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**Abstract**

We calibrate and simulate an heterogeneous agents OLG model to assess the impact of several reforms in which the personal income tax in Italy is replaced by a flat tax possibly complemented with a deduction. We find that a flat tax is welfare improving (according to a utilitarian social welfare function) only for specific subgroups of the population and for low values of the deduction.

**Keywords: personal income tax, income distribution, progressive tax, labor supply, heterogeneous agents OLG models**

**JEL Classification: E62, H31, J12, J21, J22**

## 1 Introduction

The paper studies the impact of replacing the current Italian personal income tax (PIT) with a flat tax.

PIT in Italy has an individual tax unit, increasing marginal tax rates and tax credits that decrease with income and take into account the family structure and the source of income received by the tax payer. Though in principle several types of income may be subject to the PIT, the largest component of the tax base is labor income (namely income of the employees) and pension benefits; indeed most of capital income is taxed through proportional taxes. We look at the impact of replacing this structure of the PIT with a simple flat tax, i.e. a tax with a constant marginal tax rate. We also explore the effects

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of complementing the flat tax with a tax deduction, whose value depends on the family structure.[1]

To this end we build a stochastic, small open economy OLG model with both ex-ante and ex-post intragenerational heterogeneity. Individuals within a generation are heterogeneous ex-ante along several dimensions (gender, marital status, presence of children and education) that influence labour productivity; moreover labor productivity is also affected by an idiosyncratic shock that follows a Markov process. An household, which can be a couple or a single-person household, in each period decides how much to consume and to save, as well as the labor supply of its members. In addition to the intensive margin of labor supply (i.e. the number of hours worked conditional upon working), we also explicitly model the extensive margin (i.e. the decision to participate or not to the labor market); we do this by introducing in the utility function a fixed participation cost which makes the utility function non-concave. In this enviroment we model the current Italian PIT, paying attention to reproduce all the relevant institutional features. Since pension benefits, together with labor income, represent the main component of the tax base, we also model the pension system. Finally we introduce proportional taxes on capital income and consumption. The model is solved numerically. Some parameters are chosen using estimates available in the literature while others are set using a calibration procedure. We show that the model is capable to reproduce relevant statistics that are not used as calibration targets, namely statistics on the distribution of labor income. We then perform several policy experiments in which the PIT is replaced by a flat tax with a tax deduction that can take diffent values. In particular for a single-person household we consider tax deductions equal to 0€, 2000€, 4000€, 8000€; this tax deductions are multiplied by an equivalence scale in case of a couple and if chidren are present. All the policy experiments we perform assume the government budget is balanced: in particular it's the flat marginal tax rate that is adjusted to balance the budget.

The shape of the PIT is a long-standing issue in the optimal taxation literature. A first strand of literature use static models. While the numerical simulations contained in the seminal work of Mirrlees (1971), suggest that a flat tax with a lump sum transfer could be not far from being optimal, more recent papers has criticized this view. For instance Diamond (1998) and Saez (2001) argue in favor of a U-shaped relationship between marginal tax rates and income; Heathcote and Tsujiyama (2020) find for the USA that the optimal tax schedule entails marginal tax rates that always increse with

[1] Similar reforms have been repeatedly proposed in Italy in the last years by some political parties (Baldini and Rizzo (2020))

income.

Another strand of literature uses dynamic models. Conesa and Krueger (2006) build an OLG model with intragenerational heterogeneity driven by an idiosyncratic productivity shock to discuss the issue of the optimal tax schedule in USA within the class of Gouveia and Strauss (1994) tax functions: they find that a flat tax with a tax deduction turns out to be optimal. Other papers, which are even more relevant for our analysis, do not try to characterize the optimal tax schedule in general but study the impact of replacing the current tax system in a given country with a flat tax. Ventura (1999) uses an OLG model with intragenerational heterogeneity driven by an idiosyncratic productivity shock in order to study the impact of a reform in which the PIT in the USA is replaced by a flat tax with a tax deduction. He finds sizeable positive effects on capital accumulation and mild positive effects on labor supply, as well as a more concentrated distribution of income and wealth. Guner et al. (2012) consider a model in which intragenerational heterogeneity is determined by gender, marital status, number of children, education and an extensive margin of labor supply is explicitly introduced. They study the impact of introducing a purely proportional flat tax in the USA and show that it positively affects output and generate welfare effects that are positive at an aggregate level, but very heterogeneous in sign and magnitude among individuals.

The model we use is similar to that of Guner et al. (2012), though there are important differences between our analysis and their paper. First the institutional setup is obviously different: their paper is about the USA while we study the Italian case. When assessing the effect of a reform, the *status quo* is obviously important and differences between Italy and USA seem to be of first order: on the one hand the tax unit of the US PIT is the household while in Italy the tax unit is the individual; on the other hand, as pointed out by Colonna and Marcassa (2015), in Italy there are however tax credits for children and for non-working spouses that could play an important role for working incentives of two-earner families. Second Guner et al. (2012) look at the case of a proportional flat tax while we also consider the impact of tax deductions that makes the flat tax progressive.

There are also differences related to some modelling features. With respect to our model, Guner et al. (2012) have more heterogeneity in educational levels, in childbearing and in the fixed cost of participating to the labor market; with respect to their model, we also have wage uncertainty due to the idysincratic productivity shock and endogenously determined pension benefis. As previously remarked, explicitly modelling pension benefits is important given that, at least for the Italian PIT, they represent an important fraction of the tax base. The introduction of wage uncertainty is also relevant since a tax with increasing marginal tax rates could play an insurance role that cannot be appreciated in a model with deterministic income.[2]

The paper is organized as follows. In Section 2 we describe the model we use. In Section 3 we parametrize the model, solve it numerically and discuss its performance in matching some relevant statistics. In Section 4 we perform our computational experiments, i.e. the Italian PIT is replaced by a flat tax with different values of the tax deduction. Finally section 5 concludes.

# 2 The model

We build a stochastic, small open economy OLG model with both ex-ante and ex-post intragenerational heterogeneity. In the next subsections we describe the model in details; here we provide a general overview, briefly summarizing the key assumptions concerning the consumers side, the production side, and market equilibrium.

