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Alessandro Bucciol, Laura Cavalli, Igor Fedotenkov, Paolo Pertile, Veronica Polin, Nicola Sartor, Alessandro Sommacal

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A large scale OLG model for France, Italy and Sweden: assessing the interpersonal and intrapersonal redistributive effects of public policies

A. Bucciol, L. Cavalli, I. Fedotenkov,
P. Pertile, V. Polin, N. Sartor, A. Sommacal*
University of Verona

Abstract

The paper presents a large scale overlapping generation model with heterogeneous agents, where the family is the decision unit. We model a large number of tax and public expenditure (cash and in kind) programmes, so that the equity and efficiency implications of public sector intervention may be assessed in its complexity. We do this for three european countries that show remarkable differences in the design of most of these programmes: France, Italy and Sweden. We show that the model is able to match relevant aggregate and distributional statistics of the three countries we analyse. To illustrate the working of the model, we provide examples of policy experiments that can be simulated. That is, we compare our model economies featuring the current set of public policies implemented in France, Italy and Sweden, with alternative economies where some (all) public finance programs are absent. The comparison is done, looking at the effects on both inequality and individual welfare.

Keywords: Redistribution, Fiscal policy, Computable OLG models.
JEL Classification: H2, H3.

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1 Introduction

This paper describes a large scale overlapping generation model which can be used to asses the effects on inequality and welfare of policy reforms.

Most of the public sector interventions in the economy are justified by redistributive goals. The set of tools employed to this end is typically very large, including several tax and transfer programmes with complex interactions among them, and, in some cases, potentially offsetting effects. Moreover, public policies imply both inter-personal and intra-personal redistribution (Sandmo 1999). The first type of redistribution is mainly aimed at achieving equity targets by transferring resources from the the rich to the poor. The second one, justified by efficiency targets or by the existence of merit goods, is aimed at smoothing consumption over time and over different states of the world.

Due to such complexity, a full understanding of the redistributive impact of the public sector intervention is hard to obtain both theoretically and empirically. Theoretical contributions typically focus on one programme at the time, while the modelling of indirect effects, such as the impact on the amount of resources available for other programmes due to the existence of some budget constraint is usually very stylized. From the empirical perspective, addressing these questions is very demanding in terms of data availability. In particular, longitudinal data are rarely sufficiently rich to allow the estimate of intra-personal distribution over the life-cycle.

In order to overcome this problem, the economic literature has developed tools for indirectly assessing the redistributive impact of public policies: tax-benefit microsimulation (MS) (see, for example, Bourguignon and Spadaro 2006 for an overview) and generational accounting (Auerbach, Gokhale, and Kotlikoff 1991) are two examples. Microsimulation models are typically characterized by large heterogeneity with respect to several individual characteristics and to the possibility to assess the impact of any policy experiment related to tax and benefit programmes that are modelled. Such models have been developed in a number of directions in recent years, including the shift from static to dynamic analysis and the introduction of behavioural responses. The latter are typically estimated through the empirical analysis of the correlation among relevant variables. Another approach which is relevant to the objectives of the present work is "generational accounting" (GA) (Auerbach, Gokhale, and Kotlikoff 1991). Although the original aim of this method was to assess the long-term sustainability of public finance, its output may be also interpreted in terms of inter-personal, intra-personal and inter-generational redistribution. GA shares at least two important features of our approach: the lifetime perspective and the consideration of the largest possible set of public programmes. We believe that there exist several reasons why these elements are important. For example, people are typically net payers for specific programme in one phase of their life, but may be net receivers in other phases. In the mean time, it is our objective to overcome some of the well known limitations of GA, namely the lack of behavioural responses and the limited heterogeneity of agents (usually characterized according to age and sex only). Moreover, since GA exercises are based on the individual, the role of the family in decision making process as well as the welfare impact of its size are not considered, while we are also interested in such dimension.

While we have mentioned that behavioural responses are often an issue in the MS literature, they play a key role in a third strand of literature: computable overlapping generations models (COLG) with heterogeneous agents (see Fehr 2009 for a survey). There are two main differences compared to the dynamic microsimulation models . First, the analysis of inequality may be extended to the inter-generational dimension. Second, behavioural responses are structural and they are derived assuming rationality of individuals who maximize their expected utility over the life-cycle. This leads to the definition of optimal paths for decision variables such as consumption and labour supply. The approach to the definition of the behavioural response is therefore very different from that of MS models, in which it is usually not derived from a structural model. Compared to MS models, COLG models are less demanding in terms of data (especially longitudinal) availability; however, computational constraints, typically prevent from having in COLG models the same level of heterogeneity as in MS models.

All the three approaches we have discussed above have their own strengths and weaknesses. In this paper we decide to focus on structural behavioural responses and therefore the characteristics of our model are those of a large scale OLG model with heterogeneous agents, with a strong emphasis on the need to provide a comprehensive description of the public sector intervention. The main tax and benefit programmes are described for three countries: France, Italy and Sweden. The three countries show important differences with respect to the weight of different tax and transfer programmes and to the characteristics of some of them. The lifetime equity and efficiency implications of such different architectures are obviously a subject of great interest.

The aim of the present paper is to describe the characteristics of the model that we set up in order to pursue the above objectives and to test how well it performs in matching real world data on some non-calibrated outcomes. As an instance of the type of policy questions that can be addressed through the model, we finally perform some numerical experiments.

The structure of the paper is as follows. In the next section we will review the methodological approaches that have been adopted in the literature to study issues similar to those we are interested in. Section 3 presents the model. Estimation and calibration of the structural parameters are described in Section 4, whereas in Section 5 we describe the main characteristics of the public programmes modelled for the three countries. In Section 6 we show that the model is able to match relevant aggregate and distributional statistics of the three countries we analyse. Policy reforms are simulated in Section 7. Finally some concluding remarks are provided in Section 8.

2 Literature review

2.1 Microsimulation models

Tax-benefit micro-simulation models aim to assess the redistributive and aggregate impact of policy reforms by studying their implications for each micro-unit (individuals, households, firms) in a sample.[1] The sample is expected to be representative of a population of interest and it typically corresponds to the sample of a survey. Hence, the choice of the dataset turns out to be crucial, and it may have a sizeable impact on the results (Harding (2007)). Micro-units can then be characterized according to the whole set of variables recorded in the survey, which implies that the degree of heterogeneity in the population is potentially very large.

Microsimulation models may differ according to a number of dimensions, and the choice of a specific model depends of the objective of the simulation. The first relevant dimension is the time horizon, which introduces a distinction between static and dynamic models. In static micro-simulation the time horizon is a single period, while the sample and the characteristics of its units are kept fixed. Dynamic models extend the analysis to multi-period horizons and allow for changes in the population structure, thus allowing also for the evolution of the socio-economic characteristics of the population (Zaidi and Rake (2001); Ando and Nicoletti-Altimari (2004)).

Within dynamic models, a further distinction needs to be made between single-cohort and multiple-cohort (population) models. Single cohort models are suitable to investigate life-course impacts (e.g lifetime redistribution, returns to education, probability of repaying loans) which are relevant to a specific cohort. Multi-cohort models also allow for the analysis of inter-

[1] For a detailed summary of the models see Zaidi and Rake (2001), ODonoghue (2001) and Cassells, Harding, and Kelly (2006).

generational redistribution.[2] A key step is ensuring the consistency of the results with the projections provided by different sources, including macro models. This can be ensured through a calibration process which is usually referred to as *alignment* in the literature.

A further distinction is the one between arithmetic and behavioural models. The former do not take into account individual responses to programmes or reforms, but they simulate changes (i.e., in income) assuming that individual behaviour does not change (as if the individual was exogenous to the tax-benefit systems). These models are typically employed to predict the short-term impact of policy reforms. The assumption that individual decisions (e.g. concerning labour supply) are not affected by the policy decision is obviously a very strong one. Behavioural models aim to overcome this limitation by exploiting the empirical analysis of the correlation between policy (and other relevant covariates) and decisions of the micro-unit. A known shortcoming of this approach is that the behavioural response might be altered by the policy change. Therefore the solution is satisfactory as long as the impact of the policy of interest on behavioural responses can be expected to be negligible. A major challenge in the development of such models is that data necessary to estimate behavioural processes used by dynamic microsimulation models is typically quite limited. This explains why the number of dynamic models incorporating behavioural responses is still rather small.[3] The use of behavioural models in literature is justified by the fact that they explicitly allow to analyse the efficiency-equity trade-off in redistributive theories, especially when the analysis takes into account the role of the social welfare function (Bourguignon and Spadaro 2006).

2.2 Generational Accounting

Generational Accounting (GA) was originally conceived as a method for assessing long-term sustainability of public finance and the distribution of burden of unbalances among living and future generations (Auerbach, Gokhale, and Kotlikoff (1991)). The method starts by apportioning taxes and public transfers to individuals according to their age (and often sex) in a way such that the aggregate amount as resulting for the current year in the GA model is consistent with official budget data for the same taxation or expenditure programme. Future amounts for the same individuals are then usually ob-

[2] Different choices can be also made on how to project populations over time. In this respect, a key distinction is between *static ageing* and *dynamic ageing*. See ODonoghue (2001) for a detailed discussion on this point.

[3] Examples include MICROHUS, PRISM, SESIM, NEDYMAS.

tained by assuming a growth rate in line with economic growth. This will determine a deficit or a surplus, which is the difference between the governments projected future purchases of goods and services plus its official net financial liabilities, minus the present value of projected future net tax payments of current generations. The idea is that additional payments (if any) needed to satisfy the inter-temporal budget constraint will be made by future generations.

The difference between the net tax (difference between present value of taxes to be paid over the life-cycle and present value of transfers, both cash and in-kind to be received) due by newborns, who are representative of current generations, and that due by an individual representative of future ones is in the mean time a measure of sustainability and inter-generational equity. The method can be used to assess the impact on these measures of hypothetical reforms or changes in the demographic structure. However, what is more relevant to our analysis is what usually receives less attention in the GA literature, that is the possibility of comparing the lifetime position of individuals belonging to different cohorts *vis-à-vis* the public sector.

The lifetime perspective is relevant because people tend to be net receivers of some programmes in some phases of their life-cycle and net payers in others.[4] Therefore, a comparison of different cohorts is only possible over the whole life-cycle. What is even more peculiar of GA is the comprehensiveness of the analysis with respect to the number of tax-benefit programmes considered and the consistency with official budget data. On the other hand, the degree of heterogeneity, typically low, is a limitation. However, progress has been made in this direction to go besides the standard dimensions of heterogeneity related to age and gender (Wolfson, Rowe, Lin, and Gribble (1998)).

The reference unit in the GA literature has been almost invariably the individual. This is in contrast with the increasing attention that the household is receiving as a decision unit.[5] Understanding how the generational account of an individual is affected by the characteristics of the household she belongs to, may be relevant for several reasons: some programmes are explicitly targeted to households with specific characteristics (e.g. support for children) whereas others are not; different household structures may imply different utility levels for individuals with identical incomes, and therefore

[4]Typically, transfers tend to exceed taxes during the first years of life due to the role of public education and health. As individuals approach working life labour income taxation starts to play a crucial role, so that for a number of years the net tax will be positive. The sign changes again at higher ages when former workers receive pensions and use more of some publicly provided services such as healthcare.

[5]See, for example, Apps and Rees (2009) and references therein.

also different impacts of similar tax-benefit interventions. A development of the GA model in this direction has been proposed by Polin and Sartor (2009), where a new approach to assess the lifetime incidence of budgetary policy on families is proposed.

Overall, some of the main shortcomings of original GA models have been overcome. The main limitation in comparison with the other approaches introduced in this section probably remains its inability to account for behavioural responses to policy changes.

2.3 Heterogenous agents computable OLG models

In standard generational accounting models the only sources of individual heterogeneity are represented by age and sex. The limited degree of heterogeneity is also the main limitation of the traditional computable overlapping generation (COLG) models á la Auerbach and Kotlikoff (1987), where age is the only source of heterogeneity. These models are well suited to analyse the macroeconomic impact of public policies. However their usefulness is quite limited as far the redistributive impact of public intervention is concerned: this set-up can only assess inter-generational redistribution.

More recently the literature has proposed a new generation of COLG models, where intragenerational heterogeneity is present: agents are assumed to have different endowments of efficiency units of labor; more precisely, it is often assumed that agents face an idiosyncratic productivity risk, which is considered uninsurable due to insurance market incompleteness. Accordingly, these COLG models can be used to explore both the inter- and intragenerational redistributive effects of public policies.

This kind of models have been extensively used to investigate the impact of pension reforms (namely the removal of the pension system itself). Examples include İmrohoroglu, Imrohoroglu, and Joines (1995) and Imrohoroglu, Imrohoroglu, and Joines (1999), Huggett and Ventura (1999), Nishiyama and Smetters (2007), Fehr and Habermann (2008), Fehr, Kallweit, and Kindermann (2013).[6]

Heterogenous agents COLG models have also been used to study the impact of tax reforms. For instance, Ventura (1999), Conesa and Krueger (2006) and Erosa and Koreshkova (2007) analyse the effects of progressive taxation, Nishiyama and Smetters (2005) focuses on consumption taxation, and Conesa, Kitao, and Krueger (2009) study capital income taxation. A recent, relevant trend in COLG models is the expansion of the heterogeneity

[6]See Fehr 2009 for a survey on the use of heterogenous agents COLG models for the simulation of pension reform.

dimensions, well beyond age and individual productivity, to include for example gender, marital status and the number of children. Models featuring these additional sources of heterogeneity have already been used to study both pension reforms (Hong and Rios-Rull 2007, Fehr, Kallweit, and Kindermann 2012) and tax reforms (Guner, Kaygusuz, and Ventura 2012b, Guner, Kaygusuz, and Ventura 2012a). All in all, we think that heterogenous agents COLG models models have the virtue of putting together a life cycle dimension, behavioral responses based on a structural general equilibrium model and a sizable degree of individual heterogeneity.

In the next sections of this paper, we describe the building block of an heterogeneous agent COLG model where the source of intragenerational heterogeneity is represented by individual productivity, gender, marital status and the number of children and where the household is the decisional unit. In this set-up we model a large set of public policies. We think that the inclusion of a wide range of taxes and transfers is important not only to study the "overall" redistributive impact of public intervention; it also matters because the impact of a specific program is likely to depend on the features of the other programs that are in place. In other terms, complementarities/substitutabilities between different transfer and taxes might exist and ignoring them is a potential source of bias.

This model is applied to three European countries: France, Italy and Sweden. To the best of our knowledge, heterogeneous agents COLG models have not been used to study the impact of public policies in Italy and France; for Sweden, we are aware of the work by Domeij and Klein (2002), whose focus is however limited to the pension system.

3 The model

We consider a small open economy populated by $\overline{J}$ overlapping generations. We denote by $j = \left\{1, 2, ..., J^R, ..., \overline{J}\right\}$ the age of an individual, where J^R is the exogneously fixed retirement age and $\overline{J}$ is the maximum age that can be reached. Individuals may die before age $\overline{J}$, according to a survival probability that will be later specified.

Within a generation individuals are heterogenous along several dimensions: gender (males and females), marital status (singles and married), presence of children, educational level. For tractability reasons we make some symplifying assumption concerning these variables. First we assume that single individuals never get married and married individuals never get divorced (however they can become single if their spouses die). Second we assume that married households are comprised by individuals who are of the same age. Third we restrict the (exogenous) childbearing behavior: the number of children is 0 or 2; only persons living in couple can have children; this only happens when $j = 1$.

The decisional unit is the household. At any age $j < J^R$ (working period) the household chooses labor supply and consumption of its members; for $j \geq J^R$ (retirement period) only consumption is chosen and labor supply is exogenously set equal to zero. A single makes these choices maximizing his/her intertemporal utility. Individuals within a couple pool toghether their resources and maximize the sum of their intertemporal utilities.

Households are assumed to have perfect foresight on the future values of the return on assets and of the wage rate per efficiency unit.

As to the production side, there is only one sector where a good is produced by a representative firm using capital and labor in efficiency units. This good can be used for consumption, investment, purchase of day care services and it is chosen in each period as the numeraire, i.e. its price is normalized to 1. We assume perfectly competitive markets.

The government is empowered with a large set of policy variables: a personal income tax, a consumption tax, a capital income tax, social contributions, a pension system, an health care system, a child benefit, a subsidy to day care expenditure and an income support system.

In what follows we specify in more details the features of our model economy. We focus on a steady state equilibrium and therefore we omit time subscripts and we only use the age subscript j.

3.1 Firms

The output Y is produced by a representative firm according to a Cobb-Douglas technology:

$$Y = AK^{\nu}L^{1-\nu} \tag{1}$$

where A is the total factor productivity, K is the aggregate capital stock, L is aggregate labor supply in efficiency units and $0 < \nu < 1$ is the share of capital income on output.

Profit maximization implies the standard conditions:

$$w = (1-\nu)Ak^{\nu} \tag{2}$$

$$r + \delta = \nu Ak^{1-\nu} \tag{3}$$

where δ is the depreciation rate of capital and $k \equiv K/L$.

3.2 Households

3.2.1 Utility function

We assume that each individual has an additively time separable utility function with a momentary utility $u(c_j, z_j)$ defined over his level of consumption c_j and his leisure z_j. Individual consumption c_j is equal to the aggregate consumption of the household q divided by an equivalence scale θ (which depends on the number of adults and children in the household). The momentary utility function of each individual takes the following form:

$$u\left(c_j, z_j\right) = \frac{1}{1-\gamma}\left(c_j^{\alpha} z_j^{(1-\alpha)}\right)^{1-\gamma} \tag{4}$$

with:

$$c_j = \frac{q}{\theta} \tag{5}$$

where $\alpha \in [0,1]$; $\gamma > 0$.

3.3 Time constraints

For each individual the following time constraint holds:

$$l_j + z_j = 1 \tag{6}$$

where l_j is labor supply and the time endowment is normalized to 1. Equation (6) states that, in each period of life, the time endowment can be used for labor or for leisure time.

Moreover we assume that a child, in his first period of life, requires to be cared all the time; accordingly for every unit of time that both parents works, day care services must be purchased. Therefore, recalling that we have assumed that childbearing is only possible at age $j = 1$, we have that the demand for day care services d_j is given by

$$d_j = \begin{cases} \kappa \min\left\{l_j^m, l_j^f\right\} & \text{for} \quad j = 1 \\ 0 & \text{for} \quad j > 1 \end{cases} \tag{7}$$

where κ is the number of children (equal to 0 or 2 as explained before).

3.4 Budget constraint

The budget constraint of the household is given by:

$$
\begin{aligned}
a_{j+1} =& TR + (1 + (1 - \tau_r)r)a_j + I_m(g)\left[(y_j^m - sc_j^m(y_j^m) - \overline{hs}_j^m + hs_j^m\right] \\
& + I_f(g)\left[y_j^f - sc_j^f(y_j^f) - \overline{hs}_j^f + hs_j^f\right] \\
& - t_{y,j}(y_j^m, y_j^f, \kappa_j) - p_d(1 - \tau_d)d + tr_{\kappa,j}(y_j^m, y_j^f, \kappa_j) + tr_{y,j}(y_j^m, y_j^f) - (1 + \tau_q)q
\end{aligned}
\tag{8}
$$

where $g = m, f$, $I_m(g)$ and $I_f(g)$ are indicator functions and income y_j^g is given:

$$
y_j^g = \begin{cases} we_{j,h}^g l_j^g & \text{for} \quad j < J^R \\ p_j^g(sb_{J^R}^g) & \text{for} \quad j \geq J^R \end{cases} \tag{9}
$$

We denote with w and r respectively the wage rate per efficiency unit and the interest rate; $e_{j,h}^g$ stands for efficiency units at age j of an individual of gender g and education level h; $p_j^g(sb_{J^R}^g)$ is the pension transfer received by the household and $sb_{J^R}^g$ stands for the amount of pension rights accumulated over the working life; a_j denotes assets; TR is a lump-sum age independent transfer received from the government; τ_r is the tax rate on capital income; $t_{y,j}(y_j^m, y_j^f, \kappa_j)$ is the personal income tax paid by the household; $sc_j^g(y_j^g)$ are social contributons ; $\overline{hs}_j^g$ is health expenditure needed to maintain a minimum health stock, and hs_j^g denotes the subsidy implicitly provided by the public sector through public health expenditure; p_d is the price of day care services, τ_d is the subsidy to the purchase of day care services; $tr_{\kappa,j}(y_j^m, y_j^f, \kappa_j)$ is a child subsidy; $tr_{y,j}(y_j^m, y_j^f)$ is an income support transfer; τ_q is the tax rate on consumption.

