Social Security Incidence under Uncertainty Assessing Italian Reforms

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May 2009

Abstract

This paper analyzes the e ects induced by reforms of the Italian social security system in an economic setting with uncertainty on wages, nancial market returns and life expectancy.

The introduction of a pension system reproducing the Italian statutory scheme turns out to be bene cial in ex-ante welfare terms, due to a favorable variation in net transfers to individuals. Once social security budget is forced to balance in every period, however, transfers substantially decrease and the relative convenience of social security falls dramatically. Risk insurance e ects do occur as social security is introduced, but they are largely outweighed in magnitude by transfer e ects in the overall welfare variation.

When comparing di erent pension regimes introduced in Italy by the last reforms, a slight ex-ante welfare improvement is shown to be brought about by the new pension system, after assuming away di erences in lifetime transfers across regimes. This relative gain stems from risk diversi cation across all working-life wages in computing bene ts. Moreover, the new pension system ideally provides individuals with stronger incentives to postpone retirement.

Keywords: social security Reforms; Uncertainty; Risk Insurance
JEL Classi cation: H55, H21, H31, E62

Acknowledgements

I am very grateful to Luciano Greco, Guglielmo Weber, Laurence J. Kotliko , Alessandro Bucciol, and Efrem Castelnuovo for their help and advice. I also wish to thank the participants of the Public Economics PhD Workshop 2009 at the Institute for Fiscal Studies in London, the participants of the 64th Congress of the International Institute of Public Finance in Maastricht, and the participants of seminar at the University of Padova for insightful comments.

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1 Introduction

PAYG social security programs have been introduced in many developed countries throughout the last century, providing a shelter against poverty in the retirement age. Economic and demographic trends over the last decades have induced the need to reform these programs and restore their nancial sustainability. The emergence of these problems and the need to reform social security programs raise two fundamental questions that have been widely investigated by the economic literature: are there economic reasons that could still

PAYG social security systems may also offer risk insurance tools in the absence of other markets as well. The literature has concentrated in particular on the inefficient allocation of risks among different generations. A Pareto efficient allocation of risks could be reached if all generations could ex-ante trade with each other in contingent-claims markets a la Arrow-Debreu.[2] This efficient allocation however cannot be reached in economies with different generations overlapping through time, because individuals cannot trade in risk-sharing with individuals of other generations who are not yet born (Ball and Mankiw, 2001). There is therefore room for government to introduce a (contingent) social security system letting different generations share demographic and macroeconomic risks, typically by providing pensioners with claims to labor income (Krueger and Kubler, 2005), or also workers with claims to physical capital.

Social security is in fact an additional asset yielding a return whose degree of correlation with returns on other assets - notably on individual savings - crucially determines insurance of individuals through diversification of risks (Campbell and Nosbusch, 2007).

All of the previous points suggest that analyzing the incidence of social security requires uncertainty to be taken into account.

Most of the analysis on the Italian pension system so far has been concerned with changes in both individual transfers and Social Security financial viability resulting from pension reforms. In particular, some studies have estimated the impacts of reforms from a generational accounting perspective (e.g. Cardarelli and Sartor, 2000) and the effects on social security financial sustainability (e.g. Sartor, 2001).[3]

Another strand of the literature on Italian pension reforms has been concerned with impacts related to intra-generational redistribution (e.g. Fonseca and Sopraseuth, 2005).

No studies on the Italian pension system have yet analyzed the potential policy-induced welfare changes resulting from aggregate risk insurance, when uncertainty is taken into account in its different - demographic and macroeconomic - dimensions.

This paper is aimed at investigating the Italian social security system in a setting where individuals face both mortality risk and uncertainty on factor returns, i.e. aggregate wages and financial market yields. The focus is on the welfare enhancement potentially resulting from risk insurance - if any - provided by social security under market incompleteness, notably in the absence of contingent-claims markets (a la Arrow-Debreu) and particularly of annuity markets.

By applying the salient features of the Italian pension system to a model representing the Italian economy, the paper firstly analyzes if, and to what extent, social security can actually improve individual welfare in the presence of macroeconomic and demographic

risky investments being more attractive than annuities in case of labor supply flexibility.

[2] That means in the presence of complete markets for all possible goods in each period and each possible history (all possible realizations of risks) in the economy.

[3] Key results reported in these works claim that the Italian pension reforms introduced in the 1990s (the 1992 reform and, most notably, the 1995 reform) have reduced both long-term imbalance and the difference between generational accounts (lifetime net taxes) of current and future generations. However, prospective intertemporal fiscal imbalance remains still huge, calling for interventions aimed at reducing the potential burden on future generations.

risks under market incompleteness.

Secondly, while focusing on the last Italian pension reforms, the paper performs a comparison between the “old” and the “new” Italian pension system (introduced in the mid 1990s and recently reformed). This comparison, based on ex-ante individual welfare, aims to shed light on whether and why the two systems perform differently in providing insurance against macroeconomic and demographic risks.

The whole analysis yields the main contribution of the paper, that is a deeper understanding of the nature and magnitude of the *overall* welfare impact brought about by the Italian pension system.

The main findings of the paper can be summarized as follows:

1. In a setting under uncertainty and market incompleteness, the introduction of a social security system reproducing the statutory Italian pension scheme (and allowed to run within-period deficits) turns out to be beneficial in ex-ante welfare terms from an individual perspective.

2. In case the social security budget is constrained to balance in every period, the optimal size of both the old and new regime (expressed in terms of contribution rate) is considerably lower than the actual size of pension systems in Italy. In particular, the optimal contribution rate turns out to be zero and individuals choose not to retire at all. These findings seem to suggest that the main driver of the welfare gain to the present representative individual from introducing Social Security in the statutory setting hinges on the (positive and sizeable) change in pension transfers causing future generations to bear the burden of current deficits. Once transfers are substantially reduced (as a consequence of imposing budget balance in every period), the relative convenience of social security falls dramatically. In general, risk insurance effects do occur as social security is introduced, but they are largely outweighed in magnitude by transfer effects in the overall welfare variation.

3. When comparing the old (prior to the 1992 reform) with the new (after the 1995 reform) pension regime it turns out that, after eliminating differences in lifetime transfers, the new regime proves to be slightly better in ex-ante welfare terms. This small relative gain in favor of the new pension system (after controlling for differences in transfers) is plausibly due to its enhanced risk-insurance properties, stemming in particular from risk diversification across all working-life wages.