Consumers live up to a maximum of $\bar{J}$ periods but they may die before according to a gender specific conditional survival probability $\psi_g(j+1)$, which defines the probability to be alive at age $j+1$ conditional on being alive at age $j$ for a consumer of gender $g = m, f$, where $m$ and $f$ denote respectively a male and a female consumer. In addition to gender $g$, consumers within a generation differ ex-ante also along other dimensions: marital status, number of children and level of education. For the sake of tractability we make some simplifying assumptions.[3] As to marital status, we posit that consumers enter the model economy as married or singles, i.e. we do not consider the possibility of cohabitation between two not legally married partners. Second we assume that marital status can only change along the life cycle of an individual due to the death of one of the two spouses, i.e. we allow for widows and widowers but we do not consider the possibility of marriages after the individuals entered the model economy and the existence of divorced people. Third we assume that married individuals have the same age. As to children, we make the assumption that each woman can have zero or two children and we also restrict the possibility of having children to married couples. As to the level of education, we assume that consumers enter the model economy

[2] The model we use is also similar to that of Bucciol et al. (2017), who however do not study the impact of introducing a flat tax: their focus is on the differences between life cycle inequality and annual inequality. The main difference between our model and their model is that we also consider explicitly the extensive margin of labor supply: in Section 4 we show that this margin is extremely relevant when assessing the impact of the flat tax in Italy.

[3] We here refer to computational tractability, since the model, as explained later, will be solved numerically.

as high or low skilled and their level of education stays constant along the life cycle.

Ex ante heterogeneity in education, marital status, number of children and age affects individual productivity (the so called efficiency units) which ex post does also depend on the realization of an uninsurable idiosyncratic shock which is independently distributed across agents. The law of large number holds and accordingly there is individual uncertainty but not uncertainty at an aggregate level.

Each individual has preferences defined over consumption and labor but the decision unit is the household. A single-person household maximizes the intertemporal utility function of its only member. The members of a couple pool their resources together and maximize the sum of their intertemporal utilities. At each age $j < J^R$, where $J^R$ is the retirement age, a household choose labor supply of its members, consumption and assets, taking into account the existence of a non-negativity constraint on assets. When $j > J^R$, only the intertemporal consumption choice is relevant. We assume that there is no intergenerational altruism and accordingly there are no voluntary bequests. However, since the length of life is stochastic, unvoluntary bequests may be present. We posit that unvoluntary bequests are confiscated by the government and distributed as lump transfers to all people in the age group $\left[J_1^B, J_2^B\right]$. In addition, the government levies a personal income tax on labor income (PIT), social security contributions, a capital income income tax and a consumption tax; it also pays old-age pensions and survivors' pensions.

The structure of the production side of the model is entirely standard. We consider only one sector producing a good with a constant return to scale technology whose inputs are capital and labor in efficiency units. In each period this good is chosen as the *numeraire* of the economy and it can be used for both consumption and investment purposes.

Finally we assume that markets are competitive and that the economy is in equilibrium. We focus on a steady state equilibrium and therefore we omit time subscripts.

We now describe the building blocks of our model economy in details.

## 2.1 Firms

The physical good $Y$ is produced by a representative firm using a Cobb-Douglas technology:

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

where $A$ is total factor productivity (assumed constant over time), $K$ is aggregate capital stock, $L$ is aggregate labour supply in efficiency units and

$0 < \alpha < 1$ is the capital share.

Profit maximisation implies the standard conditions:

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

$$r + \delta = \alpha A k^{1-\alpha} \tag{3}$$

where $w$ is the wage rate per efficiency unit, $r$ is the return on assets, $\delta$ is the depreciation rate of capital and $k \equiv K/L$ is the capital-labor ratio.

## 2.2 Households

In the model we have single-person households and couples. A single maximizes his/her intertemporal utility subject to a sequence of per-period budget constraints. A couple maximizes the sum of the intertemporal utilities of its members taking into account a sequence of per-period budget constraints in which the resources of the members are pooled toghether.

We assume that each individual of gender $g$ has an additively time separable intertemporal utility function with a per-period discount factor equal to $\beta$ and a momentary utility function equal to:

$$u_g(q_g, l_g) = \begin{cases} \frac{1}{1-\frac{1}{\gamma}} q_g^{1-\frac{1}{\gamma}} - \nu_g \frac{1}{1+\frac{1}{\rho}} l_g^{1+\frac{1}{\rho}} - \zeta & \text{if} \quad \gamma \neq 1 \\ \ln q_g - \nu_g \frac{1}{1+\frac{1}{\rho}} l_g^{1+\frac{1}{\rho}} - \zeta & \text{otherwise} \end{cases} \tag{4}$$

where $q_g \geq 0$ is individual consumption, $l_g \geq 0$ is labor supply, $\gamma > 0$ is the intertemporal elasticity of substitution in consumption, $\rho > 0$ is the intertemporal elasticity of substitution in labor, $\nu_g > 0$ is the weight of labor in the momentary utility function and $\zeta \geq 0$ is a fixed cost related to labor market participation. For singles of gender $g$ this fixed cost is $> 0$ when $l_g > 0$; for each member of a couple this fixed cost is $> 0$ when both $l_m$ and $l_f$ are $> 0$. Note that we allow preferences to be potentially heterogeneous along the gender dimension since the weight of labor potentially depends on gender.

The resources of an household are represented by assets, capital income, labor income and pensions. We denote assets by $a$ and accordingly capital income is $ra$ where $r$ is the interest rate. Labor income of an individual of gender $g$ is given by $w\omega l_g$ where $w$ is the wage rate per efficiency unit, $l_g$ is labor supply and $\omega$ are the efficiency units per hour of work, which depend on gender, age, marital status, education, number of children and the idyosincratic productivity shock. During retirement, labor income is equal to zero by assumption but each agent may receive an old age pension. In accordance with the Italian law we assume that a notional defined pension system is in place; accordingly the pension benefit depends on the capitalized value of social security contributions paid during the working life, where the notional capitalization rate is chosen by the government. Moreover widow and widowers may also receive a survivor pension. The overall amount of pension benefits received (old-age pension plus survivor pension) by an individual of gender $g$ will denoted by $p_g$. The government collects social security contribution at a rate equal to $\tau_s$. Moreover it levies a proportional capital income tax and a consumption tax whose rates are respectively equal to $\tau_r$ and $\tau_q$. Finally, labor income net of social contributions and pension benefits are taxed using a progressive personal income tax whose functional form will be later specified: revenues collected by the personal income tax from an individual of gender $g$ are denoted by $pit_g$.