The rate τ_r, τ_d and τ_q does not depend on individual variables. The subsidy implicitly provided by the public sector through public health expenditure hs_j^g only depends on age and gender. The specific functional forms for social contributions, the pension benefit, the personal income tax, the income support transefr will be specified in Section 5 for the different countries we are going to study.

3.5 Liquidity constraint

We assume that the households face a liquidity constraint given by:

$$
a_j \geq \bar{a} \quad \forall j \tag{10}
$$

and we assume that $\bar{a} = 0$

3.6 Household optimization problem

The optimization problem of singles and couples can be represented using dynamic programming. The state vector of a household is given by:

$$x_j = (h^m, h^f, \kappa_j, a_j, sb_j^m, sb_j^f) \tag{11}$$

where each element of the state vector is ≥ 0. We denote by h^g the level of education of an individual of gender g and we use the convention that $h^g = 0$ if and only if an individual of gender g is not present in the household. Note that, if $h^g = 0$ we obviously have $sb_j^g = 0$, i.e. the amount of pension rights accumlated up to age j by an individual of gender g in that household is zero; moreover, given our assumption that only couples have children, we also have $\kappa_j = 0$, i.e. the number of children is zero.

Accordingly we denote the state vector at age j of a single female as:

$$x_j^f \equiv (0, h^f, 0, a_j, 0, sb_j^f), \tag{12}$$

with $h^f > 0$, $a_j \geq 0$, $sb_j^f \geq 0$.

The state vector of a single male is:

$$x_j^m \equiv (h^m, 0, 0, a_j, sb_j^m, 0), \tag{13}$$

with $h^m > 0$, $a_j \geq 0$, $sb_j^m \geq 0$.

The state vector of a couple is:

$$x_j^{co} \equiv (h^m, h^f, \kappa_j, a_j, sb_j^m, sb_j^f), \tag{14}$$

where $h^m > 0$, $h^f > 0$, $\kappa_j \geq 0$, $a_j \geq 0$, $sb_j^m \geq 0$, $sb_j^f \geq 0$.

Note that the educational levels h^g are constant along the life cycle; the other state variables however do change with age. The number of children κ_j evolves according to an exogenous transition equation:

$$\kappa_{j+1} = \kappa(\kappa_j, j) = \begin{cases} \kappa_j & \text{for} \quad j < J^\kappa \\ 0 & \text{for} \quad j \geq J^\kappa \end{cases} \tag{15}$$

where J^κ is the exogenously fixed age at which children become independent and leave their parents. The transition equations for the remaining state variables are endogenous. Assets a_j change over time according to the budget constraint (8). The dynamics of pension rights sb_j^g depends on the legal rules of pension system which are described in Section 5 for the different countries we consider.

3.6.1 Optimization problem of singles

A single with state vector $x_j = x_j^g$ determines consumption and leisure from the following maximization problem:

$$\max_{c_j^g, z_j^g} u\left(c_j^g, z_j^g\right) + \psi_{j+1}(g)\,\beta V^g(x_{j+1}^g) \tag{16}$$

where $V^g(x_{j+1}^g)$ is the value function of an agent of gender g; β is the discount factor (pure time preference), and $\psi_{j+1}(g)$ is a gender-specific probability of surviving up to age $j+1$, conditional on having reached age j.

Maximization in (16) is carried out subject to the transition equations for the state variables, the liquidity constraint (10) and the time constraint (6).

3.6.2 Optimization problem of a married agent

A married couple with state vector $x_j = x_j^{co}$ determines consumption and leisure from the following maximization problem:

$$\begin{aligned}\max_{c_j^m, c_j^f z_j^m, z_j^f} & u\left(c_j^m, z_j^m\right) + u\left(c_j^f, z_j^f\right) + \\ & \psi_{j+1}(m)\,\beta\left(\psi_{j+1}(f)\,V^m(x_{j+1}^{co}) + \left(1 - \psi_{j+1}(f)\right)V^m(x_{j+1}^m)\right) + \\ & \psi_{j+1}(f)\,\beta\left(\psi_{j+1}(m)\,V^f(x_{j+1}^{co}) + \left(1 - \psi_{j+1}(m)\right)V^f(x_{j+1}^f)\right)\end{aligned} \tag{17}$$

Maximization in (17) is once again carried out subject to the transition equations for the state variables, the liquidity constraint (10), the time constraint (6), the demand for day care services constraint (7) and the relationsip between household consumption and individual consumption given by equation (5).

3.7 The distribution of households

The solutions of the optimization problem of the household are the decision rules for consumption $q_j = \hat{q}(x_j, j)$ and labor supply $l_j^g = \hat{l}(x_j, j)$. For household made up by a single male (i.e. $x_j = x_j^m$), we use the convention that $l_j^f = \hat{l}(x_j, j) = 0$; for single female (i.e. $x_j = x_j^f$) it is $l_j^m = \hat{l}(x_j, j) = 0$. Starting from the decision rules for consumption and labor and using the appropriate transition equations, decisions rules for the endogenous state variables $a_{j+1} = \hat{a}(x_j, j)$ and $sb_j^g = \hat{sb}^g(x_j, j)$ can be computed; using equation (7), we can determine the optimal demand of day care services $d_j = \hat{d}(x_j, j)$. Moreover the values of taxes and transfers as a function of the state vector and of age can be also computed: $p_j^g = \hat{p}(x_j, j)$, $t_{y,j} = \hat{t}_y(x_j, j)$,$sc_j^g = \hat{sc}^g(x_j, j)$, $tr_{\kappa,j} = \hat{tr}_\kappa(x_j, j)$, $tr_{y,j} = \hat{tr}_y(x_j, j)$.

The distribution of households must be consistent with these decision rules. Therefore the distribution of households within a particular cohort (denoted by $\chi_j(x_j)$) must obey the following equation:

$$\chi_{j+1}(x_{j+1}) = \int_X \Pi(x_{j+1}, x_j) d\chi_j(x_j) \tag{18}$$

where X is the state space and

$$\Pi(x_{j+1}, x_j) = \begin{cases} 1 & \text{if} \quad \kappa_{j+1} = \kappa(\kappa_j, j), a_{j+1} = \hat{a}(x_j, j), sb_{j+1}^m = \hat{sb}^m(x_j, j), sb_{j+1}^f = \hat{sb}^f(x_j, j) \\ 0 & \text{otherwise} \end{cases} \tag{19}$$

Finally we assume that each generation is $1 + n$ bigger than the previous one, where n is assumed to be costant over time. Therefore (since the survival probability function is also assumed to be constant over time), the population structure is stationary. The fraction of age j individuals in the population is denoted by μ_j, and it obey the following equation:

$$\mu_j = \frac{\psi_j^g}{1+n} \mu_{j-1}. \tag{20}$$

where μ_1 is normalized in order to have that the weights μ_j sum up to 1.

3.8 Goverment budget constraint

Describing the household budget constraint (8), we have already mentioned almost all the policy instruments used by the governemnt. In addition to the policy instruments mentioned above, the government wants to finance a per-capita amount G of government consumption, which in principle should include the amount of net expenditures (i.e. expenditures minus revenues) which have not been explicilty modelled within our framework.

We here specify the constraints faced by the government. First we assume that the government confiscates unvoluntary bequests and use them to finance the lump-sum transfer TR; accordingly per-capital unvoluntary bequests are equal to TR:

$$TR = \frac{\sum_j \mu_j \int_X \Psi_{j+1}(x_j) \hat{a}(x_j, j) d\chi_j(x_j)}{1+n} \tag{21}$$

where:

$$\Psi_{j+1}(x_j) = \begin{cases} (1 - \psi_{j+1}^m)(1 - \psi_{j+1}^f) & \text{if} \quad x_j = x_j^{co} \\ (1 - \psi_{j+1}^m) & \text{if} \quad x_j = x_j^m \\ (1 - \psi_{j+1}^f) & \text{otherwise} \end{cases} \tag{22}$$

is the probability that the household disappears from our model economy (i.e. both spouses are dead).

Second, for the other policy instruments, we specify a budget constraint stating that per-capita government consumption G is equal to the difference between all the revenues and the expenditures which are explicitly modelled in our set-up:

$$G = T_y + SC + T_c + T_r - P - H - TR_\kappa - TR_d - TR_y \tag{23}$$

where T_y, SC, T_c and T_r are respectively the per-capita revenues from the personal income tax, from social contributions, from the consumption tax, and from the capital income tax; P, H, TR_κ, TR_d TR_y are respectively the per-capita public expenditures for pensions, for health care, for child benefits, for day care services and for income support. Therefore we have:

$$T_y = \sum_j \mu_j \int_X \hat{t}_y(x_j, j) \; \mathtt{d}\chi_j(x_j) \tag{24}$$

$$SC = \sum_j \mu_j \int_X (\hat{sc}^m(x_j, j) + \hat{sc}^f(x_j, j) \; \mathtt{d}\chi_j(x_j) \tag{25}$$

$$T_c = \sum_j \mu_j \int_X \hat{q}(x_j, j)\tau_c \; \mathtt{d}\chi_j(x_j) \tag{26}$$

$$T_r = \sum_j \mu_j \int_X r\hat{a}(x_j, j)\tau_r \; \mathtt{d}\chi_j(x_j) \tag{27}$$

$$P = \sum_j \mu_j \int_X \hat{p}(x_j, j) \; \mathtt{d}\chi_j(x_j) \tag{28}$$

$$H = \sum_j \mu_j (hs_j^m + hs_j^f) \tag{29}$$

$$TR_\kappa = \sum_j \mu_j \int_X \hat{tr}_\kappa(x_j, j) \; \mathtt{d}\chi_j(x_j) \tag{30}$$

$$TR_d = \sum_j \mu_j \int_X \hat{d}(x_j, j)\tau_d \; \mathtt{d}\chi_j(x_j) \tag{31}$$

$$TR_y = \sum_j \mu_j \int_X \hat{tr}_y(x_j, j) \; \mathtt{d}\chi_j(x_j) \tag{32}$$

In the pre-reform scenario described in Section 4, 5 and 6, the budget balanced condition is reached by adjusting endogenously the level of G. When performing reforms in Section 7, we will carefully specify which variable is adjusted in each post-reform scenario to keep the budget balanced.

3.9 Recursive competitive equilibrium

We consider a small open economy, we assume that there is no growth in total factor productivity and we focus on a steady state path.

Given the world interest rate $\bar{r}$, a small open economy steady state competitive equilibrium is definied as a collection of factor prices w and r, aggregate capital K and aggregate labor in efficiency unit L, household distributions χ_j, household decision rules, government revenues and expenditures such that:

1. $r = \bar{r}$, and first order conditions of the firm (2) and (3) hold
2. market clearing conditions hold:

$$L = \sum \mu_j \int_X (\hat{l}^m(x_j, j)e^m_{j,h} + \hat{l}^f(x_j, j)e^f_{j,h}) \, \mathtt{d}\chi_j(x_j) \tag{33}$$

$$F(K, L) + (1 - \delta)K = G + \sum \mu_j \int_X (\hat{q}(x_j, j) + \hat{a}(x_j, j)) \, \mathtt{d}\chi_j(x_j) \tag{34}$$

3. distributions χ_j are consistent with individual behavior, i.e equation (18) hold
4. household decision rules are the solution of the dynamic programming problems described by equations (16) and (17)
5. government revenues and expenditures satisfy the government budget constraints (21) and (23).

The model complexity prevents us from deriving an analytical solution of the model, so that we resort to a numerical solution.

4 Calibration: parameters

In this section describe how parameters are set in order to provide a numerical solution to the model.

Individuals enter the model when they are 25 years old. One period in the model is equivalent to 5 years. Individuals live up to a maximum of $\bar{J} = 15$ periods (i.e. the maximum age is equal to 100 years). We set $j^R = 9$ (i.e. the retirement age is 65 years) and $J^\kappa = 5$ (i.e. children become independent and leave their parents when they are 25 years old).

4.1 Demographics

The growth rate of the population on an annual basis is set equal to 0.6799% for France, 0.3983% for Italy and to 0.4895% for Sweden. These numbers are obtained averaging the annual population growth rates available in the OECD database over the period 1951-2011.

4.1.1 Distribution of exogenous state variables

As to the level of education h^g we consider two levels: college graduates ($h^g = 1$) vs non-college graduates ($h^g = 2$).

Using the information reported in OECD (2010) for the age group $25-34$ in 2007 we set proportion of college graduates among men equal to: 38% in France, 16% in Italy and 35% in Sweden; the corresponding numbers for women are respectively: 47% in France, 25% in Italy and 49% in Sweden.

Then, we need to set the percentage of people living in a couple, the percentage of couples with children and the correlation between levels of education within couples.

To this end, we use EU-SILC 2007 data. We first compute the percentage of individuals older than 24 who are married: the number is 60.43% in France, 64.35% in Italy and 59.28% in Sweden. Then, we look at the fraction of couples in which the woman is aged between 24 and 40 that have at least one child: in Italy this is the 78.10%, which is less than the 89.22% of France and the 85.57% of Sweden. Finally we estimate correlations of agents' education levels within couples. Tables 1-3 present frequencies of educations in couples observed in EU-SILC 2007. Consider a general form of a frequency table

Table 1: Frequencies of educations in couples (Italy)

Wife	Husband	
	Low	High
Low	19773	1765
High	1736	1404

Table 2: Frequencies of educations in couples (France)

Wife	Husband	
	Low	High
Low	3511	454
High	437	741

Table 3: Frequencies of educations in couples (Sweden)

Wife	Husband	
	Low	High
Low	1869	394
High	611	817

(see table 4). In this case, it is possible to show that Spearman and Pearson correlation coefficients coincide and they can be reduced to the following formula:

$$Corr(Educ_{men}, Educ_{women}) = \frac{n_1 n_4 - n_2 n_3}{\sqrt{(n_1 + n_2)(n_3 + n_4)(n_1 + n_3)(n_2 + n_4)}}, \tag{35}$$

resulting in correlations equal to 0.51, to 0.36 and to 0.41, respectively for France, Italy and Sweden.

Table 4: Frequencies of educations in couples (general)

Wife	Husband	
	Low	High
Low	n_1	n_2
High	n_3	n_4

4.1.2 Survival probability

A proper calibration of survival probabilities should use cohort life tables rather than period life tables. Of course cohort life tables are incomplete for recent cohorts. Using easily available period life tables, however, would generally lead to an under-estimation of life length because of the well-documented downward trend in mortality.

To correctly estimate the survival probability, we then follow the Lee and Carter (1992) model and collect from the Human Mortality Database period life tables from 1979 to 2008 for France, Italy and Sweden, separately by gender. These data contain the total population on a year-by-year basis from ages 0 to 110. In these tables, $\psi^p_{j,t}$ is the population probability of surviving age j, conditional on having survived age $j-1$, for individuals observed in year t. To distinguish the trend from fluctuations, we estimate the parameters of the Lee-Carter model with singular value decomposition:

$$\ln\left(1 - \psi^p_{j,t}\right) = \alpha_j + \tau_j \chi_t + \epsilon^\psi_t,$$

Probability of dying parameter χ		
	Males	Females
France	-1.664	-1.534
Italy	-1.685	-1.597
Sweden	-1.512	-1.188

where α_j and τ_j are age-varying parameters, χ_t is a time-varying vector and ϵ_t^{ψ} is a random disturbance distributed as $N\left(0, \widetilde{\sigma}_{\psi}^2\right)$. Lee and Carter (1992) point out that the parameterization is not unique, and suggest to consider the one fulfilling the two restrictions $\sum_{j=1}^{D} \tau_j = 1$ and $\sum_{t=1}^{T} \chi_t = 0$, where $t = 1, .., T$ indicates the sample period. With these restrictions the estimated value for α_j will be the average probability over the sample that someone dies at age j, when having survived up to age $j-1$. Consistently with the existing literature we assume that the mortality index χ_t evolves as a random walk with drift χ (to describe the historical trend increase in survival probabilities):

$$\chi_t = \chi_{t-1} + \chi + \eta_t^{\psi},$$

with $\eta_t^{\psi}\tilde{}N\left(0, \sigma_{\psi}^2\right)$. We estimate the following values for χ:

Notice that the calibrated values, all negative, indicate a trend fall (especially for males) in the probability of dying at any age j, conditional on having survived up to age $j-1$.

With this information we then estimate the gender-specific probability of surviving age j for a cohort born (rather than observed) in year $s = t - j + 1$, $\psi_{j,s}^g$, using the following formula:

$$\ln\left(1 - \psi_{j,t-j+1}^g\right) = \hat{\alpha}_j + \hat{\tau}_j\left(\hat{\chi}_{t-j+1} + j\hat{\chi}\right).$$

We focus on the cohort of individuals born in year $s = 1989$ $\psi_j^g = \psi_{j,1989}^g$. Figure 1 shows the resulting survival probabilities, separately by gender and age, which we stop at age 100.

With these probabilities, life expectancy at birth is summarised in the table below. These figures are around 3 years higher than official statistics from the World Health Organization (WHO) and similar organizations, that are however based on period life tables and therefore under-estimate the life expectancy of a given cohort.

4.2 Preferences

We assume that the preference parameters are the same in the three countries we analyse.

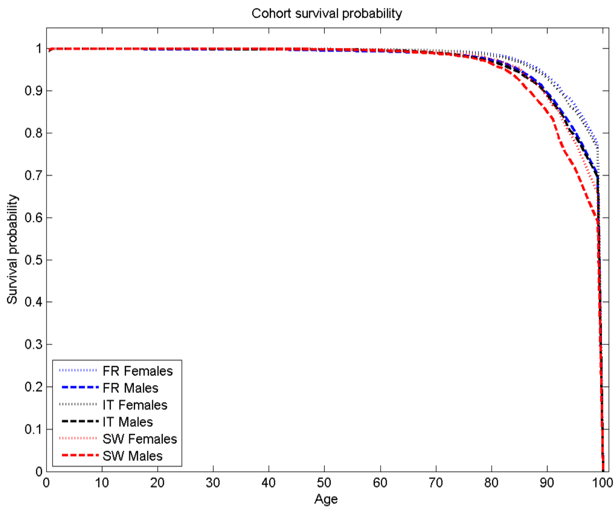


Figure 1: Survival probabilities

Life expectancy at birth (years)		
	Males	Females
France	82.701	89.048
Italy	84.079	89.198
Sweden	83.155	86.074

We choose the discount factor β equal to 0.99. We set $\gamma = 3$ which is compatible with the estimates found in the literature (see for example Ventura 1999 and the references therein). We then choose α so that the fraction of time devoted to market work is about 30% in the three countries we consider (more precisely it turns out to be 31% in France, 32% in Italy, and 31% in Sweden). The implied value of α is 0.36.

The equivalence scale θ is the one used in OECD (2011), that is the square root of the household size.

4.3 Production

The parameter ν, which is the share of capital income on total income, is set equal to 0.35. We set the annual depreciation rate to 5% and the annual world return on assets $\bar{r}$ is chosen equal to 5.5%. The small open economy assumption then implies $r = \bar{r}$. Then, using equations (3) and (2), the total factor productivity parameter A is chosen in such a way that the wage rate per efficiency units w is normalized to 1 (this calibration procedure implies

$A = 1.5332$).

