



# Flat-Tax and Minimum Income Experiment in an OLG model of Italy

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## *ABSTRACT:*

In the light of the recent political events in Italy this paper aims to quantitatively analyze the impact of a Flat-Tax and minimum income based fiscal reform for different cohort ages in an Overlapping Generation (OLG) model with permanent labour productivity across agents and a stochastic labour income component. Two Computational Experiments are conducted: the former is a Flat-Tax only for the personal labour income, the latter involves the same marginal rate for personal labour and capital income. It results that to finance a minimum income measure in support of every citizen below the absolute poverty threshold, it is required a marginal rate of respectively 20% and 23%. The amount granted would be equal to the difference of the absolute poverty threshold (€780 in Italy) and the total income of the targeted citizen. The results of this study seem to reflect the forecasts of overall growth in the aggregate output and consumption of the economy: a deeper analysis show that actually the labour supplied and aggregate welfare decrease while the inequality considerably increases.

## *SOMARIO:*

À luz dos recentes eventos políticos em Itália, este artigo visa analisar quantitativamente o impacto de uma reforma fiscal baseada na renda fixa e no imposto mínimo para diferentes idades de coorte num modelo de Overlapping Generation (OLG) com produtividade permanente do trabalho entre agentes e um componente estocástico do rendimento trabalho. Duas Experiências Computacionais são conduzidas: a primeira é um imposto fixo somente para a renda de trabalho pessoal, a segunda envolve a mesma taxa marginal para trabalho pessoal e capital. Resulta que, para financiar uma medida de rendimento mínimo, de forma a apoiar todos os cidadãos abaixo da limiar de pobreza absoluta, é necessária uma taxa marginal de respectivamente 20% e 23%. A quantia admitida seria igual à diferença do limiar de pobreza absoluta (€780 na Itália) e a renda total do cidadão visado. O resultado deste estudo parece refletir as previsões de crescimento da produção e consumo agregados à economia: uma análise mais profunda mostra que, na verdade, a mão-de-obra fornecida e o bem-estar agregado diminuem enquanto a desigualdade aumenta consideravelmente.

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## 1 Introduction

Italy's coming through a tough period during the last years. 2018 in particular has seen concerning breakdowns in the peninsula's economy. Above the many issues, two seems to be the major problems: on the one hand the estimated 190 billion euros of fiscal evasion and a tax gap of 23,28% that place the country in the worst position among the EU members. On the other an alarming unemployment rate, especially for early age citizens; with the 39,5% of young workers unemployed, in December 2018 Italy registered in fact the second highest rate in Europe.

The GDP growth forecasts for 2019 are not optimistic: they range from the +0,6% of the Monetary Fund to the more problematic -0,2% estimated few weeks ago by OCSE. According to these previsions, and the aggravating circumstance that the Quantitative Easing just stopped, the Italian ground seems not to leave any margin for a sustainable debt, that would indeed require an economic growth rate higher than the interest paid on the debt itself.

2018 have been a troubled year also for the Italian political scene. Never in the history of the peninsula's republic it happened to wait so much for a definitive election: five rounds of consultations, two exploratory terms for the presidents of the House and Senate and two pre-mandates. The Giuseppe Conte government (M5s-Lega) finally have established obtaining the majority of the consensus largely due to the promise of two reforms: "Flat-Tax 15%" for the personal labour income, to replace the current progressive IRPEF tax, and "Reddito di Cittadinanza", a pro-poor minimum income measure, and unemployment benefit, that would be granted from the mid of 2019 to citizens receiving less than the estimated absolute poverty threshold: only together these two measures should, according to the major M5s-Lega economists' opinion, stimulate and boost the economy. However the positions on the matter diverge within the country and a great debate has risen during the last year especially about the affordability of these two expensive measures, estimated to cost around 80 billion euros: to grant an minimum amount to poor citizens together with the promise of a consistent cut in the taxes seems hardly implementable in the common sense without lowering the public expenditure, increasing the consumption tax or the public debt, but renewed M5s-Lega economists such as Claudio Borghi, Alberto Bagnai and Michele Geraci still claim that it is sustainable and that the Italian economy will benefit from the reform.

In Italy firms are not able to find skilled young workers, and young people cannot find job: this incompatibility represents one of the major concerns for the economic recovery as demand and supply don't meet each other. A minimum income, besides being a pro-poor measure that an advanced economy should implement for an ethic fairness, would allow for an improvement in the efficiency of the labour force, by the moment that young people can so find an occupation that suites better their personal skills without the concern of being unemployed. On the other hand, even if this can improve

the efficiency of the allocation of the human capital, Italy also required a reform to increase the labour demand, that is to create new jobs: a constant marginal rate of 15% attract new investments, and with them new jobs opportunities. Regarding the costs of these measures, according to the abovementioned economists, it would be partially compensated by the increase of the aggregate consumption level. That is, through the Keynesian multiplier the GDP of the country should grow at a bigger share than the expenditure for these measures.

Moreover, a Flat-Tax 15% discourage tax evasion. In most of the countries that have adopted similar fiscal schemes the historical evidence (look for instance *Keen (2006)* and *Hall (2013)*) as taught that a simpler tax system enhances the tax compliance: if citizens, instead of living in a complex and abstruse fiscal system, are more aware on how much taxes they have to pay to the government and they perceive them as a fair amount, than they should be more inclined to the “fiscal loyalty”.

But again, after one year of political mandate and public discussion, it is nowadays still not clear where the government would find the money for this reform, and the persistent lack of quantitative studies on the matter does not help to consolidate an objective position about it. As economist, it is in my interest to further investigate on the possible outcomes of such a reform and to provide some results that quantify the impact that a fiscal system based on a Flat-Tax and a minimum income would have on Italian citizens in different ages.

In a good number of studies focusing on optimal taxation it results that a Flat-Tax based fiscal system brings gains in term of labour supply, consumption and capital accumulation, compared to a progressive one. *Conesa and Krueger (2006)* compute the optimal progressivity of the labour income tax for US in an Overlapping Generation model, accounting for household’s heterogeneity. It is so quantitatively characterized the optimal income tax system in an economic environment where insurance, equity and efficiency effects are present simultaneously. The main quantitative result found is that the optimal income tax structure is well approximated by a flat income tax and a fixed deduction; under such a reform, most of the agents obtain welfare gains and according to their outcomes the middle-income households are the ones that would suffer the most (they would face a higher income tax bill), whereas both high-income and low-income households would benefit. Similar results reflect *Ventura (1999)*’s findings and are supported by *Mankiw, Weinzierl and Yagan (2009)*. *Aaberge, Colombino and Storm (2004)* conduct an analysis of the welfare effects on married couples of replacing the Italian progressive tax system by three alternative hypothetical reforms: a Flat-Tax, a negative income tax, and a work fare scheme. The results suggest that there are margins for improvement upon the current system for both the efficiency and the equality criterion. According to their outcomes the estimated benefits of the reform would come from a good response in the labour

supply of poor and middle-class households, whereas the wealthier citizens appear to be much less responsive to changes in the tax rates. *Scutella (2004)* studied the implications of the introduction of a basic income and Flat-Tax system in Australia in a General Equilibrium and microeconomic model. To provide a basic income levels coinciding with current benefits rates results to be costly, with a marginal rate required to ensure revenue neutrality that turns out unsustainable. Such a system, while more equitable and social welfare enhancing than the one in use at the time, was found to have likely adverse labour supply responses confounding the cost of the system. *Shubert (2018)* quantifies the economic effects of a Flat-Tax and minimum income reform proposal for Germany. The effects are negligible, even negative for what regard the level of employment and GDP within the country: these results cast doubts on whether such a fundamental reform would have positive welfare effects.

About tax evasion and avoidance, it is possible to find studies in support of a progressive fiscal system. For instance, *Gamannossi and D. Rablen (2017)* basing on the work of *Alm and McCallin (1990)* describe avoidance as a risky asset owing to the possibility of effective anti-avoidance measures by the tax authority: they consider then the implications for optimal auditing of tax avoidance. By analyzing the audit function under progressive, proportional and regressive tax systems they find that less enforcement is required under a flat tax than under a progressive one in eliminating evasion and avoidance, for every level of income. This outcome confirms *Chander and Wilde (1998)* findings, according to which a regressive tax results to be the optimal hypothetical fiscal system in term of tax evasion and avoidance.

This paper aims to analyze and quantify the outcome for households in different ages, of a Flat-Tax and a minimum income measure reforming the progressive fiscal system in Italy. This is done employing an Overlapping Generations Model with permanent labour productivity across agents and an idiosyncratic stochastic component, calibrated to reflect the empirical evidence found in microeconometrics studies based on Italians' data. Two Computational Experiments are conducted:

- The first is a Flat-Tax reforming the current progressive IRPEF tax on the individual labour income. The marginal rate is derived so that the government finances a minimum income targeting all agents under the absolute poverty threshold (quantile 0.084 of the income distribution according to ISTAT), keeping fixed the public expenditure. The amount granted to each individual under that limit is computed as the difference between the poverty threshold and his total earnings.
- The second experiment is analogous to the first one. The difference consists in setting the same flat marginal rate for both the individual labour and capital income.

The paper is structured as follows: in the following paragraph it will be exposed the 2018 Italian fiscal system. Chapter 2 provides a brief review on OLG models. In Chapter 3 it is reported the model employed for this study. Chapter 4 and 5 describe respectively the process of calibration of the benchmark economy and the Computational Experiments. To follow Chapter 6, in which the results are discussed, and finally Chapter 7 concludes the paper.

### 1.1 The 2018 Italian fiscal-benefits system

The Italian fiscal system is national with little differences among regions and municipalities due to some local autonomy and mainly affecting the complex system of local property taxes. The individual labour income tax (*IRPEF*) is progressive and incomes deriving from capital gains and return on capital are mainly subject to a separate taxation. The main source through which the government raises funds for public expenditure are:

- *Personal labour Income Tax – IRPEF*: a progressive tax on income structured in five brackets. The taxable base is the total income (sum of working income, buildings and lands income, quotes from dividends, dividends gains) and family dimension and composition for eventual deductions and allowances.
- *Separate Taxation on Capital Income*: capital income, even though already partially included in the *IRPEF* base, is mainly subject to a separate taxation.
- *Municipality Property Taxes – IMU and TASI*: buildings and lands, like capital income, are subject to a separate taxation. *IMU* and *TASI* weight on buildings or lands' owners or to individuals who enjoy real rights on these estates.
- *Corporate Tax – IRES*: It is a proportional tax applied to all corporations, cooperatives, mutual insurance, public and private entities other than the special companies. The premise for the Corporate Tax is the ownership of an income belonging to one of the following categories: real estate, capital, employed and self-employed work, corporation.
- *Regional Tax on Business – IRAP*: a special regional tax on productive activities located in the area of regional competence. Therefore, it is applied to companies and individuals subject to *IRES*, companies subject to personal income tax (partnerships and sole proprietorships), banks, insurance companies and self-employed workers. The rate change according to the business sector.

Italy, like most of the modern developed countries, is characterized by a fragmented benefits system, made of a multitude of instruments. According to the tradition, these social measures can be categorized in Social Insurance (family and social allowances, benefits related to the end of the working activity, to the temporary suspension of the working activity, to the reduction in working

ability) and Social Assistance (family support, Pro-poor allowances, Benefits related to the reduction in working ability). Thresholds for means-tested benefits and contributions are yearly updated by the National Statistical Office.

Finally, the Social Contributions that employees, employers and self-employed individuals pay on earned income that are managed by the National Institute of Social Security (INPS), a private entity that regulates the pension system within the country. An exhaustive description of the measures composing the 2018 Italian fiscal and benefits system can be found in *Appendix 1*.

### 1.1.1 Pro-poor measures evolution in Italy

During the past decades Italy, as many advanced modern countries, have started to develop instruments pro-poor oriented to fight the wealth inequalities across the country. The design of a national measure of minimum guaranteed income has started in 1997 with a first proposal formulated by the ‘*Commissione Onofri*’ appointed by the Centre-Left government in power at that time. The proposal has been tested in a sample of local areas before being stopped when a Centre-Right came to power two years later: the competence on support policies was so transferred to the regions, which since then effectively became responsible for the design of pro-poor policies.

A more recent national minimum income scheme, the ‘*Reddito di Inclusione- REI*’ was proposed in 2017 by the ‘*Governo Gentiloni*’ and have been implemented in 2017: this instrument is meant to address the share of the population living in absolute poverty and aims to fill the gap between the resources available in the families and the minimum level of income required to fulfill their fundamental needs. Unfortunately, even though it was designed to be universal, the available funds have been sufficient to accomplish only partially the desired goal, and overall the *REI* barely impacted the fraction of the population that was meant to sustain.

## 2 OLG models: literature review

Macroeconomic models provide an efficient tool for analyzing the impact of fiscal and policies in more or less complex representations of real economies. A wide number of models have been created to date and offer different combination of features such as agents’ heterogeneity, multiple sectors, overlapping generations, adequate treatment of uncertainty and expectations. The exponential technological and theoretical progress in general or partial equilibrium models has reached insights that would not have been possible with simpler models and their limits. These tools have become the framework to use to conduct a quantitative analysis of a fiscal policy and so to be able to carry on a comprehensive evaluation of the dangers and potentials of a reform. In this literature review it is provided a fast background on OLG models and on the diversity and complexity that may be introduced.

## 2.1 The baseline OLG model structure

Overlapping Generation (OLG) models analyze the general equilibrium properties and growth dynamics of economies inhabited by finitely lived population in different cohorts ages: incorporating demographic transition, they have the potential to increase the predictive power compared to models with infinitely lived agents. They became popular mainly thanks to the seminal works carried on by *Diamond (1965)* and *Auerbach and Kotlikoff (1987)*.

The core process in an OLG model follows the choices of a representative household regarding variables such as education, savings, labour supply and according to a utility function that regulate his/her preferences: this allow to project the wealth distribution for agents in different cohorts ages over time.

### 2.1.1 The Diamond model

The most basic, two-period OLG model consists in a close economy with only firms and households (no government) and exogeneous labour. In this model agents supply labour and receive an income in return, that will spend on consumption or savings to invest in capital, since they own the firms. The whole amount invested in the first period is consumed in the second one. If  $N_t$  denote the size of young generation of agents and  $N_{t-1}$  the old cohorts, and assuming a constant rate  $n$ , so  $N_t = (1 + n)N_{t-1}$ . The young generation supplies one unit of labour (exogeneous variable) in exchange of a fixed income  $w_t$  and chooses how to allocate it between consumption and savings. In the next period the same generation becomes old and retire, so live with the investments made previously.

## 2.2 literature evolution of OLG models

### 2.2.1 Generations and cohort size

Extending the same concept of the basic Diamond OLG model, the literature has evolved considering more than just two period. For instance, a four-period OLG model have been elaborated by *Buyse et al (2012)* with three working generations, heterogeneous in labour choice, leisure and skills and one retired. *Magnani and Mercenier (2009)* study the variation of choices for retired individuals in different cohort ages employing an eight-period setup with five working generations and three retired. The recent literature has extended the analysis to include up to 100 generations of age groups: these models allow to generate predictions of consumption and saving decisions that at times closely resemble the target economy (for instance *Muto et al. 2012*; *Beetsma and Bucciol 2009*; *Cerný et al. 2006*). Additional studies can be mentioned, as the one of *Kudrna et al. (2014)* in which individuals aged 0 to 20 can rely on the public system for education and healthcare costs, reducing the amount granted for pensions to the retiree.

### 2.2.2 Individual heterogeneity

Including additional intra-generations heterogeneity allows to produce a more realistic variety of consumption and savings paths. One of the sources of heterogeneity that has been employed in most of these studies comes by assuming that agents are born in different ability levels: ability becomes then a productivity factor that impact individuals' earnings. *Fougère and Mérette (1999)* propose a spill-over model in which the aggregate savings depend on the post-secondary education of the agents in the economy. A similar heterogeneity source can be found in *Magnani and Mercenier (2009)* or either in *Buyse et al. (2012)*.

### 2.2.3 Demographic changes introduced by immigration

OLG models provides an excellent tool in the field of study that analyses the migration of agents from one market to another. Many traditional models fail to capture this complex aspect of one economy: the major issue is that the savings, labour choices and consumption patterns can diverge consistently between citizens and immigrants. *Fougère et al. (2004)*, to mention one, analyze the immigration phenomenon in Canada employing a six-region OLG model.

### 2.2.4 OLG Models with Government and Social Security

To conclude this fast overview on OLG models, they provide a useful framework to analyze the effect of government policies and reforms. *Buccioli et al. (2014)* study different policies in an OLG model with heterogeneous agents modelling the joint labour supply choices between man and women in a couple. The analysis is conducted for three European countries: France, Italy and Sweden. They show that the model is capable of matching relevant aggregate statistics of the three countries and provide examples of policy experiments that can be simulate, analyzing the outcomes on both inequality and individual welfare. *Conesa, Kitao and Krueger (2007)* compute the optimal progressive capital and labor income tax in an OLG model with stochastic income shocks, where households are heterogeneous in ability level. They find that the optimal capital income tax rate approximates a Flat-Tax of 23% with a fix deduction corresponding to about \$6,000.