We represent the intertemporal optimization problem of the household using dynamic programming. The individual state vector $x$ of a household depends on both exogenous and endogenous state variables. The first exogenous state variable is the household type, i.e. couple, never married single male, never married single female, widow, widower.

For a couple, the other exogenous state variables are: age $j$, the number of children $\kappa$, educational levels $h_g$ and the idiosyncratic shocks $\xi_g$ of the spouses. The endogenous state variables are assets and the value $b_g$ of capitalized social security contributions of each spouse. Accordingly we write the state vector of a couple as:

$$x_{co} = (a, b_m, b_f, h_m, h_f, \xi_m, \xi_f, \kappa, j) \tag{5}$$

For never married single of gender $g$ the state vector is:

$$x_{s_g} = (a, b_g, h_g, \xi_g, j) \tag{6}$$

For a widowed person of gender $g$ (whose deceased spouse is denoted by $\bar{g}$) the state vector is:

$$x_{w_g} = (a, b_g, b_{\bar{g}}, h_g, \xi_g, j) \tag{7}$$

Note that the value of the idiosyncratic shock to labor productivity is really relevant only for $j < J^R$ because in retirement labor income is by assumption zero.

With a compact notation, the individual state vector can be also denoted by:

$$x = (a, b_m, b_f, h_m, h_f, \xi_m, \xi_f, \kappa, ms, j) \tag{8}$$

where $x = x_{co}$ if $ms = co$ (i.e. the case of a couple), $x = x_{s_g}$ if $ms = s_g$ (i.e. the case of a never married individual of gender $g$), $x = x_{w_g}$ if $ms = w_g$ (i.e.

the case of a windowed person of gender $g$). For future reference, it is also useful to write the individual state vector isolating the age $j$ from the other state variables:

$$x = (\bar{x}, j) \tag{9}$$

where $\bar{x} = (a, b_m, b_f, h_m, h_f, \xi_m, \xi_f, \kappa, ms)$. The joint distribution between households of the state variables $\bar{x}$ at age $j$ is denoted by $\chi_j(\bar{x})$. Given the initial distribution $\chi_1(\bar{x})$, the evolution of $\chi_j(\bar{x})$ for $j > 1$ depends on transition equations and decision rules.

The transition equation for assets is the per-period budget constraint:

$$a' = m - (1 + \tau_c)c \tag{10}$$

where:

$$m = a + (1 - \tau_r)ra + \sum_{g=m,f} \chi_g \left[(1 - \tau_s)w\omega l_g + p_g - pit_g + tr_g\right] \tag{11}$$

$$\chi_g = \begin{cases} 1 & \text{if g belong to the household} \\ 0 & \text{otherwise} \end{cases} \tag{12}$$

$tr_g$ is a lump-sum transfer from the government financed out of unvoluntary bequests and $c$ is household consumption. Individual consumption $q_g$ is equal to the aggregate consumption of the household $c$ divided by an equivalence scale $\theta$:

$$q_g = \frac{c}{\theta} \tag{13}$$

The equivalence scale $\theta$, which depends on the number of adults and children in the household, will be specified later.

The transition equation for the capitalized value of social security contributions is:

$$b'_g = (1 + r_b)\left(b_g + \tau_s w\omega l_g\right) \tag{14}$$

where $r_b$ is the notional rate at which social security contributions are capitalized.

The transition equation for the number of children $\kappa$ is:

$$\kappa' = \mathrm{G}(\kappa, j) = \begin{cases} \kappa & \text{for } j \leq J^\kappa \\ 0 & \text{otherwise} \end{cases} \tag{15}$$

where $J^\kappa$ is the age at which children form their own household.

The level of education $h_g$ is constant along the life cycle.

The idiosyncratic shock $\xi_g$ follow a discrete state Markov process with transition probabilities $p_{h_g}(\xi'_g \mid \xi_g)$ that depend on the level of education.

If we denote the value function by $V(\cdot)$, the optimization problem of a never married person of gender $g$ can be written as:

$$V_g(x_{s_g}) = \max_{q_g, l_g} u_g\left(q_g, l_g\right) + \beta\psi^g_{j+1} \sum_{\xi'_g} p_{h_g}(\xi'_g \mid \xi_g) V_g(x'_{s_g}) \tag{16}$$

subject to the inequality constraints on control variables

$$l_g \geq 0, q_g \geq 0; \tag{17}$$

the non-borrowing constraint

$$a \geq 0; \tag{18}$$

the transition equations (10) and (14) respectively for assets and for the capitalized value of social security contributions; the relationship (13) between individual and household consumption.

A widowed person of gender $g$ solve a similar problem in which the state vectors $x_{s_g}$ and $x'_{s_g}$ are replaced by the state vectors $x_{w_g}$ and $x'_{w_g}$ and there is the additional constraint represented by the transition equation (15) for the number of children.

A couple solve:

$$\begin{aligned} V(x_{co}) = \max_{q_m, q_f, l_m, l_f} & u_m\left(q_m, l_m\right) + u_f\left(q_f, l_f\right) + \\ & \beta\psi^m_{j+1}\left[\psi^f_{j+1} \sum_{\xi'_m, \xi'_f} p_{h_m}(\xi'_m \mid \xi_m) p_{h_f}(\xi'_f \mid \xi_f) V_m(x'_{co}) + \right. \\ & \left. \left(1 - \psi^f_{j+1}\right) \sum_{\xi'_m} p_{h_m}(\xi'_m \mid \xi_m) V_m(x'_{w_m})\right] + \\ & \beta\psi^f_{j+1}\left[\psi^m_{j+1} \sum_{\xi'_m, \xi'_f} p_{h_m}(\xi'_m \mid \xi_m) p_{h_f}(\xi'_f \mid \xi_f) V_f(x'_{co}) + \right. \\ & \left. \left(1 - \psi^m_{j+1}\right) \sum_{\xi'_f} p_{h_f}(\xi'_f \mid \xi_f) V_f(x'_{w_f})\right] \end{aligned} \tag{19}$$

subject to the inequality constraints (17), which must hold for all $g$, the non-borrowing constraint (18), the transition equations (10) and (14) respectively for assets and for the capitalized value of social security contributions, the transition equation (15) for the number of children and the relationship (13) between $q$ and $c_g$.