4.4 Daycare

The unitary cost p_d of non parental care is set equal to 8.47 euros per hour in France (see Silvera 2008), 4 euros per hour in Italy (our elaborations on the data provided by Istat 2011) and 8.11 euros per hour in Sweden (see Blomquist, Christiansen, and Micheletto 2010).

4.5 Efficiency units

In the model efficiency units depend on age, gender and education level. Morever to further increase the degree of heterogeneity we assume that for given, age, gender and education, some individuals have a high level of productivity and others have instead a low endowment of efficiency units. In other terms efficiency units of an individual i of gender g and educational level h at age j, i.e. $e^g_{i,j,h}$ are given by $\Delta_\epsilon \bar{e}^g_{j,h}$ where $\bar{e}^g_{j,h}$ is mean value of efficiency unit conditional on gender, age and education and Δ_ϵ with $\epsilon = 1, 2$ determines the deviation of the efficiency units of individual i from the mean.

Efficiency units are computed looking at hourly wages. We use EU-SILC 2007 data for dependent workers. First we estimate log-hourly wages as a function of gender, marital status, presence of children, and a set of 5-year age range dummy variables. The regression is computed separately by education level (college/no college). Table 5 shows the result of the OLS estimation. Figures 2, 3, 4 plot the predicted age-wage profile for an individual with average characteristics, from the regression of Table 5. Wages follow an inverted-U shape, with the exception of Italy where they do not seem to fall at later ages.

Regression profiles presented in Table 5 give us information about average wage level conditional on some factors, such as age, gender, and education. We suppose that there are two (age independent) multiplicative rescaling factors, Δ_1 and Δ_2, ($\Delta_1 \leq \Delta_2$), affecting the productivity level of an individual. A fraction p of individuals has a low level Δ_1 of the rescaling factor (we call this individuals "low productivity" agents); a fraction of $1 - p$ has a high level Δ_2 of the rescaling factor (we call this individuals "high productivity" agents). In total we have 3 unknown parameters to calibrate: Δ_1, Δ_2 and p. We apply a moment-based approach for their calibration. Its general idea can be described as follows: As the real distribution of wages in our model is approximated by a discrete two-points distribution, we equalize the theoretical moments of our artificial distribution with the empirical moments calculated from the data. We explain this procedure in detail in the Appendix.

Table 5: Estimates of the wage profile, with age-groups dummy variables, by country. Robust standard errors in parentheses

	Country					
	France		Italy		Sweden	
	Non graduated	Graduated	Non graduated	Graduated	Non graduated	Graduated
Male	0.32***	0.27***	0.31***	0.29***	0.27***	0.32***
	(0.03)	(0.04)	(0.02)	(0.03)	(0.04)	(0.04)
Married	0.05*	0.10**	0.00	0.07**	0.11***	0.25***
	(0.03)	(0.04)	(0.02)	(0.03)	(0.04)	(0.05)
Presence of children <5	-0.05	0.00	-0.01	-0.06	-0.09*	-0.16**
	(0.05)	(0.05)	(0.02)	(0.05)	(0.05)	(0.06)
Presence of children between 5 and 18	-0.06	0.01	0.08***	0.08**	0.01	-0.07
	(0.04)	(0.06)	(0.02)	(0.04)	(0.05)	(0.07)
age groups:						
25-29	-0.03	-0.35***	-0.11**	-0.85***	-0.31***	-0.69***
	(0.06)	(0.10)	(0.05)	(0.07)	(0.07)	(0.07)
30-34	0.02	-0.11	0.05	-0.56***	-0.16**	-0.32***
	(0.07)	(0.09)	(0.05)	(0.05)	(0.08)	(0.07)
35-39	0.11*	-0.03	0.10**	-0.29***	-0.00	-0.08
	(0.06)	(0.10)	(0.05)	(0.05)	(0.06)	(0.07)
40-44	0.29***	0.14	-0.18***	-0.20***	0.04	-0.07
	(0.06)	(0.09)	(0.04)	(0.05)	(0.06)	(0.07)
45-49	0.28***	0.27**	-0.19***	-0.10*	0.05	0.09
	(0.06)	(0.09)	(0.04)	(0.05)	(0.06)	(0.08)
50-54	0.24***	0.13	0.23***	-0.05	-0.06	0.09
	(0.06)	(0.11)	(0.05)	(0.05)	(0.06)	(0.09)
Constant	2.12***	2.68***	2.30***	3.08***	2.55***	2.79***
	(0.05)	(0.09)	(0.04)	(0.06)	(0.05)	(0.06)
R^2	0.05	0.14	0.06	0.22	0.03	0.10
N	6,444	3,215	11,968	3,187	4,324	3,220

****p<0.01; **p<0.05; *p<0.1*

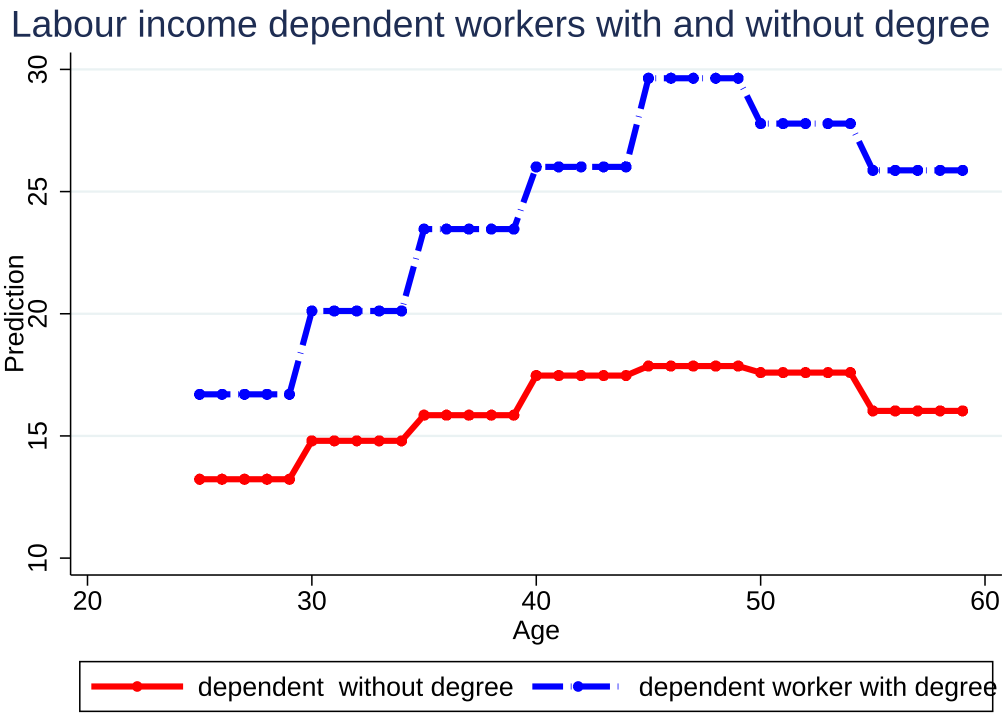


Figure 2: France

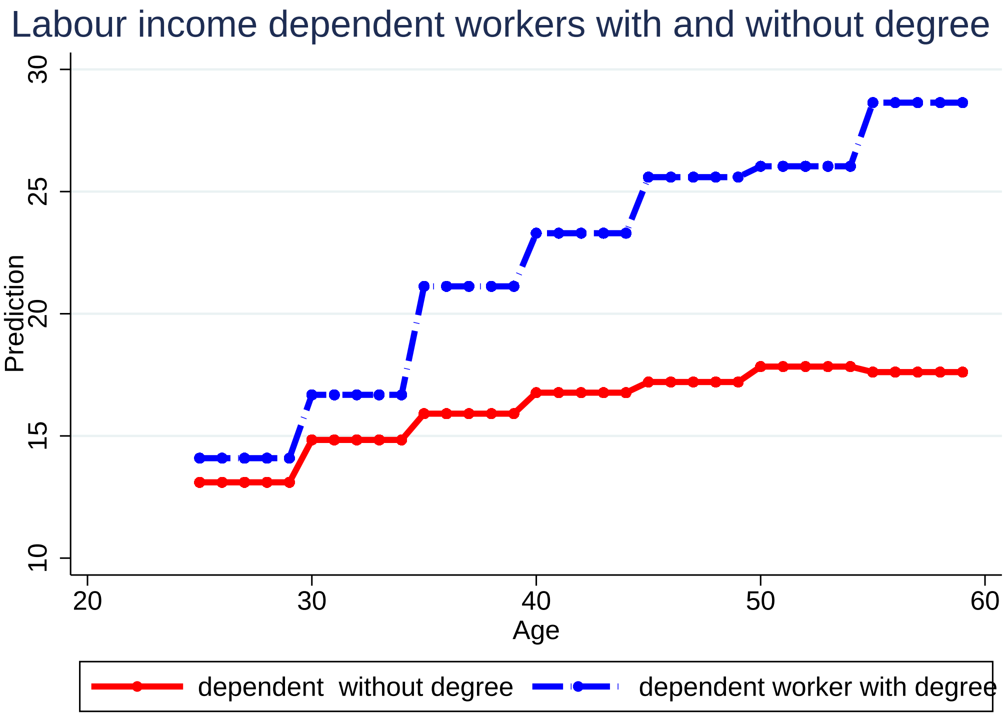


Figure 3: Italy

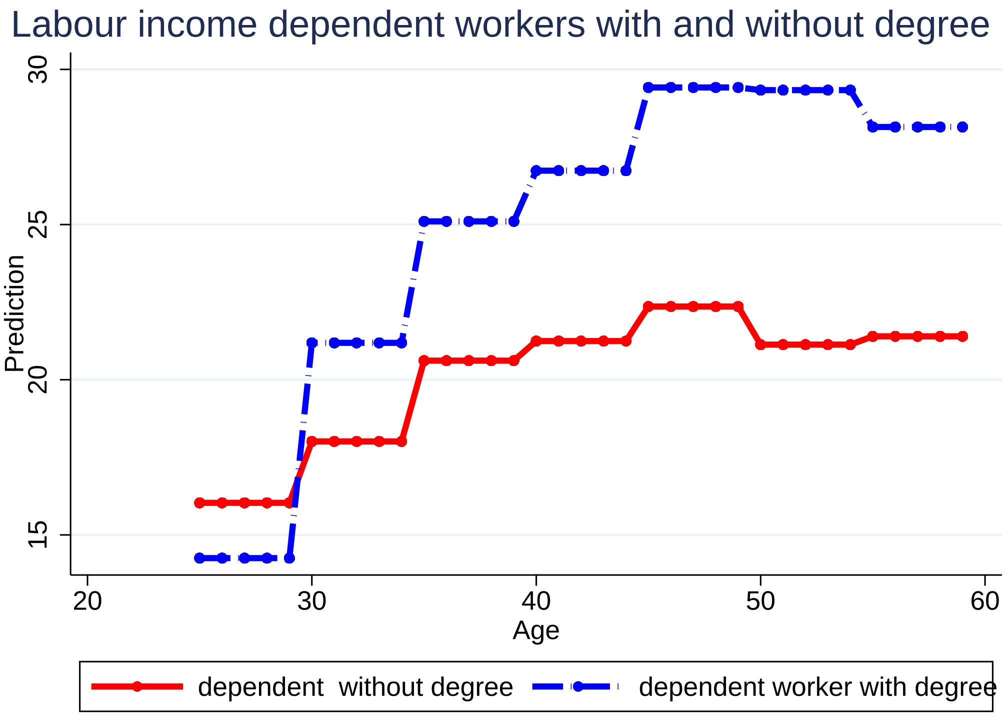


Figure 4: Sweden

Tables 6-8 present estimates for France, Italy and Sweden based on equations for the first, second and 0.5 moments (we explain in the appendix why we use a fractional moment, and cannot use an equation for the third moment). We also made a robustness check using an equation for the moment of order 1.5 instead of 0.5. As shown in the appendix (Tables 80, 81 and 82), there is not relevant impact of replacing moment 0.5 with moment 1.5.

Finally we normalize efficiency units by the wage rate of females without a college degree at age 25.

Table 6: Calibrated Δ_1, Δ_2 and p for France

	Δ_1	Δ_2	p
Women with college degree:	0.461615	1.714546	0.570300
Women without college degree:	0.373804	1.608806	0.492959
Men with college degree:	0.489259	1.799810	0.610285
Men without college degree:	0.505565	1.847716	0.631610

Table 7: Calibrated Δ_1, Δ_2 and p for Italy

	Δ_1	Δ_2	p
Women with college degree:	0.626780	1.933061	0.714288
Women without college degree:	0.436935	1.549887	0.494080
Men with college degree:	0.578149	1.926226	0.687072
Men without college degree:	0.611474	1.786300	0.669291

Table 8: Calibrated Δ_1, Δ_2 and p for Sweden

	Δ_1	Δ_2	p
Women with college degree:	0.380310	1.555908	0.472873
Women without college degree:	0.306841	1.360326	0.342033
Men with college degree:	0.554129	2.231822	0.734236
Men without college degree:	0.379318	1.343332	0.356149

5 Tax and expenditure programmes

In what follows, we describe the way in which we model public sector interventions (taxes and transfers, both cash and in-kind) for France, Italy and Sweden. In doing this, unless differently stated, the following rules have been applied:

Parameters

Symbol	**Meaning**	**Source**
$\bar{J}$	Maximum age	15 periods (=100 years)
j^R	Retirement age	9 periods(=65)
j^{κ}	Age at which children leave their parents household	9 periods(=65)
$\bar{r}$	World risk free interest rate	5.5% (annual)
ν	Share of capital income	0.35
δ	Depreciation rate	5% (annual)
A	TFP	1.5332
p_j^l	Price of non parental care	Italy: 4 €; Sweden: 8.11 €; France: 8.47 €
$\overline{H}_j\,(i)$	Total health expenditure	see the main text
$e_j^g(h)\,(i)$	efficiency units	see the main text
θ	Equivalence scale	Modified OECD equivalence scale
n	growth rate of the population	Italy: 0.3983% (annual); Sweden: 0.4895% (annual); 0.6799% (annual)
γ	Parameter related to the intertemporal elasticity	3
α	Relative weight of consumption	Italy: 0.35; Sweden 0.35; France 0.37
β	Discount factor	0.99

- Since demographic and socio-economic characteristics for the populations of France, Italy and Sweden are taken from the 2007 wave of EU-SILC survey (the latest wave available when the work was started), we refer to that year also for the description of the different tax-benefit policies. A different approach is adopted for pensions. In this case, since we are not interested in modelling transitions from one pension system to another, as those several countries are experiencing (including those under considerations), we refer to the latest rules that were defined, i.e. the rules that will be applied for the younger cohorts.
- We only consider policies such that the criterion according to which an individual is entitled to receive a benefit or pay a tax is consistent with the individual / family characteristics we account for in the model. For instance, we do not consider tax credits related to expenditure on specific goods, because we have a single consumption good in the model.

5.1 France

5.1.1 Pension system

The French pension system consists of three pillars:

1. The first pillar is mandatory and publicly managed. It includes two tiers:
   (a) an earnings-related public pension;
   (b) a mandatory occupational pension scheme, based on a points system.
2. The second pillar is voluntary and privately managed and consists of few company schemes and numerous collective insurance contracts, usually managed in small and medium enterprises.
3. The third pillar is voluntary and privately managed. It was established in 2004 and consists of individual, supplementary subsidized pension savings plans.

For France as well as for the other countries, we only model the mandatory component of the pension system.The additional components can be thought of as part of voluntary savings. Moreover, since we do not differentiate between self-employment and dependent work, we refer to the rules that apply to dependent workers in the private sector. We now move to the description of how the first pillar is characterized in the model, starting from the definition of the amount of social contributions due.

Earnings-related public pension:

Contributions related to this tier are made up of two components:

- a rate of 14.95% (6.65% paid by the employee and 8.30% paid by the employer) up to an income ceiling of 2,682 euros per month;
- an additional contribution of 1.7% (0.1% paid by the employee and 1.6% by the employer) to be paid on the whole gross salary, even above the social security ceiling.

Minimum retirement age is currently 61, but it is due to gradually increase to 62 by 2017. Since our reference is a young cohort and adjustments that take increases in life expectancy are likely to be made in the future, we set retirement age at 65.

The following formula defines the pension benefit (P) for this tier:

$$P = (T - tn) * (D/160) * SAM$$

where T is the liquidation rate equal to 50%; t is the abatement rate, equal to 1.25% per quarter of missing insurance; n is the number of missing quarters from a maximum of 160-166 (depending on the year of birth);[7] D is the insurance period under the general scheme with a limit of 160-166 quarters; the Salaire Annuel Moyen (SAM) is the annual average reference salary of 25 best salary years indexed to prices. Benefits in the basic scheme are also indexed to prices. Rules are somewhat different for civil servants, for whom they tend to be more favourable. Public employees are not differentiated from private ones in our model. Moreover, a precise implementation of this component of the French pension system would require additional state variables, thus increasing the computational burden. We address these two issues by calibrating the pension benefit in such a way that the replacement rate in the model is consistent with official forecasts (European Commission, 2012) for the general population (private and public sector employees).

Mandatory occupational pension scheme:

[7]Consistent with the general rule of modelling the rules of pension systems that apply to the younger cohorts, we set this value to 166.

This is a mandatory defined benefit component of the pension system. There are two different pension schemes in France: the ARRCO (Association pour le régime de retraite complémentaire des salariés) and the AGIRC (Association générale des institutions de retraite des cadres). We only refer to the former, as it covers a wider population. However, there are very small differences between the two schemes.

Contribution rates are defined as follows for this second tier. The contribution rate is 7.5% of the gross wage (3% employee and 4.5% employer), up to the social security ceiling (2,682 euros per month for 2007). The rate is 20% (8% employee e 12% employer) up to three times the ceiling (€8,046 per month in 2007).

The calculation of the pension benefit is based on a points system. The following formula defines the amount of the pension benefit:

$$P = \left(\frac{\sum w \cdot cr}{PP} \right) \cdot PV \cdot RC(\text{age, contribution period})$$

where w is the reference wage, cr the contribution rate, PP and PV are the price per point and the point value respectively, and RC is the reduction coefficient. We keep the same retirement age as for the first tier (65) and assume $RC = 1$.

Other social benefits for old people:

Persons aged more than 64 and with limited resources are eligible to ASPA (Allocation de solidarité aux personnes agées), whose amount is defined in the following way:

$$\text{ASPA} = \text{Monthly Maximum amount} - \text{Quarterly Family income}/3$$

Consistently with what was done elsewhere, we refer to 2007 for the definition of the maximum monthly income (621.27 euros for a single and 1,114.51 euros for a couple).

5.1.2 Mean-tested minimum income (Revenu minimum d'insertion RMI)

In order to be eligible for this programme, the individual must be aged between 26 and 64 (i.e. not be eligible for ASPA). The transfer equals the difference between the minimum income and the household income (calculated on the last quarter).[8] Hence, the programme ensures that all those

[8]For families receiving housing benefits the corresponding amount is added to the family income for the computation. This is irrelevant to our analysis, because the housing

who are eligible receive at least the minimum income. Referring to the family composition relevant to our model the value of the (monthly) minimum income is 440.86, 793.55, 661.29 and 925.81 euros respectively for singles without children, singles with two children, couples without children and couples with two children.

5.1.3 Social benefits

The following social benefits are modeled for France:

Family allowance (Allocation Familiale AF):

All households with two or more dependent children are eligible to this transfer, independent of income and wealth. The monthly amount for a family with two children (the size of our reference family with children) in the reference year is 119.72 euros.[9]

Mean-tested Young children allowances (Plan d'Accompagnement du Jeune Enfant PAJE):

We consider the version of the programme (PAJE) that replaced the old APJE (Allocation pour jeunes enfants APJE) since 2004. Are eligible for this mean-tested programme families with children under 3, whose annual income is below specific income thresholds. Maximum family income (corresponding to the net taxable income) thresholds are different for lone parents, couples with one revenue, couples with two revenues and depend also on the number of dependent children (Table 9). Under the assumptions of our model, all children are dependent according to the French legislation, as long as they leave with their parents. The monthly amount per family (not per child, excepted for multiple births) is 171.92 euros for our reference year. Since in our model one period corresponds to 5 years, whereas the benefit is paid only for the first three years of the child, the amount per period is adjusted accordingly.