The model employed in this study follows the guidelines of the *Conesa, Kitao and Krueger (2007)* one, with adjustments made to better reflect the 2018 Italian economy and fiscal system. A full description follows in Chapter 3.

## 3 Methodology: overview of the model

### 3.1 Demographics

The economy examined for this study is populated by  $J$  overlapping generations. Every year a continuum of new agents is born, and the overall population grows at a fix rate  $n$ . Each household faces a probability of dying in every period, which is dependent on the age. In specific, the probability

of being alive in period  $j + 1$  conditional being alive in period  $j$ , is  $\psi_j = \text{prob}(\text{alive at } j + 1 | \text{alive at } j)$ . Households can live up to a maximum age  $J$ , so that  $\psi_J = 0$ . The fraction of the agents who dies in every period before reaching age  $J$  leaves accidental bequests, denoted by  $Tr_t$ , that are redistributed in a lump-sum manner across the population. At age  $j_r$  households retire and receive a pension  $SS_t$  that is financed by a flat income tax  $\tau_{ss,t}$ . The Social Security taxes base is labour income  $y$ .

### 3.2 Endowments, preferences and agents' heterogeneity.

Each household starts his life without assets (besides the eventual bequests distributed) and can supply up to one unit of productive time every period. They can either spend their time working in a competitive market or consuming leisure. Their consumption-leisure preferences  $\{c_j, (1 - l_j)\}_{j=1}^J$  are represented by the following standard time-separable utility function:

$$E \left( \sum_{j=1}^J \beta^{j-1} \frac{(c_j^\gamma (1 - l_j)^{1-\gamma})^{1-\sigma}}{1 - \sigma} \right) \quad (1)$$

where  $c_j$  and  $l_j$  are respectively the level of consumption and labour in period  $j$ . The parameter  $\gamma$  measures how important is consumption relative to leisure, and  $\sigma$  controls the degree of risk aversion. Finally,  $\beta$  is the time discount factor.

In this model three sources of heterogeneity are considered to better represent the Italian households' labour productivity:

- An age-specific labor productivity component  $\varepsilon_j$ : households of different ages have a different age productivity  $\varepsilon_j$ . After the retirement age  $j_r$ , by assumption the agents' productivity is set equal to zero, that is  $\varepsilon_j = 0$ .
- Households differ in abilities  $\alpha_i$ : they are born and live as one of  $M$  possible ability types  $i \in I$ . It is not possible for them to switch from an ability type to another during their lifetime. The probability of being born with ability  $\alpha_i$  is denoted by  $p_i > 0$ . The ability type  $\alpha_i$  in addition to age-specific productivity component  $\varepsilon_j$ , determine agents' average deterministic labor productivity, the permanent component of this labour productivity process.
- Agents of the same ability type and with the same age differ in an idiosyncratic uncertainty with respect to their labor productivity, that represent the last component of agents' heterogeneity in this model. The stochastic process describing labor productivity status is the same across all the agents and follows a finite-state Markov chain with stationary transitions, described by:

$$Q_t(\eta, E) = Prob(\eta_{t+1} \in E | \eta_t = \eta) = Q(\eta, E) \quad (2)$$

Here  $\eta_t \in E$  denotes a stochastic realization of the labor productivity in time  $t$ . Households start their life at the same average productivity level  $\bar{\eta} = \sum_{\eta} \eta \Pi(\eta)$  where  $\bar{\eta} \in E$  and  $\Pi(\eta)$  is the probability of  $\eta$  under the stationary distribution. The stochastic process manifests different realizations for labour productivity, and so generates cross-sectional productivity, income and wealth distribution that become more dispersed as the cohorts grow. The agents maximize their expected utility in a lifetime prospective. These expectations are taken with respect to the stochastic processes that leads to the idiosyncratic labor productivity.

Every agent is characterized in a given time by the measures  $(a_t, \eta_t, i, j)$ , where  $a_t$  are the asset holdings (of one period, risk-free bonds),  $\eta_t$  is stochastic labor productivity status at date  $t$ ,  $i$  is the ability type and  $j$  is the age. An agent of type  $(a_t, \eta_t, i, j)$  choose to work  $l_j$  hours and then earn pre-tax labor income  $\varepsilon_j \alpha_i \eta_t l_j w_t$ , that depend on the wage per efficiency unit of labor  $w_t$ , the age specific productivity component  $\varepsilon_j$ , the ability type  $\alpha_i$  and the state  $\eta_t$ .  $\varphi_t(a_t, \eta_t, i, j)$  denote the probability measure of agents of type  $(a_t, \eta_t, i, j)$ .

### 3.3 Firms

The technology describing the firms' production process is represented by a Cobb–Douglas production function with constant return to scale. As standard with a perfect competition market it is assumed the existence of a representative firm operating this technology. The resource constraint is given by the following function:

$$C_t + K_{t+1} - (1 - \delta)K_t + G_t \leq A_t K_t^\alpha N_t^{1-\alpha} \quad (3)$$

Here  $C_t$ ,  $K_t$  and  $N_t$  represent respectively the aggregate consumption, capital stock and labour supply in time  $t$ . The term  $A_t = (1 + g)^{t-1} A_1$  captures the technological progress.

The calibration of  $A$ , as in *Conesa, Kitao and Krueger (2007)*, is normalized to 1: in accordance with similar studies on fiscal policies evaluation this paper abstract from technological progress. In this way it allows to represent households in the economy with a labour supply elasticity that is consistent with the microeconomic evidence.

### 3.4 Government policy

The government levies taxes to finance public spending and runs a balanced budget social security system represented in the model by the transfers  $SS_t$ . The tax rate  $\tau_{ss,t}$  is set to assure that the budget balance of the system time by time. The public consumption  $\{G_t\}_{t=1}^{\infty}$  is given exogenously and has three fiscal instruments to be financed: the government levies a proportional tax  $\tau_{c,t}$  on consumption

expenditures, it tax capital income of households  $r_t(a_t + Tr_t)$  according to a constant tax rate  $\tau_{K,t}$ , and finally levies a personal income tax on each individual's labour income. The income of an agent before the social security tax is defined as  $yp_t = w_t \varepsilon_j \alpha_i \eta l_t$  (4) and depend on the wage per efficiency unit of labor  $w_t$ . A part of the social contribution, in specific one third in Italy, is paid by the employer: the model takes this into account. This part is represented by  $ess_t = 0.33 \tau_{ss,t} w_t \varepsilon_j \alpha_i \eta l_t$  (5). The income base for the personal labour income tax of a household is so defined as:

$$y_t = \begin{cases} yp_t - ess_t & \text{if } j < j_r \\ 0 & \text{if } j \geq j_r \end{cases} \quad (6)$$

The individual tax function is  $T[\cdot]$ , and  $T[y]$  is the total tax liability on a labour income equal to  $y$ .

### 3.5 The structure of the market

In this economy agents cannot insure against stochastic labor income shocks by trading insurance contracts. They can however trade one period risk-free bonds to insure themselves against the risk of a decrease of their labor productivity in the future. This is limited, however, by impossibility of agents to sell bonds short. Basically, a stringent borrowing constraint is imposed upon all agents to prevents them from dying in debt, in presence of the positive conditional probability of death.

### 3.6 The competitive equilibrium

In this paragraph it is defined the competitive and stationary equilibrium in this economy (see Definition 1 and 2 below), following the same baseline of *Conesa, Kitao and Krueger (2007)*, with little adjustments mainly regarding the . For each agent, the state variables describing his status are personal asset holdings  $a$ , labor productivity  $\eta$ , ability type  $i$  and age  $j$ . The aggregate picture of the overall economy in a given time  $t$  is described by the agents' measure  $\varphi_t$  over asset positions, labor productivity status, ability and age.

Let  $a \in \mathbf{R}_+$ ,  $\eta \in E = \{\eta_1, \eta_2, \dots, \eta_n\}$ ,  $i \in I = \{1, 2, \dots, M\}$ ,  $j \in J = \{1, 2, \dots, J\}$ , and  $\mathbf{S} = \mathbf{R}_+ * E * I * J$ . Let  $\mathbf{B}(\mathbf{R}_+)$  be the Borel  $\sigma$ -algebra of  $\mathbf{R}_+$  and  $\mathbf{P}(E)$ ,  $\mathbf{P}(I)$ ,  $\mathbf{P}(J)$  the power sets of  $E$ ,  $I$  and  $J$ . Let  $\mathbf{M}$  be the set of all finite measure over the measurable space  $(\mathbf{S}, \mathbf{B}(\mathbf{R}_+) * \mathbf{P}(E) * \mathbf{P}(I) * \mathbf{P}(J))$ .

**Definition 1:** Given a sequence of social security replacement rates  $\{b_t\}_{t=1}^{\infty}$ , consumption tax rates  $\{\tau_{c,t}\}_{t=1}^{\infty}$  and government expenditure  $\{G_t\}_{t=1}^{\infty}$  and initial conditions  $K_1$  and  $\varphi_1$ , a competitive equilibrium is a sequence of functions for the household,  $\{v_t, c_t, a'_t, l_t : \mathbf{S} \rightarrow \mathbf{R}_+\}_{t=1}^{\infty}$  of production plans for the firm,  $\{N_t, K_t\}_{t=1}^{\infty}$ , government income tax functions  $\{T_t : \mathbf{R}_+ \rightarrow \mathbf{R}_+\}_{t=1}^{\infty}$ , social security taxes  $\{\tau_{ss,t}\}_{t=1}^{\infty}$  and benefits  $\{SS_t\}_{t=1}^{\infty}$ , prices  $\{w_t, r_t\}_{t=1}^{\infty}$ , transfers  $\{Tr_t\}_{t=1}^{\infty}$ , and measures  $\{\varphi_t\}_{t=1}^{\infty}$ , with  $\varphi_t \in \mathbf{M}$  such that:

### 3.6.1 Households

Given prices, policies, transfers and initial conditions, for each time, the agent choose the value  $v_t$  that maximizes the Bellman equation (where  $c_t$ ,  $a'_t$  and  $l_t$  are his policy functions):

$$v_t(a, \eta, i, j) = \max_{c, a', l} (u(c, 1 - l) + \beta \psi_j \int v_{t+1}(a', \eta', i, j + 1) Q(\eta, d\eta')) \quad (7) \quad \text{subject to:}$$

$$(1 + \tau_{c,t})c + a' = (1 - 0.66\tau_{ss,t}) \frac{w_t}{1 + 0.33\tau_{ss,t}} \varepsilon_j \alpha_i \eta l_t + (1 + r_t(1 - \tau_{K,t})) (a + Tr_t) - T_t[y_t] \quad \text{if } j < j_r \quad (8)$$

$$(1 + \tau_{c,t})c + a' = SS_t + (1 + r_t(1 - \tau_{K,t})) (a + Tr_t) - T_t[SS_t] \quad \text{if } j \geq j_r, \quad (9)$$

$$a' \geq 0, c \geq 0, 0 \leq l \leq 1 \quad (10)$$

### 3.6.2 Firms

In equilibrium, prices  $w_t$  and  $r_t$  satisfy:

$$r_t = \alpha A_t \left( \frac{N_t}{K_t} \right)^{1-\alpha} - \delta \quad (11)$$

$$w_t = (1 - \alpha) A_t \left( \frac{K_t}{N_t} \right)^\alpha \quad (12)$$

### 3.6.3 Social security system

the pensions policies satisfy:

$$\tau_{ss,t} = \int (w_t \varepsilon_j \alpha_i \eta l_t) \varphi_t(da * d\eta * di * dj) = SS_t \int \varphi_t(da * d\eta * di * \{j_r, \dots, J\}) \quad (13)$$

### 3.6.4 Transfers

The accidental bequests are defined as are given by:

$$Tr_{t+1} \int \varphi_{t+1}(da * d\eta * di * dj) = \int (1 - \psi_j) a'_t(a, \eta, i, j) \varphi_t(da * d\eta * di * dj) \quad (14)$$

### 3.6.5 Government

Government budget balances as follows:

$$G_t = \int \tau_{K,t} r_t (a + Tr_t) \varphi_t(da * d\eta * di * dj) + \int T_t[y_t] \varphi_t(da * d\eta * di * dj) \\ + \tau_{c,t} \int c_t(a, \eta, i, j) \varphi_t(da * d\eta * di * dj) \quad (15)$$

### 3.6.6 Market clearing

$$K_t = \int a \varphi_t(da * d\eta * di * dj) \quad (16)$$

$$N_t = \int \varepsilon_j \alpha_i \eta l_t(a, \eta, i, j) \varphi_t(da * d\eta * di * dj) \quad (17)$$

$$\int c_t(a, \eta, i, j) \varphi_t(da * d\eta * di * dj) + a'_t(a, \eta, i, j) \varphi_t(da * d\eta * di * dj) + G_t = K_t^\alpha (A_t N_t)^{1-\alpha} + (1 - \delta) K_t \quad (18)$$

### 3.6.7 Law of motion

$$\varphi_{t+1} = H_t(\varphi_t) \quad (19)$$

where the function  $H_t : \mathbf{M} \rightarrow \mathbf{M}$  can be explicitly written as:

a) for all  $f$  such that  $1 \in f$ :

$$\varphi_{t+1}(A * E * \mathcal{J} * f) = \int P_t((a, \eta, i, j); A * E * \mathcal{J} * f) \varphi_t(da * d\eta * di * dj) \quad (20)$$

$$\text{where } P_t((a, \eta, i, j); A * E * \mathcal{J} * f) = \begin{cases} Q(e, E) \psi_j & \text{if } a'_t(a, \eta, i, j) \in A, i \in \mathcal{J}, j + 1 \in \mathcal{J} \\ 0 & \text{else} \end{cases} \quad (21)$$

$$\text{b) } \varphi_{t+1}(A * E * \mathcal{J} * \{1\}) = (1 + n)^t \begin{cases} \sum_{i \in \mathcal{J}} p_i & \text{if } 0 \in A, \eta \in E \\ 0 & \text{else} \end{cases} \quad (22)$$

**Definition 2:** a stationary equilibrium is a competitive equilibrium in which  $b_t = b_1$ ,  $\tau_{c,t} = \tau_{c,1}$ ,  $G_t = (1 + n)^{t-1} G_1$ ,  $a'_t(\cdot) = a'_1(\cdot)$ ,  $c_t(\cdot) = c_1(\cdot)$ ,  $l_t(\cdot) = l_1(\cdot)$ ,  $N_t = (1 + n)^{t-1} N_1$ ,  $K_t = (1 + n)^{t-1} K_1$ ,  $T_t = T_1$ ,  $\tau_{ss,t} = \tau_{ss,1}$ ,  $SS_t = SS_1$ ,  $r_t = r_1$ ,  $w_t = w_1$ ,  $Tr_t = Tr_1$ , for all  $t \geq 1$  and for  $A \in \mathbf{R}_+$ . That is, per capita variables and functions as well as prices and policies are constant, and aggregate variables grow at the constant growth rate of the population  $n$ .

### 3.7 Computing the equilibrium: The Python program

This paragraph explains briefly how the Python program coded for this analysis works.

Initially are defined the choices for the last generation, who face no possibility of surviving in the next period: the investment (asset choice) is zero because it is not possible anymore to derive any utility in the future. The labour choice is also zero by the moment they retire at age 65. The consumption and value functions are then computed for agents in every asset level. The consumption coincides with the Social Security and the asset level, net of taxes (on income and on consumption). The value function for every level of asset is the utility function, with zero labour and the consumption previously computed.

For the younger cohort ages the choices distributions are compiled backward (for every asset level). From the age of 98 to 65 no labour is supplied by agents, so the only choice involved is the one on consumption and investment. This choice is derived with respect to the Euler equation (the derivation is reported in *Appendix 2*):

$$MarUtility(c, 1 - 0) = \beta \psi_j \int \left( 1 + r_t(1 + \tau_{k,t}) \right) MarUtility(c', 1 - 0) Q(\eta, d\eta') \quad (23)$$

Lower bound and upper bounds are computed (it is derived the utility for the lowest and for the highest level of asset choice) in case the Euler function does not allow a maximum inside this interval assumed for the asset grid.

Once the optimal consumption level is found for every possible asset level, the computation of Value function is straight forward.

$$Value(c, 1 - 0) = Utility(c, 1 - 0) + \beta \psi_j \int Value(c', 1 - 0) Q(\eta, d\eta') \quad (24)$$

With  $c$  and  $c'$  at the optimal level.

