta^{j-1} \left( \ln c^t_j + \gamma_j \frac{(1 - e^t_{jH} - n^t_{jH})^{1-\theta}}{1-\theta} \right),$$

where $e^t_{2H} = e^t_{3H} = e^t_{4H} = e^t_{5H} = n^t_{5H} = 0$. Here, $\beta$ represents the discount factor, $\gamma_j$ is an age-specific parameter determining the value of leisure relative to consumption and
θ is the intertemporal elasticity of substitution in leisure. The households’ budget constraints are given by (2), (3) and (4). Income is derived from labour, non-human wealth and lump sum transfers from the government. It is allocated to either consumption or savings.

\[
(1 + \tau_c)c^t_{1H} + \Omega^t_{1H} = w_{H,t}\varepsilon_1 h^t_{1H}(n^t_{1H} - \bar{n}_H)(1 - \tau_{1H}) + z_t. 
\]

\[
(1 + \tau_c)c^t_{jH} + \Omega^t_{jH} = w_{H,t+j-1}\varepsilon_j h^t_{jH}(n^t_{jH} - \bar{n}_H)(1 - \tau_{jH}) + (1 + r_{t+j-1})\Omega^t_{j-1,H} + z_{t+j-1}, \quad j \in (2, 3, 4) \quad (3)
\]

\[
(1 + \tau_c)c^t_{5H} = (1 + r_{t+4})\Omega^t_{5H} + z_{t+4} \quad (4)
\]

Employed individuals earn an after-tax wage of \( w_{H,t+j-1}\varepsilon_j h^t_{jH}(n^t_{jH} - \bar{n}_H)(1 - \tau_{jH}) \), where \( w_{H,t+j-1} \) is the pre-tax real wage per unit of effective labour, \( \varepsilon_j \) is an age-specific productivity parameter, and \( \tau_{jH} \) is the average tax rate on labour. Due to our modelling of a progressive labour income tax system, tax rates depend on individuals’ ability and age. We specify the tax system in greater detail below. Individuals endogenously choose the fraction of time endowment \( n^t_{jH} \) they allocate to labour services. The effective labour time they supply is \( n^t_{jH} - \bar{n}_H \). As in Prescott et al. (2009), Rogerson & Wallenius (2009) and Wallenius (2013), we assume that if an individual with human capital stock \( h^t_{jH} \) devotes a fraction \( n^t_{jH} \) of his/her time to the labour market, this will yield \( (n^t_{jH} - \bar{n}_H)h^t_{jH} \) units of effective labour market services. A fraction \( \bar{n}_H \) is not productive due to e.g. commuting and getting setup in a job. As such, we model the fact that the firm prefers employing few people who work more hours rather than many people who work few hours. As to other variables, we denote the lump sum transfer from the government at time \( t \) by \( z_t \). The consumption tax rate is \( \tau_c \). The households’ accumulated non-human wealth at the end of their \( j \)th period of life is \( \Omega^t_{jH} \). Households enter the model without wealth and leave no bequests.

2.1.2 Lower ability households

In the spirit of the previous subsection, we again consider a large representative household, consisting of a continuum of lower ability members. Again, the decision unit is the household. The key difference is that in this household, only a fraction \( 1 - u_{j,t+j-1} \) of the individuals is employed. A fraction \( u_{j,t+j-1} \) is unemployed. Hence, \( u_{j,t+j-1} \) represents the aggregate unemployment rate among the lower ability individuals of generation \( t \) at
age \( j \) and time \( t+j-1 \). The representative household derives utility from consumption, while it only enjoys utility from the leisure of each employed member\(^2\). Thus, lifetime utility of the representative household of lower ability individuals is given by

\[
u_L^t = \sum_{j=1}^{5} \beta^j \left( \ln c_L^t + \gamma_j (1 - u_{j,t+j-1}) \left[ \frac{(1 - n_{j,L}^t)^{1-\theta}}{1-\theta} \right] \right)
\] (5)

where \( n_{5L}^t = 0 \). Highly similar to the previous subsection, the households’ budget constraints are given by (6), (7) and (8). Again, we assume that all members of the household pool their income:

\[
(1 + \tau_c) c_{1L}^t + \Omega_{1L}^t = w_{L,t} \varepsilon_1 h_{1L}^t (1 - u_{1,t}) (n_{1L}^t - \bar{n}_L) (1 - \tau_{1L}) + \tilde{B}_1 + z_t \tag{6}
\]

\[
(1 + \tau_c) c_{jL}^t + \Omega_{jL}^t = w_{L,t+j-1} \varepsilon_j h_{jL}^t (1 - u_{j,t+j-1}) (n_{jL}^t - \bar{n}_L) (1 - \tau_{jL}) + \tilde{B}_j + \Omega_{j-1,L}^t + z_{t+j-1}, \quad j \in (2, 3, 4) \tag{7}
\]

\[
(1 + \tau_c) c_{5L}^t = (1 + \tau_{t+4}) \Omega_{4L}^t + z_{t+4} \tag{8}
\]

For the fraction \( u_{j,t+j-1} \) of its members who are unemployed, the household receives a non-employment benefit, equal to a fraction \( \tilde{b}_j \) of the after-tax labour income that these individuals would receive if they were employed. Formally,

\[
\tilde{B}_1 = \tilde{b}_1 w_{L,t} \varepsilon_1 h_{1L}^t (n_{1L}^t - \bar{n}_L) (1 - \tau_{1L}) u_{1,t} \tag{9}
\]

and

\[
\tilde{B}_j = \tilde{b}_j w_{L,t+j-1} \varepsilon_j h_{jL}^t (n_{jL}^t - \bar{n}_L) (1 - \tau_{jL}) u_{j,t+j-1}. \tag{10}
\]

The household takes both the unemployment benefit and the unemployment rate as given, when choosing consumption, savings and the supply of working hours. Note that, due to the progressivity of labour income taxes, lower ability households will face a different tax rate than higher ability households \((\tau_{jL} < \tau_{jH})\).

\(^2\)A similar utility function is now widely used in business cycle models with search and matching frictions, e.g. Tomas (2008). Note that we assume that the leisure of the unemployed members is neutral in terms of utility.
2.1.3 Human capital

Individuals enter our model at the age of 18 with a predetermined level of human capital. This level is generation-invariant, but higher for individuals with high innate ability. The latter reflects for example higher intelligence and greater capacity to learn and accumulate knowledge at primary and secondary school. In Equation (11) we normalize the human capital of a young individual with high ability to $h_0$. A young individual with low ability enters the model with only a fraction $\epsilon_L h_0$. This fraction will be calibrated.

$$h_{1a}^t = \epsilon_a h_0, \ a \in (H, L)$$  \hspace{1cm} (11)

with

$$0 < \epsilon_L < \epsilon_H = 1.$$  \hspace{1cm} (12)

During youth, individuals with high ability will invest a fraction of their time in tertiary education. They accumulate more human capital, making them more productive in later periods. We adopt in Equation (13) a human capital production function similar to Lucas (1990), Glomm & Ravikumar (1998) and Bouzahzah et al. (2002). The production of new human capital by these individuals rises in the amount of time they allocate to education ($e_{1H}^t$) and in their initial human capital ($h_{1H}^t$). The parameter $\sigma$ indicates the elasticity of time input, $\phi$ is an efficiency parameter. Individuals with low innate ability do not study. In Equation (14) their human capital remains constant. Finally, we assume in Equation (15) that the human capital of all individuals remains unchanged after the second period. A rationale for this assumption is that learning-by-doing in work may counteract depreciation. The same assumption explains the lack of depreciation in Equations (13) and (14). In no way does this assumption affect our main results in this paper.

$$h_{2H}^t = h_{1H}^t (1 + \phi (e_{1H}^t)^\sigma)$$  \hspace{1cm} (13)

$$h_{2L}^t = h_{1L}^t$$  \hspace{1cm} (14)

$$h_{4a}^t = h_{3a}^t = h_{2a}^t, \ a \in (H, L)$$  \hspace{1cm} (15)

with $0 < \sigma \leq 1, \phi > 0$.