Baby bonus:

The eligibility conditions related to income are the same as for the PAJE (see previous paragraph). This is a single payment made in the year of birth

programme is not modelled.

[9]We consider only the basic amount. In particular the additional amount for children aged more than 11 is not accounted for.

Table 9: Income thresholds for PAJE

	Income threshold
One earner couples	
One dependent Child	32,328
Two dependent Children	38,794
Three dependent Children	46,553
Each Child after the 3rd	7,759
Two earner couples or lone parents	
One dependent Child	32,328
Two dependent Children	38,794
Three dependent Children	46,553
Each Child after the 3rd	7,759

of the child. The amount is 859.29 euros in the reference year.

Mean-tested education related family benefit (Allocation de rentreée scolaire ARS):

This benefit is mean-tested and it is paid for each child aged between 6 and 18 who is attending school. The yearly amount of the benefit in the reference year is 273.92 euros.

5.1.4 Health care expenditure

For all countries, age profiles for public health expenditure are taken from Eurostat (2011). Data are provided as percentage of GDP per capita for age classes (5 years). These are converted to monetary amounts using data on GDP per capita (reference year 2007) from the national institutes of statistics (INSEE, for France). Since the same data are not available for total (public and private) health expenditure, we assume the same age profile for the private as for the public component. Country specific data on the percentage of private health care expenditure are taken from de la Maisonneuve and Oliveira Martins (2013), and are used to calculate the age specific private component of healthcare expenditure.

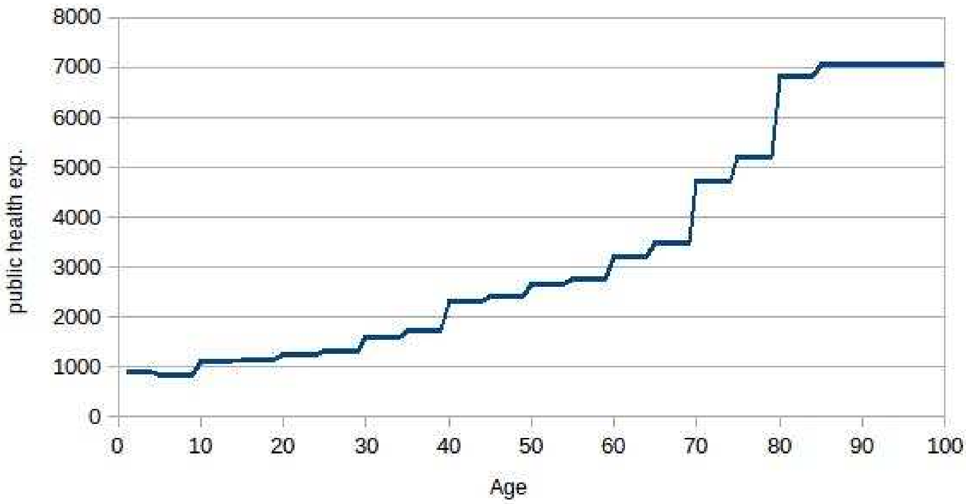


Figure 5: Public health expenditure by age: France

5.1.5 Public childcare

Given that labour supply is endogenous in our model, the cost of childcare is a crucial dimension, because people with children must either buy it in the market or reduce labour supply to look after their children. In most countries it is either the public sector that directly produces childcare, or the purchase by parents of private services may be subsidized. In the case of public provision, a co-payment may be required to parents, whose size may depend on income and/or wealth. In order to model public intervention in the same way in all countries, we estimate an average cost per hour of childcare (see Section 4.4) and calibrate the allowance provided by the public sector (τ_d) so that the overall amount of public expenditure over GDP matches OECD data (OECD (2013)). The calibrated value of τ_d is 91% for France.

5.1.6 Personal income tax

A major peculiarity of the French system of personal income taxation is the fact that the household is the tax unit.

Since the general structure of the personal income tax is rather complex, we exploit the calculator that is made available by the French government[10] to

[10]See http://www3.finances.gouv.fr/calcul_impot/2008/simplifie/index.htm

calculate the tax debit for different income levels for all the family structures the model allows for. We then interpolate the average tax rates obtained for different levels of household income with a quadratic polynomial. This is done for income levels exceeding the no tax area. By using the same approach also for Italy and Sweden, we obtain a parametric characterization of the tax schedule that makes the comparative analysis much easier. Figure 6 shows the resulting average tax rate function for six different types of household relevant to our model.

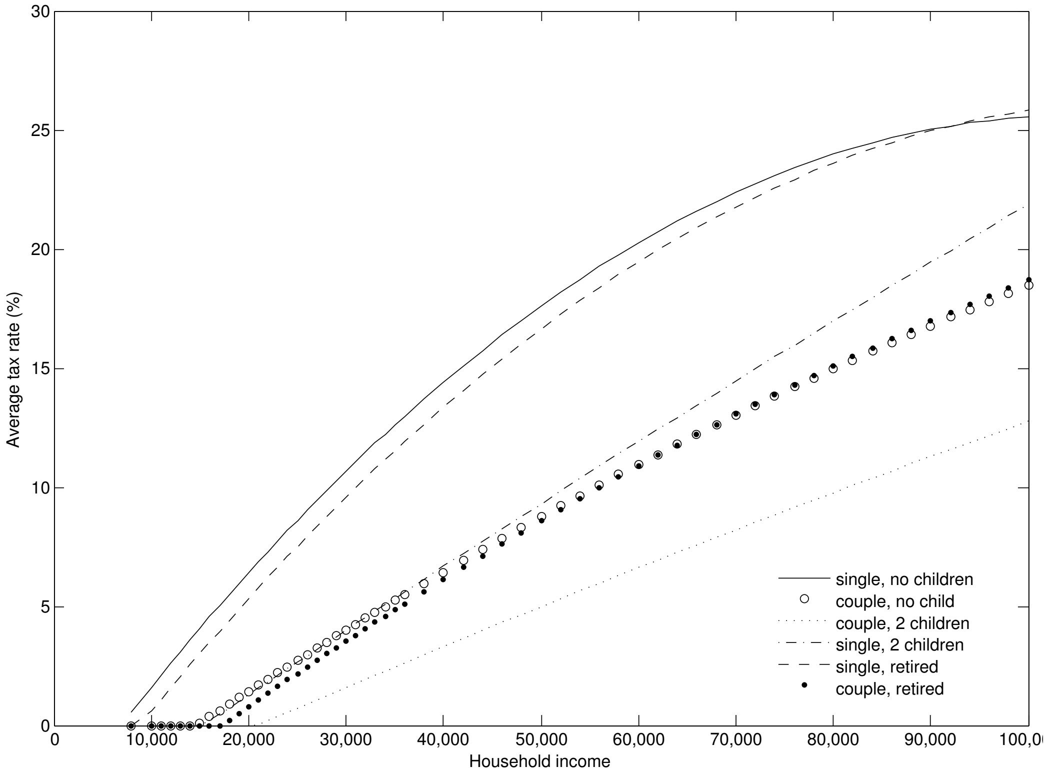


Figure 6: Average personal income tax rate as a function of household income: France

5.1.7 Capital income tax

In our model, taxation of capital is only relevant for the return on savings. In order to characterize capital income taxation through a single parameter, we refer to the implicit tax rate on "corporations", as reported in Commission (2013). The same source is also used for the other countries. This implicit tax rate was 27.7% for France in the reference year.

5.1.8 Consumption tax

We use the "implicit tax rate on consumption" (Commission 2013) to characterize consumption taxation in the model. The rate is 19.9% for France.

5.2 Italy

5.2.1 Pension system

The Italian Pension system is divided into three pillars: The first pillar is a public mandatory PAYGO pension system with similar rules applying to both public and private sector employees. The second pillar is voluntary and privately managed and is based on several "collective" agreements ("closed" pension funds), or, alternatively on "open" private pension funds. The latter are managed by banks, insurance companies, and savings management companies. At present the "Close" pension funds are the core of this second pillar of the Italian pension system. The third pillar is private and voluntary and is based on personal pension plans offered by insurance companies and other financial intermediaries. These are essentially standard long-term financial instruments that can be subscribed independently of the individual employment position.
As for France and Sweden, we only model the mandatory component of the pension system.

Old-Age Pension (Pensioni di Vecchiaia):

The PAYGO system underwent a substantial reform in 1995 when the new *notional defined contribution* (NDC) scheme replaced the existing earnings-related method.[11] The system is financed through social contributions. The contribution rate for dependent workers is 33% (in private sector 9.19% is due by employees and 23.81% by employers, in public sector respectively 8.8% and 24.2%). There is a threshold for the annual earned income above which social contributions are not due (87,187 euros in the reference year). The daily social contributions have to be calculated on a minimum daily earned income (equal to 41.43 euros in 2007).

In the NDC scheme, the minimum contributory period to be entitled to old age pensions is 20 years (reduced to 5 years if the worker retires at the age of 70) and the annual pension benefit is defined as the product of social contributions paid, capitalized using a rate equal to the 5 year moving

[11] The reform was designed with a very long transition period and fully applied only to workers who where first employed since January 1996.

Table 10: Income thresholds for PAJE

Coefficient estimate, Italy

	γ_0	γ_1	γ_2
Two parents, 3 household members	155.789	-3.916	0.024
Two parents, 4 household members	305.777	-7.598	0.046
One parent, 2 household members	155.789	-3.916	0.024
One parent, 3 household members	305.366	-7.581	0.046

average of nominal GDP variations, time a transformation factor (the same for man and woman and automatically linked to changes in life expectancy). The latter is meant to ensure the equality between the capitalized value of the social contributions at the time of retirement and the expected present value of pension benefits received during the remaining years of life. In our model we define the annual pension benefit as the amount that satisfies this condition.

Between 2010 and 2012 retirement age was increased from 60 to 65. In 2018 the standard retirement age will be of 66 years and 7 months. Earlier retirement is possible if the age is at leas 63 and contributions have been paid for 42 years and 5 months. As for France, we consider a fixed retirement age and set it at 65.

5.2.2 Family Benefits (Assegni al nucleo familiare)

The Family Benefit is a mean-tested program targeted to families of employees and retired individuals with total gross incomes below some thresholds. These thresholds, as well as the amount of the benefit, depend on the household composition. Thresholds and benefit amounts are fixed every year by law.

We approximate the family benefit by means of a quadratic function of income (measured in thousand euros):

$$Familybenefit = \gamma_0 + \gamma_1 income + \gamma_2 \left(income\right)^2 + \epsilon$$

We obtain the following estimates:

5.2.3 Health care expenditure

We adopt the same approach and the same data described above for France to estimate the age profile for total as well as public health care expenditure. Figure 7 illustrates the public health expenditure age profile for Italy.

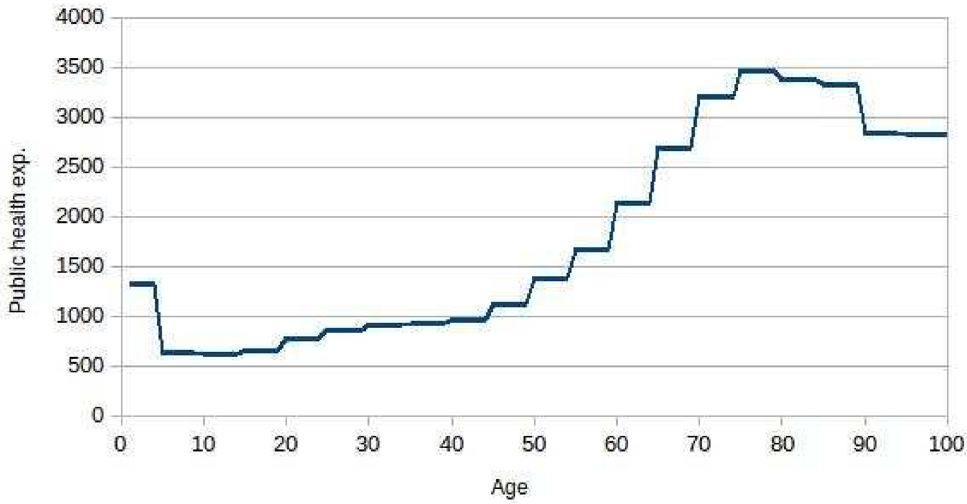


Figure 7: Public health expenditure by age: Italy

5.2.4 Public childcare

We use the same approach as for France (see Section 5.1.5) to estimate the public subsidy to childcare purchase for Italy. The calibrated value of τ_d is 73%.

5.2.5 Personal income tax (Imposta sui redditi delle persone fisiche IRPEF)

IRPEF is an individual and progressive tax on total gross income. Although, unlike in France, it is the individual income that is taxed, tax credits also depend on the family structure (number of dependent children and number of earners).

Personal income taxation is graduated, with progressively higher marginal tax rates applying to higher income brackets. For the reference year, the tax schedule is the following:[12]

[12]Tax rates reported in Table 5.2.5 are increased by a regional surcharge varying between

Table 11: Personal income tax brackets: Italy

Gross income	tax rate
up to 15,000 euro	23%
15,001 - 28,000	27%
28,001 - 55,000	38%
55,001 - 75,000	41%
over 75,000	43%

Table 12: Tax credit for dependent workers: Italy

GTI	**tax credit**
up to 8,000 euro	1,840
8,001 - 15,000	$1,338 + 502\frac{15{,}000-GTI}{7{,}000}$
15,001 - 23,000	$1,338\frac{55{,}000-GTI}{40{,}000}$
23,001 - 24,000	$1,338\frac{55{,}000-GTI}{40{,}000} + 10$
24,001 - 25,000	$1,338\frac{55{,}000-GTI}{40{,}000} + 20$
25,001 - 26,000	$1,338\frac{55{,}000-GTI}{40{,}000} + 30$
26,001 - 27,700	$1,338\frac{55{,}000-GTI}{40{,}000} + 40$
27,701 - 28,000	$1,338\frac{55{,}000-GTI}{40{,}000} + 25$
28,001 - 55,000	$1,338\frac{55{,}000-GTI}{40{,}000}$

All tax credits are non refundable: the tax liability cannot be negative. Tax credits can be classified into 4 types: Tax credits for personal expenses, tax credits with incentive purposes, tax credits for income source (employment income, pension income, self-employment income) and tax credits for dependent family members. Only the last two types of tax credits are modelled. The tax credit for dependent workers defines a no tax area (8,000 euros in 2007) and then linearly decreases in the level of gross income minus the cadastral value of the main residence (GTI). At 55,000 euro the tax credit is zero. The following table describes the value of this tax credit:

0.9% and 1.4% depending on the Region. They may also be increased by a local surcharge varying between 0% and 0.5% depending on the municipality. Local taxes on personal income are not modelled.

Table 13: Tax credit for pensioners (age$<$ 75): Italy

GTI	**tax credit**
up to 7,500 euro	1,725%
7,501 - 15,000	$1,255 + 470\frac{15{,}000-GTI}{7{,}500}$
15,001 - 55,000	$1,255\frac{55{,}000-GTI}{40{,}000}$

Table 14: Tax credit for pensioners (age$\geq$ 75): Italy

GTI	**tax credit**
up to 7,750 euro	1,783%
7,751 - 15,000	$1,297 + 486\frac{15{,}000-GTI}{7{,}250}$
15,001 - 55,000	$1,297\frac{55{,}000-GTI}{40{,}000}$

The tax credits for dependent family members are different for the spouse, the children and other family members. A family member is defined as dependent if she lives with the referent person and her income is less than €2,840.51. The family tax credits are decreasing in individual gross taxable income (GTI) and for dependent children the amount changes with the age (more or less then three years old) and the number of the children. The tax credit for dependent spouse is computed according to the following schedule:

The tax credit for dependent children is calculated according to the following formula:

$$f + (d + a + m)\left(\frac{95,000 + 15,000(nkids - 1) - GTI}{95,000 + 15,000(nkids - 1)}\right)$$

where, f is equal to €1,200 for large families (4 or more dependent children) and zero otherwise, d is equal to €800 for each child (€900 if the child is under 3 years), a is €200 for each child in the case of more than 3 dependent children and zero otherwise, m is €220 for each child with disability and zero otherwise.

In two earner couples, each single taxpayer is entitled to half of the amount of all tax credit for dependent children. If the head of tax unit is a lone parent and the tax credit for spouse is greater than the tax credit for the oldest child, the difference is given as additional tax credit for lone

Table 15: Tax credit for dependent spouse: Italy

GTI	**tax credit**
up to 15,000 euro	$800 - 110\frac{GTI}{15,000}$
15,001 - 29,000	690
29,001 - 29,200	700
29,201 - 34,700	710
34,701 - 35,000	720
35,001 - 35,100	710
35,101 - 35,200	700
35,201 - 40,000	690
40,001 - 80,000	$690\frac{80,000-GTI}{40,000}$

parent.

As for France, we interpolate the average tax rate for individuals with different characteristics as obtained by applying the rules described in this Section using a quadratic polynomial. The resulting average tax rates are showed in Figure 8.

5.2.6 Capital income tax

The implicit tax rate on "corporations" is 28.8% for Italy in 2007.

5.2.7 Consumption tax

The implicit tax rate on consumption is 17.6% for Italy in 2007.

5.3 Sweden

5.3.1 Pension system

The Swedish pension system is based on three pillars:

1. The first pillar is mandatory, with the same rules applying both for public and private sector employees. The first pillar is in turn made up of three parts:
   (a) the income pension (inkomstpension);
   (b) the premium pension (premiepension);

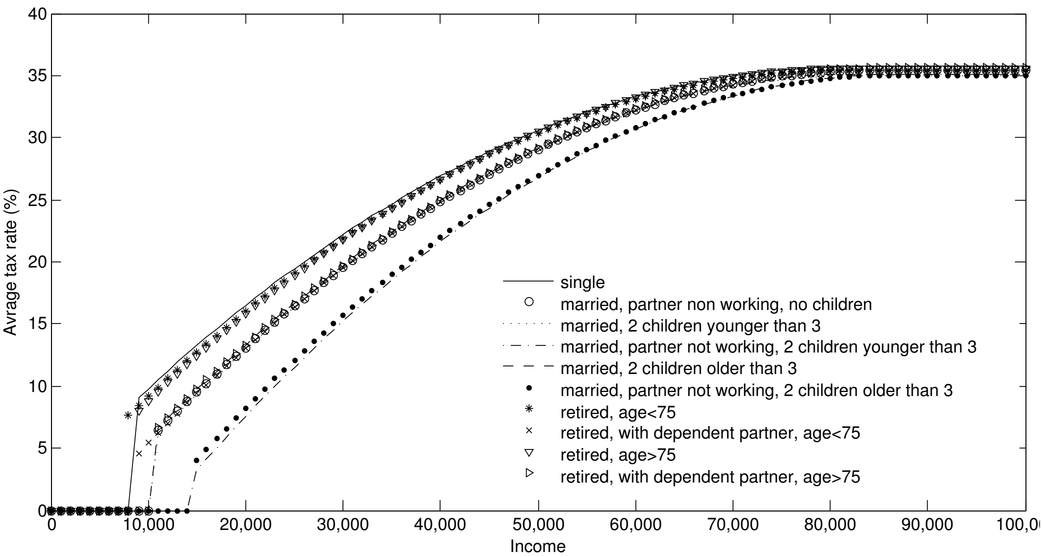


Figure 8: Average personal income tax rate as a function of household income: Italy

(c) the guaranteed pension (garantipension).

2. The second pillar is based on collective agreements, and it has therefore different characteristics for different types of employment (e.g. white vs. blue collars). Although most of Swedish workers are involved in these collective agreements, the programme is not mandatory.