For agents in working age (from 64 to 25 years), the process is substantially the same: the same outcome is derived for every possible choice of work (66 possible from 0 to 0.99) according to the Euler equation:

$$MarUtility(c, 1 - l) = \beta \psi_j \int \left( 1 + r_t(1 + \tau_{k,t}) \right) MarUtility(c', 1 - l') Q(\eta, d\eta') \quad (25)$$

The value chosen is the work-consumption couplets that maximize the Value function for each agent.

## 4 Calibration of the benchmark economy

### 4.1 Demographics

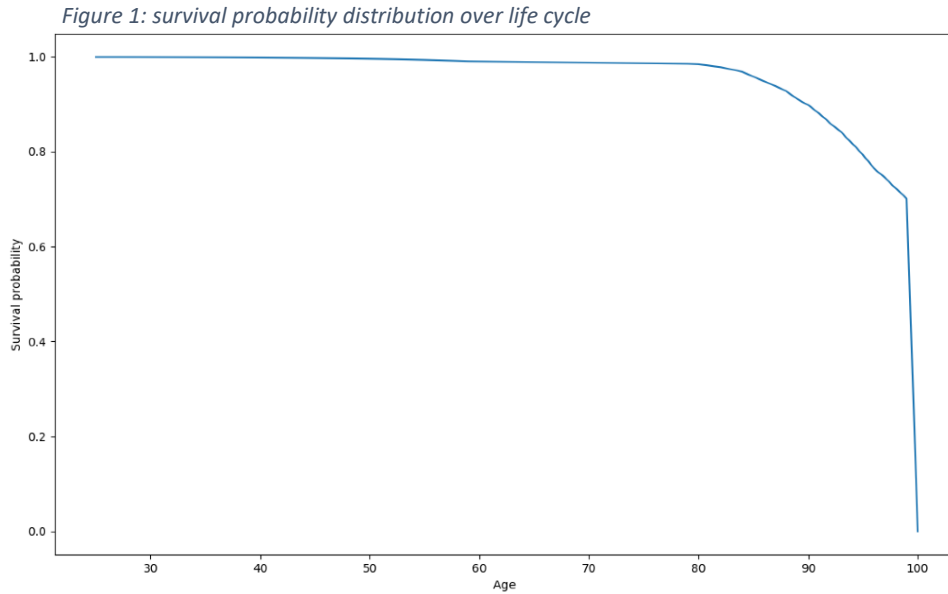
The agents enter in the economy at the age of 25 (that correspond to age 1 in the model), retire at 67 (age 42 in the model) and die at 100 years old (75 in the model).

The data relative to the Italian population growth is taken from *Worldometers Real Time Statistics database*, that carries out estimation for the future of the country. The long-term population growth parameter  $n$  is calculated as the average annual rate for the period 1965-2040.

*Conesa, Kitao and Krueger (2007)* use period life tables to compute survival probabilities  $\psi_j$ , while a proper calibration should rather use cohort life tables to not under-estimate the life length. The survival probabilities employed in the model are estimated in *Buccioli et al (2014)* with data collected by the Human Mortality Database period life tables from 1979 to 2008. They distinguish the trend from fluctuations estimating the parameters of the *Lee and Carter model (1992)* with a singular value decomposition:

$$\ln(1 - \psi_{j,t}^p) = \alpha_j + \tau_j \chi_t + \epsilon_j^\psi \quad (26)$$

where  $\alpha_j$  and  $\tau_j$  are age-varying parameters,  $\chi_t$  is a time-varying vector and  $\epsilon_j^\psi$  is a random disturbance distributed as  $N(0, \tilde{\sigma}_\psi^2)$ . The derived survival probability is reported in *Figure 1*: these results are about 3 years higher than official statistics from the World Health Organization (WHO) and similar organizations based on period life tables.



## 4.2 Preferences

The coefficient of relative risk aversion  $\sigma$  it's fixed over time. It is set at the value of 3, compatibly with the estimates found in the literature (see for instance *Buccioli et Al (2014)*, *Ventura (1999)* and the references therein).

The discount factor  $\beta$  is calibrated so that the equilibrium of the benchmark economy implies a capital-output ratio of as observed in the data. According to *Gardiner, Waights and Derbyschire (2011)* the estimated capital-outout ration for the year 1995 is 2.75 and this value is compatible with the value often adopted in the literature.

According to OECD's estimates in 2018 Italians citizens worked on average 1782 hours; considering that the daily discretionary time of a person is 16 hours (with 8 hours of sleep), Italians worked around 30,5% of their discretionary time. The share of consumption  $\Upsilon$  is calibrated so that the average time that individuals spend working in the model meet this estimate.

## 4.3 The labour productivity process

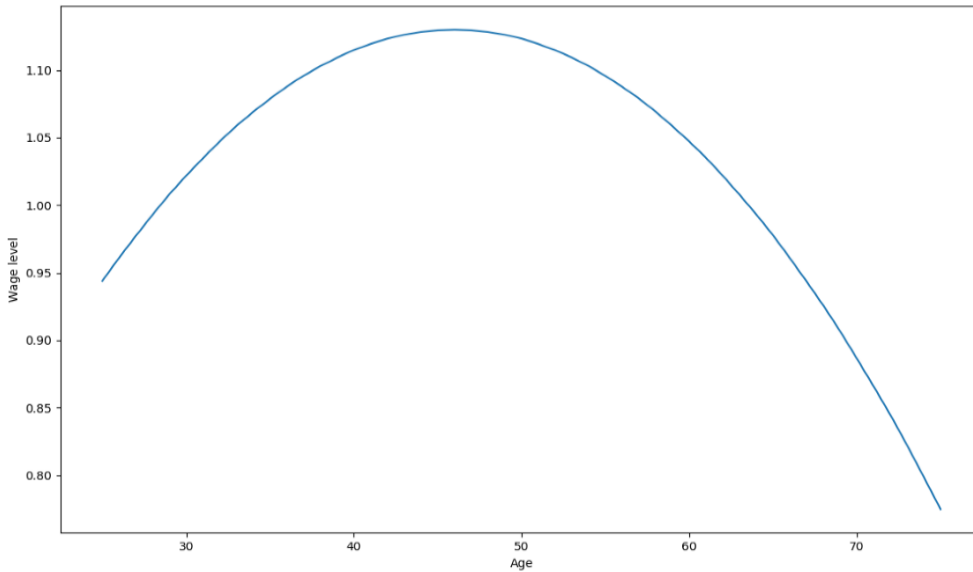
In every period each agent alive in the economy is endowed with one unit of time and can spend it either for working or leisure. The labor productivity of each individual is composed of the ability type

$\alpha_i$ , the age-specific labour productivity component  $\varepsilon_j$  and the idiosyncratic stochastic component  $\eta$ . The logarithm of wages of a household is therefore given by:

$$\log(w_t) + \log(\alpha_i) + \log(\varepsilon_j) + \log(\eta) \quad (27)$$

The age-productivity profile  $\{\varepsilon_j\}_{j=1}^{j_r-1}$  employed for this study is taken by *Walewsky (2008)*. His estimates for Italy in 2004 display the maximum productivity at the age of 46, corresponding to the value of 1.13, as displayed in *Figure 2*. The wage productivity level is then normalized to 1 around the age of 25 (age 1 in the model) and is set equal to 0 for retired agents, so older than 67 years (43 in the model).

Figure 2: Estimated age-wage profiles for full-time employees



For the calibration of ability-type dependent fixed effect  $\alpha_i$ , as for *Conesa, Kitao and Krueger (2007)*, an agent can be born in one of two possible ability type, with equal probability  $p_i = 0.5$  and fixed effects  $\alpha_1 = e^{-\sigma_\alpha}$  and  $\alpha_2 = e^{\sigma_\alpha}$ , so that the expected value  $E(\log(\alpha_i)) = 0$  is zero and the variance of the ability type  $Var(\log(\alpha_i)) = \sigma_\alpha^2$  is fixed.

Regarding the definition of the Markov process for the stochastic component of the log-wages it evolves as a discrete AR(1) process with five states, characterized by a persistence parameter  $p$  and variance  $\sigma_\eta^2$ .

In conclusion, the parameterization of the labour productivity process can be summarized in the three parameters  $\sigma_\alpha^2$ ,  $p$ ,  $\sigma_\eta^2$  to be calibrated. The choice of these parameters targets statistics quantifying how cross-sectional labor income volatility evolves over the Italian individual's life cycle: *Aktas (2017)* document the life cycle cross-sectional variance of household labor income distribution estimated for Italy with data that come from the archives of Italian Social Security Administration (INPS), covering the years from 1985 to 2012. In the model employed for this paper labour supply is

endogenous and responds optimally to the productivity process. *Aktas (2017)* reports a cross sectional variance of 0.58 at the age of 25, and around 1.36 at 60: the three parameters  $\sigma_\alpha^2$ ,  $\rho$ ,  $\sigma_\eta^2$  are chosen so that in the calibrated benchmark economy this model displays a cross-sectional variance profile consistent with these outcomes, assuming a linear distribution from the age of 25 to 60. For the purpose of the parameterization the Tauchen method is used to discretize the linear AR(1) process and derive the transition probability matrix and the reward vector.

#### 4.4 Technology

The share of capital income on total income  $\alpha = 0.35$  is chosen in accordance to the literature on General Equilibrium and OLG models; a similar choice can be found in *Bucciol et al. (2014)* and in the references therein.

The depreciation rate of capital  $\delta$ , following *Conesa, Kitao and Krueger (2007)*, is targeted so that in stationary equilibrium the benchmark economy implies an investment to output ratio consistent with the observed one in Italy. CEIC Data, institution that conduct expansive and accurate data insights into both developed and developing economies, provides annual estimates for the national investment over GDP ratio. the reference indicator for the model is 21%, estimation for the year 2018.

The Total Factor of Productivity  $A$ , following *Conesa, Kitao and Krueger (2007)* is normalized to 1.

#### 4.5 Government

The government finances public expenditure and raise funds for the minimum income through taxes on consumption, capital and labour income and grant an amount (*REI*) to individuals under a computed threshold. The taxes levels are chosen to represent the 2018 fiscal and benefits system.

##### 4.5.1 Consumption tax (IVA)

The VAT rate in Italy (IVA) is fixed at 22%, with reductions on some category of goods. It is 4% for primary food such as milk, butter, cheese, vegetables, fruits, cereals, etc. On socio-sanitary and educational services the VAT rate is 5%. Finally, on other food that is not primary is 10%. The average consumption expenditure estimated by ISTAT was € 2564 per family in 2017, the 17,8% of which was for food. Primary food consumption accounted for 7,1% and health and education for 5,4%. The fix consumption tax rate parameter employed in the model,  $\tau_{c,t}$ , is the weighted average of the different VAT rates weighted for Italians' consumption habits.

##### 4.5.2 Social Security program

Regarding the social security system, the 66% of the social contributions are paid by the employee and the remaining 33% by the employer. The tax rate  $\tau_{ss,t}$  is set to assure that the budget balance of the system time by time.

#### 4.5.3 Separate Capital Income tax

in Italy capital income is not subject to the *IRPEF*, but to a separate taxation. For income deriving from dividends, obligations, banking and postal interest income, certificates of deposits, and other sources of capital income with less than 18 months of maturity the tax rate is 26%, while for bonds, and similar with maturity longer than 18 months is 12,50%. Because in the model the agents can only invest in one-year risk free bonds, the tax rate on capital gains is set to 26%.

#### 4.5.4 Personal Labour Income tax (IRPEF)

In this paragraph it will be described how the tax function that is levied on the agents' labour income is composed in this paper to represent the Italian economy. In Italy the tax on labour income is personal and progressive, structured in the five brackets reported in the *Table 1*. A no tax area is applied for households with income below € 8174 per year, amount that goes close to the estimated absolute poverty threshold of € 780 per month (€9360 a year). According to ISTAT, in 2017 the incidence of absolute poverty in terms of individuals was 8,4%: for this study a poverty threshold matching this estimate is set for the no tax zone.

The data provided by the Banca d'Italia in the Survey on Household Income and Wealth in 2014 is reported in *Table 2*: the brackets' ranges are set to match these estimates.

Table 1: IRPEF brackets

Income range	Tax rate
Less than €15.000	23%
€15.000 - €28.000	27%
€28.000 - €55.000	38%
€55.000 - €75.000	41%
More than €75.000	43%

The quantiles of the income distribution corresponding to the *IRPEF* brackets are obtained from *Table 2* and *Table 3*. The amount of 15.000 euros is so set as the second decile. 28.000 is the mean income above the fifth and sixth decile, 55.000 is the ninth decile and 75.000 is set as the mean income of the last decile. A higher marginal rate is paid only on the part of income exceeding the previous bracket. This does not work for the no-tax area: if an agent earns more than the no tax threshold, must pay taxes on all the labour income.

The Italian fiscal scheme also provides a system of deductions and detractions for the *IRPEF*; in the model it is included a fix deduction on labour income only for agents earning less than € 55.000 (ninth decile of the income distribution in the model). By the moment that households are represented as

individuals, no family deductions or allowances, or neither any other kind of reduction (eg. for total/partial disability, war servants, etc.) are considered

Table 2: income distribution by Banca d'Italia

Mean income and share of income by deciles of households		
Household deciles	Decile (€)	Mean Income (€)
Up to the 1 <sup>st</sup> decile	10.400	6.521
1 <sup>st</sup> to 2 <sup>nd</sup> decile	14.982	12.840
2 <sup>nd</sup> to 3 <sup>rd</sup> decile	18.165	16.633
3 <sup>rd</sup> to 4 <sup>th</sup> decile	21.600	19.905
4 <sup>th</sup> to 5 <sup>th</sup> decile	25.108	23.320
5 <sup>th</sup> to 6 <sup>th</sup> decile	30.065	27.442
6 <sup>th</sup> to 7 <sup>th</sup> decile	36.018	32.978
7 <sup>th</sup> to 8 <sup>th</sup> decile	43.748	39.610
8 <sup>th</sup> to 9 <sup>th</sup> decile	55.265	48.916
Over the 9 <sup>th</sup> decile		77.189

#### 4.5.5 The “Reddito d’Inclusione” - REI

Finally, the benchmark economy calibrated for the 2018 tax-benefits system includes the *REI* (*Reddito di Inclusione*), a pro-poor instrument introduced in 2017 to sustain families with income under the absolute poverty threshold. The *REI* is included in the model as a negative income tax (so inside the personal income tax function) and a parameter adjusts the maximum amount that is paid to households and the deduction on the personal labour income tax to clear the market, so that the tax total tax revenue compensates the chosen government expenditure level.

#### 4.5.6 Individual tax function specification $T[\cdot]$

The individual labour income tax function is specified as follow:

$$T[y_t] =$$

$$-(p * \mathcal{J} - y_t - r_t(a_t + Tr_t)) \quad \text{if } y_t + r_t(a_t + Tr_t) \leq p * \mathcal{J}$$

$$0 \quad \text{if } y_t + r_t(a_t + Tr_t) \leq \mathcal{J}$$

$$0.23 * \min(y_t - \frac{p}{s}, 0) \quad \text{if } \mathcal{J} \leq y_t + r_t(a_t + Tr_t) \leq b1$$

$$0.23 * b1 + 0.27 * (y_t - b1 - \frac{p}{s}) \quad \text{if } b1 \leq y_t + r_t(a_t + Tr_t) \leq b2$$

$$0.23 * b1 + 0.27 * b2 + 0.41(y_t - b2 - \frac{p}{s}) \quad \text{if } b2 \leq y_t + r_t(a_t + Tr_t) \leq b3$$

$$\begin{aligned}
0.23 * b_1 + 0.27 * b_2 + 0.38 * b_3 + 0.41 * (y_t - b_3) & \quad \text{if } b_3 \leq y_t + r_t(a_t + Tr_t) \leq b_4 \\
0.23 * b_1 + 0.27 * b_2 + 0.38 * b_3 + 0.41 * b_4 + 0.43(y_t - b_4) & \quad \text{if } y_t + r_t(a_t + Tr_t) > b_4
\end{aligned}
\tag{28}$$

Where  $y_t$  denotes the individual labour earnings net of social contributions,  $r_t(a_t + Tr_t)$  the individual capital earnings.  $\mathcal{T}$  is the absolute poverty threshold (computed as quantile 0.084 of the income distribution, according to ISTAT estimates for 2018) and  $b_1, b_2, b_3$  and  $b_4$  correspond to the brackets of the progressive labour income tax, set to match the estimates displayed in **Table 2** as described in paragraph 4.5.4. Finally  $p$  and  $s$  are parameters defining both the minimum income amount granted in the benchmark economy (*REI*) and the fixed deduction on the individual labour income.