The paper is organized as follows. Section 2 presents the model. Section 3 illustrates the policy experiments that are considered, and presents the main findings. Section 4 concludes.

2 The Model

The model considers a discrete time setting, [4] representing a partial equilibrium economy where both wages and market returns are completely determined by foreign markets.[5]

The economy is thus a ected by two main sources of macroeconomic uncertainty, that are only partially correlated: wages and market returns. The pre-tax income of every individual in every period t is therefore determined by a stochastic real average market return r_t on their savings (government bonds, corporate bonds, stocks) and by a stochastic real wage w_t earned during working life. Wages in the model follow a (rst-order) autoregressive process, while market returns are serially uncorrelated. After retirement, every individual receives a pension bene t that is linked to their wages during their working lives, according to some bene t rule.

The model also takes into account yearly average wage growth, both at the aggregate level (growth rate of labor productivity g) and at the cohort-speci c level (seniority wage growth sw). Both growth rates are assumed to be constant and to enter the model as exogenous deterministic trends that are applied to the underlying autoregressive dynamics of wages w_t.

The economy is populated by di erent generations overlapping through time. For each generation, a representative individual is considered. All representative individuals are identical. Total population mass grows at a deterministic constant rate m from every period to the next.[6]

Representative individuals live in the economy from age 1 to at most T years. Individuals aged t (with $t = 1, ..., T$) survive to age $t + 1$ with a given (age-dependent) conditional survival probability, and they are assumed to know all survival probabilities.[7] Besides macroeconomic risks on wages and market returns, a further source of uncertainty in the model is thus represented by mortality risk.

Each representative individual maximizes their expected discounted lifetime utility with respect to within-period consumption, within-period leisure and retirement age. Maximization occurs at (just before) the beginning of life, i.e. at time $t = 0$, prior to entering the economy and thus before knowing the realized values of any variable (w,r) a ecting

[4]Every period in the model corresponds to one year in real life.

[5]Italy can be approximately regarded as a small open economy worldwide and, by further approximation, in the European Union. The paper assumes that real returns and wages are

utility in the future periods (t = 1, ..., T): [8]

$E_0[\sum_{t=1}^{T} \beta^{t\ 1}[\prod_{k=1}^{t} \psi_k] U_t(c_t, l_t)]$

where β in the above formula is the subjective time discount factor; ψ_t is the conditional survival probability from age $t-1$ to age t, with ψ_1 = 1 and ψ_{T+1} = 0 ; c_t and l_t are respectively consumption and leisure entering the utility function of agents at age t. The per-period utility function takes the CES form:

$U_t(c_t, l_t) = \frac{1}{1}(c_t^{1} + \gamma l_t^{1})^{\frac{1-\rho}{1-\sigma}}$

where $\frac{1}{}$ is the intertemporal elasticity of substitution between consumption of different years, $\frac{1}{}$ is the intratemporal elasticity of substitution between consumption and leisure, and γ represents the leisure preference parameter.

Individuals are provided with a given time endowment in every period, normalized to 2, [9] and choose consumption c_t and labor supply $2 - l_t$.

Every individual works and receives a wage w_t for each unit of time spent working, i.e. a total wage $w_t(2 - l_t)$, at every age t (if alive), until they choose to retire at age t_{ret}. While working, individuals pay in social security contributions at a rate h out of their labor income. After retirement l_t is equal to 2 and retirees receive a pension benefit p_t at every age t (if alive) until death at T.

The per-period budget constraint of individuals at every age t (assuming the world starts at time t = 1) therefore reads as follows:

$A_{t+1} = A_t(1 + r_t) + (1 - h)w_t(1 + g)^{t\ 1}(1 + sw)^{t\ 1}(2 - l_t) - c_t \qquad \text{for } t = 1, ..., t_{ret} - 1$

$A_{t+1} = A_t(1 + r_t) + p_t - c_t \qquad \text{for } t = t_{ret}, ..., T$

where A_t represents the beginning-of-period asset holdings of an age-t individual. Agents are assumed to be borrowing constrained:[10]

$A_t \geq 0 \qquad \text{for } t = 1, ..., T$

Furthermore, the model assumes there is no bequest motive: thus individuals do not leave any bequest in case they live until age T.

$A_{T+1} = 0$

In case the individual dies before reaching age T, his accumulated assets, i.e. accidental bequests, are assumed to be destroyed and provide no utility to other individuals who are

[8]Optimization over consumption, leisure and retirement age, throughout the paper, is based on the maximization of the individual's utility in ex-ante terms, i.e. at time t = 0.

[9]Normalization of per-period time endowment to 2 units turns out to be useful in calibrating the model for computational reasons.

[10]This assumption is quite common in the literature, as it is utilized basically to ensure, under a nonnegativity constraint on consumption, that individuals do not borrow more than they would be able to pay back. Moreover, individuals in reality are confronted with borrowing constraints that can be more or less tight. In the model the borrowing limit is exogenously set to its simplest (and tightest) form, i.e. it is assumed to be zero instead of some negative value, according to the approach followed e.g. by Deaton (Deaton, 1991).

still alive.[11]

Markets in the model are assumed to be incomplete. As previously outlined, individuals are borrowing constrained. In addition to that, two other main sources of market incompleteness are present in the model. Firstly, and quite realistically, agents in the economy cannot insure against uncertainty by trading contingent claims *a* la Arrow-Debreu. Secondly, annuity markets are assumed to be missing. This latter assumption re ects the very small size of the current Italian annuity market.[12] It can be noticed that the absence (or the relatively small size) of annuity markets in general, also implies in particular the absence of privately-provided annuities yielding wage-based returns, that are instead typically publicly provided through social security especially under (Pay-As-You-Go) De ned Bene t pension systems.

Government is assumed to enter the model only through running an unfunded social security system, that collects in each period contributions at rate h from workers, and pays pension bene ts to retirees.

Contribution rate h in the model is determined in two di erent ways. Firstly, the contribution rate is exogenously determined so as to match the statutory contribution rate in the Italian Social Security system. Alternatively, the contribution rate is endogenously determined so as to guarantee the within-period balance of Social Security budget. In the former case, the analysis is carried out under possible budget de cits (or surpluses) of the pension system: the model does not deal with social security budget balance, neglecting issues on government budget and public debt in general.[13] In the latter case, the analysis is instead performed under an ideally balanced pension system.