The solutions to the optimization problems of the different types of households give the following decision rules for the control variables:

$$c = c^\star(\bar{x}, j) \tag{20}$$

$$l_m = l_m^\star(\bar{x}, j) \tag{21}$$

$$l_f = l_f^\star(\bar{x}, j) \tag{22}$$

Substituting this decion rules in the transition equations (10) and (14) we finally get the decision rules for the endogenous state variables:

$$a' = a^\star(\bar{x}, j) \tag{23}$$

$$b_g' = b_g^\star(\bar{x}, j) \tag{24}$$

### 2.3 Government

The government collects revenues through the personal income tax, the social security contributions, the capital income tax and the consumption tax; it uses these revenues to finance pension benefits and government consumption. Government consumption is assumed to not affect the utility of individuals.[4]

We assume that the government runs a balanced budget:

$$G = T + SC + T_a + T_c - P \tag{25}$$

where $T$, $SC$, $T_a$, $T_c$ are aggregate revenues from the personal income tax, the social security contributions, the capital income tax and the consumption tax; $P$ is aggregate pension expenditure; $G$ is aggregate government consumption. [5] In our benchmark economy, i.e. when the personal income tax takes the form actually in place in Italy, the endogenous variable that changes in order ensure a balanced budget is government consumption $G$. In our alternative scenarios, in which the personal income tax takes the form of a flat tax, the budget balancing variable is the unique marginal tax rate of the flat tax, while $G$ is kept constant at the value computed in the benchmark economy.

[4] Equivalently we can assume that government consumption enters the utility function of the consumers in an additive way.

[5] Note that there is no separate budget for the pension system: social contributions and pension benefits enter the general budget of the government. This modelling choice is motivated by the fact that the balance of the pension system is not the focus of our analysis; moreover in Italy revenues from taxes can be used, if social contributions are not enough, to finance the pension system.

Moreover the government taxes unvoluntary bequests at a rate equal to 100% and redistribute them through a lump-sum transfer:

$$TR = B \tag{26}$$

where $B$ represents aggregate bequests and $TR$ is the aggregate transfer financed out of them.

## 2.4 Recursive Competitive Equilibrium

We consider the case of a small open economy. Given the world interest rate $\bar{r}$, the tax rates on capital income and consumption $\tau_r$ and $\tau_c$, the social contribution rate $\tau_{ss}$, the personal income tax function and pension rules, a small open economy steady state competitive equilibrium is defined as a collection of factor prices $w$ and $r$, aggregate capital stock $K$, aggregate labour in efficiency unit $L$, households' distributions $\chi_j(\bar{x})$, households' decision rules $c^\star(\bar{x}, j)$,$l^\star_m(\bar{x}, j)$,$l^\star_f(\bar{x}, j)$,$a^\star(\bar{x}, j)$,$b^\star_m(\bar{x}, j)$,$b^\star_f(\bar{x}, j)$, aggregate accidental bequests $B$, aggregate government's revenues ($T$, $SC$, $T_a$, $T_c$) and expenditures ($P$, $G$, $TR$) such that: $r = \bar{r}$, and first order conditions of the firm (2) and (3) hold; household decision rules are the solution of the dynamic programming problems described by equations (16) and (19); the distribution of households is consistent with individual behaviour, i.e. it evolves according to household decision rules and transition equations; aggregate quantities are consistent with individual beahviour; market clearing conditions hold; government revenues and expenditures satisfy the government budget constraints (25) and (26).

# 3 Calibration

The model is solved numerically. In particular to solve the dynamic optimization problem of the households we use the NEGM algorithm of Druedahl (2020). Once the decision rules of the households have been determined, we simulate the behaviour of 26690 households: the initial values of the exogenous state variables characterizing these households are chosen in order to match some empirical moments. We now present the calibration choice we make and we also discuss the ability of the model to match some key variables that are not used as calibration targets.

### Demographics and education

Individuals enter the model (i.e. they form their own houshold and take active decisions) when they are 25 years old. When they are 65 they start their retirement period and they can live up to a maximum of 100 years. The age range in which individuals may receive a bequest is assumed to be $(45, 64)$. The model period is set equal to 5 years and accordingly we have $\hat{J} = 15$, $J^R = 9$, $J^\kappa = 5$, $J_1^B = 5$ and $J_2^B = 8$.To reduce computational burden, we assume that the conditional survival probability by gender $\psi_g(j+1)$ is below 1 only when $j \geq J^R$ (the precise values are taken from Bucciol et al. (2017)). Accordingly we can have widowed persons only in the retirement period.

We now describe the composition of the population by gender, education, marital status and number of children in the first model period. We assume that there is the same number of men and women. The fraction of men with a college degree is set equal to 18.1% while for women it is equal to 25.8% (these are Eurostat data for the age group 25-54 in 2019). The fractions of couples and single-person households (respectively 67% and 33%), as well as the fraction of couples with children (83%) and the correlation between educational levels in a couple (0.4130), are once again taken from Bucciol et al. (2017).

Finally, the annual population growth is assumed to be equal to 0.3% which is the average annual growth rate of the population in the period $1970 - 2019$ according to the Eurostat database.[6]

**Preferences**

The value of $\gamma$, i.e. the intertemporal elasticity of substitution of consumption, is set equal to 1. The value of $\rho$, i.e. intertemporal elasticity of substitution of labor supply, is chosen equal to 0.2.