The following observations may be useful for a better understanding of the individual labour tax function  $T[y_t]$ :

- $p * \mathcal{T}$  define level of minimum income “*REI*” granted in the benchmark economy. For instance, if in the stationary equilibrium it is found that  $p$  equal to 0,5 the minimum income measure will be granted only for citizens with earnings below the half of the absolute poverty threshold within the country, and  $p * \mathcal{T}$  is the maximum possible amount granted by the government. This means that an agent earning 200 in an economy where the poverty threshold is 1000, will receive by the government  $1000 * 0,5 - 200 = 300$ . An agent earning 0 receives 500 and to an agent earning 500 nothing will be granted.
- $s$  is a parameter meant to proportionate the minimum income amount granted and the fixed deduction on labour income  $\frac{p}{s}$ . This deduction is available for income smaller than €55.000, so below the ninth decile (**Table 2**).

#### 4.6 The benchmark economy

To follow a brief commentary on the parametrized benchmark economy. **Table 3** lists the relevant variables that are calibrated in the model. The parameterization of the benchmark model has been conducted so these measures result proportionate to the two observed in Italy: the absolute poverty threshold have been estimated by ISTAT to be €780 monthly, the deduction about €8000 for income smaller than €55.000 a year and the maximum amount granted by the government with the *REI* for a poor individual has been estimated by INPS to be around €200 a month. In the stationary equilibrium the benchmark economy reports a parameter of 0.402, meaning that the 40,2% of the absolute poverty threshold is level of minimum income (*REI*) granted to an individual before the reform, so about

€310. The fixed deduction  $\frac{p}{s}$  results 0.0201 (the parameter  $s$  is set to be 20), value close to the one of the absolute poverty threshold, as observed in the empirical evidence.

Table 3: Calibration of the benchmark economy

**Parametrization**

Category	Variable	Value	Target/Source
Demographics	population growth $n$	0.236% per year	<i>Worldometers</i>
	Survival probabilities $\psi_j$	distribution	<i>Buccioli et Al. (2004)</i>
	Age of birth in the model $j_1$	25 years (1)	Birth age (assumed)
	Retirement age $j_r$	67 years (43)	Old age retirement
	Maximum age $J$	100 years (76)	Certain death
Preferences	Discount factor $\beta$	0.966	$K/Y$ ( <i>Gardiner</i> ) = 2.75
	Risk aversion $\sigma$	3	<i>Ventura (1999)</i>
	Consumption share $\Upsilon$	0.4	Avrg hours worked: 0.305
Labor productivity	age-productivity profile $\varepsilon_j$	distribution	<i>Walewsky (2008)</i>
	Variance types $\sigma_\alpha^2$	0.2945	<i>Aktas (2017)</i>
	Persistence $p$	0.9394	<i>Aktas (2017)</i>
	Variance shock $\sigma_\eta^2$	0.3841	<i>Aktas (2017)</i>
Technology	Capital share $\alpha$	0.35	<i>Buccioli et Al. (2004)</i>
	Depreciation rate $\delta$	0.077	$I/Y$ ( <i>CEIC Data</i> ) = 0.21
	Scale parameter $A$	1	Normalized
Government	Consumption tax $\tau_{c,t}$	18,5%	ISTAT
	Capital income tax $\tau_{k,t}$	26%	Short-time cap inc tax
	Poverty threshold $\mathcal{T}$	0.0202	ISTAT (quantile 0.084)
	Parameter $p$	0.402	Banca d'Italia
	Parameter $s$	20	MI-deduction proportion
	Social security tax $\tau_{ss,t}$	13,3%	ISTAT

## 5 Computational experiment: a Flat-Tax and minimum income reform

The purpose of the study consists in evaluating the effect of a Flat tax and a Minimum Income reform. Once the model is parametrized, it is possible to proceed to the computational experiment. Keeping fixed the level of government spending and the absolute poverty threshold calibrated in the stationary equilibrium of the benchmark economy, a new tax function is defined: this is characterized by a constant marginal rate for the individual income and by a parameter defining the level of minimum income  $p * \mathcal{T}$  in favor of the poor agents. Just like for the benchmark economy, a parameter adjusts so that the total tax revenue offsets the fixed government expenditure amount previously calibrated. The goal is to find a marginal rate allowing the government to grant a minimum income level coinciding with the absolute poverty threshold  $\mathcal{T}$ , so a marginal rate for which, in the stationary equilibrium, the parameter  $p$  equals 1; to be clear an agent earning 200 in an economy where the threshold  $\mathcal{T}$  is 1000 will receive  $1000 - 200 = 800$ . Two different experiments are conducted: the first consists in a Flat-Tax reforming only the personal labour income, so keeping the marginal rate

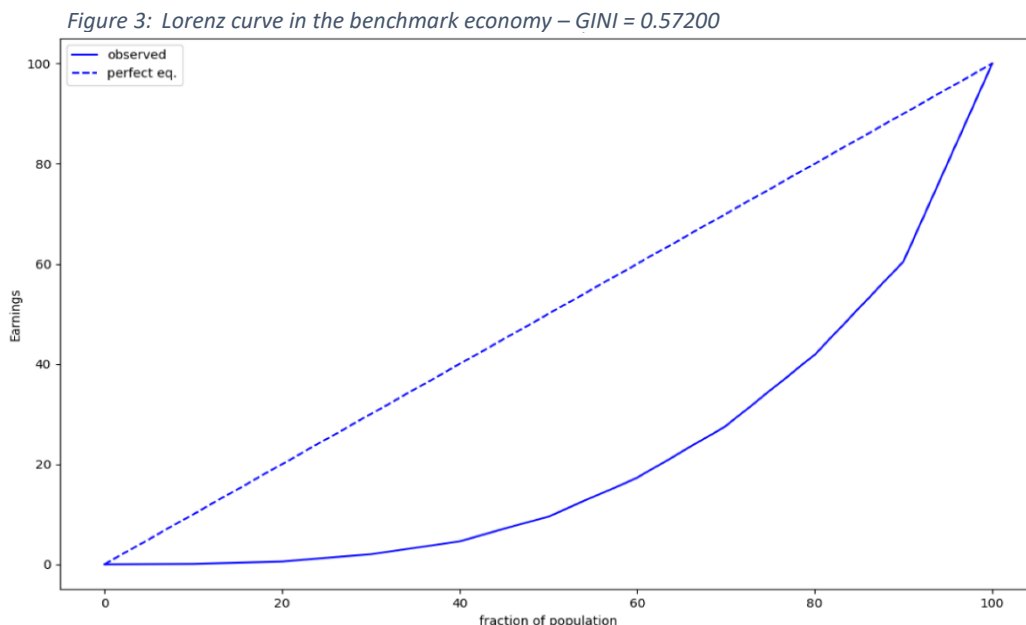
of the capital income unchanged and second involves a unique flat marginal rate for both the individual labour and capital income.

### 5.1 Result of the first experiment: a Flat-Tax on the personal labour income

The first experiment consists in simulating a Flat-Tax on the personal labour income and in deriving the marginal rate for which the maximum level of Minimum Income granted to the underprivileged individuals in the economy coincides with the poverty threshold. That is, a marginal rate that would allow to solve the absolute poverty issue within the country (so that no agent would earn less than the previously calibrated absolute poverty threshold) keeping fixed the government expenditure level. The personal labour income tax function is so defined as

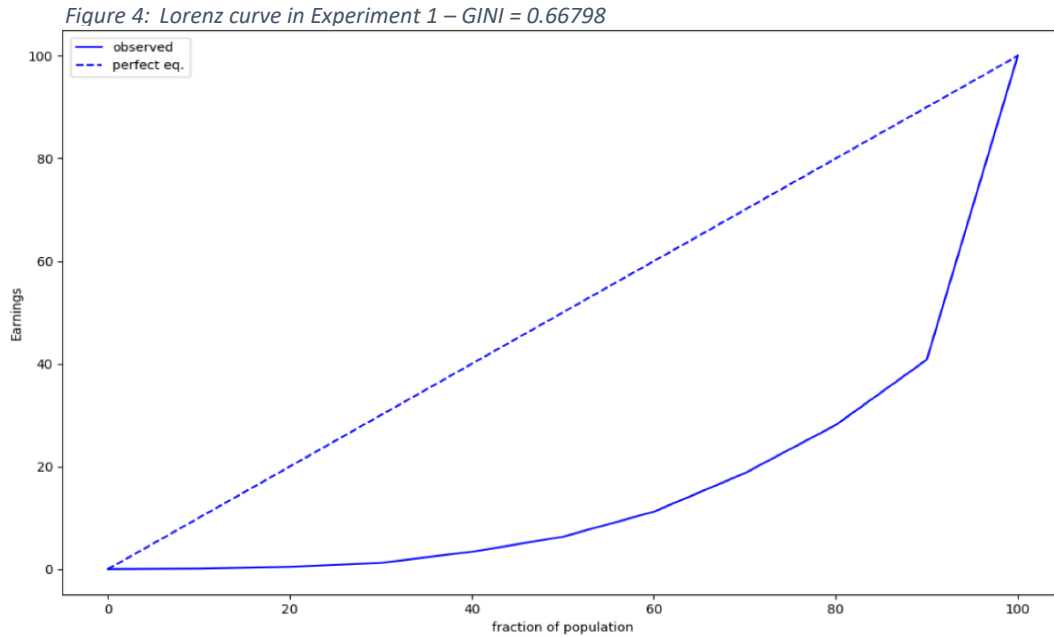
$$\begin{aligned}
 T[y_t] = & \\
 & -(p * \mathcal{J} - y_t - r_t(a_t + Tr_t)) && \text{if } y_t + r_t(a_t + Tr_t) \leq p * \mathcal{J} \\
 & \tau_y y_t && \text{if } y_t + r_t(a_t + Tr_t) > p * \mathcal{J}
 \end{aligned}
 \tag{29}$$

where  $\tau_y$  is the Flat-Tax's marginal rate. This rate results to be 20%: the stationary equilibrium reports indeed a parameter of 1,0255 meaning that the level of minimum income granted is the 102,55% of the poverty threshold (look in the *Appendix 3*).

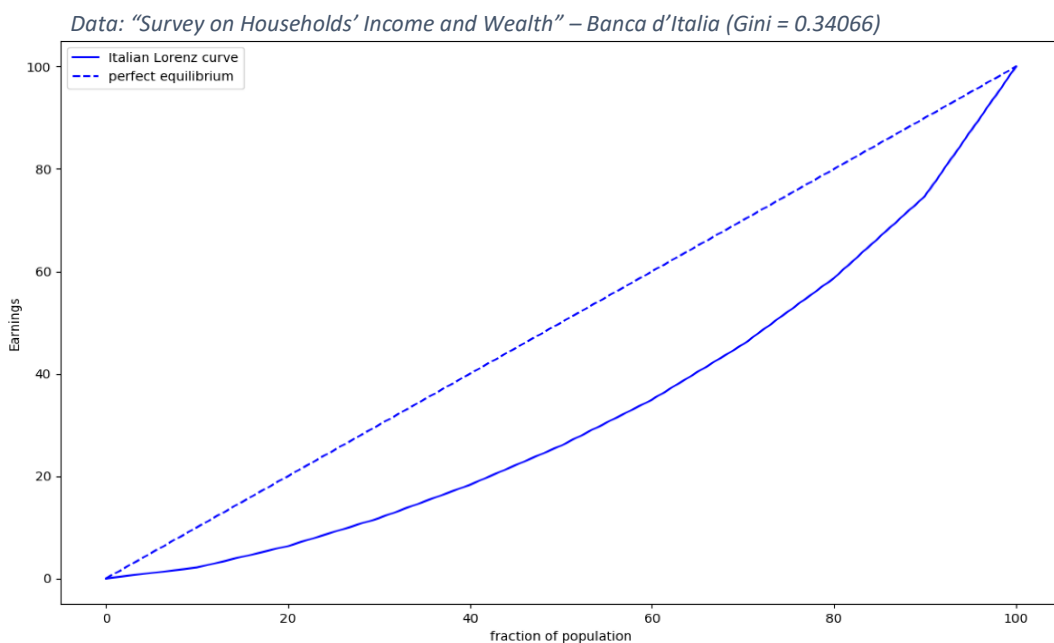


The Gini coefficient is the measure chosen to assess the inequalities within the country and is computed for both the Benchmark economy and the computational experiment: it is a measure of statistical dispersion intended to represent the income distribution of a nation's residents. It is usually defined mathematically based on the Lorenz curve, which plots the proportion of total income of the

population that is cumulatively earned by the bottom  $x$  of the population. A line representing the perfect equality of income is then plotted at 45 degrees. The Gini index is finally computed as the ratio of the area that lies between the perfect equality and the Lorenz curve. *Figure 3* and *Figure 4* provide a graphical representation of the Lorenz curve for respectively the benchmark economy and the Experiment 1.



Worth to notice, the earnings distribution derived in the stationary equilibrium is far from reflecting the empirical evidence: the figure below report the actual Italian Lorenz curve, with data employed from the Survey on Households’ Income and Wealth carried on by the Banca d’Italia in 2016.



In order to assess the overall state of welfare in the economy, a Utilitarian Social Welfare is derived as follow:

$$W(c, l) = \int V(c, 1 - l) \varphi_t(da * d\eta * di * dj) \quad (30)$$

The stationary welfare variation resulting by switching from an allocation  $(c_0, l_0)$  to  $(c_1, l_1)$  is:

$$CEV = \left[ \frac{(c_1, l_1)}{(c_0, l_0)} \right]^{\frac{1}{Y(1-\sigma)}} - 1 \quad (31)$$

The basic findings of this first experiment are listed in the table below. The percentual changes of the Computational Experiment 1 with respect to the benchmark economy are computed as:

$$\frac{Variable_{Experiment} - Variable_{benchmark}}{Variable_{benchmark}} \quad (32)$$

Under the reform it is observed an increase in the labour supply, as displayed in **Table 4**. As a consequence the aggregate output within the country increases as well, leading to a significantly higher level of aggregate consumption and savings. The Gini coefficient of the country is 0.6679, consistently increased in the experiment when compared to the Benchmark economy: this is an expected outcome, since by definition a progressive tax is a fiscal system meant to reduce the inequalities within a country. Despite the overall apparent improvement in macro aggregates, the equilibrium displays an unexpected decrease in the average hours worked and social welfare: an investigation on the causes of these effects is conducted in Chapter 6.

*Table 4: results of a Flat-Tax on the personal labour income*

**Computable Experiment 1**

<i>Variable</i>	<i>Benchmark</i>	<i>Experiment 1</i>
<i>Total Labour Supply N</i>	8,38260	9,04090 (+7,87%)
<i>Capital Stock K</i>	38,9965	43,2251 (+10,96%)
<i>Output Y</i>	14,3567	15,6331 (+8,94%)
<i>Aggregate consumption C</i>	7,41246	8,34010 (+12,49%)
<i>Average hours worked</i>	0,30488	0,27965 (-8,27%)
<i>Gini Coefficient for Income</i>	0,57200	0.66790 (+16,78%)
<i>ECV</i>	---	-1,81%

## 5.2 Result of the second experiment: a Flat Tax on the personal labour and capital income

The second Computational Experiment is conducted similarly to the first one: it consists in simulating a Flat-Tax with the same marginal rate for both the personal labour and capital income. If  $\tau_y$

represents this marginal rate, the problem that faces an household earning more than the poverty level becomes so:

$$v_t(a, \eta, i, j) = \max_{c, a', l} (u(c, 1 - l) + \beta \psi_j \int v_{t+1}(a', \eta', i, j + 1) Q(\eta, d\eta')) \quad \text{subject to:}$$

$$(1 + \tau_{c,t})c + a' = (1 - 0.66\tau_{ss,t}) \frac{w_t}{1 + 0.33\tau_{ss,t}} \varepsilon_j \alpha_i \eta l_t + (1 + r_t)(a + Tr_t) - T[y_t] \quad \text{for } j < j_r,$$

$$(1 + \tau_{c,t})c + a' = SS_t + (1 + r_t(1 - \tau_y)) (a + Tr_t) - \tau_y SS_t \quad \text{for } j \geq j_r.$$

**(33)**

$$T[y_t] =$$

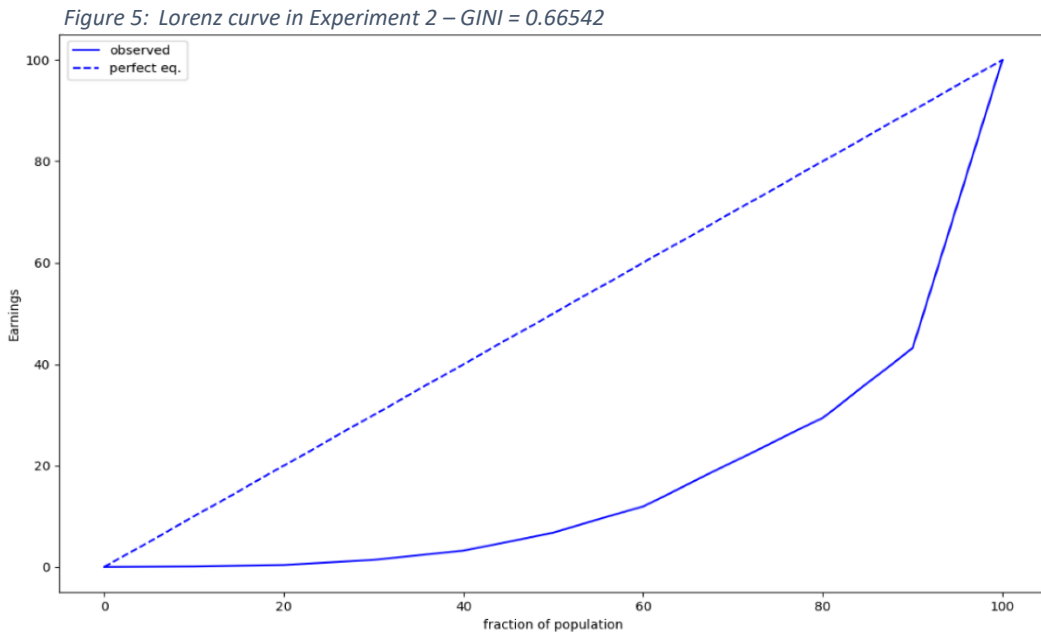
$$-(p * \mathcal{J} - y_t - r_t(a_t + Tr_t)) \quad \text{if } y_t + r_t(a_t + Tr_t) \leq p * \mathcal{J}$$

$$\tau_y(y_t + r_t(a_t + Tr_t)) \quad \text{if } y_t + r_t(a_t + Tr_t) > p * \mathcal{J}$$

**(34)**

The marginal rate found is 23%: the stationary equilibrium reports a parameter of 1,053, that means the maximum amount of minimum income granted in the economy is the 105,3% of the poverty threshold.