2.1 Calibration and Optimization Problem

In order to solve the optimization problem, the parameters of the model are assigned speci c values resulting from an appropriate calibration aiming to replicate stylized facts

[11]This assumption is made for the sake of simpli cation when performing numerical computations. It does not a ect - *per se* - the main results of the paper regarding risk-insurance e ects of social security, since it only deals with the distribution of accidental bequests across individuals. Alternative assumptions regarding accidental bequests may involve redistributing unintended bequests to all or some of the surviving generations according to some criteria, e.g. in a lump-sum fashion or proportionally to wealth conditions of the survivors.

[12]The size of the Italian annuity market is likely to increase in the next years, due to recent law provisions aimed at developing pension funds, while mandating annuitization of at least half of a worker's pension fund capital. Nonetheless, there seems to be at least one possible obstacle to the development of the Italian annuity market: private annuities in Italy are estimated to be still considerably more expensive than public annuities implicit in the PAYG system (Guazzarotti and Tommasino, 2008).

[13]Put it alternatively, following Green and Kotliko 's approach (Green and Kotliko , 2006), every government scal policy (including Social Security policy) in the model could ideally be relabeled as having government budget balanced in every period, thus preventing public debt being taken into account. Neglecting public debt issues does not appear to be overly restrictive wherever the analysis is mainly focused on pure risk-insurance e ects rather than on impacts of intergenerational redistribution related to government budget imbalances.

of the Italian economy. The resulting model speci cation is the \baseline" model, i.e. the reference setting for all simulations.

The benchmark economy utilized in the calibration is the Italian economy under the old pension system, i.e. the pension regime before the introduction of the 1992 reform (the so-called Amato reform).[14] Because the old pension regime has been uniquely or mostly applied in Italy until recently - even after reforms in the 1990s, due to a long transition period set by law - it represents the most suitable regime to be considered when calibrating the model to reproduce reality.[15] While applying the main statutory features of the old regime, the calibration utilizes a replacement rate lying within a range that reasonably includes the *actual* replacement rate enjoyed at retirement by individuals in Italy under the old system: according to OECD estimates, the actual average (net) replacement rate was plausibly above 90%.[16] In the calibrated benchmark model, the replacement rate has been set at 93%.

From simulations performed in the calibrated model, individuals turn out to choose to retire as soon as they are allowed to (i.e. after 35 years of work), as it was actually the case in Italy under the old regime, most likely due to favorable pension conditions inducing individuals to retire early.[17]

The calibrated lifetime consumption path has a quite smooth pro l(gime97(that)-49 Tmsghn)28(tly)

2003; Battistin et al, 2007) under the old regime (prior to Amato reform and as modified by Amato reform).

The calibrated path of assets involves an asset accumulation occurring roughly until retirement age, thereafter assets are gradually de-cumulated until death, as it is typically the case in reality.

Simulated leisure choice in the calibrated model is such that individuals on average work approximately 50% of the total time endowment in each period during working life. If the maximum number of hours an individual can work is considered to equal 16 hours per day - that is quite a plausible assumption, utilized in the literature - the model is quite in line with OECD data for Italy (2007).[19]

The baseline model specification, following from calibration, is as follows.

Within-period leisure in the model, l_t, is discretized so as to take on values in $\{0,1,2\}$. Therefore in the calibrated model individuals choose to work 1 unit of time (enjoying 1 time unit of leisure) during working life, whereas they enjoy the whole time endowment, i.e. 2 time units of leisure, after retirement.

Each representative individual - representing both males and females - is assumed to enter the economy when 21 years old, corresponding to the first period (t = 1) in the model. This reflects the real average entry age in the labor market in Italy.

Agents live at most 80 years (T = 80), i.e. until they are actually 100 years old, surviving from every period to the next with a certain (conditional) survival probability.

The sequence of conditional survival probabilities $\{\psi_t\}_{t=1}^{T}$ is computed as weighted average of Italian males and females survival probabilities per cohort as of 2004 [20], reported by Istat (Italian National Institute of Statistics).

In the baseline calibration, population mass in every period is equal to one, i.e. yearly population growth rate is equal to zero: m = 0. This is in line with recent demographic trends and with demographic projections for Italy.[21]

Econometric analysis on Italian wages and market returns suggests that the processes underlying wages (w_t) and market returns (r_t) can be represented as follows:

$w_t = 38.7227 + 0.6451 * w_{t-1} + ew_t$

where ew_t is the error term, normally distributed with mean zero and variance σ_w^2 = 2.9932.

$r_t = 0.0656 + er_t$

where er_t is the error term, normally distributed with mean zero and variance σ_r^2 = 0.01798.

[19] Based on OECD data, the yearly average amount of hours worked by Italian employees in period 1989-2007 lies around 45% of the total time endowment for working, if this endowment is considered to equal 16 hours per day in 52 weeks.

[20] 2004 is one of the last years as of which data are available, and is in line with most time spans for data utilized in the calibration.

[21] According to Istat data, the Italian population in the 1990-2004 period has experienced an average yearly population growth rate equal to 0.15%. Istat demographic projections for the 2007-2051 period, under the so-called "central" scenario, forecast an average yearly population growth rate close to zero, namely 0.1%.

Wages in the model therefore follow an autoregressive process: in each period wages partly depend on the value realized in the previous year, and partly on an i.i.d. stochastic component (ew_t). Market returns are instead estimated to be serially uncorrelated (i.e. \white noise"), namely consisting of an i.i.d. random variable (er_t), around a constant mean value. The covariance between the error terms ew_t and er_t, denoted as σ_{wr}, represents the degree of correlation between (the stochastic part of) wages and market returns. It is estimated as

$\sigma_{wr} = 0.0557$

suggesting a slight positive correlation between wages and market returns.

Once the underlying stochastic processes are estimated, for the sake of numerical tractability both wages and market returns in the model are discretized into three levels (\low", \mean" and \high").

The yearly growth rate of aggregate real wages is assumed to be zero: $g = 0$. This is in line with the average yearly growth rate of real compensations per employee in period 1990-2004, that was roughly zero: according to OECD data for Italy, average growth rate of real compensations in 1990-2004 was approximately equal to -0.04%.

The only source of deterministic wage variation through time is a cohort-speci c component tracking changes in wages due to career dynamics, namely to seniority-driven (contractual) increases in wages. This is consistent with an *aggregate* growth of real wages equal to zero, since seniority growth of real wages regards every single cohort, under the assumption - made in the model - that contractual wage dynamics is constant throughout generations. By approximation based on OECD and Bank of Italy data, the average yearly \seniority" growth rate in real wages is set at $sw = 2\%$.