The weight of labor $\nu_g$ and the participation cost $\zeta$ are set in order to match the average labor supply by gender of those who work and the overall (i.e. without distinguishing between males and females) activity rate. According to Eurostat data, in 2019 the activity rate is equal to 72.9%, while the average number of working hours in the main job per week of employed persons is equal to 38.6 for males and 32.1 for female. Assuming, as it is usually done, that time available for discretionary use amounts to 100 hours per week, we require average labor supply for males (females) to be equal to

[6] Note that a positive growth rate of the population $n$ is per se inconsistent with the assumptions we make on the fertility behaviour of households, i.e. the maximum amount of children per household is equal to two and singles cannot have children. Indeed such assumptions would imply a negative $n$. To deal with this problem, we assume that in each period there is an inflow of newborn migrants, such that the size of the new born cohort (natives plus migrants) produces the assumed value of $n$. Moreover we assume that such newborn migrants have the same characteristics of native individuals.

about 39% (32%) of the time endowment that in the model is normalized to 1. These calibration targets imply $\nu_m = 10$, $\nu_m = 27$ and $\zeta = 0.51$.

The discount factor $\beta$ is calibrated to have a ratio between private savings and GDP equal to about 4.5% (Eurostat data for 2019). The implied discount factor on an annual basis is equal to 0.97.

The equivalence scale $\theta$ is the OECD equivalence scale, which is the square root of the household size including both adults and children.

### Production

The small economy assumption implies that the return on capital $r$ is set equal to the world return on capital $\bar{r}$, which is set equal to 6.5% on an annual basis. The total factor productivity $A$ is chosen in such a way that the wage rate per efficiency unit $w$ is normalised to 1; this calibration procedure implies $A = 1.5886$. The share of capital income $\alpha$ is set equal to 47.3%: thus the labor share is 52.7% which is the adjusted labor share in Italy for 2019 according to the Ameco database. Finally, the annual depreciation rate $\delta$ is chosen equal to 5.6%.

### Structure of wages

Since the wage rate per efficiency unit $w$ has been normalized to 1, the wage rate per hour of work $w\omega$ is equal to the efficiency units per hour of work $\omega$. As explained in Section 2, efficiency units per hour of work are a function of gender, age, marital status, education, number of children and an idiosyncratic productivity shock that follow a Markov process with education specific transition probilities. The choice of the precise functional form for this relationship and the setting of its parameters is borrowed from Bucciol et al. (2017). First they estimate for Italy, sperately for college and non-college graduates, the following model:

$$\ln(\omega) = \phi_0 + \sum_{i=1}^{19} \phi_i x_i + \epsilon, \tag{27}$$

$$\epsilon = \eta + u \tag{28}$$

$$\eta' = \rho\eta + v \tag{29}$$

$$u \perp\!\!\!\perp v \quad u \overset{iid}{\sim} \mathcal{N}\left(0, \sigma_u^2\right) \quad v \overset{iid}{\sim} \mathcal{N}\left(0, \sigma_v^2\right) \tag{30}$$

where $\phi_i$ are parameters and $x_i$ denotes explanatory variables: $x_i$ for i=1,...,6 are 5 years age dummies from age 24 to 54; $x_7$ is a dummy for gender; $x_8$ is a dummy for marital status; $x_9$ and $x_{10}$ are dummies for the presence of children in the age range 0-5 and 6-24 respectively; $x_i$ for i=11,...,19 are year dummies for the years 2003-2011. Then they obtain the individual wage per hour of work as: [7]

$$E\left(\omega' \mid \eta\right) = e^{\left(\hat{\phi}_0+\sum_{i=1}^{10}\hat{\phi}_i x_i+\hat{\rho}\eta\right)} e^{\left(\frac{\hat{\sigma}_v^2+\hat{\sigma}_u^2}{2}\right)} \tag{31}$$

where the ˆ denotes an estimated value.[8] Finally they discretize the AR(1) process in equation (29) using the Tauchen (1986) method with 4 nodes and they find the values of nodes and the transition probabilities $p_h(\xi' \mid \xi)$ of the Markov process for the idyosincratic shock. The wage rates per hour of work used in the numerical solution of the model are thus obtained replacing $\rho\eta$ with $\xi'$ in equation (31).

### Policies

Tax rates $\tau_c$ and $\tau_r$ are respectively set equal to 18% and 11% in order to have revenues from the consumption tax and the capital income tax respectively equal to 11.1% and 3.5% of GDP (Eurostat (2020).[9]

The rate $\tau_s$ is set to 33% which is the standard contribution rate, including both contributions paid by the employer and by the employee. The public pension system in Italy has been subject to some important reforms in the last 30 years. In particular in 1995 a notional defined contribution system (NDC) has replaced the previous earning related system: however a long transition phase has been arranged and only in the long run all the pensions will be paid according to the NDC system. In our model economy, we have made the simplifying assumption that only the NDC system is present. In such a system, the capitalized value of social contributions at retirement age is computed, using a notional return rate equal to a 5-year moving average of the growth rate of GDP (which in our model economy is equal to the growth rate of the population). To get the annual pension, this capitalized value of

[7]The term $e^{\frac{\sigma_v^2+\sigma_u^2}{2}}$ in the prediction of $\omega$ given by equation (31) is due to the fact that the estimation has been done on a model in which the dependent variable is in ln (see for instance Wooldridge (2013))

[8]The estimates they obtain for non-college graduates are: $\hat{\phi}_0 = 2.436$, $\hat{\phi}_1 = -0.342$, $\hat{\phi}_2 = 0.251$, $\hat{\phi}_3 = -0.193$, $\hat{\phi}_4 = -0.139$, $\hat{\phi}_5 = -0.070$, $\hat{\phi}_6 = -0.010$, $\hat{\phi}_7 = 0.102$, $\hat{\phi}_8 = 0.019$, $\hat{\phi}_9 = 0.008$, $\hat{\phi}_{10} = 0.007$, $\hat{\rho} = 0.848$, $\hat{\sigma}_u^2 = 0.058$, $\hat{\sigma}_v^2 = 0.237$; for college graduates: $\hat{\phi}_0 = 2.912$, $\hat{\phi}_1 = -0.717$ , $\hat{\phi}_2 = -0.524$, $\hat{\phi}_3 = -0.364$, $\hat{\phi}_4 = -0.285$, $\hat{\phi}_5 = -0.176$, $\hat{\phi}_6 = -0.110$, $\hat{\phi}_7 = 0.141$, $\hat{\phi}_8 = 0.097$, $\hat{\phi}_9 = 0.007$, $\hat{\phi}_{10} = 0.047$, $\hat{\rho} = 0.838$, $\hat{\sigma}_u^2 = 0.071$, $\hat{\sigma}_v^2 = 0.240$.