2.2 Firms

Both the goods market and the labour market for higher ability individuals are perfectly competitive, whereas the labour market for lower ability individuals is unionized. All firms are identical. They maximize profits, pay taxes on capital income and social security contributions when hiring labour. Total domestic output is given by the production
function (16). Production exhibits constant returns to scale in aggregate physical capital \( K_t \) and labor in efficiency units \( A_t H_t \). Given our assumption of perfect competition on the goods market, profits are zero in equilibrium.

\[
Y_t = K_t^\alpha (A_t H_t)^{1-\alpha}
\]  

(16)

Technology \( A_t \) is growing at an exogenous and constant rate \( x \): \( A_{t+1} = (1 + x)A_t \). As to total effective labour \( H_t \), we assume that higher and lower ability individuals are imperfectly substitutable in production. This framework was pioneered by Katz & Murphy (1992) and Borjas (2003). So,

\[
H_t = \left[ \eta H^\frac{\eta-1}{\eta} + (1 - \eta) H^\frac{\eta-1}{\eta} \right]^\frac{-1}{\eta-1}
\]  

(17)

with \( \eta \) being a share parameter and \( \iota \) the elasticity of substitution between higher and lower ability labour. Furthermore, workers of the same ability type but different age are assumed to be perfect substitutes. Formally,

\[
H_{H,t} = \sum_{j=1}^{4} (n_{jH}^{t-j+1} - \bar{n}_H) \varepsilon_j h_{jH}^{t-j+1}
\]  

(18)

\[
H_{L,t} = \sum_{j=1}^{4} (1 - u_{j,t})(n_{jL}^{t-j+1} - \bar{n}_L) \varepsilon_j h_{jL}^{t-j+1}
\]  

(19)

### 2.3 Unions

The economy is populated by decentralized trade unions, operating at the firm level. Every single union represents all the lower ability workers in a firm. As such, unions are large compared to the workers. The union will determine the lower ability workers’ wage while taking aggregate variables and fiscal policy parameters as given. Just like in e.g. Pencavel (1984) and de la Croix et al. (1996), the objective function of the unions follows the Stone-Geary specification,

\[
V_t = \sum_{j=1}^{4} \left[ \frac{1}{\chi_j} (w_{L,t}(1 - \tau_{jL}) - \bar{w}_{j,t})^{\chi_j} (1 - u_{j,t}) \right].
\]  

(20)

The union takes both wages and employment into account, albeit to a different degree. As (20) indicates, the firm-specific trade union only derives utility from the difference between the after-tax wage \( w_{L,t}(1 - \tau_{jL}) \) and a reference wage, \( \bar{w}_{j,t} \). The age-specific parameter \( \chi_j \) measures the concavity with respect to the excess wage gap. The higher
\( \chi_j \), the higher the preferences of the union for wages versus employment for the age group \( j \), i.e. the more jobs it is willing to give up for a higher wage. Every union has the same reference wage. We define this as a weighted average or combination of the after-tax wage that would prevail if the lower ability labour market were competitive, the after-tax wage of higher ability workers and the unemployment benefit. The respective weights are \( \varrho_1 \), \( \varrho_2 \) and \( \varrho_3 (= 1 - \varrho_1 - \varrho_2) \). These sum up to 1. Formally,

\[
\bar{w}_{j,t} = \varrho_1 w_{L,t}^c (1 - \tau_{jL}) + \varrho_2 w_{H,t} (1 - \tau_{jH}) + \varrho_3 \tilde{b}_j w_{L,t} (1 - \tau_{jL})
\]

At the beginning of each period \( t \), in the first stage the monopoly union decides on the pre-tax wage, knowing that in the next stage the firm and the household decide on the extensive and intensive margin of employment. Both individuals and the firms take the wage set by the monopoly union as given. Moreover, as they move simultaneously, they take the action of the other player as given. Therefore, the union maximizes its utility subject to the optimality conditions of both the household and the firm. Once the wage is determined, the firm decides on the extensive margin (number of employees of low ability) and the household on the intensive margin (hours worked per employed).

### 2.4 Government

Government expenditures on unemployment benefits and government spending on goods are financed by taxes on capital, labour (both on employers and employees) and consumption. Lump sum transfers ensure a balanced budget. Formally, the government budget constraint is given by

\[
G_t + B_t + Z_t = T_{nt} + T_{kt} + T_{ct} \tag{21}
\]

with:

\[
\begin{align*}
G_t &= g_Y t \\
B_t &= B_{L,t} \\
Z_t &= 10 z_t \\
T_{nt} &= T_{nH,t} + T_{nL,t} \\
T_{kt} &= \tau_k \alpha Y_t \\
T_{ct} &= \tau_c \sum_{j=1}^{4} (c_{jH}^{t+1-j} + c_{jL}^{t+1-j})
\end{align*}
\]

And
\[ B_{L,t} = \sum_{j=1}^{4} \tilde{b}_j w_{jL,t} \varepsilon_j h_j^{L+1-j} (n_j^{L+1-j} - \bar{n}_L)(1 - \tau_{jL}) u_j^L \quad (23) \]

\[ T_{nH,t} = \sum_{j=1}^{4} w_{jH,t} (n_j^{H+1-j} - \bar{n}_H) \varepsilon_j h_j^{H+1-j} (\tau_{jH} + \tau_j^p) \quad (24) \]

\[ T_{nL,t} = \sum_{j=1}^{4} w_{jL,t} (1 - u_{j,t}) (n_j^{L+1-j} - \bar{n}_L) \varepsilon_j h_j^{L+1-j} (\tau_{jL} + \tau_j^p) \quad (25) \]

Where \( \tau_{ja} \) is the average tax rate that applies to the labour income of an individual of age \( j \) and ability \( a \) and \( \tau_j^p \) is the tax rate paid by the employer. What remains is the specification of progressive income taxes. The tax rates appearing in the budget constraints of the households are average tax rates and are given by

\[ \tau_{ja} = \Gamma \left( \frac{y_{ja,t}}{\bar{y}_{lab,at}} \right)^\xi \text{ with } a = (H, L), \xi \geq 0, 0 < \Gamma \leq 1 \quad (26) \]

where \( y_{ja,t}^{lab} \) is the total pre-tax labour income of a household of age \( j \) and ability \( a \) at time \( t \) and \( \bar{y}_{lab}^{lab} \) is the average total labour income in the economy. Just like in Guo & Lansing (1998) and Koyuncu (2011), the parameters \( \xi \) and \( \Gamma \) govern the level and slope of the tax schedule. The average tax rate \( \tau_{ja} \) increases with the total taxable labour income of the household when \( \xi > 0 \). In previous work, \( \xi \) was equal to 0, meaning that all households faced the same average tax rate. Households are aware of the progressive structure of the tax system when making decisions. The marginal tax rate \( \tau_{ja}^m \) is then simply the rate applied to the last euro earned:

\[ \tau_{ja}^m = (1 + \xi) \Gamma \left( \frac{y_{ja,t}^{lab}}{\bar{y}_{lab}} \right)^\xi \quad (27) \]

Rewriting this yields

\[ \frac{\tau_{ja}^m}{\tau_{ja}} = 1 + \xi \quad (28) \]

This means that the marginal tax rate is higher than the average tax rate when \( \xi > 0 \), i.e. the tax schedule is said to be progressive. When \( \xi = 0 \), the average and marginal tax rates coincide.
3 Optimisation and Equilibrium

3.1 Households

3.1.1 Higher ability households

The maximization problem of the higher ability households boils down to:

$$\max_{\Upsilon_H} u_H^t = \sum_{j=1}^{5} \beta^{j-1} \left[ \ln c_{jH}^t + \gamma_j \frac{(1 - c_{jH}^t - n_{jH}^t)^{1-\theta}}{1-\theta} \right]$$

s.t. the household budget constraints and the human capital accumulation process, while taking fiscal policy variables, the wage and the interest rate as given. The vector $\Upsilon_H$ of decision variables is $[\Omega_{1H}^t, \Omega_{2H}^t, \Omega_{3H}^t, \Omega_{4H}^t, n_{1H}^t, n_{2H}^t, n_{3H}^t, n_{4H}^t, e_{1H}^t]$. Optimisation yields the following first order conditions guiding the optimal consumption path (29), the labour-leisure choice (30, 31) and the optimal time allocation to education (32):

$$\frac{c_{j+1,H}^t}{c_{jH}^t} = \beta(1 + r_{t+j}), \quad j \in (1, 2, 3, 4) \quad (29)$$

$$\frac{\gamma_1}{(1 - n_{1H}^t - e_{1H}^t)^{\theta}} = \frac{w_{H,t} \xi_1 h_{1H}^t(1 - \tau_m^m)}{(1 + \tau_c) c_{1H}^t} \quad (30)$$

$$\frac{\gamma_j}{(1 - n_{jH}^t)^{1-\theta}} = \frac{w_{H,t+j-1} \xi_j (1 + \phi(e_{1H}^t)^{\sigma}) h_{1H}^t(1 - \tau_m^m)}{(1 + \tau_c) c_{jH}^t}, \quad j \in (2, 3, 4) \quad (31)$$

$$\frac{\gamma_1}{(1 - n_{1H}^t - e_{1H}^t)^{\theta}} = \frac{1}{c_{2H}^t} \frac{\partial c_{2H}^t}{\partial e_{1H}^t} + \frac{\beta^1}{c_{3H}^t} \frac{\partial c_{3H}^t}{\partial e_{1H}^t} + \frac{\beta^2}{c_{4H}^t} \frac{\partial c_{4H}^t}{\partial e_{1H}^t} \quad (32)$$

with: $$\frac{\partial c_{jH}^t}{\partial e_{1H}^t} = \frac{w_{H,t+j-1} \xi_j h_{1H}^t(1 - \tau_{jH}^m)}{(1 + \tau_c)} \left( n_{jH}^t - \bar{n}_H \right), \quad j \in (2, 3, 4) \quad (33)$$