Since $m = 0$ and $g = 0$, the overall yearly growth of the economy in the baseline scenario is equal to zero. Moreover, seniority wage growth (sw) is assumed to remain constant throughout generations. Consequently, no macroeconomic or demographic e ects in uence welfare levels of di erent generations under di erent pension systems through time. This fact, along with the partial equilibrium assumption, provide an advantage when performing welfare analysis: instead of considering several overlapping generations through time, the whole analysis will focus on a single representative individual under di erent possible social security systems.[22]

Preference parameters, i.e. the subjective time discount factor β, parameters ρ and σ related to intertemporal and intratemporal elasticity of substitution, and leisure preference parameter γ are calibrated as follows:

$\beta = 0.9575$

$\rho = 0.6$

$\sigma = 0.96$

$\gamma = 15$

[22]In case the calibrated value for either g or m were di erent from zero, the implicit return on social security would change. However, when adopting a purely risk-insurance perspective, welfare analysis would not be a ected since both parameters in the model are assumed to represent deterministic, rather than stochastic, trends.

The values for the above parameters are such that the individuals' (simulated) optimal economic decisions in the model roughly reproduce those observed in reality.

The value assigned to ρ lies in the range between 0.5 and 1.5 that can be considered as a \reasonable" range for the reciprocal of the intertemporal elasticity of substitution (e.g. Battistin et al, 2007). The subjective time discount factor β is also in line with values commonly utilized in the literature.

The model would t reality quite well also in case preference parameters were assigned di erent values lying in ranges utilized in the literature. A calibration yielding lifetime consumption and leisure paths as well as retirement behavior most closely reproducing those observable in reality, would be ensured in case ρ lies between 0.5 and 1.2; in case β lies between 0.95 and 1; in case σ lies between 0.9 and 0.98.

Social security in the model reproduces the main actual features of the di erent pension systems in Italy. The contribution rate is either exogenously xed or endogenously determined. In case the contribution rate is exogenously xed, it is equalized to the statutory average contribution rate on wages of employees under di erent Italian pension systems. In case the contribution rate is endogenously determined, it is equalized to the value that ideally guarantees Social Security budget balance under each pension system.

Analogously to wages and market returns, pension bene ts under all systems are also discretized into three levels.

Considering the model as described above, the solution to the corresponding optimization problem for a representative individual entering the economy at age $t = 1$ is a sequence of optimally chosen values for consumption and leisure ($\{c_t\}_{t=1}^{T}$ and $\{l_t\}_{t=1}^{T}$) and the optimal retirement age t_{ret}, maximizing the individual's expected discounted lifetime utility (measured at time $t = 0$).

The solution to the optimization problem is found by numerically simulating the calibrated model: each analysis in the paper is carried out through running 10000 simulations.[23]

3 Simulations and Findings

Simulations are run by applying to the model various social security schemes reproducing di erent past and current pension regimes in Italy.

3.1 The Italian Pension System

The major pension reforms in Italy considered in the model are the so-called Amato reform (1992) and Dini reform (1995).

Before the introduction of the Amato reform (i.e. under the \pre-Amato", or \old" regime) the Italian pension system was an unfunded de ned bene t system (PAYG-DB),

[23] A great number of simulations is required in order to smooth out the e ect of single realizations for wages and market returns, and therefore to obtain results that do not depend (or do depend to a negligible extent) on particular realizations drawn by the computer.

in which pension benefits were based on wages earned in the last five years of working life (and only on last year's wage for public sector employees). Individuals were allowed to retire after 35 years of work and contribution to social security (20 years for public sector employees), or alternatively when they were 60 years old (55 for females) with at least 15 years of contribution. Pension benefits were computed by applying to the average wage (over the last 5 working years) a replacement rate equal to 2% per every year of work (and contribution): thus, after working (and paying in contributions to social security) for 35 years, a pensioner could count on a pension amounting to 70% of the average wage in the last five years (alternatively, 70% of last year's wage for public sector employees). The maximum possible replacement rate was equal to 80% (corresponding to 40 years of work), for individuals working 40 years or more. Moreover, pension benefits were indexed to current wages in the economy.

The Amato reform (1992) basically tightened the previous system through \parametric" variations, while keeping unchanged its \systemic", i.e structural, aspects. Among the changes introduced by the Amato reform: pension benefits would be computed by applying the replacement rate to the average of all wages earned throughout the entire working life; pension indexation to wages was substituted with indexation to inflation, so that pension benefits would stay constant in real terms.

The Dini reform (1995) instead changed the Italian pension system (\post-Dini", or \new" regime) to a greater extent, by turning it from DB into NDC (notional defined contribution): in order to compute pension benefits, Social Security contributions are \notionally", i.e. fictitiously, capitalized at a rate that is linked to the growth rate of the economy during working life, and the amount accumulated in this way is turned into annuities through multiplying it by annuity rates (so called \transformation coefficients") that are statutorily fixed. Dini reform allowed individuals to choose their retirement age from any age between 57 and 65 years (with a minimum required number of years of contribution). Annuity rates vary according to the age at which an individual chooses to retire (the higher the retirement age, the greater the annuity rate, and the greater the pension benefit), and are periodically revised in order to account for changes in the (average) life expectancy of population. The \post-Dini" system therefore turns out to be, in principle, actuarially fair (pension benefits are strictly linked to individual contributions). Individuals under the post-Dini system may also choose to retire later, i.e. after 65: in this case the annuity rate (transformation coefficient) utilized in the benefit rule remains constant thereafter, and equal to the annuity rate applied in case of retirement at 65.

A transition period is set by law: whoever at the end of 1995 had contributed for more than 18 years, is not affected by Dini reform; for whomever entered the labor market after 1995, Dini reform fully applies; for those having contributed to social security for less than 18 years at the end of 1995, a mixed regime applies, with pension determined pro-rata (proportionally to time spent contributing before and after 1995).[24]

[24] The last reform introduced in Italy, the so-called Maroni reform (2004), basically preserved the post-Dini regime, but setting a gradual increase in the minimum retirement age, from 60 years in 2008 to 62 years in 2014 onwards. Moreover, the Maroni reform provided some incentives for workers to invest their accrued severance pay into pension funds, on an individual voluntary basis.

The above described features of the Italian pension system are reproduced (slightly simplified) in the model.

Following the approach of Cardarelli and Sartor (2000), the main comparison across regimes in the paper is performed between the system before the Amato reform (old regime) and after the Dini reform (new regime), chiefly aiming at comparing the relative performance of the "pre-Amato" and the "post-Dini" regimes in terms of risk insurance under uncertainty.