[9]For data on capital income tax we consider those on capital income of households and corporations.

social contribution is then multiplied by a coefficient that takes into account life expectancy at retirement age.

In addition to the old age pension described above, we also model survivors' pensions. In Italy such benefits are determined as follows:

$$p^{surv} = \begin{cases} 0.6p^o & \text{if} \quad y \leq 20087.73 \\ \max\{y + 0.45P, 20087.73 + 0.6p^o\} - y & \text{if} \quad 20087.73 < y \leq 26783.64 \\ \max\{y + 0.36P, 26783.64 + 0.6p^o\} - y & \text{if} \quad 26783.64 < y \leq 33479.55 \\ \max\{y + 0.3P, 33479.55 + 0.6p^o\} - y & \text{if} \quad y > 33479.55 \end{cases} \tag{32}$$

where $p^o$ is the old-age pension of the deceased spouse and $y$ is the income of the survived spouse (only the income belonging to the tax base of the PIT must be considered).

As to the personal income tax (PIT), it is progressive and the tax unit is the individual. The tax base $y$ includes several items and in particular labor income (of the employees and the self employed) net of social contributions, pension benefits, non-corporate business income and some types of capital incomes (most of capital income is taxed through a proportional tax). However, labor income net of social contributions (namely income of the employees) and pension benefits are the largest components of the tax base: in 2018 the 52.6% of the tax base was represented by income of the employees and the 29.3% was given by pension benefits (data of the Ministry of Finance). Accordingly, for the sake of simplicity, in the model we assume that only labor income net of social contributions and pension benefits are subject to the progressive PIT, while all capital income is taxed using the proportional tax whith a rate $\tau_r$ mentioned above. Thus we have $y = (1 - \tau_s)w\omega l + p$.

The tax brackets and the legal marginal tax rates of the PIT are:

[Table 1 about here.]

and accordingly the tax function is:

$$t(y) = \hat{t}(y) - F \tag{33}$$

where:

$$\hat{t}(y) = \begin{cases} 23\%y & \text{if} \quad y \leq 15000 \\ 3450 + 27\%(y - 15000) & \text{if} \quad 15000 < y \leq 28000 \\ 6960 + 38\%(y - 28000) & \text{if} \quad 28000 < y \leq 55000 \\ 17220 + 41\%(y - 55000) & \text{if} \quad 55000 < y \leq 75000 \\ 25420 + 43\%(y - 75000) & \text{if} \quad 75000 < y \end{cases} \tag{34}$$

and $F$ denotes the sum of different types of tax credits: the tax credits that depend on the source of income and the tax credits that depend on the family structure.

The tax credit for an employee is:

$$F_{y_l} = \begin{cases} 1880 & \text{if} \quad y \leq 8000 \\ 978 + 902\frac{28000-y}{20000} & \text{if} \quad 8000 < y \leq 28000 \\ 978\frac{55000-y}{27000} & \text{if} \quad 28000 < y \leq 55000 \\ 0 & \text{if} \quad y > 55000 \end{cases} \tag{35}$$

Moreover for an employee there is an additional tax credit (which is called "bonus"), whose value, starting from 1st July 2020, is:

$$F_B = \begin{cases} 600 & \text{if} \quad y \leq 28000 \\ 480 + 120\frac{35000-y}{7000} & \text{if} \quad 28000 < y \leq 35000 \\ 480\frac{40000-y}{5000} & \text{if} \quad 35000 < y \leq 40000 \\ 0 & \text{if} \quad y > 40000 \end{cases} \tag{36}$$

The tax credit for a pensioner is:

$$F_{y_P} = \begin{cases} 1880 & \text{if} \quad y \leq 8000 \\ 1297 + 583\frac{15000-y}{7000} & \text{if} \quad 8000 < y \leq 15000 \\ 1297\frac{55000-y}{40000} & \text{if} \quad 15000 < y \leq 55000 \\ 0 & \text{if} \quad y > 55000 \end{cases} \tag{37}$$

The tax credit if the individual has a dependent spouse, i.e. a spouse with income below 2840.51 is:

$$F_s = \begin{cases} 880 - \frac{110y}{15000} & \text{if} \quad y \leq 15000 \\ 690 & \text{if} \quad 15000 < y \leq 29000 \\ 700 & \text{if} \quad 20000 < y \leq 29200 \\ 710 & \text{if} \quad 29200 < y \leq 34700 \\ 720 & \text{if} \quad 34700 < y \leq 35000 \\ 710 & \text{if} \quad 35000 < y \leq 35100 \\ 700 & \text{if} \quad 35100 < y \leq 35200 \\ 690 & \text{if} \quad 35200 < y \leq 40000 \\ 690\frac{80000-y}{40000} & \text{if} \quad 40000 < y \leq 80000 \\ 0 & \text{if} \quad y > 80000 \end{cases} \tag{38}$$

The tax credit for each dependent child is:

$$F_c = f_c \frac{95000 + 15000\,(n_{kids} - 1) - y}{95000 + 15000\,(n_{kids} - 1)} \tag{39}$$

where $n_{kids}$ is the number of children, $f_c = 1250$ if the age of the child is $< 3$ years and $f_c = 950$ if the age of the child is $\geq 3$ years. The tax credit $F_c$ is equally distributed between the two spouses who can however decide to give all the tax credit to the spouse the highest income.

Notice that the tax function is equal to equation (33) if and only if the tax is positive; otherwise the tax is simply equal to zero, i.e. there is no negative income tax in Italy.

### Properties of the benchmark model economy

We now look at the performance of the model in terms of its ability to match some statistics that have not been used as calibration targets. Table 1 shows revenue from the PIT, social contributions and expenditures on pensions (as a percentage of GDP) in the model and in the data.

[Table 2 about here.]

Table 2 reports some distributional statistics.

[Table 3 about here.]

Table 3 reports the activity rate for men and women: indeed we have calibrated the model to match the overall activity rate and thus it is not trivial that the model is capable to reproduce the activity rate by gender.

[Table 4 about here.]

We conclude that the model performs reasonably well in matching some key statistics that have not been used as calibration targets.