3. The third pillar consists of a subsidized private pension with tax-deductible payments.

As for the other countries, we only model mandatory pension systems, because the additional components can be thought of as part of voluntary savings. Hence we model the first pillar, and, more precisely, the rules introduced with the 1994 reform. These rules will be fully in operation for younger cohorts (pension benefits entirely calculated according to the new rules will not start to be paid until 2018), whereas most of the pension benefits which are currently paid are based either entirely on the old system, or on a mix of the old and the new.

Social contributions:

The burden of social contributions is split in the following way between employees and employers:[13]

- Employees pay the 7% for annual gross income between €1,773 and €38,524;
- The social contribution base for employers is the same as for employees (gross income), whereas the contribution rate is 10.21%. For employers, however, contributions are also due above the €38,524 threshold. Since the part exceeding this provides no pension credit, it can be actually interpreted as a tax.

The total amount of pension related social contributions paid is split in the following way:

- 86% goes to the income pension (inkomstpension). The employee cannot decide on the destination of this part;
- 14% goes to "premimum pension" (premiepension). In this case, the employee is free to choose among several privately managed financial account schemes with different risk-return profiles.

The following paragraphs describe the characteristics of the three components of the pension system.

The income pension (inkomstpension):

This part of the pension system is based on a pay-as-you-go *notional defined contribution* scheme. The return on contributions related to this part of the pension system corresponds to the per-capita wage growth rate.[14]

At retirement, the pension benefit is calculated by applying a coefficient to the value of accumulated social contributions. The coefficient is the same

[13]Here we describe only the part of social contributions related to pensions. In Sweden, social contributions also finance other public sector interventions, such as health care, occupational injuries and parental insurance. Reference to these components of social contributions will be made in other parts of this document for programmes that are modelled.

[14]The actual return on contributions paid also depends on two additional components that we do not model. The first is a deduction for administrative costs that we ignore because it tends to be a very small amount (0.1% on average in 2011). The second is an increase to social contributions related to the redistribution of contributions paid by workers who die before reaching pension age. Ignoring this is consistent with one of the assumptions that are introduced to reduce the computational burden, namely a survival probability equal to 1 throughout working age.

for men and women, but depends on age and life expectancy. Consistent with the assumption that was made for Italy,[15] we define the pension benefit as the amount that ensures the equality between the value of social contributions at the time of retirement and the expected present value of pension benefits received during the remaining years of life.

The premium pension (premiepension):

In this case, the return from the pension scheme is specific to the fund chosen by the employee. In the model, we assume a return equal to the return on private savings. Moreover, we assume that the age at which the worker starts to receive the benefit is the same as for the income pension (65). The premium pension, though it is mandatory, is not implemented in the version of the model used in this paper.

The guaranteed pension (garantipension):

For individuals with no or low earnings related benefits, the system provides a guaranteed benefit to ensure a minimum standard of living in retirement. The guaranteed benefit is means-tested against public pension income and it is payable from age 65. The maximum guaranteed pension (for those who do not have other income sources) is:

- €8,927 per year for a single pensioner;
- €7,963 per year if married.

The amount of the transfer is defined so that there is a 100% offset up to €5,281 and €4,778, respectively for singles and married individuals. The offset is reduced to 48% for a single individual with income between €5,281 and €12,867.23, and for a married individual with income between €4,778 and €11,400.28.[16]

5.3.2 Social benefits

We model the child benefit (Barnbidrag) that is paid monthly for each child until 16 years (increased to 20 if the child studies in upper secondary school; in this case it is only paid for 10 months a year). The monthly amount is

[15] This component of the Swedish pension system shares several characteristics with the Italian one, which was described in Section 5.2.1.

[16] According to the available data, the fraction of pensioners receiving some transfer is very large (46% in 2010).

€109 per child. An extra amount is paid starting from the second child, and it is increasing with the number of children (it starts with only €10 per month for the second child and reaches €109 per month if the number of children is 5 or more).

5.3.3 Health care expenditure

The same approach and the same data that were described above for France have been also adopted to estimate the age profile for total as well as public health care expenditure for Sweden.

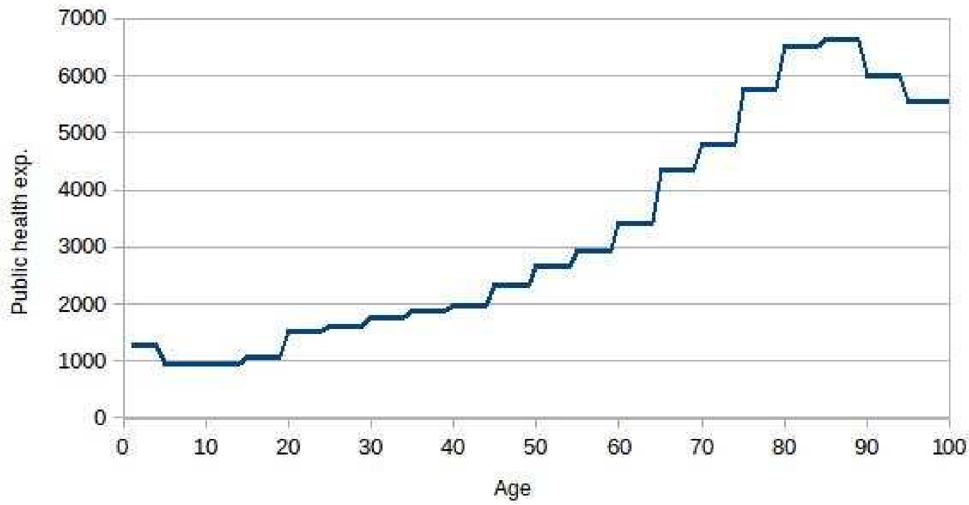


Figure 9: Public health expenditure by age: Sweden

5.3.4 Public childcare

We use the same approach as for France (see Section 5.1.5) to estimate the public subsidy to childcare purchase for Sweden. The calibrated value of τ_d is 100%.

5.3.5 Personal income tax

Sweden has a purely individual personal income tax system. The system is pretty simple, the main characteristics being:

- The tax base is defined as the difference between taxable income and two types of allowance: basic allowance and allowance for voluntary private pension. Since we do not explicitly model voluntary private pensions, we consider only the former. The basic allowance, which varies with income, contributes to the progressivity of the tax system.

- Personal income taxation has both a central and a substantial local component. The former is based on three tax rates that apply on the corresponding income bands according to the following scheme:

Band	**Tax rate**	**Income range (€)**
1	0%	0- 32,937
2	20%	32,937 - 49,578
3	25%	49,578

Table 16: Government personal income tax schedule: Sweden

Local tax rates share the same tax base as the government component, but are defined at the Municipality level. Although we follow the general rule of not modelling purely local programmes, ignoring this component of the Swedish tax system would introduce a large bias, due to its size. Therefore, we refer to the average tax rate across municipalities, as reported in Bengt and Klas (2012). This amounts to 31.84%, and it is split between "municipality tax" (20.78%), "County council tax" (10.84%) and "funeral tax" (0.22%).

- There are ten different types of tax credit, which are non-refundable. Most of these refer to specific types of expenditure that we are unable to model (e.g. broadband connections, domestic and reconstruction services). We only model the "earned income tax credit". This depends on the income level and on age (it is more favourable for people aged more than 65).

The combination of the characteristics of the personal income tax system with our modelling assumptions leads to a simple taxation scheme, which differs only depending on whether the individual age is more or less than 65 (Figure 10). In order to obtain also for Sweden a parametric characterization of the average tax rate, we adopt the same approach that was described in Section 5.1.6.

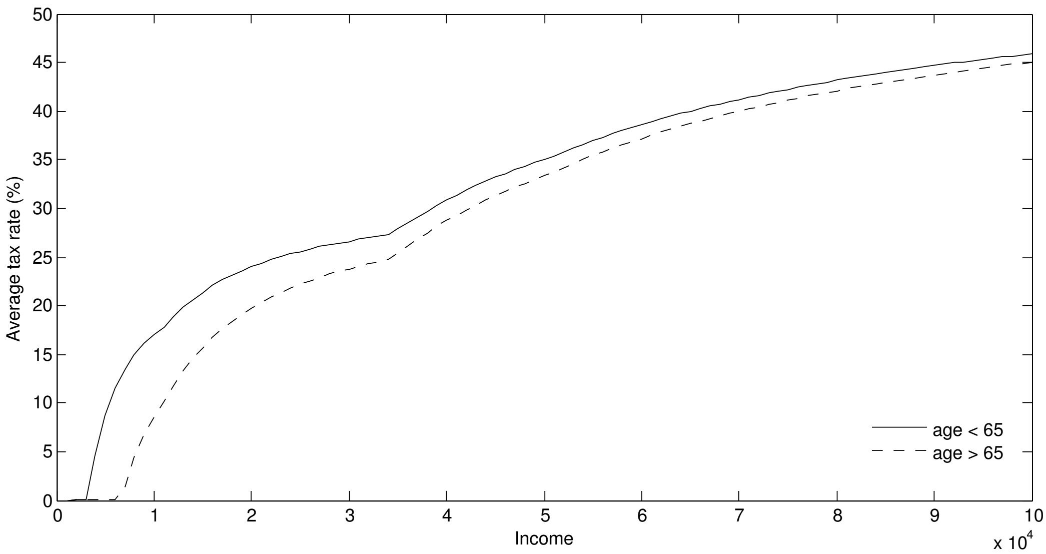


Figure 10: Average personal income tax rate as a function of household income: Sweden

5.3.6 Capital income tax

As for the other countries, the implicit tax rate on "corporations" (Commission 2013) is assumed for the taxation of returns on savings. The rate is 22.3% in the reference year.

5.3.7 Consumption tax

The Swedish "implicit tax rate on consumption" is 27.4% (European Commission, 2011).

6 How well does the model match the data?

The model is able to match quite well some important aggregate and distributional features of the three countries we analyse.

Table 17 shows the ratios between the main tax and expenditure programs and GDP generated by the model and their empirical counterpart computed from OECD data for the year 2007. As explained in Section 5, public day care expenditures are calibrated to match their empirical counterpart. The other public finance programs have not been calibrated to match a given target in terms of their ratio to GDP. Accordingly the comparison between the prediction generated by the model and the data is more meaningfull: we can see that the model is able to reproduce quite well the data for all the three countries. The last row of the Table reports the value of "Goverment consumption" G, which is simply the difference between all the revenues and the expenditures which have been explicitly modelled in our set-up (see equation 23). Therefore, the difference between the values of G predicted by the model and those computed on the data can be used to get aggregate measure of how the model is able to replicate the public finance data. We can see that such a difference is small in all the three countries we consider.

Table 17: Main Taxes and Expenditures as a share of GDP

	France		Italy		Sweden	
	Model	Data	Model	Data	Model	Data
Consumption tax	8.3%	11.0%	7.2%	10.4%	9.7%	12.4%
Capital Income tax	3.3%	2.9%	4.1%	4.0%	2.8%	3.8%
Personal income tax	6.5%	7.6%	11.5%	11.3%	17.8%	17.2%
Social security contributions	14.5%	15.1%	12.3%	11.1%	11.6%	9.1%
Pensions-Old age	12.4%	10.4%	12.1%	11.1%	7.1%	6.5%
Health care expenditure	6.2%	7.6%	4.5%	6.8%	6.5%	6.6%
Daycare expenditure	0.4%	0.4%	0.2%	0.2%	0.8%	0.9%
"Government consumption"	12.6%	14.3%	18.0%	17.9%	26.9%	26.4%

Then, we look at the ability of our model economy to reproduce some distributional features of the economies of France, Italy and Sweden, namely we focus on the Gini coefficient. The OECD computes the Gini coefficient of gross and net incomes. However, the Gini coefficient of the overall income is probably not the right benchmark to evaluate the model predictions. Indeed, according to OECD (2011), a sizeable part of the overall earning inequality in Italy and France depends on the presence of self-emolyed workers: when they are taken into account the Gini coefficient increases. Given that we intentionally excluded self-employed workers from the sample we use to compute wages, it is therefore more meaningful to compare the model with an empirical benchmark which excludes self-employed workers. The only OECD data we found which explicitly remove self-employed workers from the computation of Gini coefficient are: the Gini coefficient of gross earnings in Sweden; the Gini coefficient of net earnings in Italy and France (see Fig. 5 in OECD (2011)). These data and their counterparts generated by the model are reported in Table 18.

Table 18: Gini coefficient of earnings exluding self employed workers (net earnings for Italy and France; gross earnings for Sweden)

	Model	Data
France (2000)	0.311	0.340
Italy (2004)	0.248	0.252
Sweden (2005)	0.311	0.326

7 Numerical experiments

The model we describe in the previous sections can be used for many purposes: a wide range of policy reforms can be simulated in order to assess their impact along several dimensions. In particular, it is possible to simulate both marginal reforms, where policy parameters are changed by a small amount, and more radical reforms. In performing these policy experiments both a positive approach (which simply looks at the impact of the reforms) and a normative approach (whose aim is the determination of the optimal reform) can be adopted.

In this Section, we give a specific example of how the model can be used. Namely, we focus on radical reforms with a positive approach, and we ask: what would it happen if some (all) taxes and expenditures were removed? In others terms we compare our model economy with the full set of public policies described in Section 5, with an alternative one where some (all) public finance programs are absent. The comparison is done looking at the effects on both inequality and individual welfare.

As to inequality, we study both annual redistribution (i.e. income redistribution in a given period of time) and lifetime redistributon (redistribution of lifetime incomes). We measure inequality using the Gini coefficient. We compute the redistributive effect of public policies looking at how the Gini coefficient changes when taxes and expenditures are removed.

A first possibility is to remove public finance programs while keeping individual decisions constant at their initial level: the difference between the Gini coefficient of gross and net incomes (the so called Reynold-Smolensky index) provides a first measure of the redistributive effects of public intervention. Such a measure, which does not take the behavioural effects of public policies into account, is presented in Table 19.

Note that inequality of lifetime gross incomes is much lower than inequality of annual gross incomes; moreover, public policies are more effective in redistributing incomes on an annual basis than in reducing lifetime income inequality, that it the Reynold-Smolensky index computed on annual incomes

Table 19: PRE-REFORM EQUILIBRIUM, Gini coefficients

	France		Italy		Sweden	
	Annual	Lifetime	Annual	Lifetime	Annual	Lifetime
Gini coefficient of gross incomes	0.457	0.321	0.414	0.270	0.428	0.273
Gini coefficient of net incomes	0.333	0.280	0.263	0.208	0.298	0.234
Reynold-Smolensky index	0.124	0.041	0.151	0.062	0.130	0.039

is higher than the Reynold-Smolensky index computed on lifetime income. These results are in line with the previous literature, which has investigated the topic using alternative approaches, e.g. see Aaberge and Mogstad (2012) and see Nelissen (1998).

The value added of the model we built is that it allows to study the redistributive effects of public policies taking behavioural responses into account. To this end, we can perform several policy experiments in which we remove taxes and/or expenditures, compute the new equilibrium values of individual decisions and then look at the resulting distribution of incomes.

As to the effects on individual welfare we measure them using the notion of equivalent variation *à la* Hicks: for each type of household, we compute the percentage change ϕ in both consumption and leisure[17] required in the pre-reform equilibrium in order to be as well of as after the policy reform. When $\phi > 0$, the reform improves the utility of that specific group; when $\phi < 0$ the *status quo* is preferred. We also look at the percentage of people who are worse off after the removal of the policy reform.

In performing the policy experiments we treat the value of government consumption G computed in the initial equilibrium as an exogenous revenue requirement and we assume that the government budget must be balanced in each period.

Before moving to the simulation of the policy reforms and to better appreciate their effects, it is useful to compute (see Table 20), for the working age population, the average of the average and the marginal tax rates of the personal income tax (PIT) over the simulated population. Table 20 also reports, for the sake of convenience, the value of the tax rates of the capital income tax and of consumption tax (see Section 5)

7.1 Policy reform I

The first policy experiment we simulate is designed in order to capture the idea of a minimal state. All expenditures are set equal to zero: since there is an exogenous revenue requirement G, revenues cannot be set equal to zero;

[17]The percentage change is assumed to be the same for consumption and leisure.

Table 20: PRE-REFORM EQUILIBRIUM, Tax rates

	France		Italy		Sweden	
	Males	Females	Males	Females	Males	Females
PIT: average of the average tax rates	9.3%	9.4%	17.2%	16.3%	27.6%	25.5%
PIT: average of the marginal tax rates	18.4%	19.0%	29.2%	28.9%	39.2%	37.3%
Tax rate on capital income	27.7%		28.8%		22.3%	
Tax rate on consumption	19.9%		17.6%		27.4%	

we replace the progressive tax on labor income and the proportional taxes on capital and consumption, with a proportional tax whose basis is labor and capital income. The rate of this proportional tax is set in such a way that revenues are enough to meet the revenue requirement G. The flat tax rate turns out to be 12.3% in France, 17.9% in Italy and 20.4% in Sweden.

Table 21 reports the percentage change in labor supply for France, Italy and Sweden: in all the three countries labor supply increases[18].

Table 21: REFORM I, percentage change in labor supply

	France	Italy	Sweden
Male	8.7%	15.8%	16.0%
Female	26.9%	8.3%	16.1%
Total	16.6%	12.2%	16.0%

Table 4 shows the Gini coefficient of gross and net incomes (on an annual and a lifetime basis) for the new equilibrium.

Table 22: REFORM I, Gini coefficients

	France		Italy		Sweden	
	Annual	Lifetime	Annual	Lifetime	Annual	Lifetime
Gini coefficient of gross incomes	0.361	0.290	0.339	0.249	0.349	0.248
Gini coefficient of net incomes	0.348	0.280	0.326	0.241	0.337	0.241
Reynold-Smolensky index	0.013	0.010	0.013	0.009	0.012	0.007

It is interesting to compare these Gini coefficient with those presented in Table 19. As to the Gini coefficient of net incomes in France, for annual incomes, it goes from 0.334 in Table 19 to 0.348 in Table 22; for lifetime incomes there is no sizeable change. In Italy both the Gini coefficient for net annual incomes and for net lifetime incomes rise (from 0.263 to 0.326 for annual incomes; from 0.208 to 0.241 for lifetime incomes). Qualitively the

[18]Note that, given the small open economy assumption we make, the ratio between capital and labor supply is constant; therefore, capital increases by the same amount as labor supply.

same happens in Sweden (from 0.298 to 0.337 for annual incomes; from 0.234 to 0.241 for lifetime incomes). These results on the distribution of net incomes are determined by two counteracting effects. First, the Gini coefficient of gross incomes decreases: labor supply increases for the different individuals in such a way that the distribution of gross income is less concentrated. Second, the Reynold-Smolensky index is lower after the policy reform. In Italy and Sweden the second effect always dominates, resulting in a more unequal distribution of net incomes both on an annual and on a lifetime basis. In France this happen for annual incomes. For lifetime incomes the first effect is so high to perfectly offset the second one, and the degree of inequality turns out to be unaffected by the policy reform.

We then look at the effects of this policy reform on individual welfare. We first compute the percentage of people damaged by the reform: it is 9.3% in France, 6.3% in Italy and 5.2% in Sweden.

To quantitatively assess the effect of the policy reform on individual utility we then look at equivalent variations for individuals living in different types of household. Households are distinguished according to the marital status (singles vs couples), the educational level (college degree or not) and the wage rescaling factors (high or low, see Section 4.5) of the spouses.

Tables 23-25 show equivalent variations for singles. Tables 26-28 and Tables 29-31 report equivalent variations respectively for males and females in different types of couples. Finally, in Tables 32-34 we compute equivalent variations at the household level for different types of couples.