3.2 Main Findings and Discussion

The findings presented in this section are derived from simulations run on the baseline model, as previously outlined in Section 2.

3.2.1 Benchmark model and optimization

As outlined in the previous Section, the baseline model is calibrated so as to reproduce the main features of the benchmark Italian economy as closely as possible. From the corresponding simulations it turns out that individuals under the old pension system choose to retire as soon as they are allowed to (i.e. after 35 years of work and contribution, corresponding to retirement at 56 real-life years), since they enjoy a very high effective replacement rate.

When optimization is instead performed under the statutory features of the pre-Amato system (including statutory replacement rate equal to 2% for every year of contribution, up to a maximum of 80%), individuals turn out to choose to retire at a later age than the minimum allowed by the system: in the simulated model, it is optimal for individuals under the old system to work for 40 years, corresponding to retirement at 61 (real-life) years. After working for 40 years, the ceiling to the replacement rate (no longer increasing after 40 years of work) seems to provide an incentive to retire.[25]

Under the statutory post-Dini system, ex-ante optimization requires individuals to choose to retire after working for 44 years, corresponding to retirement at 65 (real-life) years. Again, the statutory "ceiling" on benefit computation (the annuity rate, the so-called "transformation coefficient", used to compute pension benefit when retiring at any age later than 65, remains constant and equal to the coefficient utilized for retirement at 65) apparently induces individuals to retire before being "penalized".[26]

Before carrying out a comparison between the old and the new system in ex-ante welfare terms, some considerations are in order.

A comparison in terms of incentives to retire suggests two things. Firstly, if the statutory features of the Italian pension system had been strictly complied with in providing pensions, instead of allowing individuals to enjoy *de facto* more favorable conditions

[25] If simulations are run assuming there is no ceiling to the replacement rate, individuals turn out to retire at a later age.

[26] If simulations are run assuming there is no ceiling to annuity rates after 65, individuals turn out to retire at a later age.

(through many exceptions to the statutory rules), the old pension system would have induced people to retire later than just as soon as possible. Secondly, the introduction of the Dini reform is likely to induce people to retire later than under the old regime, basically because of tighter eligibility rules.[27]

The main reason why the pre-Amato system was reformed in the mid 1990s was that it was "too generous", i.e. it paid high pension benefits as compared to collected contributions, thus causing Social Security budget to run within-period deficits and to bear a huge long-term projected debt. Under the pre-Amato system in the model, the within-period social security deficit[28] ($deficit_{pre\ Amato}$) turns out to be bigger than under the post-Dini system ($deficit_{post\ Dini}$):[29]

$SSdeficit_{pre\ Amato} = 1376.4$

$SSdeficit_{post\ Dini} = 275.6$

suggesting that shifting from the pre-Amato system to the pure (i.e. fully applied) post-Dini system is likely to bring about some gains in terms of financial sustainability to the social security budget. In the simulations run above, the resulting deficit under the pre-Amato regime is approximately equal (in absolute value) to the amount of assets accumulated during the first 26 working years by the representative individual in the economy, whereas the deficit under the post-Dini regime roughly equals (in absolute value) the amount of assets accumulated during the first 3 working years by the representative individual in the economy. The simulated budget gain (roughly 1100 in terms of reduced within-period deficit) is approximately equal to the amount of assets accumulated by the representative individual during the first 23 years of life under the old regime.[30]

A similar improvement in the financial sustainability of the pension system, in principle, could have been achieved also by fully applying the statutory post-Amato/pre-Dini system as shaped by the Amato reform. With individuals retiring after 40 years of work, the social security budget deficit under the post-Amato/pre-Dini system turns out to be $SSdeficit_{post\ Amato} = 295$. That means, Amato reform was likely to considerably improve financial conditions of the Italian pension system, by substantially tightening benefit rules.

All of these results provide an argument for fully applying the last pension reforms in order to improve the financial sustainability of social security.[31]

[27] As above noticed, however, in reality Dini reform will not be fully applied until the mid 2030s, because of the long transition period set by law.

[28] Within-period deficit can be considered as a measure of fiscal imbalance of the Italian pension system: the projected long-term debt of the social security system indeed simply equals the discounted summation of all future deficits.

[29] In the model the simulated within-period deficit (resulting on average across 10000 simulations) is roughly constant at every time, therefore a single "representative" period is taken as reference.

[30] To express it alternatively, this within-period gain is roughly equal to the total amount of pension benefits paid to the representative individual in 8 years of retirement under the old system.

[31] This conclusion corresponds to the main findings in the literature on Italian pension reforms, claiming that pension reforms introduced in the 1990s (Amato and Dini reform) may bring about a decrease in the long-term imbalance of the Social Security budget, although other legislative interventions aimed at further reducing the gap are needed to completely restore financial sustainability.

3.2.2 Introduction of unbalanced Social Security

A question to be tackled is whether and why the introduction of social security is ex-ante welfare improving for individuals in the model. The answer to this question serves in particular to investigate the magnitude of risk insurance e ects that are possibly brought about by social security.

Two cases are considered. In the rst case, the social security budget is allowed to be unbalanced, thus possibly running de cits in every period, as it is actually the case in reality. Since only one representative individual of one current generation is considered in the analysis, welfare e ects of social security only concern this individual, without taking into account the fact that budget de cits are carried over to future generations.[32]

In the second case, the social security system is constrained to nancially balance in every period, thus implying a long-term balance of the system, and other generations are thereby prevented from bearing any debt burden.

The analysis rstly focuses on the case where the social security budget is possibly unbalanced in every period.

Simulations are run to compare the model's economic setting respectively in the absence and in the presence of a social security system. In the former scenario, individuals do not contribute to social security and do not get any pension bene t, so the only way of transferring resources through time is by saving while working to provide for old age; in the latter scenario, the pension system is modeled so as to reproduce the pre-Amato regime, a quite standard PAYG DB system.[33]

It turns out from simulations that in the presence of uncertainty the introduction of a social security system, all the rest being kept unchanged, is bene cial to the (representative) individual. This result is obtained by performing an analysis in ex-ante terms at time zero before individuals enter the economy, through a comparison between the ex-ante expected discounted lifetime utility, i.e. between the value function at the beginning of life (at time $t = 1$), under the two scenarios.[34] The comparison is performed in terms of \Compensating Variation" (CV), i.e. in terms of the amount of assets that should be given to the individual in a setting (e.g. without social security) before the beginning of his life, in order to let him bene t from the same level of ex-ante expected discounted lifetime utility as he would enjoy in the other setting (e.g. with social security). If the introduction of social security under uncertainty turns out to increase ex-ante utility level of individuals, then the Compensating Variation to the individual in the setting without social security (in order to let him enjoy the same ex-ante utility level he enjoys with social

[32] The simulated magnitude of within-period de cits under di erent pension regimes is above reported in the paper.