A graphical representation of the Lorenz curve is plotted in *Figure 5*, and the Gini coefficient is computed as the ratio of the area that lies between the perfect equality and this curve.



As in the first Computational Experiment this reform (look *Table 5*) apparently seems to boost the economy, despite then displaying lower average number of hours worked and social welfare: the

increase in the aggregate labour supply brings a to higher aggregate output within the country, and as a consequence to higher level of consumption and savings. Again, the flat fiscal system results in a higher income inequality in the economy, with a Gini coefficient of 0,6654

Table 5: results of a Flat-Tax reforming the personal labour and capital income

### Computable Experiment 2

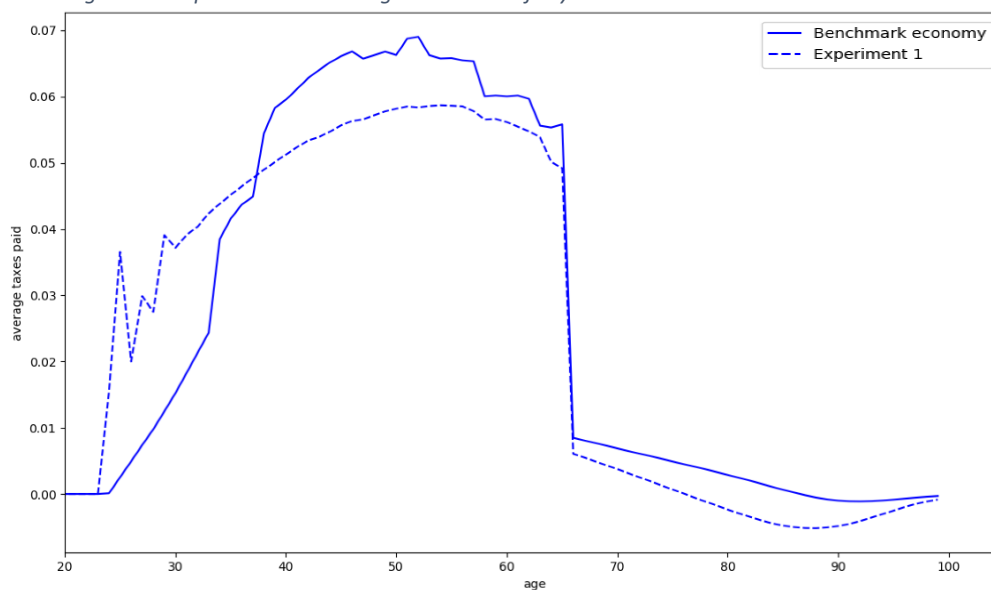
Variable	Benchmark	Experiment 2
Total Labour Supply $N$	8,38260	8,81568 (+5,52%)
Capital Stock $K$	38,9965	41,3002 (+5,59%)
Output $Y$	14,3567	15,1356 (+5,43%)
Aggregate consumption $C$	7,41246	7,99237 (+7,82%)
Average hours worked	0,30488	0,25221 (-0,17%)
Gini Coefficient for Income	0,57200	0,66542 (+16,33%)
ECV	---	-5,78%

## 6 Discussing the results

In order to better analyze the effects of these fiscal reforms and to understand how the new tax code impact the agents in different cohort ages, this chapter compares the post-reform distributions of asset holdings, labour supply, labour earnings and consumption for different cohort ages to the pre-reform ones. The discussion is conduct on the average distributions over life cycle.

### 6.1 First experiment: 20% Flat-Tax on the individual labour income

Figure 6A: Experiment 1 – Average taxes over life cycle

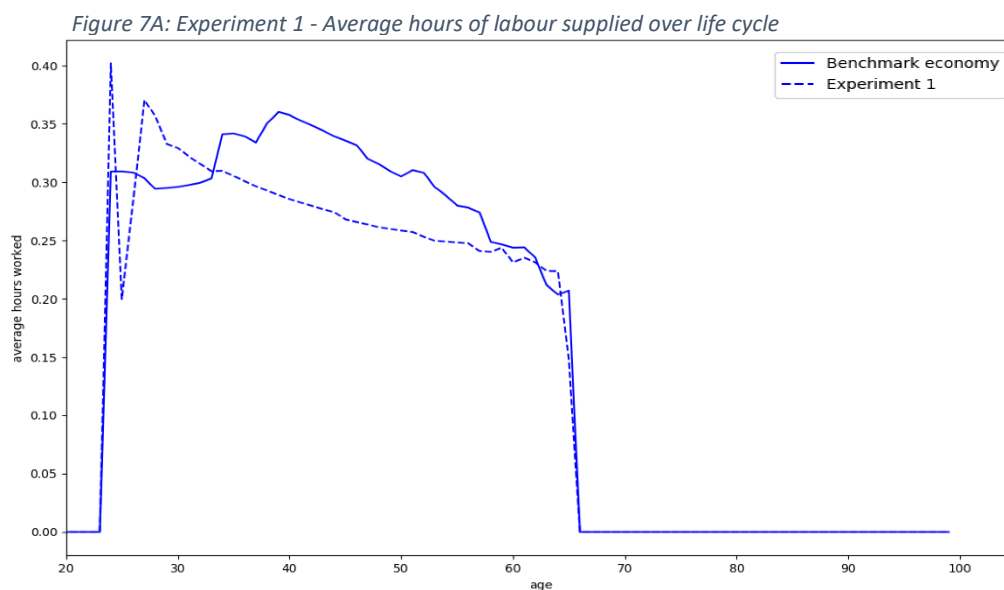


The average capital and labour earnings taxes paid by agents in different cohort ages are plotted in *Figure 6A* for the benchmark economy (continuous line) and the Computational Experiment 1 (dotted

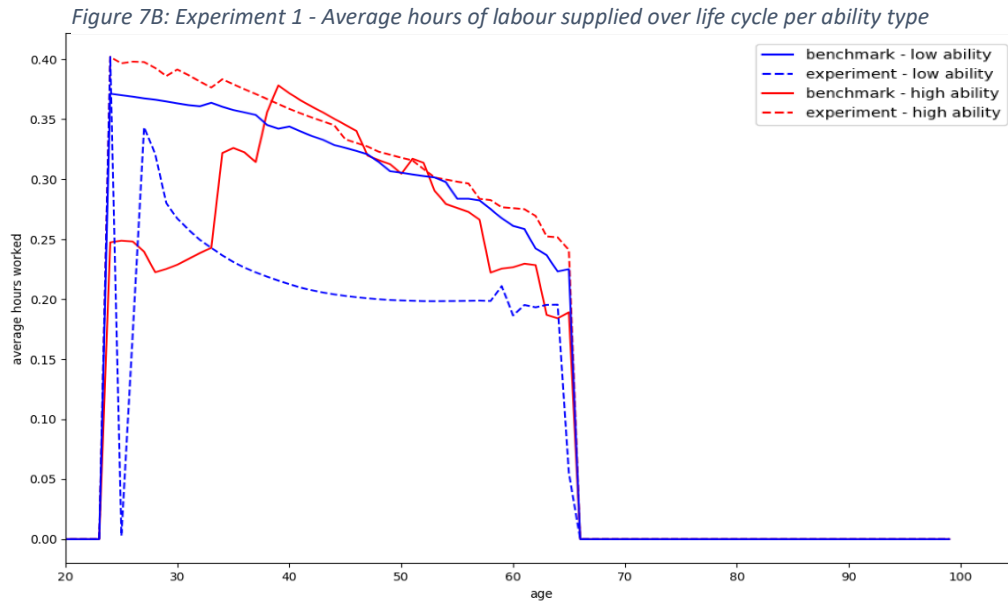
line). The distribution is computed including the minimum income amount granted to the agents earning less than the previously calibrated threshold. It appears that agents under the age of 37 face a higher fiscal burden, while in other cohort ages they pay significantly lower taxes.



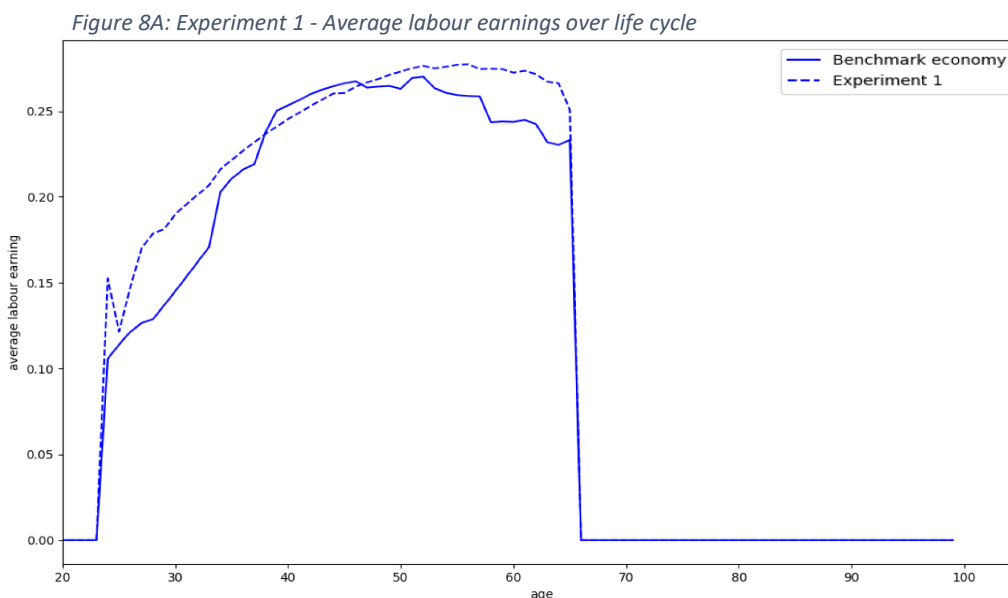
In *Figure 6B* the effect of the fiscal reform on taxes paid are separated above low and high skilled agents over life cycle: high level workers under 37 face significantly higher taxes, and significantly lower after that age. The average tax on the other hand decreases for low skilled workers basically for every age due to the increase in the minimum income level, by the moment they are the ones benefitting the most from it.



The average hours worked for different cohort ages is displayed in *Figure 7A*. As expected from the results previously observed and reported in *Table 4*, the average hours worked seems to drop consistently for basically every age level, with some exception for the early aged agents.



A further decomposition is required to understand why the aggregate labour supply in the economy increased after the reform despite the average hours worked by the agent have decreased (*Table 4*). For this purpose, it is reported the average distribution of labour supply over life cycle for different ability types in *Figure 7B*. In contrast to what one might suppose, young agents with high ability react to the reform supplying more labour despite the higher taxes paid. In this term, the simulated reform overall stimulates the average hours by the early aged agents, one of the main goals targeted in Italy.



On the other hand, the average hours worked drop consistently for the low skilled ones, who are in fact disincentivized by the minimum income's reform. The increase in the aggregate labour supply is explained by the fact that high skilled agents that react supplying more hours of labour are the ones with higher productivity of work, leading to an higher level of aggregate output that overcompensates the decrease brought by the overall decrease of hours worked caused by the low skilled ones.

Figure 8A displays the average distribution of labor income over life cycle. It is possible to notice that in the Computational Experiment the average labour income is higher than the one computed for the benchmark economy for basically every age, with an exception for agents ranging from 37 to 45 years old: this is a direct consequence of the peak of average hours worked displayed in Figure 7A. What is, again, worth to notice, is the increase in the labour earnings of early age agents, explained by the higher number of average hours worked by the high skilled ones.

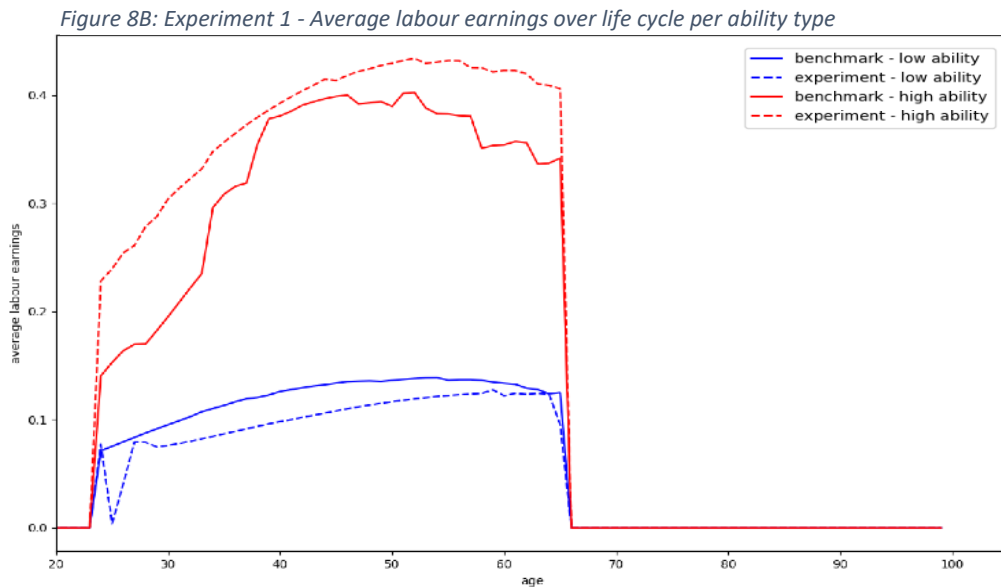


Figure 8B decomposes the labour earning distribution over life cycle for the two different ability types. The labour earnings increase for high skilled agents in every age as a direct consequence to the higher number of average hours worked, while decrease for low skilled workers.