3.1.2 Lower ability households

For the lower ability individuals, the objective is to

$$\max_{\Upsilon_L} u_L^t = \sum_{j=1}^{5} \beta^{j-1} \left[ \ln c_{jL}^t + (1 - u_{j,t+j-1}) \gamma_j \frac{(1 - n_{jH}^t)^{1-\theta}}{1-\theta} \right]$$

s.t. the household budget constraints and the human capital accumulation process, while taking the unemployment rate, wages, taxes and the unemployment benefit as given. The
vector $\mathbf{\Omega}_L$ of decision variables is $[\Omega_{1L}, \Omega_{2L}, \Omega_{3L}, \Omega_{4L}, n_{1L}, n_{2L}, n_{3L}, n_{4L}]$. Optimisation yields the following first order conditions:

$$\frac{c_{j+1,L}}{c_{jL}} = \beta(1 + r_{t+j}), \quad j \in (1, 2, 3, 4) \quad (34)$$

$$\frac{\gamma_1}{(1 - n_{1L})^\alpha} = \frac{w_{L,t} \varepsilon_1 h_{1L}^\alpha (1 - \tau_{1L}^n)}{(1 + \tau_c) c_{1L}^\alpha}, \quad j \in (1) \quad (35)$$

$$\frac{\gamma_j}{(1 - n_{jL})^\alpha} = \frac{w_{L,t+j-1} \varepsilon_j h_{1L}^\alpha (1 - \tau_{jL}^n)}{(1 + \tau_c) c_{jL}^\alpha}, \quad j \in (2, 3, 4) \quad (36)$$

### 3.2 Firms

The representative firm in our model operates in a small open economy with perfect mobility of physical capital. In Section 2, we extensively described the nature of the labour market for lower ability individuals. Therefore, the problem every firm faces is somewhat different from previous work. It chooses the optimal capital stock and the total amount of effective higher ability labour, since there is no unemployment present on the latter market. However, on the labour market for lower ability individuals, the firm can only choose the fraction of persons it wants to employ, as the wage is chosen by the union and hours of work are chosen by the households. In terms of production, the firm prefers a combination of few people working more hours over a combination of many people working few hours, as each individual causes a time cost for commuting and getting setup in a job. Firms maximize profits with respect to the vector $[K_t, H_{1t}, H_{2t}, H_{3t}, H_{4t}, (1 - u_{1,t}), (1 - u_{2,t}), (1 - u_{3,t}), (1 - u_{4,t})]$, leading to the following first order conditions,

$$\alpha \left( \frac{A_t H_t}{K_t} \right)^{(1 - \alpha)} (1 - \tau_k) = r_t \quad (37)$$

$$(1 - \alpha) A_t ^{1 - \alpha} \left( \frac{K_t}{H_t} \right)^\alpha \eta \left( \frac{H_t}{H_{1t}} \right)^\frac{1}{2} = w_{H,t}(1 + \tau^n) \quad (38)$$

$$(1 - \alpha) A_t ^{1 - \alpha} \left( \frac{K_t}{H_t} \right)^\alpha (1 - \eta) \left( \frac{H_t}{H_{L,t}} \right)^\frac{1}{2} = w_{L,t}(1 + \tau^n) \quad (39)$$

where $H_{H,t}$ and $H_{L,t}$ are defined in equations (18) and (19). Equation (37) relates the after-tax marginal product of capital to the exogenous world interest rate, $r_t$. Due to the perfect mobility of capital, the firm will hire capital until its after-tax marginal product
equals the exogenous world interest rate. There is no depreciation of capital. Whenever the net return to investment exceeds the world interest rate, capital will flow into the country until optimality is restored. Equations (38) and (39) are standard equations relating the marginal product of high and lower ability individuals to their total wage cost for the employer. Equation (39) implies that following a change in the supply of hours or the wage rate, the firms will change the unemployment rate to restore the equality between the marginal product of lower ability labour and the total wage cost.

Our assumptions of constant population and of individuals entering the model with a predetermined and generation-invariant level of human capital imply that in steady state effective labor will be constant. Physical capital, output and real wages by contrast will all grow at the exogenous technology growth rate $x$.

3.3 Union

The maximization problem of the union boils down to

$$\max_{w_{L,t}} V_t = \sum_{j=1}^{4} \left[ \frac{1}{\chi_j} (w_{L,t}(1 - \tau_{jL}) - \bar{w}_{j,t})^{\chi_j} (1 - u_{j,t}) \right]$$

$$\text{s.t.} \begin{cases} F(n_{jL}^{t-j+1}, 1 - u_{j,t}, w_{L,t}) = (1 - \alpha)A_t^{-\alpha} \left[ \frac{K_t}{H_t} \right]^{\alpha} (1 - \eta) \left[ \frac{H_t}{H_{L,t}} \right] \frac{1}{1 + \tau_p^j} - w_{L,t} (1 + \tau_p^j) = 0 \\ G(n_{jL}^{t-j+1}, 1 - u_{j,t}, w_{L,t}) = \frac{\gamma_j}{(1 - n_{jL}^{t-j+1})^{\theta}} - \frac{w_{L,t}^j h_{jL}^{t-j+1}(1 - \tau_m^j)}{(1 + \tau_c^j) e_{jL}^{t-j+1}} = 0 \end{cases}$$

with $j \in (1, 2, 3, 4)$. To derive the first order condition, one has to know how the optimal unemployment rate resulting from the second stage of the game changes when the chosen wage changes. From the second stage, we derive a system of two implicit equations in the supply of hours worked, the unemployment rate, and the wage rate.

Using matrix notation, evaluating at the equilibrium values of the supply of hours worked, the unemployment rate, and the wage rate, and taking the total differential yields:

$$\begin{bmatrix} \frac{\partial F}{\partial n_{jL}^{t-j+1}} & \frac{\partial F}{\partial (1-u_{j,t})} \\ \frac{\partial G}{\partial n_{jL}^{t-j+1}} & \frac{\partial G}{\partial (1-u_{j,t})} \end{bmatrix} \begin{bmatrix} d n_{jL}^{t-j+1} \\ d(1-u_{j,t}) \end{bmatrix} = \begin{bmatrix} -\frac{\partial F}{\partial w_{L,t}} dw_{L,t} \\ -\frac{\partial G}{\partial w_{L,t}} dw_{L,t} \end{bmatrix}$$

Under normal parameter values the (2x2)-matrix is non-singular. We can then take the inverse to calculate $d(1-u_{j,t})$, the change in the equilibrium unemployment rate resulting from the second stage of the game, following an increase in the chosen wage rate by the union. The first order condition for the union is given by:
As the right-hand side of this equation is positive, the left-hand side has to be positive as well. This implies that the after-tax wage determined by the union will exceed the alternative wage. The higher $\chi_j$, the higher the ex-ante union wage premium. Ex-post, a rise in $\chi_j$ will also be reflected in higher unemployment $u_j$, though. The reason is that if the union has a higher preference for wages for a particular age group, the firm will in the end replace the workers of this age group by low ability workers of other age. Unemployment among these other age groups might fall. Due to more expensive low ability labour, however, aggregate unemployment among low ability workers will rise.