Table 23: REFORM I (France), equivalent variations (%), singles

	Low (Δ_1)	High (Δ_2)
Male, no college	12.5%	19.3%
Male, college	12.6%	19.9%
Female, no college	-2.6%	16.4%
Female, college	10.9%	18.8%

Table 24: REFORM I (Italy), equivalent variations (%), singles

	Low (Δ_1)	High (Δ_2)
Male, no college	8.4%	19.8%
Male, college	9.7%	20.6%
Female, no college	1.8%	15.2%
Female, college	8.0%	19.7%

Table 25: REFORM I (Sweden), equivalent variations (%), singles

	Low (Δ_1)	High (Δ_2)
Male, no college	9.2%	23.3%
Male, college	13.6%	28.4%
Female, no college	4.7%	21.1%
Female, college	7.6%	23.1%

Table 26: REFORM I (France), equivalent variations (%), married males

	M: Low F: Low	M: High F: Low	M: Low F: High	M: High F: High
Male: no college, Female: no college, Children: yes	0.2%	10.6%	10.4%	11.2%
Male: no college, Female: no college, Children: no	8.2%	15.0%	13.7%	17.4%
Male: college, Female: no college, Children: yes	5.2%	14.1%	11.2%	15.0%
Male: college, Female: no college, Children: no	9.6%	16.9%	14.2%	19.3%
Male: no college, Female: college, Children: yes	8.1%	11.9%	12.4%	11.1%
Male: no college, Female: college, Children: no	10.1%	15.7%	15.3%	18.9%
Male: college, Female: college, Children: yes	3.9%	14.2%	12.9%	14.4%
Male: college, Female: college, Children: no	11.1%	16.9%	15.5%	19.6%

Table 27: REFORM I (Italy), equivalent variations (%), married males

	M: Low F: Low	M: High F: Low	M: Low F: High	M: High F: High
Male: no college, Female: no college, Children: yes	-1.1%	15.7%	17.5%	13.8%
Male: no college, Female: no college, Children: no	4.2%	16.0%	17.9%	16.8%
Male: college, Female: no college, Children: yes	-0.9%	19.7%	16.4%	15.7%
Male: college, Female: no college, Children: no	5.0%	20.1%	17.0%	19.3%
Male: no college, Female: college, Children: yes	4.4%	14.7%	24.3%	14.4%
Male: no college, Female: college, Children: no	9.5%	14.6%	22.2%	18.4%
Male: college, Female: college, Children: yes	0.7%	16.3%	20.5%	18.8%
Male: college, Female: college, Children: no	8.6%	16.4%	19.4%	22.8%

Table 28: REFORM I (Sweden), equivalent variations (%), married males

	M: Low F: Low	M: High F: Low	M: Low F: High	M: High F: High
Male: no college, Female: no college, Children: yes	-5.6%	14.3%	23.1%	13.2%
Male: no college, Female: no college, Children: no	4.2%	17.7%	25.4%	20.6%
Male: college, Female: no college, Children: yes	5.5%	25.1%	21.3%	20.6%
Male: college, Female: no college, Children: no	10.8%	27.7%	22.7%	25.4%
Male: no college, Female: college, Children: yes	-3.9%	13.4%	30.2%	15.9%
Male: no college, Female: college, Children: no	7.7%	16.9%	31.8%	24.4%
Male: college, Female: college, Children: yes	7.2%	24.4%	26.7%	21.6%
Male: college, Female: college, Children: no	11.8%	26.8%	27.8%	26.9%

Table 29: REFORM I (France), equivalent variations (%), married females

	M: Low F: Low	M: High F: Low	M: Low F: High	M: High F: High
Male: no college, Female: no college, Children: yes	3.4%	14.9%	8.2%	15.6%
Male: no college, Female: no college, Children: no	11.9%	16.9%	13.7%	18.5%
Male: college, Female: no college, Children: yes	-13.8%	17.6%	8.9%	17.5%
Male: college, Female: no college, Children: no	11.6%	20.3%	14.3%	18.6%
Male: no college, Female: college, Children: yes	-1.6%	13.2%	12.0%	17.2%
Male: no college, Female: college, Children: no	10.7%	16.0%	15.7%	19.2%
Male: college, Female: college, Children: yes	9.3%	17.4%	12.7%	19.5%
Male: college, Female: college, Children: no	11.9%	19.8%	16.2%	19.3%

Table 30: REFORM I (Italy), equivalent variations (%), married females

	M: Low F: Low	M: High F: Low	M: Low F: High	M: High F: High
Male: no college, Female: no college, Children: yes	8.9%	29.9%	8.0%	22.4%
Male: no college, Female: no college, Children: no	13.0%	31.9%	11.9%	21.5%
Male: college, Female: no college, Children: yes	14.4%	19.8%	9.8%	20.1%
Male: college, Female: no college, Children: no	17.4%	22.3%	12.4%	20.0%
Male: no college, Female: college, Children: yes	7.8%	24.7%	12.2%	23.0%
Male: no college, Female: college, Children: no	9.9%	27.1%	15.2%	22.8%
Male: college, Female: college, Children: yes	11.4%	23.4%	14.4%	18.4%
Male: college, Female: college, Children: no	12.9%	25.3%	17.3%	18.5%

Table 31: REFORM I (Sweden), equivalent variations (%), married females

	M: Low F: Low	M: High F: Low	M: Low F: High	M: High F: High
Male: no college, Female: no college, Children: yes	2.4%	31.3%	9.7%	24.7%
Male: no college, Female: no college, Children: no	9.2%	34.5%	14.4%	25.1%
Male: college, Female: no college, Children: yes	-10.8%	25.9%	12.0%	28.6%
Male: college, Female: no college, Children: no	21.6%	27.2%	18.7%	27.8%
Male: no college, Female: college, Children: yes	2.8%	29.2%	13.3%	23.6%
Male: no college, Female: college, Children: no	8.3%	31.7%	18.5%	23.5%
Male: college, Female: college, Children: yes	-8.2%	26.9%	13.8%	27.1%
Male: college, Female: college, Children: no	18.7%	28.3%	20.4%	26.4%

Table 32: REFORM I (France), equivalent variations (%), household

	M: Low F: Low	M: High F: Low	M: Low F: High	M: High F: High
Male: no college, Female: no college, Children: yes	1.6%	12.1%	9.0%	13.2%
Male: no college, Female: no college, Children: no	9.9%	15.6%	13.7%	17.9%
Male: college, Female: no college, Children: yes	-3.5%	15.3%	9.9%	16.0%
Male: college, Female: no college, Children: no	10.4%	18.1%	14.3%	19.0%
Male: no college, Female: college, Children: yes	2.9%	12.3%	12.1%	14.1%
Male: no college, Female: college, Children: no	10.5%	15.8%	15.5%	19.1%
Male: college, Female: college, Children: yes	6.3%	15.3%	12.8%	16.7%
Male: college, Female: college, Children: no	11.5%	17.9%	16.0%	19.5%

Table 33: REFORM I (Italy), equivalent variations (%), household

	M: Low F: Low	M: High F: Low	M: Low F: High	M: High F: High
Male: no college, Female: no college, Children: yes	3.1%	20.6%	11.9%	17.6%
Male: no college, Female: no college, Children: no	8.1%	21.7%	14.5%	19.0%
Male: college, Female: no college, Children: yes	5.1%	19.8%	12.7%	17.4%
Male: college, Female: no college, Children: no	10.2%	20.9%	14.5%	19.6%
Male: no college, Female: college, Children: yes	6.0%	18.6%	16.5%	18.8%
Male: no college, Female: college, Children: no	9.7%	19.8%	17.8%	20.7%
Male: college, Female: college, Children: yes	5.5%	18.8%	16.7%	18.7%
Male: college, Female: college, Children: no	10.7%	19.6%	18.1%	20.8%

Table 34: REFORM I (Sweden), equivalent variations (%), household

	M: Low F: Low	M: High F: Low	M: Low F: High	M: High F: High
Male: no college, Female: no college, Children: yes	-2.1%	20.1%	15.0%	18.5%
Male: no college, Female: no college, Children: no	6.5%	23.7%	18.9%	22.8%
Male: college, Female: no college, Children: yes	-2.5%	25.3%	16.1%	23.7%
Male: college, Female: no college, Children: no	15.2%	27.5%	20.6%	26.4%
Male: no college, Female: college, Children: yes	-0.7%	19.3%	19.5%	19.7%
Male: no college, Female: college, Children: no	8.0%	22.6%	23.5%	24.0%
Male: college, Female: college, Children: yes	-0.7%	25.3%	19.2%	23.9%
Male: college, Female: college, Children: no	14.9%	27.3%	23.6%	26.7%

The results presented in this section suggest that a very large majority of people would be better off after the policy reform. Since this reform entails many policy changes, a natural question that arises concerns the role played by each of them. In particular, it is likely that the removal of the pension system is crucial for the results presented in the Tables above. Indeed, our model economy is clearly dynamically effcient: the annual return on asset is equal to 5.5% (and it is not affected by the removal of the pension system, given the small open economy assumption) and the annual growth rate of the population is equal to 0.6799% in France, to 0.3983% in Italy and to 0.4895% in Sweden. As a consequance, the removal of the pension system generates a strong positive income effect in the long run. However, it is well known that, when talking about pension reforms, the transition dynamics is a crucial issue: long run results mixe up efficiency effects and intergenerational redistribution. Morever, the increase in the capital stock determined by the removal of the pension system is likely to reduce the return on assets when general equilibrium effects on factor prices are taken into account. Since in this policy experiment we are abstracting from the transitional dynamics and we are assuming the existence of a small open economy, the results presented in the Tables above should be read with caution.

A better way to evaluate the overall effect of public intervention in the model we use is to perform the same policy experiment of this Section, but for the removal of the pension system. This is done in the next Section.

7.2 Policy reform II

We here remove all expenditure but for the pension system. As in Section 7.1 we replace the progressive tax on labor income and the proportional taxes on capital and labor income, with a proportional tax on labor and capital income. The results of these policy experiments are presented following the same structure of the previous Section.

The flat tax rate is equal to 11.2% in France, 21.3% in Italy and 16.5% in Sweden. Tables 35 shows the changes in labor supply. The Gini coefficient are reported in Table 36. The percentage of individuals who are worse off after the reform remarkably increases with respect to the previous section: for France it goes from 9.3% to 42.5%; for Italy it rise from 6.3% to 50.3%. These numbers confirm the intuition that the results we get in Section 7.1 for France and Italy are largely driven by the pension system. For Sweden the situation is different: the percentage of people who are worse off after the reform is only slightly higher than that of the previous Section (11.0% instead of 5.2%).

Table 35: REFORM II, percentage change in labor supply

	France	Italy	Sweden
Male	13.4%	14.2%	19.3%
Female	33.8%	16.1%	17.8%
Total	22.3%	15.1%	18.6%

Table 36: REFORM II, Gini coefficients

	France		Italy		Sweden	
Gini coefficient of gross incomes	0.402	0.291	0.398	0.266	0.367	0.253
Gini coefficient of net incomes	0.340	0.286	0.305	0.250	0.330	0.253
Reynold-Smolensky index	0.062	0.006	0.093	0.016	0.037	0.000

Tables 37-48 report equivalent variations.

In the next two Sections we perform two additional policy experiments with the aim of disentagling the effects on redistribution and welfare of the tax system from those induced by the expenditure programs.

Table 37: REFORM II (France), equivalent variations (%), singles

	Low (Δ_1)	High (Δ_2)
Male, no college	-0.1%	9.3%
Male, college	1.2%	11.0%
Female, no college	-16.6%	5.8%
Female, college	-1.5%	9.1%

Table 38: REFORM II (Italy), equivalent variations (%), singles

	Low (Δ_1)	High (Δ_2)
Male, no college	-2.4%	8.0%
Male, college	0.1%	10.5%
Female, no college	-4.8%	3.4%
Female, college	-1.6%	8.5%

Table 39: REFORM II (Sweden), equivalent variations (%), singles

	Low (Δ_1)	High (Δ_2)
Male, no college	3.3%	19.7%
Male, college	8.3%	25.8%
Female, no college	-2.1%	16.8%
Female, college	1.4%	19.4%

Table 40: REFORM II (France), equivalent variations (%), married males

	M: Low F: Low	M: High F: Low	M: Low F: High	M: High F: High
Male: no college, Female: no college, Children: yes	-13.2%	-0.2%	-0.1%	1.6%
Male: no college, Female: no college, Children: no	-4.0%	4.2%	3.6%	7.7%
Male: college, Female: no college, Children: yes	-8.6%	4.1%	1.2%	5.0%
Male: college, Female: no college, Children: no	-1.9%	7.1%	4.3%	9.2%
Male: no college, Female: college, Children: yes	-12.6%	1.9%	3.5%	1.4%
Male: no college, Female: college, Children: no	-1.2%	5.7%	6.7%	9.7%
Male: college, Female: college, Children: yes	-1.7%	4.0%	3.9%	4.5%
Male: college, Female: college, Children: no	0.2%	6.9%	6.5%	10.3%

Table 41: REFORM II (Italy), equivalent variations (%), married males

	M: Low F: Low	M: High F: Low	M: Low F: High	M: High F: High
Male: no college, Female: no college, Children: yes	-10.4%	3.1%	8.2%	2.2%
Male: no college, Female: no college, Children: no	-1.0%	3.8%	7.5%	5.6%
Male: college, Female: no college, Children: yes	-11.5%	8.1%	5.4%	3.6%
Male: college, Female: no college, Children: no	-1.3%	9.0%	5.9%	7.3%
Male: no college, Female: college, Children: yes	-7.4%	2.6%	13.3%	3.8%
Male: no college, Female: college, Children: no	1.1%	3.6%	11.8%	8.8%
Male: college, Female: college, Children: yes	-11.8%	6.0%	13.9%	6.7%
Male: college, Female: college, Children: no	0.3%	7.9%	12.2%	11.2%

Table 42: REFORM II (Sweden), equivalent variations (%), married males

	M: Low F: Low	M: High F: Low	M: Low F: High	M: High F: High
Male: no college, Female: no college, Children: yes	-12.5%	10.9%	20.6%	9.3%
Male: no college, Female: no college, Children: no	-1.3%	14.6%	23.0%	17.2%
Male: college, Female: no college, Children: yes	-3.1%	22.0%	17.6%	17.0%
Male: college, Female: no college, Children: no	5.7%	25.4%	19.3%	22.3%
Male: no college, Female: college, Children: yes	-10.9%	9.4%	28.9%	12.1%
Male: no college, Female: college, Children: no	2.3%	13.1%	30.0%	21.8%
Male: college, Female: college, Children: yes	-3.1%	21.3%	24.2%	18.8%
Male: college, Female: college, Children: no	6.3%	24.5%	25.3%	24.1%

Table 43: REFORM II (France), equivalent variations (%), married females

	M: Low F: Low	M: High F: Low	M: Low F: High	M: High F: High
Male: no college, Female: no college, Children: yes	-10.0%	6.5%	-2.2%	6.1%
Male: no college, Female: no college, Children: no	-0.9%	9.3%	3.1%	8.4%
Male: college, Female: no college, Children: yes	-6.9%	10.4%	-1.7%	9.7%
Male: college, Female: no college, Children: no	-0.4%	13.1%	4.0%	10.7%
Male: no college, Female: college, Children: yes	-7.0%	3.6%	1.8%	8.1%
Male: no college, Female: college, Children: no	-0.8%	7.0%	5.9%	9.3%
Male: college, Female: college, Children: yes	-15.2%	10.1%	2.6%	11.2%
Male: college, Female: college, Children: no	0.9%	13.1%	6.5%	11.0%

Table 44: REFORM II (Italy), equivalent variations (%), married females

	M: Low F: Low	M: High F: Low	M: Low F: High	M: High F: High
Male: no college, Female: no college, Children: yes	-5.3%	17.3%	-5.1%	10.4%
Male: no college, Female: no college, Children: no	-2.9%	18.9%	-0.2%	10.2%
Male: college, Female: no college, Children: yes	-0.5%	12.8%	-2.4%	13.4%
Male: college, Female: no college, Children: no	2.5%	15.9%	1.8%	14.1%
Male: no college, Female: college, Children: yes	-6.6%	13.2%	2.0%	10.9%
Male: no college, Female: college, Children: no	-2.1%	14.7%	7.0%	10.3%
Male: college, Female: college, Children: yes	-1.2%	14.0%	1.4%	10.4%
Male: college, Female: college, Children: no	2.2%	14.6%	6.2%	9.9%

Table 45: REFORM II (Sweden), equivalent variations (%), married females

	M: Low F: Low	M: High F: Low	M: Low F: High	M: High F: High
Male: no college, Female: no college, Children: yes	-4.7%	28.0%	4.9%	21.3%
Male: no college, Female: no college, Children: no	3.2%	31.4%	9.8%	21.8%
Male: college, Female: no college, Children: yes	9.1%	26.0%	7.1%	27.6%
Male: college, Female: no college, Children: no	17.8%	25.8%	14.0%	26.1%
Male: no college, Female: college, Children: yes	-4.0%	27.2%	8.6%	20.6%
Male: no college, Female: college, Children: no	2.8%	29.8%	14.8%	20.8%
Male: college, Female: college, Children: yes	7.8%	27.1%	8.9%	24.6%
Male: college, Female: college, Children: no	14.7%	27.0%	16.2%	23.7%

Table 46: REFORM II (France), equivalent variations (%), household

	M: Low F: Low	M: High F: Low	M: Low F: High	M: High F: High
Male: no college, Female: no college, Children: yes	-11.8%	2.0%	-1.4%	3.6%
Male: no college, Female: no college, Children: no	-2.6%	5.9%	3.3%	8.0%
Male: college, Female: no college, Children: yes	-7.9%	6.2%	-0.5%	6.8%
Male: college, Female: no college, Children: no	-1.3%	9.2%	4.1%	9.8%
Male: no college, Female: college, Children: yes	-9.8%	2.5%	2.4%	4.7%
Male: no college, Female: college, Children: no	-1.0%	6.2%	6.2%	9.5%
Male: college, Female: college, Children: yes	-8.6%	6.0%	3.1%	7.4%
Male: college, Female: college, Children: no	0.5%	9.0%	6.5%	10.6%

Table 47: REFORM II (Italy), equivalent variations (%), household

	M: Low F: Low	M: High F: Low	M: Low F: High	M: High F: High
Male: no college, Female: no college, Children: yes	-8.2%	7.9%	0.2%	5.9%
Male: no college, Female: no college, Children: no	-1.9%	9.2%	3.1%	7.7%
Male: college, Female: no college, Children: yes	-7.1%	9.6%	0.9%	7.3%
Male: college, Female: no college, Children: no	0.4%	11.3%	3.7%	10.0%
Male: no college, Female: college, Children: yes	-7.0%	6.7%	6.1%	7.4%
Male: no college, Female: college, Children: no	-0.6%	8.2%	8.8%	9.6%
Male: college, Female: college, Children: yes	-7.1%	8.8%	5.9%	8.3%
Male: college, Female: college, Children: no	1.2%	10.4%	8.5%	10.6%

Table 48: REFORM II (Sweden), equivalent variations (%), household

	M: Low F: Low	M: High F: Low	M: Low F: High	M: High F: High
Male: no college, Female: no college, Children: yes	-9.1%	16.8%	11.0%	14.8%
Male: no college, Female: no college, Children: no	0.8%	20.6%	15.1%	19.5%
Male: college, Female: no college, Children: yes	1.6%	23.3%	11.7%	21.0%
Male: college, Female: no college, Children: no	10.5%	25.6%	16.5%	23.8%
Male: no college, Female: college, Children: yes	-7.7%	15.9%	15.8%	16.2%
Male: no college, Female: college, Children: no	2.6%	19.4%	20.4%	21.3%
Male: college, Female: college, Children: yes	1.5%	23.3%	15.1%	21.2%
Male: college, Female: college, Children: no	10.0%	25.4%	20.1%	23.9%

7.3 Policy reform III

As in the previous sections we replace the progressive tax on labor income and the proportional taxes on capital and consumption with a proportional tax on labor and capital income; however, here, we do not remove any transfer. The purpose of this policy experiment is to identify the effects of the current tax system.

The value of the flat tax rate is now 23.2% for France, 29.4% for Italy and 31.6% for Sweden. The percentages of individuals who are worse off after the reform are: 50.1% in France, 53.3% in Italy and 7.4% in Sweden. Tables 49-62 present the same information reported in the previous sections.