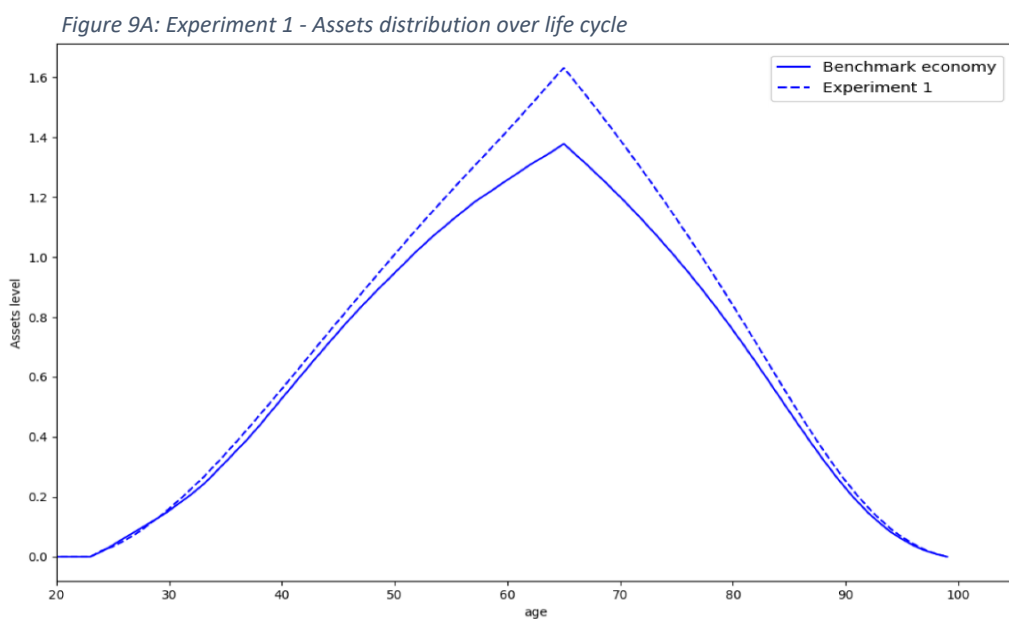
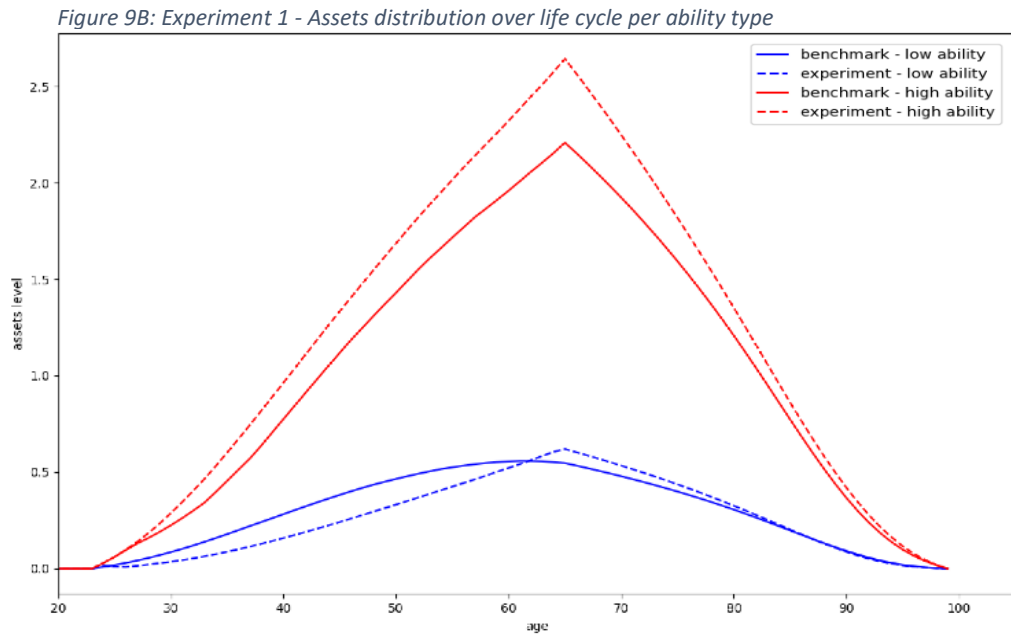
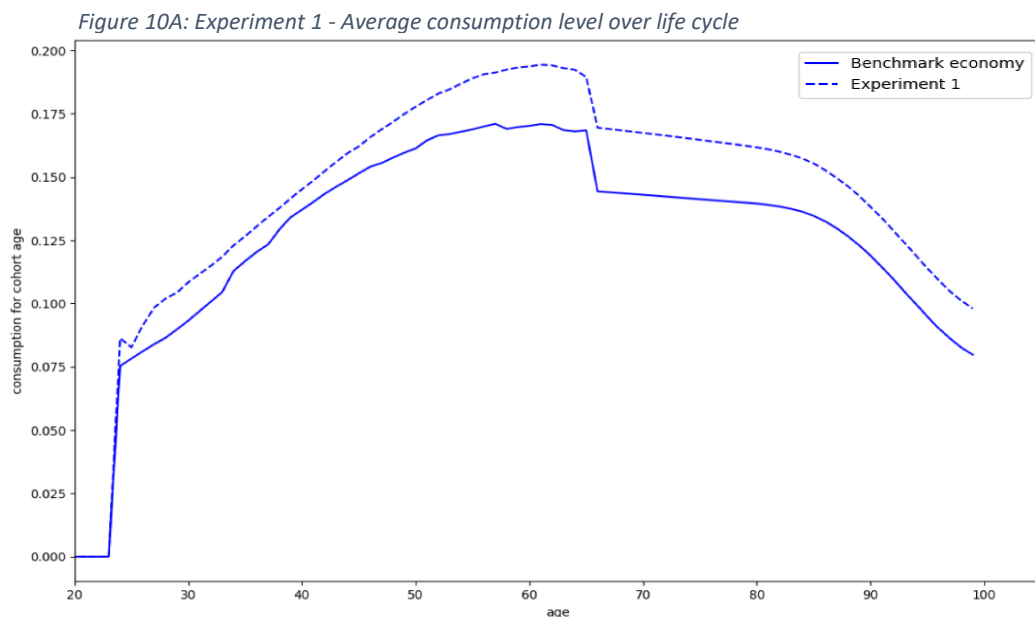


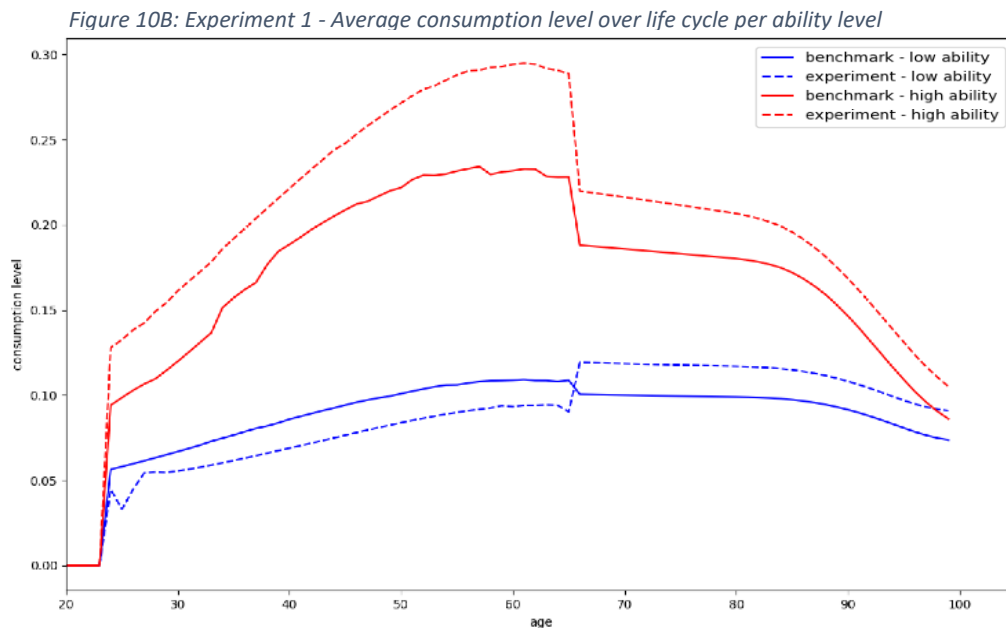
Figure 9A reports the average asset holding over the life cycle. The distributions display the humped behavior commonly found in life cycle models: in specific, it can be observed that most of the government revenues deriving from capital income taxes comes from the central part of the distributions. Agents react to the higher average earnings increasing the level of the aggregate capital savings overall in all the cohort ages, as the dotted line is higher substantially in every lifetime.



Analyzing the assets distribution over life cycle for different ability type, Figure 9B shows that high skilled workers after the reform on increase their asset holdings due to their increased labour earnings, while low skilled workers under 62 years old, so basically in every working age, decrease their savings compared to the pre-reform scenario.



Finally, *Figure 10A* plotting the average consumption distribution over life cycle displays an increase in consumption for every age level. This outcome can be decomposed across high and low skilled agents as reported in *Figure 10B*: as expected, high ability level workers react to the first Computational Experiment increasing their consumption in any age, while low skilled agents in working age (younger than 67) decrease their consumption, as a result of the lower average number of hours worked and so of the lower labour earnings.



## 6.2 Second experiment: 23% Flat-Tax on individual labour and capital income

In this section are reported the average distributions over life cycle derived in the second Computational Experiment. These distributions appear to behave in a strictly analogous manner to the ones computed in the first Experiment: due to the large similarities, the conclusions that can be drawn are specular to the ones reported in the paragraph 6.1

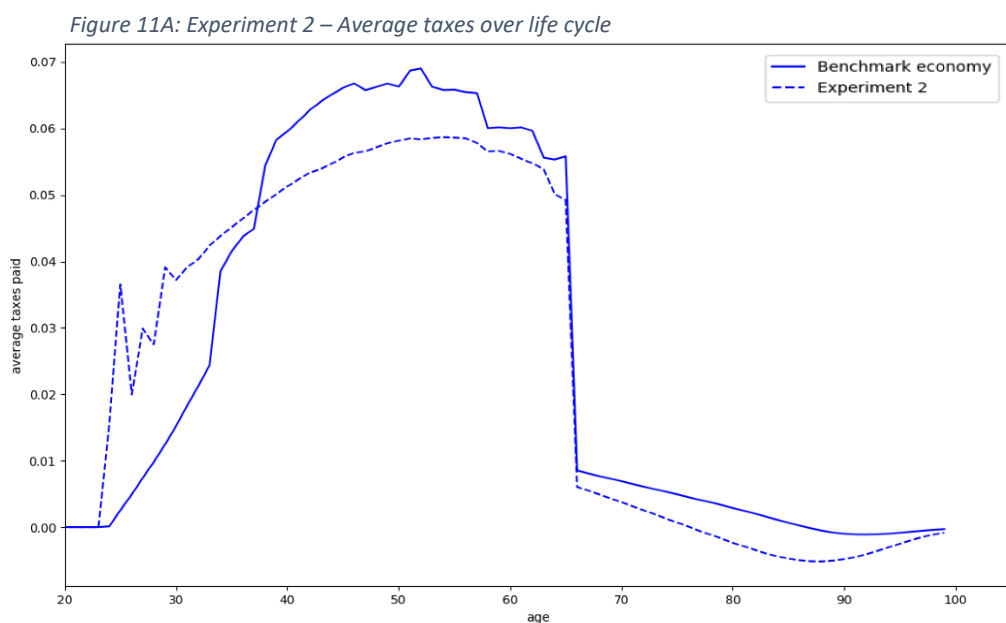


Figure 11B: Experiment 2 – Average taxes over life cycle per ability level

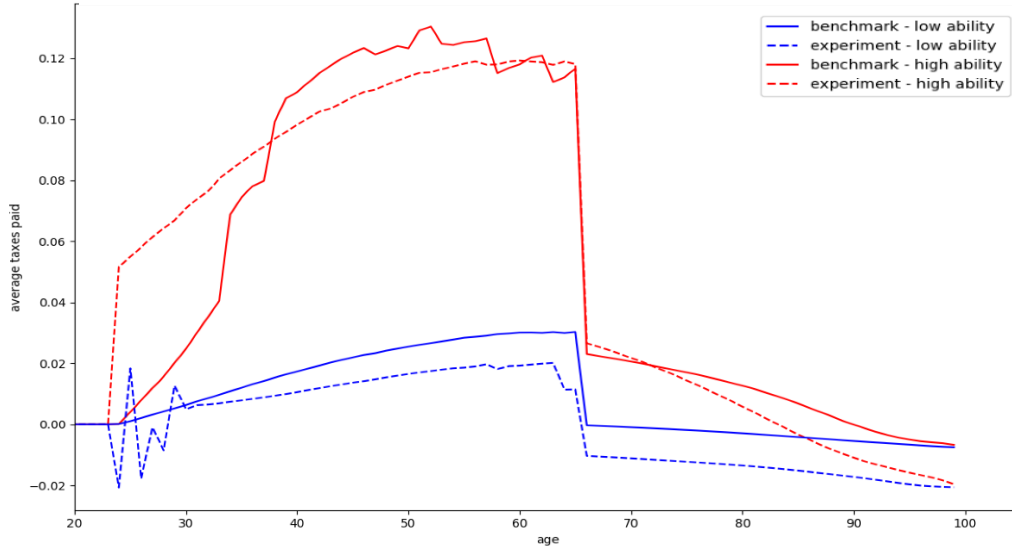


Figure 12A: Experiment 2 - Average hours of labour supplied over life cycle

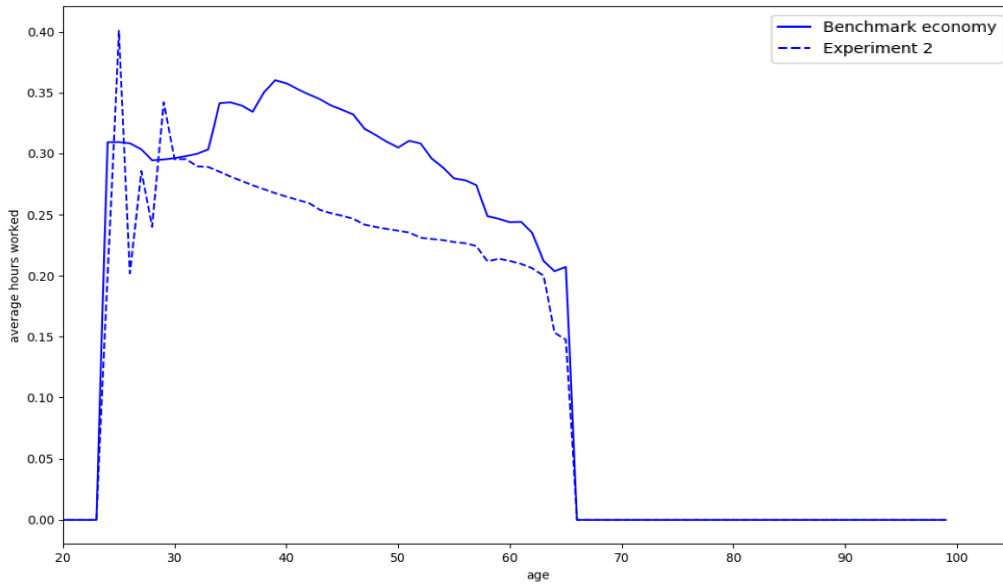


Figure 12B: Experiment 2 - Average hours of labour supplied over life cycle per ability type

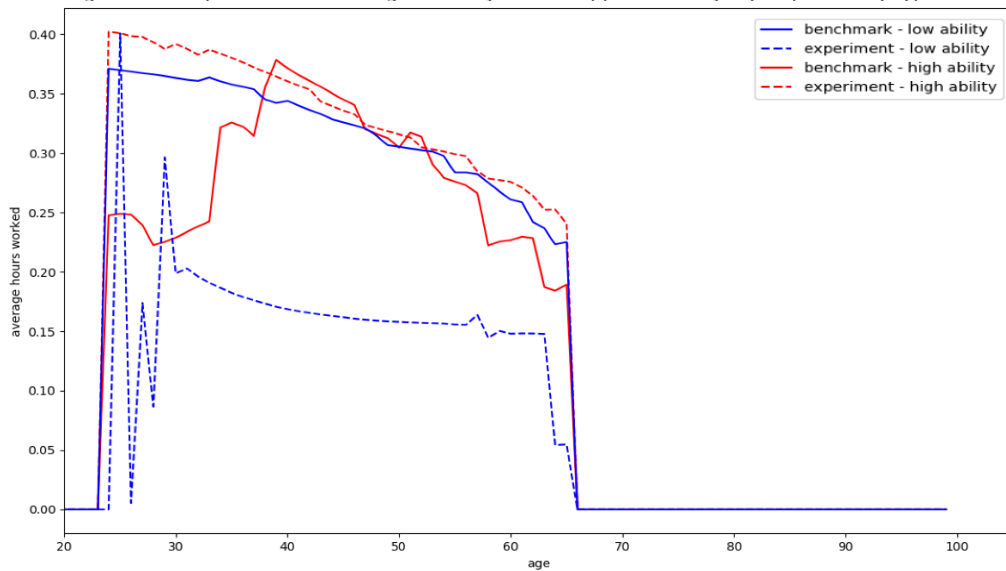


Figure 13A: Experiment 2 - Average labour earnings over life cycle

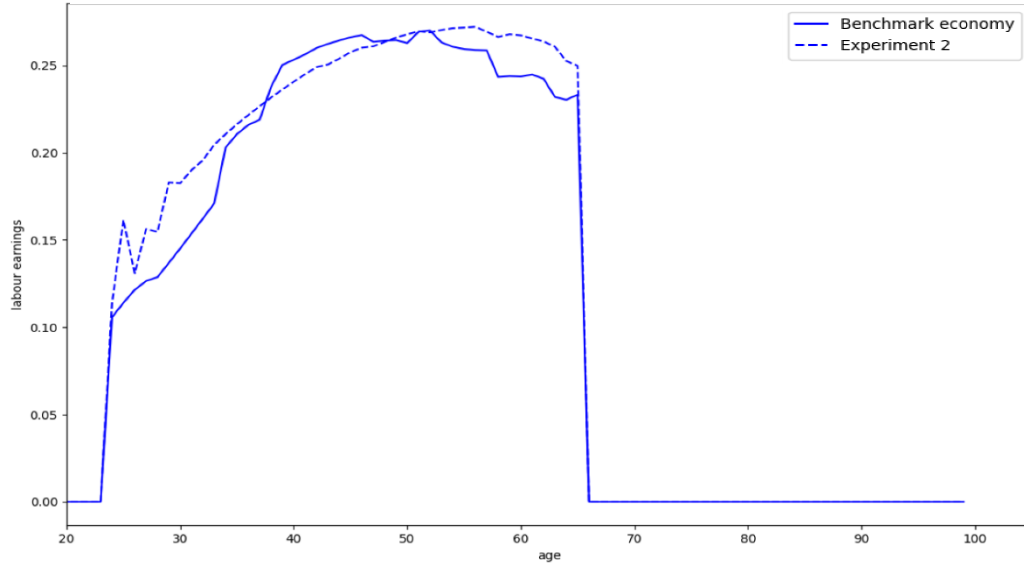


Figure 13B: Experiment 2 - Average labour earnings over life cycle per ability type