3.4 Solving for the Subgame Perfect Equilibrium

Within every period $t$, a dynamic, two-stage game is played between a triplet of a firm, a union and a lower ability household. In the first stage, the unions choose the wage for the lower ability workers, whereas in the second stage firms choose the fraction of people they want to employ, and lower ability households choose their labour supply in hours. As such, the second stage is a static game, played between the firm and the lower ability household. We use backward induction to solve for the subgame perfect equilibrium of our game. In the second stage, the firm and the households play simultaneously, taking the union’s wage and the action of the other player as given. In the previous sections, we already solved for the best responses of the household and the firm, taking the optimal behaviour of the other player into account, while also taking the wage and the fiscal policy variables as given. We then proceed to the first stage, where the monopoly union chooses the wage, taking into account the optimal responses of both the firm and the households to this wage. The union values both high wages and a high employment rate in persons, albeit to a different degree. In Graph 1, we show the second stage of the game. The flatter curves are the ‘best response’-fuctions of the households given the real wage rate, the unemployment rate chosen by the firm, tax rates and the unemployment benefit. If the unemployment rate increases, the income and consumption of the household will decrease, implying that the marginal benefit of working increases. Household members will then supply more hours. This argument explains the negative slope of the households’ best-response curves. If the wage chosen by the union increases, the best-response curves shift upwards, leading to a higher supply of hours for a given unemployment rate. Intuitively, the substitution effect of a higher wage dominates the income effect. The best-response curves of the firm are calculated
using the first-order conditions of the firm. If the households decide to supply more hours for a given wage rate, the firm will employ fewer people. If the wage chosen by the union increases and households maintain their supply of hours, the firm will also employ fewer people, implying that the best-response curves will shift to the left. Thus, if the wage increases, the best-response curves of the household shift upwards, while the best-response curves of the firm shift to the left. The intersection of the ‘best response’ functions for different wage rates represent the Nash equilibria of the second stage of our game. In Graph 2, an indifference curve of the union has been drawn. The other curve is the collection of Nash equilibria for different wage rates resulting from the second stage of the game. This curve indicates the employment rates which are Nash Equilibria in the second stage given different levels of the real wage rate. The optimal combination of the wage and the employment rate is found where the indifference curve of the union is tangent to the Nash-function of the second stage. In Graph 2, one optimal point is drawn. From this value for the wage, we can calculate the exact Nash equilibrium in the second stage. In a symmetric equilibrium, the wage will be the same at every firm.
Graph 1: Second stage of the game
3.5 Equilibrium

Definition 1. Given an initial value for the technology stock level $A_0$ and a value for the predetermined human capital stock of young higher ability individuals $h_0$, a vector of exogenous fiscal policy variables $\{\tau_c, \tau_k, \tau_p, g_y, g_c, b_j\}_{j=1}^4$ and the exogenous world interest rate, an intertemporal equilibrium consists of sequences of household decision rules $\{c_{t}^{1a}, c_{t}^{2a}, c_{t}^{4a}, c_{t}^{5a}, \Omega_{t}^{1a}, \Omega_{t}^{2a}, \Omega_{t}^{3a}, \Omega_{t}^{4a}, e_{t}^{1H}, n_{t}^{1a}, n_{t}^{2a}, n_{t}^{3a}, n_{t}^{4a}\}_{t=0}^{\infty}$, sequences of prices $\{w_{H,t}\}_{t=0}^{\infty}$, human capital stocks $\{h_{t}^{1a}, h_{t}^{2a}, h_{t}^{3a}, h_{t}^{4a}\}_{t=0}^{\infty}$, lump sum transfers $\{Z_{t}\}_{t=0}^{\infty}$, tax rates $\{\tau_j, \tau_{ja}\}_{j=0}^{4}$, unemployment rates $\{u_{1,t}, u_{2,t}, u_{3,t}, u_{4,t}\}_{t=0}^{\infty}$ and aggregate variables $\{Y, K, H, A\}_{t=0}^{\infty}$ for $a \in \{H, L\}$ such that

1. Households’ decision rules maximize the intertemporal utility function subject to the budget constraints and the human capital accumulation process.

2. Firms’ choices $\{K_t, H_{1H,t}, H_{2H,t}, H_{3H,t}, H_{4H,t}, (1 - u_{1,t}), (1 - u_{2,t}), (1 - u_{3,t}), (1 - u_{4,t})\}$ maximize profits.

3. The wage $\{w_{H,t}\}$ is such that the labour market for higher ability individuals clears.
4. Given the wages chosen by the union, each couple \( \{n_{ij,t}, 1 - u_{j,t}\} \) forms a Nash equilibrium in the second stage of the dynamic game played between the household, the firm and the union.

5. The union chooses \( \{w_{L,t}\} \) to maximize its utility subject to the optimal responses of the household and the firm.

6. All actions in (3) and (4) form a subgame perfect equilibrium.

7. Human capital of the individuals evolves according to the human capital accumulation process.

8. Lump sum transfers ensure a balanced government budget.

9. Average and marginal tax rates are determined via equations (26) and (27).

10. \( Y_t \) follows from the production function and the values for \( K_t \) and \( A_t H_t \).

11. National income equals the aggregate demand for goods.

4 Data and Calibration

In this paper we construct an OLG model where unemployment and hours worked by individuals of different age and ability are the main endogenous variables. Our aim is that the model is able to explain cross-country differences in these variables. Similar to Pissarides (2007) and Rogerson (2007), we study three groups of countries: Anglo-Saxon countries (the United States, the United Kingdom and Canada), continental European countries (Belgium, France, Germany, the Netherlands, and Austria) and Nordic countries (Denmark, Finland, Norway and Sweden). In the first step we will calibrate our model and compare its predictions regarding the main labour market variables to the true data for these twelve countries. If explanatory power is good, we want to know in the next stage what exogenous variables in the model exactly account for the largest parts of the explanation. What is the share of fiscal policy variables? What is the role of union preferences? And what is the contribution of household preferences? Section 4 is devoted to a description of the data and the calibration. For a detailed summary of the different data sources and for details on the construction of the data, we refer to Appendix A. In Section 5, we test the empirical relevance of our model. We will see that the model’s predictions match the actual cross-country data well for hours worked. By far the best match emerges, however, for unemployment among the lower educated.
In section 6, our focus will therefore be on explaining the cross-country variation in unemployment rates.

4.1 Unemployment

In our model we have assumed that all individuals (except the retired) of both higher and lower ability participate in the labour market. Those of higher ability will all work. Among those of lower ability, only a fraction $1 - u^l_j$ will work. The difference between both employment rates corresponds to the rate of unemployment $u^l_j$. The data that we report in Table 3 reflect this setup. They are the difference in percentage points between the actual employment rate (in persons) among those within a particular age group who enjoyed tertiary education and those who did not. We notice that in most countries older individuals (age 54-65) of lower education are suffering the highest unemployment rates, followed by the young (age 18-29). Exceptions are the UK and Belgium with relatively low unemployment in the oldest age group and Denmark, Norway and Sweden with relatively low unemployment in the youngest age group.

Our proxy for unemployment among the lower educated is consistent with the setup of our model. It differs, however, from official unemployment series, which are also affected by participation decisions. The fact that we assume everyone to participate will therefore induce some bias in our data. It will not affect our main conclusions though. The correlation coefficient between respectively the difference in employment rates and the difference in unemployment rates between higher and lower ability individuals in actual data is strongly negative. Depending on the age group considered, it varies between -0.60 and -0.85 (see also Figure 1(c)).

4.2 Hours worked per employed person

Data on hours worked are given in Table 4. We report the fraction of time individuals devote to work relative to their total time endowment on an annual basis. Like Wallenius (2013), we assume that the total time endowment of each individual consists of 14 hours a day, 7 days a week and 52 weeks per year. Except in Germany and Austria, the life-cycle profile of hours worked in every country in our sample is hump-shaped. People with a job tend to work the lowest number of hours at the age of 18-29. In the second and third period of life, there is a considerable increase in hours worked, whereafter it decreases somewhat in the fourth period of life. As already mentioned in the introduction, the number of hours worked is the highest in the Anglo-Saxon countries.
Table 3: Unemployment rates among four generations of lower educated individuals (2001-2007), in %

<table>
<thead>
<tr>
<th>Unemployment rates</th>
<th>18-29</th>
<th>30 - 41</th>
<th>42 - 53</th>
<th>54 - 65</th>
</tr>
</thead>
<tbody>
<tr>
<td>Belgium</td>
<td>23.7</td>
<td>17.1</td>
<td>18.9</td>
<td>17.6</td>
</tr>
<tr>
<td>France</td>
<td>5.9</td>
<td>12.5</td>
<td>10.2</td>
<td>17.4</td>
</tr>
<tr>
<td>Germany</td>
<td>20.0</td>
<td>18.5</td>
<td>18.5</td>
<td>23.5</td>
</tr>
<tr>
<td>Austria</td>
<td>9.8</td>
<td>14.1</td>
<td>16.4</td>
<td>25.0</td>
</tr>
<tr>
<td>Netherlands</td>
<td>10.5</td>
<td>12.4</td>
<td>13.5</td>
<td>17.7</td>
</tr>
<tr>
<td>Denmark</td>
<td>4.9</td>
<td>10.2</td>
<td>11.4</td>
<td>19.1</td>
</tr>
<tr>
<td>Finland</td>
<td>20.7</td>
<td>12.5</td>
<td>13.8</td>
<td>17.0</td>
</tr>
<tr>
<td>Norway</td>
<td>7.9</td>
<td>13.5</td>
<td>14.2</td>
<td>23.1</td>
</tr>
<tr>
<td>Sweden</td>
<td>1.2</td>
<td>11.1</td>
<td>10.9</td>
<td>15.7</td>
</tr>
<tr>
<td>United States</td>
<td>17.3</td>
<td>15.7</td>
<td>15.8</td>
<td>21.0</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>17.7</td>
<td>14.5</td>
<td>13.9</td>
<td>8.5</td>
</tr>
<tr>
<td>Canada</td>
<td>15.7</td>
<td>14.3</td>
<td>14.5</td>
<td>12.9</td>
</tr>
<tr>
<td>Average</td>
<td>13.5</td>
<td>14.0</td>
<td>14.3</td>
<td>18.2</td>
</tr>
</tbody>
</table>