Table 49: REFORM III, percentage change in labor supply

	France	Italy	Sweden
Male	5.1%	10.9%	12.6%
Female	6.5%	10.8%	11.4%
Total	5.7%	10.9%	12.0%

Table 50: REFORM III, Gini coefficients

	France		Italy		Sweden	
Gini coefficient of gross incomes	0.484	0.343	0.428	0.279	0.443	0.280
Gini coefficient of net incomes	0.378	0.319	0.312	0.256	0.368	0.278
Reynold-Smolensky index	0.105	0.024	0.116	0.023	0.074	0.002

Table 51: REFORM III (France), equivalent variations (%), singles

	Low (Δ_1)	High (Δ_2)
Male, no college	-4.1%	3.3%
Male, college	-2.4%	4.9%
Female, no college	6.4%	0.6%
Female, college	-2.9%	3.3%

7.4 Policy reform IV

As in Section 7.1 we remove all expenditures but for the pension system; however here we leave the tax structure unchanged. To keep the government budget balanced, we simply rescale by a common factor the marginal and average tax rates on the Personal income tax, and the flat tax rates of the

Table 52: REFORM III (Italy), equivalent variations (%), singles

	Low (Δ_1)	High (Δ_2)
Male, no college	-5.2%	4.1%
Male, college	-2.0%	6.2%
Female, no college	-5.4%	0.2%
Female, college	-3.2%	4.6%

Table 53: REFORM III (Sweden), equivalent variations (%), singles

	Low (Δ_1)	High (Δ_2)
Male, no college	1.3%	8.7%
Male, college	-2.4%	14.4%
Female, no college	-0.1%	6.2%
Female, college	0.9%	8.6%

Table 54: REFORM III (France), equivalent variations (%), married males

	M: Low F: Low	M: High F: Low	M: Low F: High	M: High F: High
Male: no college, Female: no college, Children: yes	0.9%	-1.6%	-1.6%	0.6%
Male: no college, Female: no college, Children: no	-3.8%	-0.3%	-0.6%	2.3%
Male: college, Female: no college, Children: yes	-1.4%	0.6%	-1.3%	2.1%
Male: college, Female: no college, Children: no	-2.5%	1.4%	-0.2%	3.5%
Male: no college, Female: college, Children: yes	-3.7%	0.0%	-0.3%	2.3%
Male: no college, Female: college, Children: no	-2.9%	1.0%	1.9%	3.6%
Male: college, Female: college, Children: yes	-3.0%	0.9%	0.5%	3.6%
Male: college, Female: college, Children: no	-2.0%	1.8%	1.6%	4.4%

Table 55: REFORM III (Italy), equivalent variations (%), married males

	M: Low F: Low	M: High F: Low	M: Low F: High	M: High F: High
Male: no college, Female: no college, Children: yes	-3.8%	1.6%	3.7%	1.2%
Male: no college, Female: no college, Children: no	-2.6%	1.0%	4.6%	1.8%
Male: college, Female: no college, Children: yes	-4.2%	5.8%	2.1%	2.6%
Male: college, Female: no college, Children: no	-2.9%	5.6%	2.5%	4.1%
Male: no college, Female: college, Children: yes	-0.4%	0.8%	8.7%	3.4%
Male: no college, Female: college, Children: no	-0.6%	0.7%	7.5%	5.0%
Male: college, Female: college, Children: yes	-3.5%	3.7%	8.8%	6.1%
Male: college, Female: college, Children: no	-2.5%	4.0%	7.3%	7.2%

Table 56: REFORM III (Sweden), equivalent variations (%), married males

	M: Low F: Low	M: High F: Low	M: Low F: High	M: High F: High
Male: no college, Female: no college, Children: yes	0.3%	7.8%	14.5%	7.1%
Male: no college, Female: no college, Children: no	-0.2%	7.6%	14.2%	7.3%
Male: college, Female: no college, Children: yes	1.4%	15.0%	9.2%	11.3%
Male: college, Female: no college, Children: no	1.3%	15.4%	9.1%	12.1%
Male: no college, Female: college, Children: yes	1.5%	5.8%	20.4%	10.5%
Male: no college, Female: college, Children: no	1.2%	5.8%	19.9%	11.4%
Male: college, Female: college, Children: yes	1.0%	14.4%	16.2%	13.1%
Male: college, Female: college, Children: no	1.1%	14.6%	15.0%	13.7%

Table 57: REFORM III (France), equivalent variations (%), married females

	M: Low F: Low	M: High F: Low	M: Low F: High	M: High F: High
Male: no college, Female: no college, Children: yes	-3.9%	1.1%	-2.0%	0.9%
Male: no college, Female: no college, Children: no	-4.5%	2.5%	-0.8%	2.5%
Male: college, Female: no college, Children: yes	-4.5%	4.9%	-1.5%	3.5%
Male: college, Female: no college, Children: no	-3.2%	6.9%	-0.2%	4.6%
Male: no college, Female: college, Children: yes	-3.3%	-0.9%	-0.2%	2.0%
Male: no college, Female: college, Children: no	-3.1%	1.2%	0.8%	3.6%
Male: college, Female: college, Children: yes	-2.4%	4.6%	0.3%	3.9%
Male: college, Female: college, Children: no	-2.0%	5.6%	1.4%	4.7%

Table 58: REFORM III (Italy), equivalent variations (%), married females

	M: Low F: Low	M: High F: Low	M: Low F: High	M: High F: High
Male: no college, Female: no college, Children: yes	-3.6%	13.3%	-3.2%	7.2%
Male: no college, Female: no college, Children: no	-3.1%	14.0%	-2.0%	6.4%
Male: college, Female: no college, Children: yes	1.1%	8.3%	-1.2%	8.7%
Male: college, Female: no college, Children: no	1.0%	10.1%	-0.6%	7.9%
Male: no college, Female: college, Children: yes	-3.6%	9.6%	1.6%	6.4%
Male: no college, Female: college, Children: no	-3.1%	10.5%	3.6%	6.2%
Male: college, Female: college, Children: yes	-0.3%	9.9%	1.3%	4.9%
Male: college, Female: college, Children: no	0.4%	10.0%	3.1%	5.4%

Table 59: REFORM III (Sweden), equivalent variations (%), married females

	M: Low F: Low	M: High F: Low	M: Low F: High	M: High F: High
Male: no college, Female: no college, Children: yes	3.6%	19.8%	2.6%	11.0%
Male: no college, Female: no college, Children: no	2.9%	19.7%	2.5%	10.6%
Male: college, Female: no college, Children: yes	9.2%	16.4%	3.6%	16.0%
Male: college, Female: no college, Children: no	10.3%	15.9%	4.0%	16.5%
Male: no college, Female: college, Children: yes	2.2%	19.8%	5.9%	10.3%
Male: no college, Female: college, Children: no	1.7%	18.8%	7.1%	10.4%
Male: college, Female: college, Children: yes	7.7%	17.3%	6.3%	13.4%
Male: college, Female: college, Children: no	7.7%	16.8%	6.3%	13.1%

Table 60: REFORM III (France), equivalent variations (%), household

	M: Low F: Low	M: High F: Low	M: Low F: High	M: High F: High
Male: no college, Female: no college, Children: yes	-1.3%	-0.7%	-1.9%	0.7%
Male: no college, Female: no college, Children: no	-4.1%	0.6%	-0.7%	2.4%
Male: college, Female: no college, Children: yes	-2.6%	2.1%	-1.4%	2.7%
Male: college, Female: no college, Children: no	-2.8%	3.3%	-0.2%	3.9%
Male: no college, Female: college, Children: yes	-3.5%	-0.3%	-0.3%	2.2%
Male: no college, Female: college, Children: no	-3.0%	1.0%	1.2%	3.6%
Male: college, Female: college, Children: yes	-2.8%	2.1%	0.4%	3.8%
Male: college, Female: college, Children: no	-2.0%	3.1%	1.5%	4.5%

Table 61: REFORM III (Italy), equivalent variations (%), household

	M: Low F: Low	M: High F: Low	M: Low F: High	M: High F: High
Male: no college, Female: no college, Children: yes	-3.7%	5.7%	-0.3%	3.9%
Male: no college, Female: no college, Children: no	-2.9%	5.7%	0.8%	3.9%
Male: college, Female: no college, Children: yes	-2.0%	6.6%	0.3%	4.9%
Male: college, Female: no college, Children: no	-1.2%	7.2%	0.8%	5.6%
Male: no college, Female: college, Children: yes	-2.0%	4.3%	4.2%	5.0%
Male: no college, Female: college, Children: no	-1.9%	4.8%	5.1%	5.6%
Male: college, Female: college, Children: yes	-2.0%	5.8%	4.1%	5.6%
Male: college, Female: college, Children: no	-1.1%	6.2%	4.7%	6.4%

Table 62: REFORM III (Sweden), equivalent variations (%), household

	M: Low F: Low	M: High F: Low	M: Low F: High	M: High F: High
Male: no college, Female: no college, Children: yes	1.8%	12.0%	7.3%	9.0%
Male: no college, Female: no college, Children: no	1.2%	12.0%	7.2%	8.9%
Male: college, Female: no college, Children: yes	4.5%	15.4%	6.1%	13.1%
Male: college, Female: no college, Children: no	4.9%	15.6%	6.3%	13.8%
Male: no college, Female: college, Children: yes	1.8%	11.0%	11.2%	10.4%
Male: no college, Female: college, Children: no	1.4%	10.7%	11.8%	10.9%
Male: college, Female: college, Children: yes	3.9%	15.4%	10.5%	13.2%
Male: college, Female: college, Children: no	4.0%	15.3%	9.9%	13.5%

capital income tax and of the consumption tax. The aim of this policy experiment is to isolate the effects induced by the current structure of the transfer system.

The percentages of individuals who are worse off after the reforms are: 29.5% in France, 31.7% in Italy and 7.0% in Sweden.

Tables 63-76 report the same information presented in the previous sections.

Table 63: REFORM IV, percentage change in labor supply

	France	Italy	Sweden
Male	9.1%	6.7%	13.8%
Female	30.0%	8.2%	12.0%
Total	18.2%	7.4%	12.9%

Table 64: REFORM IV, Gini coefficients

	France		Italy		Sweden	
Gini coefficient of gross incomes	0.392	0.287	0.388	0.261	0.358	0.254
Gini coefficient of net incomes	0.325	0.272	0.281	0.225	0.311	0.243
Reynold-Smolensky index	0.067	0.016	0.107	0.036	0.047	0.011

Table 65: REFORM IV (France), equivalent variations (%), singles

	Low (Δ_1)	High (Δ_2)
Male, no college	1.7%	8.0%
Male, college	2.4%	9.1%
Female, no college	-13.5%	5.8%
Female, college	0.5%	7.8%

Table 66: REFORM IV (Italy), equivalent variations (%), singles

	Low (Δ_1)	High (Δ_2)
Male, no college	0.4%	5.9%
Male, college	2.3%	7.2%
Female, no college	-0.3%	4.0%
Female, college	1.2%	6.2%

Table 67: REFORM IV (Sweden), equivalent variations (%), singles

	Low (Δ_1)	High (Δ_2)
Male, no college	5.3%	17.5%
Male, college	8.6%	21.7%
Female, no college	1.3%	15.7%
Female, college	3.8%	17.2%

Table 68: REFORM IV (France), equivalent variations (%), married males

	M: Low F: Low	M: High F: Low	M: Low F: High	M: High F: High
Male: no college, Female: no college, Children: yes	-9.9%	0.7%	1.2%	1.7%
Male: no college, Female: no college, Children: no	-1.7%	4.5%	4.2%	6.8%
Male: college, Female: no college, Children: yes	-5.9%	3.6%	2.2%	4.5%
Male: college, Female: no college, Children: no	-0.1%	6.1%	4.7%	8.3%
Male: no college, Female: college, Children: yes	-1.1%	2.4%	3.6%	0.8%
Male: no college, Female: college, Children: no	0.5%	5.4%	6.4%	7.9%
Male: college, Female: college, Children: yes	0.2%	3.7%	4.3%	3.3%
Male: college, Female: college, Children: no	1.6%	6.1%	6.3%	8.5%

Table 69: REFORM IV (Italy), equivalent variations (%), married males

	M: Low F: Low	M: High F: Low	M: Low F: High	M: High F: High
Male: no college, Female: no college, Children: yes	-5.8%	3.2%	4.9%	2.3%
Male: no college, Female: no college, Children: no	-0.3%	3.9%	5.2%	3.9%
Male: college, Female: no college, Children: yes	-7.3%	5.1%	4.1%	3.5%
Male: college, Female: no college, Children: no	1.4%	6.2%	5.1%	6.1%
Male: no college, Female: college, Children: yes	-4.6%	1.9%	9.3%	2.7%
Male: no college, Female: college, Children: no	2.9%	2.5%	7.3%	6.6%
Male: college, Female: college, Children: yes	-4.8%	4.0%	9.8%	4.0%
Male: college, Female: college, Children: no	1.6%	5.9%	7.6%	7.5%

Table 70: REFORM IV (Sweden), equivalent variations (%), married males

	M: Low F: Low	M: High F: Low	M: Low F: High	M: High F: High
Male: no college, Female: no college, Children: yes	-9.7%	8.4%	16.1%	7.1%
Male: no college, Female: no college, Children: no	1.4%	12.8%	18.8%	15.4%
Male: college, Female: no college, Children: yes	-1.9%	17.6%	14.9%	13.7%
Male: college, Female: no college, Children: no	6.8%	21.0%	17.1%	19.1%
Male: no college, Female: college, Children: yes	-8.6%	7.7%	22.2%	9.3%
Male: no college, Female: college, Children: no	4.0%	11.8%	23.9%	18.7%
Male: college, Female: college, Children: yes	-1.9%	16.9%	19.9%	14.4%
Male: college, Female: college, Children: no	7.3%	20.2%	21.2%	20.2%

Table 71: REFORM IV (France), equivalent variations (%), married females

	M: Low F: Low	M: High F: Low	M: Low F: High	M: High F: High
Male: no college, Female: no college, Children: yes	-6.7%	6.5%	-0.8%	6.0%
Male: no college, Female: no college, Children: no	1.5%	8.4%	3.8%	7.6%
Male: college, Female: no college, Children: yes	-4.3%	9.2%	-0.5%	7.6%
Male: college, Female: no college, Children: no	1.5%	11.3%	4.4%	8.3%
Male: no college, Female: college, Children: yes	-11.3%	4.1%	2.3%	7.5%
Male: no college, Female: college, Children: no	1.0%	6.9%	5.6%	8.1%
Male: college, Female: college, Children: yes	-12.8%	9.2%	2.9%	9.5%
Male: college, Female: college, Children: no	2.2%	10.4%	6.1%	9.2%

Table 72: REFORM IV (Italy), equivalent variations (%), married females

	M: Low F: Low	M: High F: Low	M: Low F: High	M: High F: High
Male: no college, Female: no college, Children: yes	-2.7%	8.1%	-2.8%	6.6%
Male: no college, Female: no college, Children: no	1.6%	10.0%	2.2%	8.0%
Male: college, Female: no college, Children: yes	0.5%	8.4%	-0.6%	6.9%
Male: college, Female: no college, Children: no	2.9%	10.0%	2.8%	8.2%
Male: no college, Female: college, Children: yes	-2.6%	8.6%	1.0%	7.1%
Male: no college, Female: college, Children: no	0.9%	9.8%	5.6%	6.6%
Male: college, Female: college, Children: yes	0.4%	9.2%	0.7%	7.5%
Male: college, Female: college, Children: no	3.3%	9.2%	5.0%	7.0%

Table 73: REFORM IV (Sweden), equivalent variations (%), married females

	M: Low F: Low	M: High F: Low	M: Low F: High	M: High F: High
Male: no college, Female: no college, Children: yes	-2.8%	22.3%	4.6%	17.9%
Male: no college, Female: no college, Children: no	4.6%	25.6%	10.1%	19.0%
Male: college, Female: no college, Children: yes	7.5%	21.1%	6.2%	22.4%
Male: college, Female: no college, Children: no	15.0%	21.4%	13.4%	21.6%
Male: no college, Female: college, Children: yes	-1.9%	21.2%	7.0%	16.9%
Male: no college, Female: college, Children: no	4.5%	24.1%	13.2%	17.8%
Male: college, Female: college, Children: yes	6.9%	22.2%	7.2%	20.8%
Male: college, Female: college, Children: no	13.1%	22.6%	14.5%	20.1%

Table 74: REFORM IV (France), equivalent variations (%), household

	M: Low F: Low	M: High F: Low	M: Low F: High	M: High F: High
Male: no college, Female: no college, Children: yes	-8.5%	2.6%	0.0%	3.6%
Male: no college, Female: no college, Children: no	-0.2%	5.8%	4.0%	7.2%
Male: college, Female: no college, Children: yes	-5.3%	5.5%	0.6%	5.7%
Male: college, Female: no college, Children: no	0.6%	7.8%	4.5%	8.3%
Male: no college, Female: college, Children: yes	-6.7%	3.0%	2.8%	4.1%
Male: no college, Female: college, Children: no	0.8%	6.0%	5.9%	8.0%
Male: college, Female: college, Children: yes	-6.4%	5.5%	3.4%	6.1%
Male: college, Female: college, Children: no	1.9%	7.6%	6.2%	8.8%

Table 75: REFORM IV (Italy), equivalent variations (%), household

	M: Low F: Low	M: High F: Low	M: Low F: High	M: High F: High
Male: no college, Female: no college, Children: yes	-4.4%	5.0%	0.4%	4.3%
Male: no college, Female: no college, Children: no	0.6%	6.3%	3.5%	5.8%
Male: college, Female: no college, Children: yes	-4.1%	6.2%	1.4%	4.9%
Male: college, Female: no college, Children: no	2.1%	7.5%	3.9%	7.0%
Male: no college, Female: college, Children: yes	-3.6%	4.6%	4.1%	5.0%
Male: no college, Female: college, Children: no	1.9%	5.6%	6.3%	6.6%
Male: college, Female: college, Children: yes	-2.4%	5.9%	4.1%	5.5%
Male: college, Female: college, Children: no	2.4%	7.2%	6.1%	7.2%

Table 76: REFORM IV (Sweden), equivalent variations (%), household

	M: Low F: Low	M: High F: Low	M: Low F: High	M: High F: High
Male: no college, Female: no college, Children: yes	-6.7%	13.3%	9.2%	12.1%
Male: no college, Female: no college, Children: no	2.9%	17.5%	13.7%	17.2%
Male: college, Female: no college, Children: yes	1.8%	18.7%	10.1%	17.1%
Male: college, Female: no college, Children: no	10.1%	21.1%	15.2%	20.1%
Male: no college, Female: college, Children: yes	-5.4%	12.8%	12.6%	13.0%
Male: no college, Female: college, Children: no	4.3%	16.6%	17.3%	18.3%
Male: college, Female: college, Children: yes	1.9%	18.7%	12.5%	17.0%
Male: college, Female: college, Children: no	9.9%	21.1%	17.4%	20.1%

8 Conclusion

This paper describes the building blocks of a large scale overlapping generation model which can be used to asses the effects on inequality and welfare of policy reforms.

Within a generation, individuals are heterogeneous along several dimensions: gender (males and females), marital status (singles and married), presence of children, educational level, productivity level. The decisional unit is the household.

A wide range of tax and expenditures programs is included in the model: a personal income tax, a consumption tax, a capital income tax, social contributions, a pension system, an health care system, a child benefit, a subsidy to day care expenditure and an income support system. The model is calibrated for France, Italy and Sweden and it can be used for many purposes. With the aim of illustrating the functioning of the model, we provide examples of policy experiments that can be simulated. That is, we compare our model economies featuring the current set of public policies implemented in France, Italy and Sweden, with alternative economies where some (all) public finance programs are absent. The comparison is done, looking at the effects on both inequality and individual welfare. As to inequality, we measure it looking at the Gini coefficient and we study both annual and lifetime redistribution. As to individual welfare, we look at the percentage of individuals who are worse off after the reforms we simulate and we also compute equivalent variations for individuals with different types of family arrangements.