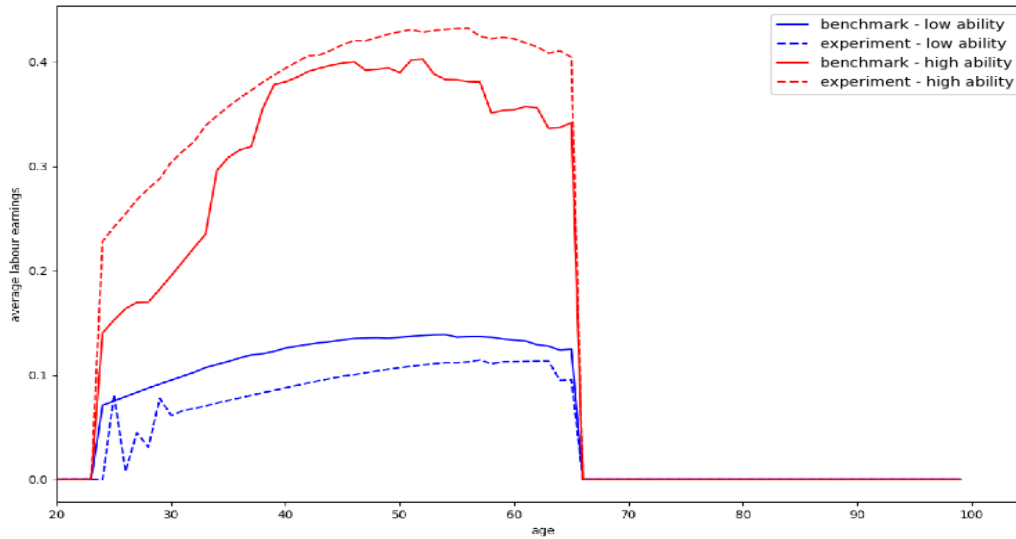


Figure 14A: Experiment 2 - Assets distribution over life cycle

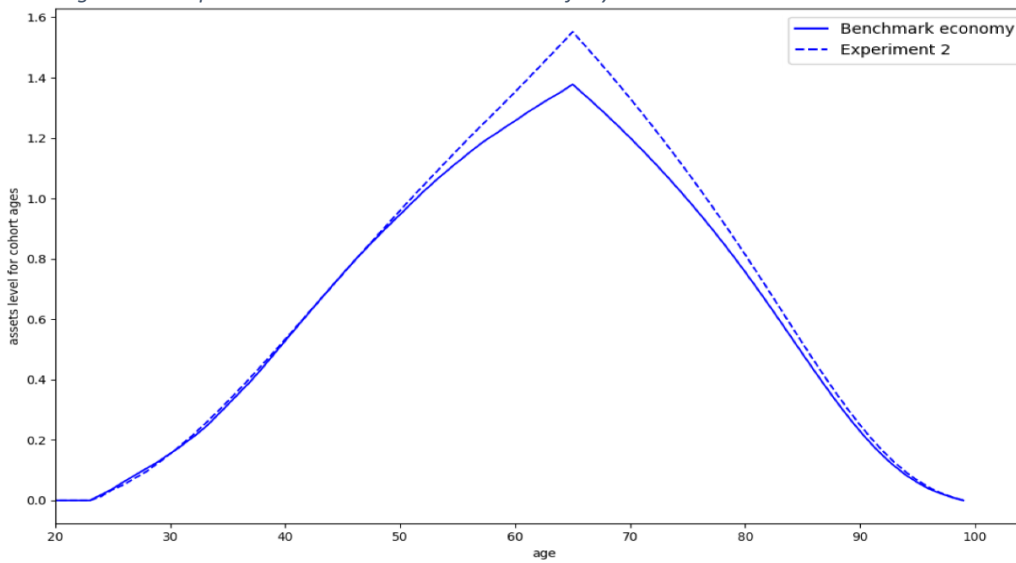


Figure 14B: Experiment 2 - Assets distribution over life cycle per ability type

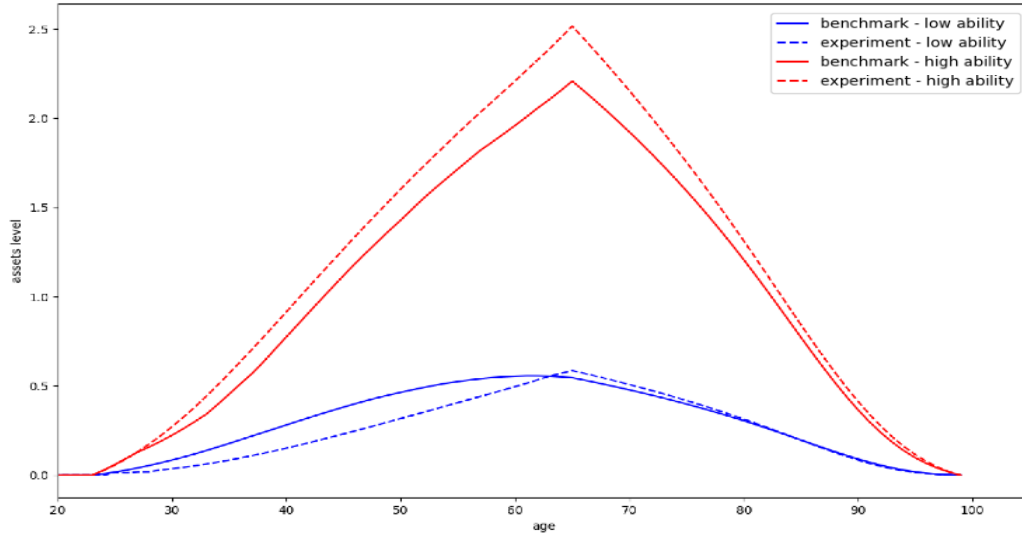


Figure 15A: Experiment 2 - Average consumption over life cycle

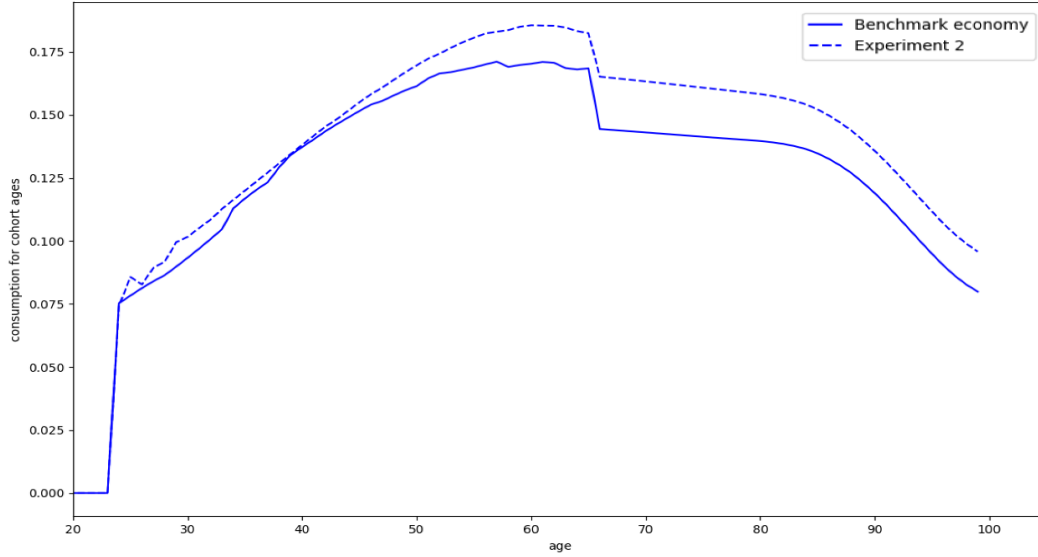
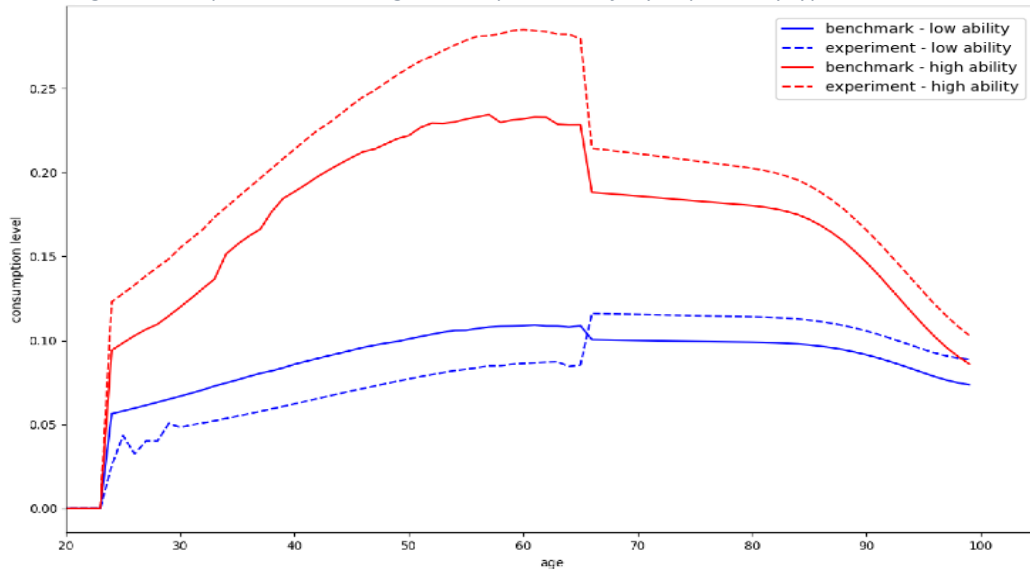


Figure 15B: Experiment 2 - Average consumption over life cycle per ability type



### 6.3 Comparing the Computational Experiments

Table 6: Experiment 1 vs Experiment 2

<i>Variable</i>	Experiment 1	Experiment 2
<i>Total Labour Supply N</i>	9,04090	8,81568
<i>Capital Stock K</i>	43,2251	41,3002
<i>Output Y</i>	15,6331	15,1356
<i>Aggregate consumption C</i>	8,34010	7,99237
<i>Average hours worked</i>	0,27965	0,25221
<i>Gini Coefficient for Income</i>	0.66790	0,66542

The first Computational Experiment simulated in this paper consisted in a Flat-Tax with a marginal rate of 20% for the personal labour income and a minimum income scheme for agents under the poverty threshold, keeping fixed the marginal tax rate on the capital earnings at 26%. The second Experiment is a Flat-Tax 23% for both labour and capital income and a minimum income for poor agents. The key macro aggregates are stored in **Table 6**, comparing these results in the stationary equilibrium. Given the nature of the Experiments, it appears counter-intuitive the decreased aggregate capital stock in the second reform, by the moment it was implying a lower marginal tax rate for the capital earnings. A further investigation is then conducted, with reference to the distributions over life-cycle reported in *Appendix 4*. The second reform, compared to the first one, have increased the tax burden for high skilled agents in the economy and slightly decreased for the low skilled, who now rely more on the minimum income granted and so decrease their average working hours. The consequence is a lower level of average labour earnings for basically all the age levels. High skilled adopt instead a similar choice in average working hours supplied despite the higher taxes faced, leading to slightly lower labour earnings in all the cohort ages. Finally, the lower aggregate earnings translate inevitably in the initially counter-intuitive lower level of savings and consumption.

## 7 Conclusion

This paper study the effects for households in different ages of a Flat-Tax and a minimum income measure reforming the progressive fiscal system in Italy. It employs an OLG model structured to represent the peninsula's economy, inhabited by agents characterized by different degrees of heterogeneity and with a permanent labour productivity and a stochastic component. The benchmark economy is then calibrated so that key macro aggregates observed in the empirical evidence are met. Then two Computational Experiments are conduct. The first consists in a proportional tax on the labour income reforming the progressive *IRPEF* and a raise of the pre-existing weak minimum income measure: the marginal rate of the labour income tax is computed so the government is able to grant an amount to all the citizens under the absolute poverty threshold, computed as quantile of the

income distribution estimated for Italy, without increasing the fiscal burden on consumption or capital income or neither the public debt. The second reform, similar to the first one, involves a common marginal rate for both the proportional labour income and capital income taxes. The marginal rates found in the stationary equilibrium simulated in the two Computational Experiments are respectively 20% and 23%. Under these rates the government manage to finance a pro-poor measure so that within the country no one would earn anymore less than the absolute poverty threshold estimated for Italy, that is €780. The results seem to meet at least in part the forecasts propagated by the last times' political campaigns, that have been promising a boost in the Italian economy: macroeconomic aggregates such as overall labour productivity, consumption and savings increase within the country. On the other hand, a consistent drop in the average hours worked and on the overall aggregate welfare and an increase in the Gini index casts some doubt on the apparent improvement and on the actual repartition of the reform effects across different type of agents. A deeper investigation on the source of these effects finally shows that the reason for the improvements in the macro aggregates comes from the young agents born with high level of ability, who supply higher productive work. Despite they perceive a higher fiscal pressure, they react supplying more hours of work and so their income increase: as a direct consequence, it this bring higher level of aggregate consumption and savings. Their work manages to offset the drastic decrease in the work supplied on the other hand by young low-productive agents, who in what is defined "poverty trap" and now rely more on the minimum income. This explains the initially counter-intuitive effects drawn off by the simulated reform.

To conclude, according to the fiscal experiments simulated in this paper the "Reddito di Cittadinanza" and "Flat-Tax 15%" reforms that lately have been in the politics' spotlight and subject of analysis in this paper of could eventually improve the overall economic situation in Italy in term of GDP, aggregate consumption and savings. Unfortunately, the significant decline of aggregate welfare suggests that the costs derived by the reduction of the labour supplied by youngs with low productivity, which among the other things are the ones that the reform itself is meant to push, may overcome the benefits.

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## APPENDIX 1:

The following tables report a list of the measures constituting the Italian benefits system (Social Insurance and Social Assistance). The classification order follows the EUROMOD 2017 Report for Italy, and all the information have been verified and updated to 2018. The tables moreover define some basic feature for each benefits instrument, to eventually consider some further implementation to the model in the future.