Source: Eurostat (see Appendix A). For a description of the data, see also the main text.
Table 4: Hours worked per person employed (fraction of time) - average for tertiary and non-tertiary educated individuals (2001-2007)

<table>
<thead>
<tr>
<th>Hours worked</th>
<th>18-29</th>
<th>30 – 41</th>
<th>42 – 53</th>
<th>54 – 65</th>
</tr>
</thead>
<tbody>
<tr>
<td>Belgium</td>
<td>0.309</td>
<td>0.311</td>
<td>0.311</td>
<td></td>
</tr>
<tr>
<td>France</td>
<td>0.292</td>
<td>0.301</td>
<td>0.301</td>
<td>0.291</td>
</tr>
<tr>
<td>Germany</td>
<td>0.285</td>
<td>0.283</td>
<td>0.283</td>
<td>0.277</td>
</tr>
<tr>
<td>Austria</td>
<td>0.339</td>
<td>0.349</td>
<td>0.349</td>
<td>0.351</td>
</tr>
<tr>
<td>Netherlands</td>
<td>0.252</td>
<td>0.319</td>
<td>0.319</td>
<td>0.299</td>
</tr>
<tr>
<td>Denmark</td>
<td>0.283</td>
<td>0.354</td>
<td>0.354</td>
<td>0.344</td>
</tr>
<tr>
<td>Finland</td>
<td>0.327</td>
<td>0.366</td>
<td>0.366</td>
<td>0.349</td>
</tr>
<tr>
<td>Norway</td>
<td>0.263</td>
<td>0.309</td>
<td>0.309</td>
<td>0.297</td>
</tr>
<tr>
<td>Sweden</td>
<td>0.300</td>
<td>0.341</td>
<td>0.341</td>
<td>0.332</td>
</tr>
<tr>
<td>United States</td>
<td>0.338</td>
<td>0.383</td>
<td>0.383</td>
<td>0.374</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>0.325</td>
<td>0.359</td>
<td>0.359</td>
<td>0.332</td>
</tr>
<tr>
<td>Canada</td>
<td>0.331</td>
<td>0.371</td>
<td>0.371</td>
<td>0.358</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td>0.305</td>
<td>0.338</td>
<td>0.338</td>
<td>0.323</td>
</tr>
</tbody>
</table>

Source: OECD (see Appendix A). Data limitations explain why there is no difference in hours worked between the age groups 30-41 and 42-53.
4.3 Education

In Table 5, we report the education rate. In our model, the education rate is the fraction of time higher ability individuals devote to tertiary education. The US and the Nordic countries show the highest participation in tertiary education.

4.4 Fiscal policy variables and education quality

The government in our model finances government spending on goods and benefits to the unemployed with taxes on consumption, labour and capital. Data on $\tilde{b}_j$, $\xi$, $\Gamma$ and $\tau^p$ are new. For the variables $\tau_k$, $\tau_c$, and $g$, we use the same data as Heylen & Van de Kerckhove (2013).

As we have mentioned in section 2.4, the government administers a non-linear tax system applied to employees. In our sample, we see in Table 6 an average value for $\xi$ of 0.347, which implies that the tax code is progressive. Continental European countries are less progressive than the average, Anglo-Saxon countries are more progressive. Finland and Sweden stand out. The cross-country average value of $\Gamma$ is 25.7, indicating an average labour tax rate for an individual whose income coincides with the average income in the economy of 25.7%. Belgium and Germany have higher values, France a lower one.
Table 6: Labour tax rates on employees and employers and unemployment benefit, in %

<table>
<thead>
<tr>
<th>Country</th>
<th>ξ</th>
<th>Γ</th>
<th>τ_p</th>
<th>b_j</th>
</tr>
</thead>
<tbody>
<tr>
<td>Belgium</td>
<td>0.337</td>
<td>33.5</td>
<td>29.5</td>
<td>59.6</td>
</tr>
<tr>
<td>France</td>
<td>0.285</td>
<td>22.0</td>
<td>39.3</td>
<td>46.0</td>
</tr>
<tr>
<td>Germany</td>
<td>0.236</td>
<td>29.7</td>
<td>20.1</td>
<td>64.7</td>
</tr>
<tr>
<td>Austria</td>
<td>0.313</td>
<td>27.9</td>
<td>29.0</td>
<td>56.3</td>
</tr>
<tr>
<td>Netherlands</td>
<td>0.396</td>
<td>25.5</td>
<td>10.6</td>
<td>55.0</td>
</tr>
<tr>
<td>Denmark</td>
<td>0.226</td>
<td>34.4</td>
<td>0</td>
<td>61.9</td>
</tr>
<tr>
<td>Finland</td>
<td>0.450</td>
<td>28.3</td>
<td>24.5</td>
<td>61.3</td>
</tr>
<tr>
<td>Norway</td>
<td>0.395</td>
<td>25.3</td>
<td>12.9</td>
<td>56.9</td>
</tr>
<tr>
<td>Sweden</td>
<td>0.424</td>
<td>28.5</td>
<td>32.7</td>
<td>55.4</td>
</tr>
<tr>
<td>United States</td>
<td>0.374</td>
<td>16.5</td>
<td>7.8</td>
<td>30.5</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>0.383</td>
<td>23.6</td>
<td>9.9</td>
<td>51.1</td>
</tr>
<tr>
<td>Canada</td>
<td>0.357</td>
<td>16.9</td>
<td>11.3</td>
<td>44.4</td>
</tr>
<tr>
<td>Average</td>
<td>0.347</td>
<td>25.7</td>
<td>16.4</td>
<td>53.4</td>
</tr>
</tbody>
</table>

Sources and data construction: see Appendix A.

Hence, the tax rates in continental European countries are high in level, but increase less following an increase in income. The opposite holds for the Anglo-Saxon countries: low in level, but they increase more when income increases. The Nordic countries administer tax codes which are high in level and with a high degree of progressivity.

In addition to the non-linear tax system applied to employees, the fiscal government also imposes a linear tax system on employers. The average value for $\tau_p$ is 16.4%. All continental European countries have higher values, while all Anglo-Saxon countries have lower ones. The Nordic countries are in between, with an honourable mention of Denmark, where employers do not have to pay social security contributions on wages.

The fourth column in Table 6 lists the data for the net replacement rate in the unemployment benefit formula. We observe the highest replacement rates in Germany, Denmark, Finland and Belgium. Unemployed workers receive the lowest after-tax benefits in France, Canada and the US.

The data in Table 7 have been taken from Heylen & Van de Kerckhove (2013). The Nordic countries stand out with the highest consumption tax rates, the US with the lowest. While labour and consumption are heavily taxed in the Nordic countries, the opposite holds for capital, which is taxed relatively little. Next to among the highest
Table 7: Tax rates on consumption and capital (in%), and government spending on goods (in % of GDP)

<table>
<thead>
<tr>
<th></th>
<th>$\tau_c$</th>
<th>$\tau_k$</th>
<th>$g$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Belgium</td>
<td>13.4</td>
<td>27.1</td>
<td>24.8</td>
</tr>
<tr>
<td>France</td>
<td>17.1</td>
<td>21.7</td>
<td>28.5</td>
</tr>
<tr>
<td>Germany</td>
<td>11.1</td>
<td>34.4</td>
<td>23.2</td>
</tr>
<tr>
<td>Austria</td>
<td>13.2</td>
<td>17.3</td>
<td>23.4</td>
</tr>
<tr>
<td>Netherlands</td>
<td>12.2</td>
<td>24.3</td>
<td>27.3</td>
</tr>
<tr>
<td>Denmark</td>
<td>18.9</td>
<td>22.5</td>
<td>29.8</td>
</tr>
<tr>
<td>Finland</td>
<td>15.2</td>
<td>17.2</td>
<td>26.8</td>
</tr>
<tr>
<td>Norway</td>
<td>16.4</td>
<td>22.1</td>
<td>26.3</td>
</tr>
<tr>
<td>Sweden</td>
<td>17.9</td>
<td>16.1</td>
<td>32.6</td>
</tr>
<tr>
<td>United States</td>
<td>7.2</td>
<td>23.6</td>
<td>19.5</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>14.5</td>
<td>21.2</td>
<td>21.4</td>
</tr>
<tr>
<td>Canada</td>
<td>14.5</td>
<td>24.8</td>
<td>23.6</td>
</tr>
<tr>
<td>Average</td>
<td>14.3</td>
<td>22.1</td>
<td>25.7</td>
</tr>
</tbody>
</table>

Sources and data construction: see Appendix A.
labour tax rates, Germany and Belgium also have the highest capital tax rates. As to government spending on goods, we observe the largest numbers in the Nordic countries. Anglo-Saxon governments spend the lowest fraction of GDP on goods. The continental European countries take an intermediate position.