In the paper we focus on the long run effect of the policy reforms, therefore we abstract from the transition dynamics. As we also stress in Section 7, transition dynamics is however an important issue, especially for those reforms which affect the pension system. Moreover the labor income process is assumed to be deterministic. The absence of a stochastic labor income dynamics implies that we are underestimating the potential insurance role of public intervention. Both the inclusion of the transition dynamics and of a stochastic process for labor income are natural extensions of the framework we use and they are on the top of our research agenda.

9 Appendix

In the Appendix, first we present one of the main data set used for the estimation performed in Section 5. Then we describe in more details the procedure used for the estimation of the wage rescaling factors of Section 4.5.

9.1 EU-SILC 2007

As already mentioned the model is applied to three European countries: France, Italy and Sweden. We use micro data for the year 2007 from the EU-SILC, the European Union Survey on Income and Living Conditions. The EU-SILC project was launched in 2003 on the basis of an agreement in six Member States (Belgium, Denmark, Greece, Ireland, Luxembourg and Austria), as well as in Norway. The starting date for the EU-SILC instrument under the below-mentioned framework Regulation was 2004 for the EU-15 (with the exception of Germany, the Netherlands and the United Kingdom, which had derogations until 2005), as well as for Estonia, Norway and Iceland. The 10 new Member States with the exception of Estonia started in 2005. The instrument has also been implemented in Bulgaria, Romania, Turkey and in Switzerland as from 2007.

The survey collects on an annual basis individual and household information relating to a broad range of issues in relation to income and living conditions. EU-SILC dataset has primary been chosen for comparability purposes. EU-SILC is an output-harmonised survey: Member states are required to deliver data to Eurostat on an annual basis concerning a harmonised list of target variables produced according to common concepts and classifications, but they have substantial discretion concerning the data collection instruments employed to derive the data. The data collection methods differ across countries and can be classified into two broad groups: the "register countries" (Denmark, Finland, The Netherland, Slovenia and Sweden) that rely on administrative sources for collecting several variables and obtain the other information via interviews with a single representative person" in the household, who provides information on all household members; the "survey countries", where all information is collected through personal interviews with all adults in each household over 16 years (Lohmann 2011).

EU-SILC provides two types of data: cross-sectional data and longitudinal data. The EU-SILC longitudinal data is a rotating panel, in which individuals are interviewd for a maximum of four years. For our purposes, we use the cross-sectional data because of the brief longitudinal observation window of the panel. We combine household and personal information to construct a unique dataset that contains all the relevant information of the household members. The data set provides also information about gross labour income of all members of the household and total household income.

The following section, starting from EU-SILC, reports and compares the characteristics of the population in the three countries.

9.1.1 Individual and household characteristics in France, Italy and Sweden

The dataset used in order to prepare the input for the model consists on a total of 65,324 individual living in a household, precisely 25,510 French (where the 37.65 % are women) 52,433 Italian (where the 51.79 % are women) and 18,825 Swedish (where the 39.31 % are women) respondents. Among all the individuals we investigate the characteristics of interests, starting from the level of education, the partnership status and the employment characteristics, in particular the hourly wage for dependent workers. In order to give an overview of the distribution of respondents age by country, table 77 compares the different cohorts. Given the importance in the model of being able to clearly identify the different types of household, it is relevant also considering the partnership status of the respondents.

Table 77: Distribution of age, by country (percentage)

	Country		
Age	Italy	France	Sweden
0-4	4.14	4.97	5.60
5-9	4.67	6.66	5.35
10-14	4.75	6.90	6.37
15-19	5.06	6.90	10.35
20-24	5.21	6.44	5.99
25-29	5.30	5.34	4.99
30-34	6.40	5.33	5.97
35-39	7.60	6.90	6.45
40-44	7.99	7.26	7.38
45-49	7.70	7.18	7.24
50-54	6.84	6.76	6.90
55-59	6.22	6.85	6.39
60-64	6.55	6.06	6.65
65-69	5.96	4.46	4.82
70-74	5.49	4.07	3.56
75-79	4.55	3.80	2.79
80+	5.57	4.12	3.20
N	52,433	25,510	18,825

Table 78 reports a summary of the partnership status within the three countries for individuals older than 24 years, highlighting the higher percentage of married (and also the lower percentage of divorced) individuals in Italy if compared with those in the other two countries. However, note that cohabiting individuals -a phenomenon that is much more widespread in Sweden than in Italy- result single (given that they never got married).

Table 78: Partnership status, by country (percentage)

	Country		
Partnership Status (aged 25+)	Italy	France	Sweden
Single, never married	21.16	23.56	25.81
Married	64.35	60.43	59.28
Widowed	10.38	7.83	4.15
Divorced	4.11	8.18	10.76

Moving to the fertility characteristics, we have a quite heterogeneous situations among the three countries; specifically in Italy we have more than 42.5 percent of childless people, while among the remaining 57.5 percent who are parents, 25.50 percent have one child and 25.24 percent have two children (only the remaining 6.7 percent have more than two children); in a different situation we find Sweden, where we have 34 percent of childless people, 22.43 percent with one child, 28.86 percent two children and more than 13.5 percent with more than two children. France shows an intermediate composition, where among the 63.7 percent of the individuals with children (36.93 percent are childless), 25.9 percent have only one child, 34.1 percent have two children and almost 10 percent have more than two children. Another interesting feature is to find while considering particular age, in particular the percentage of couples in which the woman is aged between 24 and 40 that have at least one child on the total number of couples (again where the woman is aged 24-40) in the three countries: we see that in Italy, 78.10 percent of the married couples has at least one child, compared to the higher percent of 89.22 and of 85.57 recorded respectively in France and Sweden.

Finally, given that the model focuses on dependent workers only, Table 79 reports the number of dependent workers aged 25-64 by gender and country: note that this number is computed starting from the declared labour income of the respondents, that -in the dataset- is already split in income from dependent and independent work. Furthermore, we assume that individuals who declared to be students but recorded a positive labour income are only occasional workers; we then ignore them from the analysis. From the table we notice that the percentage of female and male workers is roughly the same in all the countries with the exception of Italy, where the percentage of male workers is higher.

Table 79: Dependent workers by gender and country (absolute number and percentage)

	Country		
	Italy	France	Sweden
Male Dependent Worker	8,243	4,828	3,742
percent	54.39%	49.98%	49.60%
Female Dependent Worker	6,912	4,831	3,802
percent	45.61%	50.020%	50.40%
N	15,155	9,659	7,544

Referring again to dependent workers only, we see that an important difference emerges when we compare Sweden with the other two countries. In particular, Italians and French earn on average a yearly individual gross labour income of 31,623 Euros and 31,650 Euros respectively (equal to a mean hourly wage of 17.65 Euros and 18.01 Euros), while Swedish dependent workers earn 36,217 Euros per year, equal to 20.97 Euros per hour. We infer hourly wage from monthly wage under the assumption of a monthly amount of 160 working hours for full time workers and 80 working hours per day for part-time workers; we made this assumption after noticing that the actual number of working hours reported by the respondents is often unreliable.

9.2 Calibration of Δ_1, Δ_2 and p

Regression profiles presented in Table 5 give us information about average wage level conditional on some factors, such as age, gender, and education $E(W|\cdot)$. A forecast from the regressions corresponds to $\hat{W} = \overline{W}_{(\cdot)}$, where $\overline{W}_{(\cdot)}$ is a simple mean of hourly wages conditional on $(\cdot)$. This condition includes age, gender and education, but to simplify notation we will simply use $(\cdot)$. We use the method of moments for the calibration of the wage rescaling factor, equalizing theoretical moments of the simplified two-points distribution that we use for simulations with their empirical counterparts:

$$p\big(\Delta_1\overline{W}_{(\cdot)}\big)^m + (1-p)\big(\Delta_2\overline{W}_{(\cdot)}\big)^m = \overline{W^m}_{(\cdot)}, \tag{36}$$

where $\overline{W}_{(\cdot)}$ is an estimate of hourly wages coming from regressions estimated in Table 5. Changing the level of m, we get three different equations. It is rather natural to use equations for the first moment (equalization of means), second moment (equalization of variances); however, we have not used an equation for the third moments (skewnesses), because there are good reasons to believe that hourly wages come from a distribution without a finite third moment. This is shown in the following subsection of this appendix. If we take an equation for a fractional moment close to 1 or 2 - the system of equations resembles the property of collinearity: one equation becomes too similar to another equation, making the system of equations unsolvable, or leading to unreliable results; therefore, it is better to choose out of two possible third equations: an equation for the moment of order 0.5 (as done in the main text), or an equation for the moment of order 1.5 (as done in section 9.2.2, as a robustness check).

Initially, we calculated wage rescaling factors for different types of agents (men/women, with high degree/without high degree) and different age (in groups of 5 years, as it is implemented in the model). Then wage rescaling factors were averaged across ages. Such a procedure works better than inserting all the data to equations (36) not distinguishing between their ages. This can be seen from the following: in the beginning of working age agents usually receive relatively small salaries. The maximal wages are received when agents are 45-50 years old. If we used the data not separated by age, high salaries would be mixed with low salaries, overestimating the variance of hourly wages for a specific age, and leading to a bias in equation for the second moment. It is more logical to estimate these parameters for different age groups, and to calculate the final estimate as a weighted average of age-specific recsaling factors, with weights equal to the number of observations in a specific age group. After the rescaling factors are calculated, their probability is adjusted in such a way, that the expectation of this rescaling factor would be equal to unity (equation for the first moment holds).

9.2.1 Number of moments in distributions underlying hourly wages

The problem of choosing an appropriate third equation is due to the fact that data often comes from heavy-tailed distributions. Often such distributions do not have third, fourth or another finite moment. It means, sometimes skewnesses, kurtoses and/or other moments are infinite or undefined.[19] In this case an equalization of the corresponding moments is not only meaningless, but can also lead to unreliable results. Therefore, we need to verify how large is the maximal finite moment in the distribution our data is drawn from. Now we do not need to distinguish between gender, education levels and different ages, since if these observations come from distributions with different "heaviness" of the tails, the estimated number of moments shall correspond to the distribution with the smallest tail index (smallest number

[19]If one finite moment does not exist, the moments of higher order do not exist either.

of moments).

Nowadays, the most popular methods for estimating tail indexes and finding the finite moments are based on the Hill estimator (Hill 1975). Hill estimator uses an assumption that the right tail of the distribution is similar to the Pareto distribution: $Pr(X > x) \approx cx^{-a}$, for some large x and a constant c, $c > 0$. Parameter a, $a > 0$ corresponds to the tail index. But usually it is not clear how many observations shall be treated as a tail, and used for estimation of the tail index. This problem is often solved in the following way: choosing different numbers of observations treated as a tail (denote them k), different Hill estimates are received. Plotting the Hill estimator over k gives us a Hill plot, and a region of stability shall give an inference about the tail index. As in Hill plots the region of stability often cannot be seen, Resnick and Stărică (Resnick and Stărică 1997) introduced an alternative Hill plot. They suggested to take the number of observations treated as a tail equal to n^{θ}, where n is a number of observations, and to plot Hill estimates over θ. We tried to use both methods; however, the region of stability was found only for Italy, tail indexes for distributions underlying French and Swedish data remaining unclear, since even the alternative Hill plots did not give the regions of stability. This indicates that the tails of the distributions may have other forms than Pareto. In order to solve for this problem, we use the method of Mandelbrot (Mandelbrot 1963). This method is sometimes criticized for its informality (Fedotenkov 2013), but it is rather popular in the literature (Cont 2001).[20]

The method of Mandelbrot works as follows: first the empirical moment of interest $\overline{W^m}$ is plotted over the number of observations used for its calculation. The method relies on the fact, that due to the Marcinkiewicz-Zygmund law of large numbers, if the corresponding finite moment exists, the curve shall exhibit some properties of convergence, when the number of observations is increased. If this is not the case, it is likely that the moment of interest is infinite.

On Figure 11 we present the second and third empirical moments as a function of observations used for its calculation for Italy. For the second moment the plot behaviour is rather stable, and we can conclude that the data comes from a distribution with a finite second moment. The behaviour of the third moment is unstable; therefore, it is likely that the third finite moment does not exist. Similar conclusions can be drawn for the distributions underlying hourly wages in France and Sweden (Figures 12 and 13). It is likely that they have finite variances, but skewnesses are infinite.

[20] For Italian data, both methods lead to the identical conclusions.

Figure 11: Mandelbrot plots for Italy

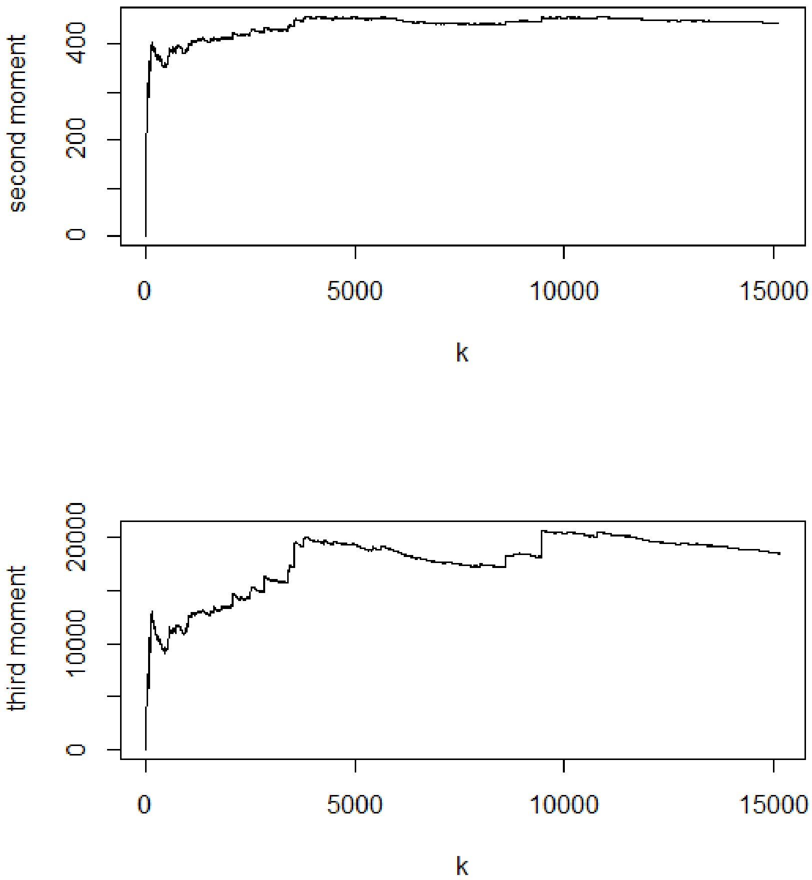


Figure 12: Mandelbrot plots for France

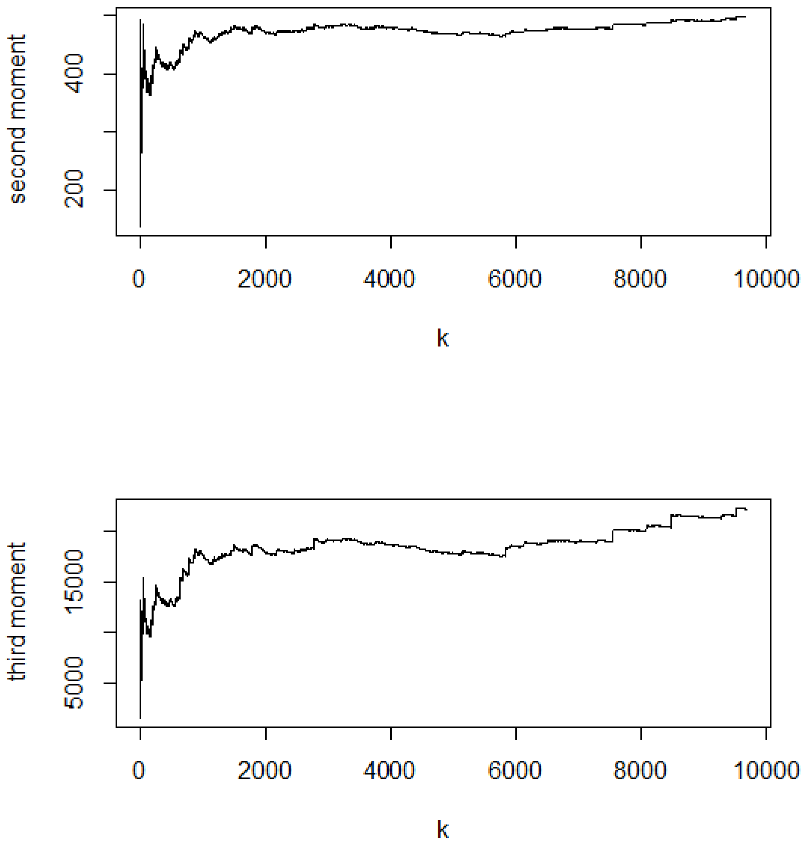
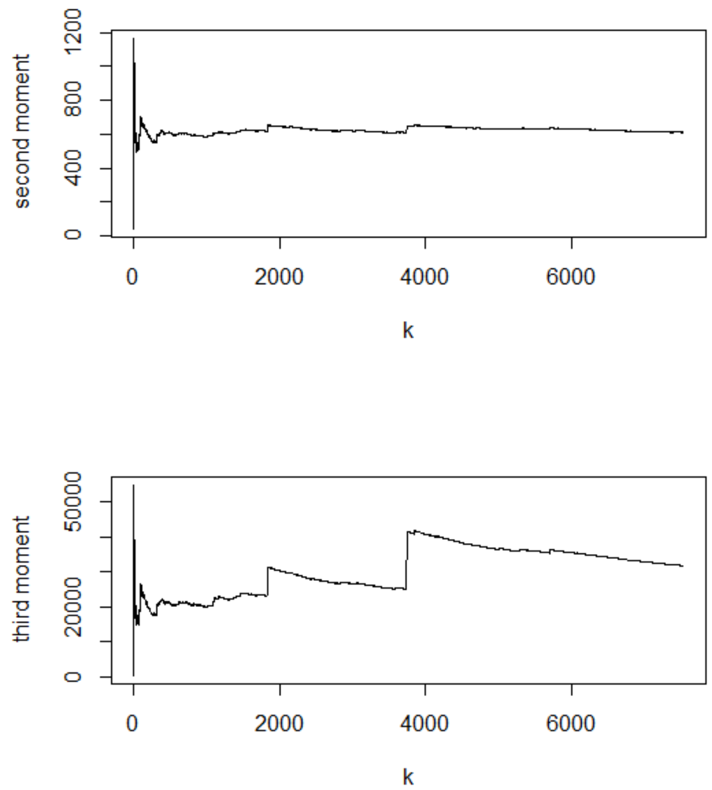


Figure 13: Mandelbrot plots for Sweden (third moment)



9.2.2 Robustness check with calibrated wage rescaling factors using equation for the 1.5 moment

Tables 81-82 present wage rescaling factors calculated by use of equation for the 1.5 moment for France, Italy and Sweden.

Table 80: Calibrated Δ_1, Δ_2 and p for France

	Δ_1	Δ_2	p
Women with high degree:	0.587176	1.912632	0.688542
Women without high degree:	0.526907	1.813196	0.632203
Men with high degree:	0.619846	2.117518	0.746170
Men without high degree:	0.464338	1.416055	0.437163

Table 81: Calibrated Δ_1, Δ_2 and p for Italy

	Δ_1	Δ_2	p
Women with high degree:	0.613444	2.068668	0.734367
Women without high degree:	0.512746	1.809730	0.624318
Men with high degree:	0.616514	2.301080	0.772353
Men without high degree:	0.681362	2.399998	0.814598

Table 82: Calibrated Δ_1, Δ_2 and p for Sweden

	Δ_1	Δ_2	p
Women with high degree:	0.527995	1.764908	0.618401
Women without high degree:	0.452503	1.487105	0.470814
Men with high degree:	0.616489	2.266470	0.767567
Men without high degree:	0.558690	1.520967	0.541390

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