[33] A Pay-As-You-Go de ned bene t system is utilized as the benchmark social security regime, since it is the traditional type of pension system in most developed countries. The pre-Amato speci cation, in particular, is used as it constitutes the reference case in the paper for comparative analysis on the Italian pension system

[34] By maximizing lifetime utility, the representative individual under the pre-Amato regime turns out to retire after 40 years of work (as previously mentioned), whereas in the absence of social security the individual chooses not to retire until the last possible lifetime period T.

security) is positive.

Compensating Variation is utilized to gauge welfare di erences between alternative settings, because such measure is related to a variable (assets) representing individuals' wealth accumulation in the model. Therefore CV has more than just an ordinal meaning.

After running simulations, Compensating Variation to individuals under no social security (CV_{NoSS}) turns out to be positive:

CV_{NoSS} = 610.0781

This simulated value of the compensation to be given to the individual in case of no social security is quite huge, since it is approximately equal to the amount of assets scenarios should be taken into account and somehow \eliminated" from the overall welfare e ect.

The following comparison tries to do this by simulating, on the one hand, a setting with (pre-Amato) social security where the individual is forced to choose the same lifetime assets and leisure paths as those they would choose in the no-social security scenario; on the other hand, a setting with no social security where the individual is forced to retire at the same age as that they would choose under the pre-Amato pension system. While preventing the individual from optimizing over their choice variables under both settings, these constraints make the risk-insurance component better (although not exactly) quanti able.[37]

Under these assumptions, the Compensating Variation ($CV_{SSFixed}$) that should be given to the individual passing from a setting with no social security (with retirement being exogenously set at time t = 41) to a setting with a pre-Amato pension system (where assets and leisure are kept xed at the level under no social security) turns out to be negative:

$CV_{SSFixed} = -22.6483$

The above value of $CV_{SSFixed}$, as expected, is smaller than CV_{SS} but is still negative, meaning that there is still a gain from introducing social security.

This last result however cannot be straightforwardly interpreted as suggesting that the introduction of social security brings about some risk-insurance e ect. Firstly, because there is also another remaining component of ex-ante utility variation, that is the change in net taxes (transfers): this transfer component may indeed be the main determinant of the above result.[38] Secondly, because individuals in the absence of social security are not allowed to optimize over retirement age (since they are assumed to retire at the age optimally chosen in the presence of social security): although this is a useful assumption to perform a comparison between the two scenarios, it certainly in uences the result by penalizing (perhaps considerably) individuals' utility in the absence of Social Security.[39]

Regardless of the relative magnitude of the risk-insurance component out of the overall welfare variation, why may risk-insurance e ects - of any size - be brought about by social security?

Considering that the pension system utilized in the above comparisons reproduces the main features of the Italian pre-Amato regime, there are plausibly two possible sources of welfare improvement related to risk insurance.

On the one hand, the provision of annuities to retired individuals prevents mortality risk from making them leave unintended bequests.[40]

[37]The choice variables in the model are retirement age, and assets (A_{t+1}) and leisure (l_t) in every period t. After constraining the individual to the same lifetime economic choices under both settings, the remaining sources of ex-ante utility variation across the two settings are the change in net taxes (transfers), and the utility variation due to risk insurance.

[38]The fact that the Social security budget runs a huge de cit, is likely to cause the transfer component to play an important role in determining the above result.

[39]This penalization to the individual in the absence of social security may however be \o set", to some extent, by the fact that the individual in the presence of social security is forced to follow sub-optimal lifetime assets and leisure paths.

[40]From all simulations it turns out that retired individuals in the model tend not to outlive their

On the other hand, a pension system à la pre-Amato provides pensioners with an additional asset (pension claims) yielding a return that is linked to (past) wages, thereby potentially improving risk diversification over their assets portfolio (provided that, as it is usually the case, financial market returns are imperfectly correlated to wages entering the benefit formula).[41]

3.2.3 Introduction of balanced Social Security

The analysis moves on to the second case, where the social security budget is forced to balance in every period, i.e. not to run a deficit nor a surplus.

Under this assumption, the understanding of whether the introduction of social security into the Italian economy is potentially ex-ante welfare improving, requires deriving conditions for "optimality" of social security, i.e. institutional conditions under which both social security budget balance and maximization of individuals' utility occur.

In performing this kind of analysis, both the pre-Amato (old) and the post-Dini (new) pension system are taken into consideration.

Policy parameters (i.e. replacement rate under the pre-Amato system and the annuity rate under the post-Dini system) are assumed to vary so as to get social security budget exactly balanced under both systems, for a given level of the contribution rate h.[42]

The optimal size of the social security system is therefore represented by that value of the contribution rate (h) which maximizes individuals' welfare (in ex-ante terms) while satisfying social security budget balance condition.

A first analysis is therefore carried out to find the optimal size (i.e. the optimal h, denoted as h^*) of social security. From simulation it turns out that the optimal size of the contribution rate (thus, of social security) under both the old and the new regime is zero: $h^*_{pre-Amato} = h^*_{post-Dini} = 0$. That means, there is no social security system. Moreover, individuals prefer to work during the whole lifetime in case they survive, without retiring at all until the maximum possible age $t = T$ (if they are still alive), corresponding to real-world age 100. Under this setting, therefore, the reduction in pension benefits needed to fully restore the financial sustainability of the social security system is so penalizing to individuals (in terms of payroll taxes paid and transfers received) that they prefer not to contribute to a social security system.[43]

This result is robust to different specifications of the model. For instance, it still holds

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savings, rather they face the risk of unintendedly leaving resources when dying without consuming all of their accumulated wealth.

[41] Moreover, in the model (ex-ante) intergenerational risk-sharing implicitly occurs. Since the social security budget currently runs within-period deficits, (ex-post) intergenerational transfers will occur, due to debt burden being transferred to future generations.

[42] That is to say, both replacement rate (under the old regime) and annuity rate (under the new regime) are treated as functions of the contribution rate h.