4.5 Calibrated parameters

How well does our model match reality? When we impose each country’s policy parameters described in the previous section, how close are the model’s predictions to the true data? To find out, we first have to parameterize the model. We discuss our procedure in this section. Tables 8 and 9 contain an overview of all parameters. Many have been set in line with, or taken from, the existing literature. Others have been calibrated to match key data.

We set the rate of time preference to 2% per year and the (exogenous and constant) world real interest rate at 4.5% per year. Considering that periods in our model last 12 years, this choice implies a discount factor $\beta = 0.788$ and interest rate $r = 0.696$. In the production function for goods, we assume a capital share coefficient $\alpha$ equal to $\frac{1}{3}$. Following Caselli & Coleman (2006), who state that the empirical labour literature consistently estimates values between 1 and 2, we set the elasticity of substitution $\iota$ between the two ability types in effective labour equal to $1.5$. In line with Rogerson (2007), who considers a value for the inverse of the intertemporal elasticity of substitution in leisure $\theta$ between 1 and 3 as being reasonable, we set $\theta = 2$. Two other sets of parameters that we took directly from the literature are the age-specific productivity parameters $\epsilon_j$ and the time cost of commuting and being set-up in a job $\bar{n}$. For the former we follow the hump-shaped pattern imposed by Miles (1999) and Cournède & Gonand (2006). For the latter we impose a value of 0.05, in line with Wallenius (2013). We impose the same $\epsilon_j$ and $\bar{n}$ for both ability types.

Three parameters relate to the production and inheritance of human capital. For the elasticity with respect to education time ($\sigma$) we choose a conservative value of 0.3. This value is within the range considered by Bouzahzah et al. (2002) and Docquier & Paddison (2003), but much lower than the value imposed by Lucas (1990). The literature provides much less guidance for the calibration of the relative initial human capital of lower ability individuals (relative to the initial human capital of high ability individuals, $\epsilon_L$). To determine this parameter we follow Buyse et al. (2014) who rely on PISA science scores. We use the average of the test scores of students at the 17th and the 50th percentile as representative for lower ability individuals in our model, and the test score of students at the 83th percentile as representative for high ability individuals. The data
Table 8: Basic parameterization of the model - imposed on all countries

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discount factor in utility</td>
<td>0.788</td>
</tr>
<tr>
<td>World real interest rate</td>
<td>0.696</td>
</tr>
<tr>
<td>Inverse of the intertemporal elasticity of substitution in leisure</td>
<td>2</td>
</tr>
<tr>
<td>Age-specific productivity parameter 18-29</td>
<td>2.325</td>
</tr>
<tr>
<td>Age-specific productivity parameter 30-41</td>
<td>2.770</td>
</tr>
<tr>
<td>Age-specific productivity parameter 42-53</td>
<td>2.776</td>
</tr>
<tr>
<td>Age-specific productivity parameter 54-65</td>
<td>2.341</td>
</tr>
<tr>
<td>Capital share parameter in goods production</td>
<td>0.33</td>
</tr>
<tr>
<td>Share parameter of high ability individuals in effective labour</td>
<td>0.6074</td>
</tr>
<tr>
<td>Elasticity of substitution between different ability types of labour</td>
<td>1.5</td>
</tr>
<tr>
<td>Exogenous technology growth</td>
<td>0.255</td>
</tr>
<tr>
<td>Efficiency parameter in human capital production</td>
<td>3.44</td>
</tr>
<tr>
<td>Human capital inheritance parameter</td>
<td>0.755</td>
</tr>
<tr>
<td>Elasticity of human capital with respect to education time</td>
<td>0.3</td>
</tr>
<tr>
<td>Time cost for e.g. commuting</td>
<td>0.05</td>
</tr>
</tbody>
</table>

are remarkably robust across countries. The science test score of students at the 17th percentile is always very close to 67% of the test score of students at the 83rd percentile, while in all countries the test score of students at the 50th percentile is very close to 85% of the test score of students at the 83rd percentile\(^3\). The differences across countries being so small, we take these relative scores as objective indicators of the relative cognitive capacity of lower and high ability individuals, and will correspondingly set \(\epsilon_L\) equal to 0.755 (= the average of 0.67 and 0.85). Last but not least, the efficiency parameter \(\phi\) in the human capital production function of the individuals with high ability has been determined by a calibration procedure that we discuss now.

We determined 36 parameters by calibration. Next to the efficiency parameter in human capital production \((\phi)\), these are the exogenous technology growth rate \((x)\), the share parameter in aggregate effective labor \((\eta)\), the four taste for leisure parameters \((\gamma_1, \gamma_2, \gamma_3, \gamma_4)\) which we allow to differ by country group, and the seven union preference parameters \((\chi_1, \chi_2, \chi_3, \chi_4, \varrho_1, \varrho_2, \varrho_3)\), which may also differ across the three country groups. The efficiency parameter in human capital production \((\phi)\) is determined to correctly predict average participation in education \((e)\) over all twelve countries in our sample. The parameter turns out to be 3.44. The exogenous growth rate of technol-

\(^3\)The data that we report are averages of the PISA results for the years 2000, 2003 and 2006. The available data concern students aged 15.
ogy ($x$) is calibrated to match actual per capita growth over a period of 12 years. The underlying annual growth rate is 1.91%, being the average annual per capita growth in our sample of twelve countries in 2001-2007. Following Buyse et al. (2014), we calibrate the share parameter in aggregate effective labor ($\eta$) to match the relative wage of young workers without a tertiary degree versus young workers with tertiary degree in the US. This relative wage is 0.53. As shown by Equations (38) and (39), the share parameter $\eta$ is an important determinant of the relative productivity of labour and relative wages. Actual wages are informative if a close link can be assumed between wages and productivity. This condition is much more likely fulfilled in the US than in Europe, which explains the introduction here of US relative wages. The value for $\eta$ that emerges is 0.61.

Finally, we calibrated the taste for leisure parameters of the households ($\gamma_j$), the union’s preference for wage parameters ($\chi_j$) and the weights in the reference wage of the union ($\varrho_1, \varrho_2$ and $\varrho_3 = 1 - \varrho_1 - \varrho_2$) for each of the three country groups, using a sensitivity analysis in line with Heylen & Van de Kerckhove (2013). In a first step — executed separately for each country group — we imposed values for $\varrho_1, \varrho_2$ and $\varrho_3$. With these imposed values we calibrated the parameters $\chi_j$ with $j = 1, 2, 3, 4$ to match the average of actual unemployment rates in four generations over all countries in the country group. Analogously, we calibrated the parameters $\gamma_j$ with $j = 1, 2, 3, 4$ to match the average of actual hours worked $n$ per generation (over both ability types) over all countries in the country group. The obtained set of household taste for leisure and union preference parameters for each of the three country groups - together with all other calibrated parameters - would then allow us to compute the predictions of our model for all unemployment rates and all hours worked in all generations in each of the twelve countries in our sample. We repeated this procedures many times, each timing starting from different values for $\varrho_1, \varrho_2$ and $\varrho_3$. Our guideline to pin down our final values for these parameters and the corresponding values for $\gamma_j$ and $\chi_j$ was to minimize the deviation of our model’s predictions from the true data.

The results in Table 9 reveal much higher values for $\chi_j$ in the continental European countries than in the Anglo-Saxon countries and — even more so — the Nordic countries. Intuitively, considering Graph 2 and Equation (42), this implies that in the continental

---

4OECD data (Education at a Glance, 2009, table A7.1a) show a relative wage of 0.43 for workers of age 25-34 without upper secondary education versus workers of this age with a tertiary degree. The relative wage of workers of age 25-34 with upper secondary degree is 0.63. On average this is 0.53.