# 4 Policy experiments and results

We now perform several computational experiments in which the complex tax function characterized by equations (33), (5), (35), (36), (37), (38), (39) is replaced by the following flat tax:

$$t(y) = \tau(y - \theta D) \tag{40}$$

where $\tau$ is the flat marginal tax rate, $y = \sum \chi_g y_g$ with $\chi_g$ defined by equation (12), $y_g = (1 - \tau_s)w\omega l_g + p_g$ and $D \geq 0$ is the deduction for a single-person household. We consider different levels of the tax deduction and in particular D=0€, 2000€, 4000€, 8000€. When D=0 the tax function is proportional while for $D > 0$ we have a progressive tax, i.e. the average tax rate is increasing with income. We always assume that $t(y) > 0$, that is we do not consider the case of a negative income tax.

As already explained in Section 2.3, when the personal income tax takes the form of equation (40), the government budget (25) is balanced through the tax rate $\tau$ while government consumption $G$ is kept constant. The values of $\tau$ turn out to be 15.02%, 17.58%, 21.73%, 43.67% respectively for D=0€, D=2000€, D=4000€, D=8000€.

Table 4 reports the impact of the flat tax on labor supply and GDP for the different values of D. Table 5 shows the Gini coefficient of income before taxes (i.e. market income plus pension benefits) and of disposable income for the benchmark economy (in which the PIT is the one currently in place in Italy) and for the economies in which the flat tax is introduced (with different values of D).

When a proportional tax is introduced (i.e. D=0€), GDP per-capita increases by 3.21% and the total number of hours worked increases by 1.85%. The increase of labor supply has to be attributed to the intensive margin, i.e. to an increase of working hours of those who work before and after the introduction of the flat tax; indeed, the activity rate is lower once the flat tax is introduced. The contribution of the extensive margin in mitigating the positive impact of the flat tax on working hours is quite sizable: the increase of working hours along the intensive margin only is 3.94%, i.e. 2.09 (=3.94% − 1.85%) percentage points higher than the increase in working hours when both margins of labor supply are considered.

The positive impact of the proportional tax on economic performance comes along with an increase in income inequality: the gini coefficient of disposable income shows a sizeable rise from 0.265 to 0.312. Progessive flat tax functions (i.e. flat tax functions with $D > 0$) helps in mitigating the rise in income inequality. Actually, when the deduction is equal to 8000€, income inequality as measured by the Gini coefficient of disposable income turns out to be even lower than in the benchmark economy. Though the introduction of a tax deduction is good for inequality, it however dampens the positive impact that the flat tax has on economic performance. For D equal to 2000€ and 4000€, the flat tax still increases labor supply, though less than in the case of a proportional tax; for D equal to 8000€ labor supply shrinks: this is not suprising since in this case (as mentioned above) the marginal tax rate is equal to 43.67%.

[Table 5 about here.]

[Table 6 about here.]

Finally we look at the impact of the flat tax on welfare. Table 6 shows the fraction of households better off after the introduction of the flat tax and reports if utilitarian social welfare (defined as the sum of intertemporal utilities of the households) increases or decreases. The analysis is carried out for the entire population and for different subgroups defined in terms of marital status, presence of children and level of education. If we consider the whole population without distinguishing between housholds' types, we see that the flat tax reduces welfare, as measured by a utilitarian social welfare function, for all the levels of the tax deduction; moreover the fraction of households that benefits from the tax reform decreases with the value of D, ranging from 36.60% when D=0€ to 1.04% when D=8000€. The flat tax increases utilitarian social welfare only when we focus on specific types of households (namely those in which we have at least one individual with a college degree) and we consider low values of the deduction.

[Table 7 about here.]

# 5 Conclusions

In this paper we calibrate and simulate an OLG model to assess the impact of several reforms in which the personal income tax in Italy is replaced by a flat tax possibly complemented with a deduction.

When a proportional flat tax is introduced a clear trade-off between economic performance and equality emerges: indeed GDP per-capita and labor supply rise along with income inequality. The attempt to mitigate the rise in inequality through the use of a deduction turns out to dampen the positive effect of the flat tax on economic performance. Rising the deduction to a level that is high enough to completely avoid the increase in inequality generates a reduction of labor supply and GDP per-capita.

We also find that a flat tax is welfare improving only for specific subgroups of the population and for low values of the tax deduction: the aggregate impact on welfare (as measured by a utilitarian social welfare function) of the flat tax is negative.

# References


**Baldini, Massimo and Leonzio Rizzo**, "Flat tax: european experiences and the Italian proposal," *Hacienda Publica Espanola*, 2020.

**Bucciol, Alessandro, Laura Cavalli, Igor Fedotenkov, Paolo Pertile, Veronica Polin, Nicola Sartor, and Alessandro Sommacal**, "A large scale OLG model for the analysis of the redistributive effects of policy reforms," *European Journal of Political Economy*, 2017, *48* (C), 104–127.

**Colonna, Fabrizio and Stefania Marcassa**, "Taxation and female labor supply in Italy," *IZA Journal of Labor Policy*, December 2015, *4* (1), 1–29.

**Conesa, Juan Carlos and Dirk Krueger**, "On the optimal progressivity of the income tax code," *Journal of Monetary Economics*, 2006, *53* (7), 1425–1450.

**Diamond, Peter A**, "Optimal Income Taxation: An Example with a U-Shaped Pattern of Optimal Marginal Tax Rates," *American Economic Review*, March 1998, *88* (1), 83–95.

**Druedahl, Jeppe**, "A Guide on Solving Non-convex Consumption-Saving Models," *Computational Economics*, 2020.

**Eurostat**, *Taxation trends in the European Union*, Eurostat, 2020.

**Gouveia, Miguel and Robert P. Strauss**, "Effective Federal Individual Tax Functions: An Exploratory Empirical Analysis," *National Tax Journal*, June 1994, *47* (2), 317–339.

**Guner, Nezih, Remzi Kaygusuz, and Gustavo Ventura**, "Taxation and Household Labour Supply," *Review of Economic Studies*, 2012, *79* (3), 1113–1149.

**Heathcote, Jonathan and Hitoshi Tsujiyama**, "Optimal Income Taxation: Mirrlees Meets Ramsey," *mimeo*, 2020.

**Mirrlees, J. A.**, "An Exploration in the Theory of Optimum Income Taxation," *Review of Economic Studies*, 1971, *38* (2), 175–208.