[43] In the simulations, the replacement rate under the pre-Amato system varies as a function of h in order to nullify per-period deficit, and so does the annuity rate under the post-Dini system, thereby changing the value of pension benefits relative to wages and contributions. This leads the absence of social security to be the scenario preferred by individuals.

in case: the system provides a at-rate pension (rather than being based on DB or NDC rules); wages in the economy are marked by higher variability (even much higher than the variance in the baseline model); survival probabilities are higher than in the baseline setting (including the case in which there is no uncertainty on death, i.e. $\psi(t)$ = 1 in every period t); preference parameters are allowed to vary within a broad range of reasonable values, in particular the leisure preference parameter (γ) is assumed to be time-dependent, either increasing or decreasing over time, and to be much greater than the baseline value (e.g., more than 1000 instead of 15).[44]

A second analysis is performed by keeping retirement age exogenously xed at a given threshold. Under this assumption, retirement age is no longer a choice variable, and the optimal size of social security is the one maximizing ex-ante utility of individuals at the exogenously set retirement age (while satisfying social security budget balance). The retirement age is assumed to be set at 65, corresponding to 44 working years in the model.[45]

The analysis thus aims to nd the optimal size of the Social Security system following the assumption of xed retirement age at 65 (while replacement rate and annuity rate under the two regimes are still functions of the contribution rate h). Simulations under this assumption yield an optimal contribution rate $h_{pre\ \ Amato}$ = $h_{post\ \ Dini}$ = 0.02, i.e. 2% under both the pre-Amato and the post-Dini system.[46] When compared to the statutory contribution rates (approximately 24% under the old regime and 33% under the new

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It is worth stressing some further findings.

The optimal size of social security with exogenously fixed retirement age at 65, i.e. $h = h$ = 2%, is a small part (one fiftieth) of gross labor income. Under both regimes [48], when applying the optimal (conditional on fixed retirement age) contribution rate h = 2%, individuals save part of their labor income during the first 13 years of working life, during which on average roughly 3.36% of gross labor income is put aside in every period. Considering the whole working life (44 years), the average saving rate on gross labor income per period is instead slightly negative (roughly -1.11%), because during most of the working years (from the 14th period onwards) individuals consume more than the after-tax (net) labor income, thus spending part of the capital income earned in each period. This can be compared to the social security contribution rate on gross labor income, amounting to 2% in every period.

When computing saving rates on the overall income (capital income plus labor income) under both regimes, it turns out that the amount invested out of the gross overall income per period is sharply decreasing during most of the working life (though always positive), and amounts on average (throughout working life) to roughly 2.48% of the gross overall income. This amount is the "total" saving, i.e. saving out of the total (gross) income, representing the actual investment in financial assets in every period, that increases the amount of accumulated assets. When this per-period investment in market assets is compared to labor income, it turns out that financial savings represent on average (throughout the whole working life) roughly 2.55% of gross labor income. When comparing the investment in financial assets relative to the size of the investment in the social security "asset", it turns out that the social security contribution rate amounts on average (across all working life) to 1.93% of gross overall income, while it is obviously equal to a constant 2% of gross labor income in every period.

The average return on financial assets is approximately equal to 6.55%, whereas the implicit rate of return on social security contributions under both systems turns out to be considerably smaller, since it is roughly equal to 1.78%. This difference in returns on the two assets (financial assets and social security) could be the reason why it turns out to be optimal (conditional on fixed retirement age, and balanced social security budget) for individuals during working life to invest in the social security asset a smaller percentage (1.93%) of total income than that invested in financial assets (2.48%), as above described.

These figures may be compared to a setting with no social security, where contribution rate h and pension benefits are equal to zero, and financial markets are the only destination for individual savings. In the absence of social security, therefore in the absence of any possibility of diversifying investment through the "pension asset", individuals (assumed to compulsorily retire at 65) save out of labor income in the first 14 years of working life

$h_{post\ Dini}$ = 0.03, i.e. 3% under both systems. This result suggests that even if individuals retire earlier (because of some exogenous reason), the preferred size of the social security system is still low, in case they need to "pay" for restoring the financial sustainability of Social Security.

[48]Under optimality and budget-balance conditions, the pre-Amato and the post-Dini system induce individuals to choose (almost) equal asset (thus consumption) and leisure paths over their lifetime, thus determining roughly equal pension benefit levels.

(one year longer than in the presence of social security), during which savings represent on average roughly 4.43% of gross labor income per period; the average ratio of saving to labor income during the whole working life is instead negative and approximately equal to -1.92%. As regards instead the actual investment in financial assets, it turns out that the amount invested out of the gross overall income per period is heavily decreasing during working life, and amounts on average (throughout working life) to roughly 3.18% of the per-period gross overall income. The investment in financial assets represents on average (throughout working life) 3.3% of gross labor income.

This suggests that in the absence of additional assets (through which diversifying their portfolio) individuals tend to invest more in financial assets during working life (on average, 3.18% out of per-period overall income) than they do in the presence of Social Security (on average, 2.48% out of per-period overall income). With no possibility to diversify their investments through the social security asset, individuals tend to partially [49] substitute (public) pension wealth with private assets.[50]

As expected, the additional social security asset is bound to greatly benefit individuals (even though it provides a lower implicit rate of return), as it is apparent from Compensating Variation to individuals passing from a setting with no Social Security to a setting with social security (either pre-Amato or post-Dini) in case of optimal (2%) contribution rate (conditional on fixed retirement age at 65). CV turns out to be negative and sizeable in absolute value: $CV_{SS} = -1747.4$.[51]

According to the last result, in case individuals are forced to retire at a certain age, the presence of a pension system, although small in size, brings about a welfare improvement with respect to the absence of social security. Investigating the nature of this welfare improvement also allows to shed a light on the main issue tackled in this Section, when analyzing welfare effects from introducing Social Security in the Italian statutory setting: when introducing Social Security, what is the relative importance of the risk-insurance component with respect to the variation in transfers?

The results obtained from studying the optimal size of the pension system seem to suggest that the importance of the risk-insurance component out of the overall welfare variation is relatively low. When making the social security budget balance, i.e. when eliminating most of the "generous" pension transfers resulting from an unbalanced system (running a deficit), individuals prefer not to have social security at all ($h_{pre\ Amato} = h_{post\ Dini} = 0$) and choose to retire as late as possible [52] Moreover, when forcing them to retire at a certain age (65 in the above example), they prefer to have a social security

[49] In the presence of Social security (under exogenously set retirement age at 65), individuals optimally contribute to the pension system by as much as 1.93% of their gross overall income. A part of it (i.e. 0.7%, filling the gap from 2.48% to 3.18%) is "turned" into financial investment in the absence of Social Security.