5From the predictions of our model and the true data for 12 countries we computed each time for each variable ($u_j, n_j$ with $j = 1, 2, 3, 4$) the root mean squared error normalized to the mean. We minimized the average normalized RMSE over all variables.
European countries the unions’ indifference curves are flatter, wages will more rigid, and the mark-up of union wages on the reference wage will be higher. Note also that in each country group $\chi_j$ rises in the age of the workers involved. Wages are therefore the least (most) rigid and the lowest (highest) for the youngest (oldest) workers. As to the different weights in the unions’ reference wage, we notice in each country group a major role for the competitive wage of lower ability individuals. In continental Europe this competitive wage has weight 0.8, in the other two groups even 0.9. In the Nordic countries the only other variable that matters in the unions’ reference wage seems to be the unemployment benefit, in the Anglo-Saxon countries the wage of the high skilled. In continental Europe both these other variables have an impact on union wage setting, with unemployment benefits being more important. For the household taste for leisure parameters $\gamma_j$, our main finding is that these hardly differ across country groups, confirming the approach adopted by e.g. Prescott (2004), Rogerson (2007), and Dhont & Heylen (2008). Somewhat surprising is to see a hump shaped pattern in these parameters by age. Observing a higher taste for leisure among workers of middle age than among the young is fully in line with earlier results of Heylen and Van de Kerckhove (2013). But finding a lower taste for leisure among older workers is not.
5 Empirical relevance of the model

In this section we demonstrate the empirical relevance of the model. In Figure 2, we relate our model’s predictions to the facts for the time allocated to labour by the employed members of households aggregated over all generations and both ability types. Note that the model’s predictions are presented on the horizontal axis, whereas the actual data are represented on the vertical axis. The coefficient of correlation between the two is 0.544, which implies that the model matches cross-country differences fairly well. In Figure 3 we have a closer look at per capita labour input of the age group 55-64. Formally, our measure is $n_{4H} + (1 - u_4)n_{4L}$. It rises in hours worked per employed high ability individual of age 54-65 and in hours worked per employed lower ability individual of this age. It falls in the unemployment rate among lower ability individuals in this age group. Correlation in Figure 3 is 0.451.

Figure 4 is the key novelty in this paper. Plugging each country’s policy parameters into our calibrated model, it matches the facts for the aggregate unemployment rate very well. Correlation between the predictions of the model and the facts is over 80%.
Figure 3: Per capita hours worked in the age group 54-65 (both ability types, 2001-07) - Correlation: 0.451

Figure 4: Aggregate unemployment rate (all age groups, both ability types in %, 2001-07) - Correlation: 0.804
6 Quantitative experiment: accounting for cross-country variation in unemployment.

Figure 4 showed large differences across OECD countries in the unemployment rate. From Figure 1 we know that these differences explain an important fraction of cross-country differences in aggregate employment and labour market performance. The final step in this research is to account for these unemployment differences. What exactly causes higher unemployment in some countries compared to other countries? Are these variations due to differences in fiscal policy variables or to union preferences and wage setting? Or to differences in the taste for leisure of the households? And what is the contribution of (progressive) tax rates on labour, tax rates on consumption, unemployment benefits, etc.? For policy makers who are challenged to tackle unemployment, it is crucial to know.

6.1 Description of the experiment

We find a correlation of 0.804 between the predictions of our model for the aggregate unemployment rate and the actual unemployment data. From this, we derive an R-squared coefficient of 0.646. Following Israeli (2006), we perform a Shapley decomposition of the R-squared coefficient in order to evaluate the relative importance of the different fiscal policy variables, union wage setting and household preferences in generating cross-country unemployment differences. More specifically, according to a Shapley decomposition, the contribution of each of our variables equals its marginal effect measured by the change in the R-squared coefficient after eliminating the cross-country differences in this variable. This change in R-squared is computed for every subset S of other explanatory variables. For example, if we had four explanatory variables, $x_1, x_2, x_3,$ and $x_4$, the marginal effect of $x_1$ on the R-squared would be

$$M_1 = R^2[x_1, S \subseteq \{x_2, x_3, x_4\}] - R^2[S \subseteq \{x_2, x_3, x_4\}]$$

for every subset S. Next, we take a weighted average over all these marginal effects where the weight is respectively $\frac{s!(n-s-1)!}{n!}$, with $s$ the number of elements in the subset and $n$ the total number of explanatory variables. Hence, for each of our variables in the Shapley decomposition, we successively replace the cross-country values of one or more fiscal policy variables by the average value over the ten countries in our sample, implying that we shut down the influence of these specific variables in generating cross-country differences in the unemployment rate. These variables are (i) the labour tax rate imposed...
on employers; (ii) the labour tax rate imposed on employees; (iii) the replacement rate in the unemployment benefit formula; (iv) the tax rate on capital; (v) the tax rate on capital; (vi) government spending; (vii) the union preference parameters, and (viii) the taste for leisure of the households. Using this Shapley decomposition, we investigate how the power of the model to explain the true data (R-squared) changes. As such, we examine the contribution of (progressive) tax rates on labour, tax rates on consumption, unemployment benefits, union preferences, etc.

### Table 10: Shapley Decomposition

| $\chi$, $\varphi_1$, $\varphi_2$ | $u_t$ | 50.89% |
| $\xi$, $\Gamma$ | $-0.059$ | $-8.80\%$ |
| $\tau^p$ | $-0.028$ | $-4.12\%$ |
| $\delta_j$ | 0.217 | 32.61% |
| $\gamma_j$ | $-0.018$ | $-2.77\%$ |
| $\tau_c$ | 0.040 | 6.07% |
| $\tau_k$ | 0.051 | 7.58% |
| $g$ | 0.124 | 18.55% |
| Total $R^2$ | 0.6667 | 100% |

6.2 Fiscal policy, union preferences and wage setting, or households’ taste for leisure?

In this first subsection, we investigate whether the variation in cross-country unemployment rates is due to differences in union behaviour, household preferences or in fiscal policy variables. Blanchard (2004) and Alesina et al. (2005) emphasize the role of union behaviour and differences in the taste for leisure of households. Other authors such as Prescott (2004), Ohanian et al. (2008) and Dhont & Heylen (2008) conclude that differences in fiscal policy are superior. Looking at Table 10, the conclusion is that both fiscal policy variables and union preferences and wage setting matter. They account each for about half of the unemployment variation across countries. A correct diagnosis of the unemployment problem and analysis of cross-country differences clearly seems to require both components. On the other hand, any differences in households’ taste for leisure can safely be ignored. Integrating these findings, our interpretation is that while the above market-clearing wage chosen by the unions is the source of unemployment, the fiscal policy variables explain a large part of the magnitude of the unemployment rate.
Looking at the different components of fiscal policy, a surprising result is that $\xi$, $\Gamma$, and $\tau^p$ have no role to play when it comes to explaining unemployment differences across countries. This result implies that countries with higher average and marginal tax rates are not necessarily the countries with the highest aggregate unemployment rate, e.g. Sweden and France.

The major role of the replacement rate $\tilde{b}_j$ is not a surprising result, however. From the results of the calibration in Table 9, it is clear that unions in both continental Europe and Nordic countries attach a weight to the level of these benefits. Especially in continental European countries, the level of the replacement rate seems to drive unemployment differences across countries. The contribution of $\tilde{b}$ might even be an underestimation, as it is the combined impact of the net replacement rate and the region-specific union preferences that drive the Shapley results for the union preferences.

The consumption and capital tax rates both have a positive contribution to the $R^2$. The influence of the capital tax rate is determined via its influence on the first order condition of the firm with respect to capital, and will as such also have an impact on the variation in wages over the different countries.

7 Conclusion

Huge differences in labour market performance across OECD countries have attracted the attention of many researchers during the last decade. One strand of the literature has emphasized the major role of the composition of fiscal policy, i.e. the level and structure of taxes and government expenditures (e.g. Prescott (2004), Rogerson (2007), Dhont & Heylen (2008), Olovsson (2009), Wallenius (2013), Alonso-Ortiz (2014)). The focus of these studies is mainly on explaining employment (hours worked). All assume perfect competition and as such disregard any role for labour market imperfections. Unemployment is not an issue in these studies. A second tradition in the literature also recognizes the role of labour taxes and unemployment benefits, but this tradition has put much more emphasis on the role of unions (e.g. union power and wage bargaining) and labour and product market institutions (e.g. Daveri & Tabellini (2000), Nickell et al. (2005), Alesina et al. (2005)). Last but not least, some other authors (e.g. Blanchard (2004)) have pointed to the key role of household preferences. In their view, a major element behind the weaker employment performance in many European countries compared to the US is a higher taste for leisure in Europe. Alesina et al. (2005) explain that stronger unions may have contributed to this higher taste for leisure in Europe.