**Saez, Emmanuel**, "Using Elasticities to Derive Optimal Income Tax Rates," *Review of Economic Studies*, 2001, *68* (1), 205–229.

**Tauchen, George**, "Finite state markov-chain approximations to univariate and vector autoregressions," *Economics letters*, 1986, *20* (2), 177–181.

**Ventura, G.**, "Flat tax reform: A quantitative exploration," *Journal of Economic Dynamics and Control*, 1999, *23* (9), 1425–1458.

**Wooldridge, Jeffrey Marc**, *Introductory Econometrics: A Modern Approach* ISE - International Student Edition, 5th ed., South-Western, 2013.

# List of Tables

| income bracket | legal marginal tax rate |
|---|---|
| [0, 15.000] | 23% |
| (15.000, 28.000] | 27% |
| (28.000, 55.000] | 38% |
| (55.000, 75.000] | 41% |
| >75.000 | 43% |

Table 1: Revenues from the personal income tax, social security contributions and pensions (% of GDP)

| | Data | Model |
|---|---|---|
| PIT | 11.6 | 8.3 |
| Social Contribution | 13.0 | 14.2 |
| Pensions | 15.0 | 13.4 |

Data source: Eurostat database.

Table 2: Earning distribution (working age): Gini coefficient and ratios between percentiles

| | Data | Model |
|---|---|---|
| Gini | 0.301 | 0.302 |
| P90/P10 | 4.249 | 4.270 |
| P90/P50 | 1.839 | 2.064 |
| P75/P25 | 1.993 | 2.086 |
| P10/P50 | 0.433 | 0.483 |

Data source: Bucciol et al. (2017).

Table 3: Activity rate by gender (%)

| | Data | Model |
|---|---|---|
| Men | 83.6 | 80.8 |
| Women | 62.4 | 64.74 |

Data source: Eurostat database.

Table 4: Impact of the flat tax (% change with respect to the pre-reform model economy) for different values of D

| | D=0€ | D=2000€ | D=4000€ | D=8000€ |
|---|---|---|---|---|
| Activity rate | -2.30 | -2.71 | -3.49 | -6.48 |
| Activity rate (men) | -2.30 | -2.67 | -3.07 | -4.96 |
| Activity rate (women) | -2.30 | -2.75 | -4.01 | -8.39 |
| Working hours | 1.85 | 1.18 | 0.08 | -4.99 |
| Working hours, intensive margin | 3.94 | 3.46 | 2.88 | 0.12 |
| Working hours (men) | 1.84 | 1.23 | 0.40 | -3.76 |
| Working hours, intensive margin (men ) | 3.99 | 3.55 | 2.95 | 0.096 |
| Working hours (women) | 1.87 | 1.10 | -0.40 | -6.86 |
| Working hours, intensive margin (women) | 3.88 | 3.32 | 2.77 | 0.16 |
| GDP per-capita | 3.21 | 2.63 | 1.69 | -3.52 |

Table 5: Gini coefficient of income before taxes and disposable income for the benchmark economy (no flat tax) and for the economies in which the flat tax is introduced (with different values of D)

| | Benchmark | D=0€ | D=2000€ | D=4000€ | D=8000€ |
|---|---|---|---|---|---|
| Income before taxes | 0.279 | 0.297 | 0.296 | 0.296 | 0.285 |
| Disposable income | 0.265 | 0.312 | 0.307 | 0.301 | 0.263 |

Table 6: Impact on welfare: % of households better off and increase (↑) or decrease (↓) of utilitarian social welfare for different types of households

| | D=0€ | | D=2000€ | | D=4000€ | | D=8000€ | |
|---|---|---|---|---|---|---|---|---|
| | % better off | SWF | % better off | SWF | % better off | SWF | % better off | SWF |
| all | 36.60 | ↓ | 33.38 | ↓ | 25.18 | ↓ | 1.04 | ↓ |
| $s_L^m$, | 37.43 | ↓ | 32.51 | ↓ | 18.19 | ↓ | 0.00 | ↓ |
| $s_H^m$ | 78.42 | ↑ | 73.67 | ↑ | 61.92 | ↑ | 0.00 | ↓ |
| $s_L^f$ | 6.99 | ↓ | 4.18 | ↓ | 0.30 | ↓ | 0.00 | ↓ |
| $s_H^f$ | 39.75 | ↓ | 34.00 | ↓ | 19.76 | ↓ | 0.00 | ↓ |
| $c_{L,L}^{nk}$ | 45.19 | ↓ | 40.25 | ↓ | 25.56 | ↓ | 0.19 | ↓ |
| $c_{L,H}^{nk}$ | 72.04 | ↑ | 63.16 | ↑ | 54.28 | ↑ | 0.66 | ↓ |
| $c_{H,L}^{nk}$ | 86.16 | ↑ | 85.53 | ↑ | 79.87 | ↑ | 0.00 | ↓ |
| $c_{H,H}^{nk}$ | 91.07 | ↑ | 88.21 | ↑ | 81.79 | ↑ | 0.36 | ↓ |
| $c_{L,L}^{k}$ | 24.52 | ↓ | 22.51 | ↓ | 18.77 | ↓ | 2.20 | ↓ |
| $c_{L,H}^{k}$ | 55.82 | ↑ | 56.39 | ↑ | 46.36 | ↓ | 4.28 | ↓ |
| $c_{H,L}^{k}$ | 75.46 | ↑ | 73.61 | ↑ | 68.07 | ↑ | 0.92 | ↓ |
| $c_{H,H}^{k}$ | 87.39 | ↑ | 85.61 | ↑ | 81.05 | ↑ | 2.78 | ↓ |

all=all types of households;
$s_{educ}^g$=single-person household with a person of gender $g = m, f$ end educational level $educ = H, L$ (where H means high skilled and L means low skilled);
$c_{educ1,educ2}^{nk}$=couple with no kids in which the man has educational level $educ1 = H, L$ and the woman has educational level $educ2 = H, L$;
$c_{educ1,educ2}^{k}$=couple with kids in which the man has educational level $educ1 = H, L$ and the woman has educational level $educ2 = H, L$.