### Social Insurance

Benefits related to the end of the working activity	<p><b>Old-Age Pension</b> (<i>Pensione di Vecchiaia</i>): is related to a pay-as-you-go social security program. The old-age pension can be obtained when two conditions are fulfilled: age (66 and 7 month) and a minimum contribution (for at least 20 years). It is also provided an Early Pension possibility for people over a certain age (42 years and 10 months for men and 41 years and 10 months for women) who have paid a minimum contribution (for at least 35 years). The Early Pension is discounted by 1 percentage point for each year of age that it takes to become 62 years old.</p>
	<p><b>Survivors Pension</b> (<i>Pensioni ai Superstiti</i>): benefit for family members of a deceased insured worker. Eligible family members are in order: the spouse, the dependent children, dependent grandchildren, the parents, unmarried brothers and sisters if there are none of the above. Quotes of pension differ among eligible members.</p>
	<p><b>Unemployment benefit</b> (<i>Indennità di Disoccupazione</i>): ordinary unemployment benefit, unemployment benefit with minor requirements, ordinary agricultural unemployment benefit, agricultural unemployment benefit with minor requirements, special benefit for agricultural and building unemployment. These measures insure workers who have been dismissed. It is not granted to resigned employees, unless the resignation is due to good cause. Eligible conditions are: contribution against unemployment for at least two years or 52 weeks of contribution in the two-years period before the date of work suspension. The benefit amount and the duration of the treatment is different according to the age of the employee.</p>
	<p><b>Procedure for Mobility</b> (<i>Mobilità</i>): a measure in favor of employees who have already been granted of redundancy payment for all the allowed period, who have been dismissed as a result of a firm policy of staff reduction or production transformation or for the shutdown of the firm. Eligible individuals are employees who have a long-term contract, have been enrolled in the mobility lists, have at least twelve months service in the same firm.</p>
Benefits related to the temporary suspension of the working activity	<p><b>Redundancy payment</b> (<i>Cassa Integrazione Guadagni</i>): is a measure that supports firms in difficult times providing an income to employees. There are three types of redundancy payments: ordinary, extraordinary and building. Eligible individuals are blue collars, white collars and executives in case the working activity is suspended or reduced because of transitory reasons not caused by employers or employees behavior or temporary market stagnation. The benefit amount is up to the 80% of the gross wage.</p>
	<p><b>Salary supplement for agriculture workers</b> (<i>Integrazioni salariali a favore dei lavoratori</i>): it is a measure that aims to help firms when it is not possible to carry on working. Eligible individuals are employees working full time in farms for at least 180 days per year. The benefit amount is up to the 80% of the wage received in the month before the working suspension, and it is granted for at most 90 days.</p>
	<p><b>Marriage leave</b> (<i>Assegno per congedo matrimoniale</i>): seven salary days are granted for the wedding of an employee. Entitled individuals are employed individuals who have been working at the wedding day from at least one week. Both spouses are granted if one is entitled. This benefit is provided without income test.</p>
Benefits related to the reduction in working ability, family and social allowances	<p><b>The Sickness Leave</b> (<i>Indennità di Malattia</i>): an allowance is granted starting from the fourth day of sickness of the worker for a maximum of 180 days a year. The amount is given without income test and is equal to the 50% of the daily wage for the first 20 days, after that 66.66% of the daily wage.</p>
	<p><b>Invalidity Pension</b> (<i>Pensione di Invalidità</i>) The invalidity pension is given to individuals suffering from some physical or mental disease that causes an inability to work, it is granted for three years and it can be extended if the inability persists. After three years it is automatically renewed. If instead the working ability is totally wiped, the worker is entitled to receive the <b>Inability Pension</b> (<i>Pensione di inabilità</i>).</p>

	<b>Inability Pension</b> (Pensione di Inabilita'): entitled individuals have a contributory history of at least five years, three of which paid in the five years before the pension request.
	<b>Inability Allowances for Civil Servants.</b> Civil servants can access to different inability allowances or pensions. The most important ones are the <b>Absolute and Permanent Inability to the assignment</b> (Pensione per inabilità assoluta e permanente alla mansione), <b>Absolute and Permanent Inability to profitable activity</b> (Pensione per inabilità assoluta e permanente a proficuo lavoro), <b>Absolute and Permanent Inability to work</b> (Pensione per inabilità assoluta e permanente ad attività lavorativa) and the <b>Direct Disability Pension</b> (Pensione Diretta Privilegiata)
	<b>Family Allowance</b> (assegni familiari) The Family Allowance is meant to families of workers below determined thresholds. The thresholds and the amounts of the benefit are different according to the household composition and number of children
	<b>Maternity Allowances</b> (assegni di maternità). The Italian law provides two maternity allowances: the mandatory <b>maternity leave</b> (Indennità per astensione obbligatoria) and the <b>parental leave</b> (Indennità per astensione facoltativa o congedo parentale)
	<b>Family leave for severe disability</b> (Congedo retribuito per assistenza a familiari in condizione di handicap). It is an allowance granted to (in order of eligibility) employed parents, siblings, children, spouse of an individual affected by severe disability. The benefit is equal to the last wage and comprehends the figurative social security contribution. It is granted for at most two years and until an annual maximum.
	<b>Special Sickness allowances</b> (Indennità e assegni per malattia speciale). It is an allowance substitute for the wage granted to employees and family members suffering of tuberculosis. Eligible individuals have at least a year of contribution, then other conditions apply according to the type of allowance.
	<b>Death Allowance</b> (Rendita per morte) occurs whether the accident at work causes the employee death: his family is entitled to receive an allowance equal up to the 100% of previous year wage, 50% to the spouse and 20% to each child.
	<b>Hours of Rest</b> (Riposi orari, ex allattamento). Within the first year of age, the mother (also the adoptive mother) is entitled to two hours of rest each day if the working hours are at least six, one if the working hours are less than six.
	<b>Daily permits for blood and spinal cord donors</b> (Permessi giornalieri per donatori di sangue e midollo).
	<b>Daily permits for mountain and spelaeological rescuers</b> (Permessi giornalieri per i volontari del soccorso alpino e speleologico).
Other Benefits	<b>Compensation benefit</b> (Pensioni Indennitarie) The compensation benefit is given to workers disabled by an industrial accident.
	<b>War Pension</b> (Pensione di Guerra) The benefit is given by the Ministry of Economy and Finance to disabled citizens or to eligible family members of a deceased citizen because of war events.

## Social Assistance

Family Support	<b>Family Allowance for families with at least three children</b> (Assegno di sostegno per nuclei familiari con almeno tre figli minori) The Support Benefit for families with at least three children is granted by the municipalities and paid by INPS in 13 monthly instalments. The means testing criterion to be entitled of the allowance is based on the ISEE
	<b>Family Allowance for families with at least four children</b> (Assegno di sostegno per nuclei familiari con almeno quattro minori)
	<b>Bonus for Babies</b> (Bonus bebe'). A monthly allowance of €80 (€960.00 per year) is granted for each child born and is paid up to the end of the third year of age or the third year of entry in the household in the case of adoption, to families with a ISEE income not exceeding €25,000 per year.
	<b>Allowance for the birth or adoption:</b> an amount of 800 euro is granted for the birth of each child or adoption.
	<b>Scholarships and Free Textbooks Supplies.</b> The Ministry of Public Education gives each year funds to the regional scholastic offices to finance scholarships and free textbooks supplies.
Pro-poor Allowances	<b>Social Pensions and Social Allowances to individuals older than 65</b> (Assegni sociali a ultra sessantacinquenni) It consist in an amount granted to poor individuals older than 65 years without any income source or an income under a certain threshold. The monthly amount is related to the income level and the family status of the entitled individual and it is index-linked to the minimum pensions granted by INPS.
	<b>Minimum Incursion Income</b> (reddito Minimo di incursion - REI): a measure meant to tackle poverty and social exclusion. Eligible families have an income below the fixed threshold and satisfy at least one of the following conditions: presence of an under-age person, ab invalid, a pregnant woman, having been dismissed from the previous job by at least 3 months. The amount granted changes according to the family dimension and income.

	<p><b>Housing Benefit:</b> monetary transfers issued by Regions in order to help households the purchase of the main residence or for paying the rent. It is a measure in favor of a special kinds of households, such as young couples, couples with young children or single mothers. The issued amount changes among Regions and citizens can take advantages of Housing Benefits according to an eligibility criteria (that differs according to the Region), and a selectivity criteria (that necessarily rule out eligible individual, due to the limited budget). Regions have access to a special location-fund (Fondo nazionale per il sostegno all'accesso alle abitazioni in locazione) that is fixed by law each year.</p>
	<p><b>Basic Needs Debit Card (Carta acquisti)</b> It is a pro-poor allowance granted every two months on a special debit card. This card can be used for purchases in grocery stores, superstores, pharmacies or gas and electricity bills in postal offices. The benefit amount is 80 euro every two months. Moreover, there are agreements with some shops which allow a 5% discount. Entitled individuals are poor citizens older than 65 or parents of children younger than 3 having an Indicator of Equivalent Economic Situation (ISEE) below a threshold defined yearly.</p>
	<p><b>Young Culture Card (Carta Giovani per la Cultura)</b> An electronic card with a maximum amount of €500 expendable in education and culture has been issued for all Italian citizens who turn eighteen</p>
<b>Benefits related to the reduction in working ability</b>	<p><b>Civil Infirmary Allowance (Prestazione di invalidita' civile).</b> Individuals with total invalidity, in working age, with an income smaller than the fixed thresholds and without any other benefit granted for the same invalidity reason are eligible for an allowance, granted for 13 months of 279,47 euro.</p>
	<p><b>Monthly Assistance Allowance (Assegno mensile di assistenza).</b> Individuals with an invalidity between 74% and 99%, in working age, who are not capable of working, without any other allowances and with an annual income below the fixed thresholds are eligible for an allowance, granted for 13 months, of 279,47 euro.</p>
	<p><b>Accompany Benefit (Indennita' di accompagnamento).</b> Are eligible individuals with total invalidity, who are not able to walk or carry daily life activities.</p>
	<p><b>Frequency Benefit (Indennita' di frequenza)</b> It is a benefit awarded for 13 months to minor citizens living in Italy and foreigners with long-term residence permit, who are enrolled in schools, vocational schools, rehabilitative institutions, having persistent troubles in daily life activities or having ear damages.</p>
	<p><b>Blindness Pension (Pensione di cecità).</b> It consists in a monthly allowance provided for individuals affected by absolute blindness.</p>
	<p><b>Special Benefit (Indennita' speciale):</b> an allowance for Individuals affected by partial blindness</p>
	<p><b>Deaf-Dumb Pension (Pensione ai sordomuti):</b> a monthly transfer for deaf-dumb individuals. After 65 years and three months of age, the pension is turned into a social allowance.</p>
	<p><b>Communication Benefit (Indennità di comunicazione)</b></p>
	<p><b>Personal, Long-term Assistance Allowance (Assegno per assistenza personale continuativa)</b></p>

## Fiscal measures

<p><b>Personal Income Tax (IRPEF - Imposta sui redditi delle persone fisiche):</b> it is an individual and progressive tax on total income. Family dimension and composition is also taken into account by the system of deductions and tax credits. The definition of taxable income is broad, but the actual tax base is smaller because several income sources are subject to separate taxation. The tax base is made of income from land and buildings, from employment and self-employment, business income and capital income in a marginal way (only a quote of dividends and capital gains from dividends).</p>
<p><b>Personal Income Regional Additional Tax (IRPEF Addizionale regionale)</b> is subject to the same tax base of the IRPEF. The tax rate is made of two components: a mandatory rate and an additional discretionary rate defined by each region within certain limits.</p>
<p><b>Separate Taxation on Capital Income (Imposte sostitutive sui redditi da capitale).</b> Capital income is split in two groups: income deriving from financing relationships and Income from investment financial assets. The first category is subject to withholding taxes that can be of 26% if they refer to interest on dividends, bonds, bank, post office or 12.5% if they refer to interest on government bonds, postal savings bonds or equivalent securities issued by international bodies from foreign states white list (a lower rate to incentivize long-term investments). The second group, on the other hand, address to income that derives from the participation in the risk capital of IRES companies or taxable persons. For this category the tax rate changes according to the subject the capital income is addressed to: individuals, partnerships or corporations.</p>
<p><b>Corporate Tax (IRES - Imposta sui redditi delle società):</b> a proportional tax on net profits of corporates. The basis is computed by summing up revenues (trade of goods, services, bonds, shares), capital gains, perceived dividends and interests (at nominal value), stocks and subtracting the cost of labor, of goods and services, capital losses, paid</p>

interests, depreciation and current losses. The tax rate is 24% for 2018 and is possible to deduct the 10% of the IRAP from the IRES.

**Value Added Tax** (IVA - Imposta sul valore Aggiunto) The base of the Value Added Tax is the total business value added minus investment expenses, and therefore coincides with the value of final consumption. The tax rate is 22%, but for primary goods it is applied a lower rate.

**Regional Tax on Business** (IRAP - Imposta sui Redditi delle Attività Produttive) IRAP provides about a half of the financing for Regions (mainly devoted to the health system). The tax is imposed on commercial business and on public administrations. It is charged on the net added value resulting from the business defined as the sum of labor costs, interests paid and profits, net from depreciation.

**Municipality Property Taxes:** IMU (Imposta Municipale Propria) and TASI (Tassa sui Servizi Indivisibili) are addressed to owners of buildings, areas or lands located in Italy, or to individuals enjoying some real rights on that building areas or lands, or again on lessees. These measures don't weight on the main residence, except for luxury flats, villas, castles and palaces of historic or artistic importance. For what concerns IMU, the tax base for registered buildings is the cadastral value increased by 5% and multiplied by a coefficient that differs according to the building type. Tax rates are different according to the type of building and municipalities can modify them. For the first residences there is a tax credit of 200 euro (more 50 euros for each child living in the household who is less than 26). The sum of TASI and IMU cannot exceed the 1.06%.

There is a wide amount of other indirect taxes, traditionally classified in business taxes, taxes on production, monopoly and State lottery. **The Registration Duty** (Imposta di Registro) is applied upon a legal registration or operation. its main source of revenues is connected to real estate transaction and corporate operations. **The Mortgage Duty** (Imposta Ipotecaria) regards mortgage institutions, modifications and transcriptions concerning real estate's immovable. **The Stamp Duty** (Imposta di Bollo) weights on acts, notices, posters, advertisements. **Excise duties on energy** which particularly is applied to oil derivatives, but also hits beer and spirits. **Monopoly and State lottery** provides a non-negligible source of revenue.

### *Social contributions*

**Social Contributions** that employees, employers and self-employed individuals pay on earned income. They are managed by the National Institute of Social Security (INPS). The amount differs according to the source of income (whether the individual is employed or self-employed), number of persons working in the firm, sector of the firm, occupational status (executives, white collars, blue collars). The following insurances are financed by Social Contributions: **Invalidity, Old Age and Survivors** (Invalidità, Vecchiaia, Superstiti), **Unemployment** (Disoccupazione), **Dependency benefit Fund** (Cassa Unica Assegni Familiari), **Redundancy Fund** (Cassa Integrazione Guadagni), **Procedure for mobility and Collective Dismissals** (Mobilità), **Sickness and Maternity Benefit** (Malattia e Maternità), **Severance Pay** (TFR).

## APPENDIX 2:

### Derivation of the Euler equation

$$V(a_0) = \max \sum_{t=1}^T \beta^t u(c_t, l_t)$$

$$\text{s.t.} \quad c_t + a_{t+1} = F(a_t, l_t)$$

$$\sum_{t=1}^T \beta^t u_t = u_0 + \beta u_1 + \beta^2 u_2 + \dots = u(c_0, l_0) + \beta(u_1 + \beta u_2 + \beta^2 u_3 + \dots)$$

$$\beta(u_1 + \beta u_2 + \beta^2 u_3 + \dots) = V(a_1)$$

$$V(a) = \max (u(c, l) + \beta V(a'))$$

$$\text{s.t.} \quad c + a' = F(a, l)$$

$$L = u(c, l) + \beta V(a') - \lambda(c + a' - F(a, l))$$

$$c) \quad u_c = \lambda$$

$$l) \quad u_c = -\lambda F_l$$

$$a') \quad \beta V_{a'}(a') = \lambda = u_c$$

$$\frac{dV}{da} = \frac{dL}{dc} \frac{dc}{da} + \frac{dL}{dl} \frac{dl}{da} + \frac{dL}{da'} \frac{da'}{da} + \frac{dL}{da}$$

The maximum implies that  $c, l, a'$  are at optimal level, so their partial derivatives are equal to zero, so

$$\frac{dV}{da} = \frac{dL}{da}$$

$$V_a(a) = \lambda F_a$$

$$V_{a'}(a') = \lambda' F_{a'}$$

$$\beta \lambda' F_{a'} = u_c$$

$$\beta u_c' F_{a'} = u_c$$

## APPENDIX 3

In this Appendix are reported the results found in the stationary equilibrium that have been computed by the Python program. The program starts with some guesses for the endogenous variables and at the end of the process compute the new guesses. The same process is then iterated until the difference between the values found and the previous ones is smaller than a tolerance error, that is set to 0.0025.

The calibration of the four parameters (discount factor  $\beta$ , consumption share  $\Upsilon$ , Depreciation rate  $\delta$  and level of government expenditure) is conduct so that in the stationary equilibrium the benchmark economy meets three targets observed in the Italian economy: capital over GDP, investment over GDP and the average hours worked. Below are reported these targets and the equilibrium results in the benchmark economy.

	Targets	Benchmark economy
<i>K/Y</i>	2.75	2.71666
<i>I/Y</i>	0.21	0.21559
<i>Avg hours worked</i>	0.305	0.30488

Finally, the last table lists the endogenous variables and the relevant macroeconomics aggregates found in the stationary equilibrium for the benchmark model and the two computational experiments. This table will come to use in comparing the experiments results.

		Benchmark	Exp 1	Exp 2
<i>Endogenous variables</i>	<i>Interest rate</i>	0.051841	0.049532	0.051186
	<i>Labour supply</i>	8.382604	9.040901	8.815682
	<i>SS benefits</i>	0.402282	0.074245	0.071922
	<i>Parameter</i>	0.402282	1.025456	1.053045
	<i>Threshold</i>	0.020221	---	---
<i>Macro aggregates</i>	<i>K/Y</i>	2.71666	2.766708	2.731338
	<i>I/Y</i>	0.21559	0.219566	0.216759
	<i>G/Y</i>	0.24379	0.223884	0.221243
	<i>C/Y</i>	0.51631	0.533490	0.538051
	<i>Average tax rate</i>	0.18619	0.156646	0.168314

## APPENDIX 4

*This Appendix reports a comparison the distribution for average taxes paid, hours worked, labour earnings, consumption and assets holdings across agents in different cohort ages for the two Computational Experiments (Experiment 1 in blue, Experiment 2 in red, left Figures). The effects are further decomposed above agents in different ability levels.*