This paper is situated within the first strand of the literature. We also develop a
general equilibrium model (OLG model) that explains hours worked as one of the main variables. Our first contribution, though, is to take the dynamic general equilibrium literature one step further. We extend the model so that it can also explain equilibrium unemployment among lower educated individuals. Two assumptions are key. The first one is the assumption that individuals are heterogeneous by ability. They enter the model with different human capital stocks and have different capacity to build more human capital. A second assumption and key novelty compared to previous work in this tradition is the assumption of a unionized labour market and union wage setting for lower ability (lower educated) individuals. For higher ability individuals we assume that wages and employment are determined in a perfectly competitive way.

Calibrating and simulating this richer model for twelve OECD countries belonging to three regions (continental Europe, Nordic countries and Anglo-Saxon countries), we are able to assess the relative importance of a whole range of explanatory variables for cross-country differences in labour market performance. Our focus in this paper is on cross-country unemployment variation. What exactly causes higher unemployment in some countries than in others? What is the contribution of (progressive) tax rates on labour, tax rates on consumption, unemployment benefits, etc.? What is the contribution of union preferences and wage setting? What is the contribution of differences in households’ taste for leisure? Performing a Shapley decomposition we find an almost equal role for differences in fiscal policy variables and in union preferences. Both account for about half of the cross-country variation in unemployment rates explained by our model. By contrast, any differences in the households’ taste for leisure play no role. Integrating our findings, our interpretation will then be that the above market-clearing wage chosen by the unions is the source of unemployment, while the fiscal policy variables explain the major share of its magnitude. Going into greater detail on the fiscal side, we find that differences in unemployment benefit generosity play a much more important role than tax differences. In the Nordic countries and (even more) the continental European countries, the unemployment benefit replacement rate has a significant impact on union wage setting.

Our results highlight the relevance of integrating heterogeneity in individuals’ ability and labour market imperfections into dynamic general equilibrium analyses of labour market performance. Imposing perfect competition seems to imply that an important fraction of reality is unfortunately ignored. By contrast, cross-country differences in households’ taste for leisure seem insignificant, and can safely be disregarded.
References


A Appendix: Details on data construction and sources

In this appendix we provide details on the construction and sources of our data.

A.1 Individuals of high and low ability

Individuals of high ability pursue tertiary education when they enter our model at the age of 18. Individuals of lower ability do not: they achieve at most an upper secondary degree, but no tertiary degree. These assumptions explain why we use existing data for individuals with a tertiary degree as proxy for variables (e.g. wages, employment) relating to higher ability individuals in our model, and the average of existing data for individuals with a lower secondary degree and individuals with an upper secondary degree (but no tertiary degree) as proxy for variables relating to lower ability individuals. According to ISCED classification, data for high ability individuals therefore relate to education levels 5-6. Data for lower ability individuals are constructed as the average for education levels 0-2 and 3-4.

A.2 Unemployment

In our model, all individuals participate in the labour market during four periods of working age (18-29, 30-41, 42-53, 54-65). A fraction of lower ability individuals becomes unemployed. High ability individuals are always employed. Since we do not model participation as an endogenous variable, our setup implies that the unemployment rate among lower ability individuals in a particular age group is the same as the gap in percentage points between the employment rate among higher ability individuals and the employment rate among lower ability individuals in that age group. In line with our explanation in A.1, as a proxy for the former we use data for individuals with a tertiary degree. As a proxy for the latter, we compute the average of data for individuals with a below upper secondary degree and individuals with an upper secondary degree, but no tertiary degree.

Data sources: Eurostat (Employment rates by sex, age and highest level of education attained (%) [lfsa_ergaed]) provides employment rates in persons by level of educational attainment and by age for all EU15 countries and Norway since 1995 at the latest. Data are available for the age groups 20-24, 25-29, 30-34, 35-39, 40-44, 45-49, 50-54, 55-59 and 60-64, among others. We compute the data for our four larger age groups as weighted averages of the Eurostat data. The data that we report and employ are for 2001-2007. For the United States and Canada we use data provided by OECD Education at a
Glance. Data by educational attainment are available for the age groups 25-34, 35-44, 45-54, 55-64.

A.3 Hours worked

For hours worked, we proceed as follows. First, we gather available OECD (Labour Force Statistics) data on the usual weekly number of hours that individuals work. These data are available for the age groups 15-24, 25-54 and 55-64. We compute the data for our four age groups as weighted averages of the OECD data. Second, we compute how many weeks individuals work per year. We divide OECD data on total annual hours worked per employee by the average number of hours worked per week. Data on total annual hours are only available at the level of the aggregate labour force. As such, we obtain a proxy for the number of weeks individuals work per year, also at the level of the aggregate labour force. Multiplying the first variable (usual hours per week) by the second (weeks per year), we obtain our proxy for total annual hours worked per employee in each generation. We express this number as a fraction of the total time endowment. Like Wallenius (2013), we assume that the total time endowment of each individual is 14 hours a day, 7 days a week and 52 weeks per year. This time can be allocated to work, leisure or (for young higher ability individuals) education.

A.4 Education rate of the young higher ability individuals

The education rate indicates the fraction of their total time endowment that high ability individuals allocate to schooling. Considering that in countries like Canada and Norway almost (or even more than) 50% of the 25-34 year-olds succeed in obtaining a tertiary degree, it will be our assumption that 50% of the population in each country has high ability, and therefore the potential to succeed at high level. The extent to which this potential is fully exploited may however differ across countries. Differences may show up in the fraction of individuals that effectively succeed in tertiary education and in the level of the tertiary degree that these individuals eventually achieve. We expect that the latter will be reflected in the number of years that is studied. Building on this assumption and these considerations, our empirical proxy for the education rate is the number of students in tertiary education in full-time equivalents divided by 50% of size of the population of age 18-29. Data on the number of students is obtained from Eurostat (Students by ISCED level, study intensity (full-time, part-time) and sex [educ_enrl1ad]). Population data are from the OECD database (Total Population by sex and age). The education rates that we report are averages for 2002-2007.
A.5 Growth rate of real per capita output

To compute the growth rate of real per capita output, which we need for the calibration of exogenous technological progress \((x)\), we use data on real potential GDP and on population at working age (15-64). The former are available from OECD Economic Outlook (supply block), the latter from OECD Labour Force Statistics. In line with all other data we compute average growth rates over 2001-2007.

A.6 Fiscal policy variables

The government in our model finances spending on goods and unemployment benefits from taxes on labour (on both employers and employees), consumption, and capital. Lump sum transfers ensure a balanced budget. For the tax rates \(\tau_k\) and \(\tau_c\), we use the same data as Heylen & Van de Kerckhove (2013). For government spending on goods in percent of GDP \((g)\) we compute the sum of their data for government consumption and productive government spending. For details on the construction of these fiscal policy variables, we refer to Heylen & Van de Kerckhove (2013, their appendix 1).

For the unemployment benefit replacement rate \((\hat{b})\) we make use of data provided by the OECD (Tax-Benefit Models). Since in our model unemployment is a structural or equilibrium phenomenon, the data that we use concern net transfers received by structurally or long-term unemployed people. They include social assistance, family benefits and housing benefits in the 60th month of benefit receipt. They also include unemployment insurance or unemployment assistance benefits if these benefits are still paid, i.e. if workers can be structurally unemployed for more than five years without losing benefit eligibility. The OECD provides net replacement rates for six family situations and three earnings levels. Our data in Table 6 are the averages of these 18 cases. Data for 2001-2004.

Regarding labour tax rates, we distinguish between social security contributions paid by employers and taxes and social security contributions on labour income paid by employees. Our data source is OECD (Taxation, Tax Database, Tables I.4, I.5, I.6). More specifically, we use the OECD’s average rate of employer social security contributions for \(\tau_p\) (Table I.5). We calibrate the level parameter \(\Gamma\) in the workers’ income tax rate using the OECD data for all-in average personal income tax rates at average wage. The all-in tax rate is calculated as the combined central and sub-central government income tax plus employee social security contribution, as a percentage of gross wage earnings. The OECD provides these tax rates for four family types (Table I.6). We computed the average over these types. A novelty compared to previous work is the inclusion of
progressive income taxation. Just like Koyuncu (2011), we calibrate the country-specific degree of progressivity \( \xi \) according to Equation (28) as the ratio (minus 1) of the marginal tax rate on workers’ gross wage to the average tax rate, both including social security contributions. The OECD provides these marginal and average tax rates for a single person without dependent at four different income levels (Tables I.4 and I.5). Our proxy for \( \xi \) reflects the average of the results over these four income levels. All computed and reported tax data in our Table 6 are averages over the period 2000-2007.