[50] This result is in line with findings on substitutability between private and pension wealth for Italian households (Attanasio and Brugiavini, 2003).

[51] The value of Compensating Variation is qualitatively, and roughly quantitatively, in line with that resulting from the benchmark case in the previous subsection, i.e. $CV_{SS} = -1892.7$.

[52] In the previous subsection, individuals in the absence of social security were not allowed to optimize over retirement age.

system that is very small in size (with contribution rate equal to 2%), while investing more in the financial market mainly because of the higher return on financial assets than on the social security "asset".

Therefore, whenever some welfare improvement arises after introducing social security, this occurs conditionally on sizeable pension transfers being provided under an unbalanced budget. Risk insurance effects plausibly occur, but are relatively less important and largely outweighed by transfer effects in the overall welfare variation.

3.2.4 Comparison between Different Regimes

After analyzing the introduction of social security in the Italian economic setting, a comparison is carried out between the two main regimes considered in the paper, i.e. the pre-Amato and the post-Dini regimes, that are at first modeled according to their statutory features.[53]

Although applied to the specific features of the Italian institutional setting, this comparison is basically between a typical DB system and a notional DC system.

The comparison is performed by analyzing the effects of different pension systems on the welfare of a given representative individual entering the economy at time $t = 1$. If such a comparison were performed between different generations through time subject to different pension systems, qualitatively the same results would be obtained from a risk-insurance perspective, regardless of potential effects related to economic growth.[54]

A first general result is that the pre-Amato regime is more beneficial in welfare terms than the post-Dini regime, since the ex ante lifetime expected utility of the representative individual turns out to be greater. The Compensating Variation (CV_{New}) from the old to the new regime (amount of assets compensating individuals under the new regime to let them enjoy an ex-ante expected lifetime utility level equal to that enjoyed by individuals under the old regime) is indeed positive, and approximately amounting to assets accumulated in the first 14 years of work by an individual under the new regime:

$CV_{New} = 196.6905$

However, the two regimes are subject to different statutory rules, implying different lifetime transfers, i.e. different contributions and pension benefit levels. Moreover, the welfare comparison between the two systems is also misled by the fact that individuals under the old regime in the model retire at an earlier age (after 40 years of work, when

[53] The most notable differences between the pre-Amato and the post-Dini statutory settings are the different benefit rules and different contribution rates, both more favorable to individuals under the old regime; optimal retirement age in the model - as outlined above - turns out to be higher under the post Dini system (after 44 years of work as compared to 40 years of work under the pre-Amato system).

[54] Individuals under the new pension system may benefit (lose) from positive (negative) economic growth occurring over time. However, in the baseline model both g (yearly growth rate of real wages) and m (yearly population growth rate) are equal to zero. Most notably, even in case the calibrated value for either g or m were different from zero, results would still hold qualitatively the same from a risk insurance perspective, since both parameters in the model are assumed to represent *deterministic*, rather than stochastic, trends.

they are 61 years old) than individuals under the new regime (retiring after 44 years of work, when they are 65 years old).

From simulations in the model pension benefits under the new regime turn out to exceed benefits under the old regime by roughly 10%.[55] The pre-Amato system however had a lower contribution rate on wages during working life [56].

For a more accurate comparison, there is therefore the need to eliminate those differences across systems.

Firstly, let us consider the case where the contribution rate is equalized across the two systems, and set at the pre-Amato level, i.e. at h = 24%. In this case, it turns out that the CV is equal to CV_{New} = 49.9065, meaning that the new regime is still worse than the old regime in ex-ante utility terms (since the CV is still positive), but it becomes relatively more favorable to individuals (since CV is smaller than above).

After equalizing contribution rate (negative transfers) under the two regimes, lifetime transfers under the old system become higher than under the new system, due to different pension benefits.[57] Therefore, any welfare comparison between the two regimes is certainly influenced by the difference in pension levels. Pension benefits under the two regimes need to be equalized, in order to evaluate the welfare differences due to (possibly different) risk insurance properties of the two systems. Moreover, difference in lifetime transfers also depends on retirement age: eliminating the "transfer" component of utility variation from one system to the other, therefore requires also retirement age to be (exogenously) equalized.

$CV_{New} = -0.0159$

The above negative CV means that the ex-ante expected lifetime utility under the new regime is slightly greater than utility under the old regime. This result is crucial in the analysis carried out in the paper: it suggests that the post-Dini system, when all statutory di erences across systems are eliminated, is potentially ex-ante welfare improving, and this improvement is due to its better risk diversi cation properties with respect to the pre-Amato system.

The reason why the last CV (-0.0159) is solely due to the risk-insurance component of the overall utility variation is that the other components of utility variation are neutralized in the last simulation. Not only has the transfer component been eliminated (through equalizing contribution rate, pension level and retirement age), but also the component due to changes in individual behavior has been neutralized. Individuals under the two systems are equal, face the same realizations of wages and rates of return in every period [61], and receive (or pay) the same transfers: their simulated labor/leisure and consumption/saving choices turn out to be the same (or di erent to a negligible extent) under the two systems.[62] The only remaining utility-variation component is the one related to risk-insurance, that is represented by the *ex-ante* di erence in probabilities of di erent pension levels occurring (ex-post). This di erence is due to the bene t computation rules under the two systems: while the pre-Amato system provides bene ts based on only the last (5) years of working life, the post-Dini system provides pension bene ts based on all working life contributions (and thus wages). Therefore the new regime ex-ante reduces the variance of pension bene ts, by determining a higher probability of a mean pension level to occur, and leaving lower probability of tail values (low or high bene ts) to occur, thereby *ex-ante* bene tting risk-averse individuals.

Moreover, it is worth noticing that individuals under the post-Dini regime are not optimizing over retirement age. While contribution rate as well as annuity rate are parameters, retirement age is a choice variable, constraining which to a non-optimizing level plausibly takes away some welfare from individuals in the new regime. Therefore, the welfare gain to the new system is plausibly higher than that represented by the above Compensating Variation CV_{New}.

The above result can be further delved into by taking the optimal post-Dini system as benchmark (with h = 0.33, retirement age after 44 years of work, pension bene ts based on statutory annuity rate for retirement when 65 years old) and reversing the above comparison to let the old system adopt the same features of the new system in order to

[61] The comparison is focused on the welfare of a given representative individual under di erent pension systems. The underlying macroeconomic setting remains therefore the same across systems.

[62] The result in terms of Compensating Variation is indeed equal in case simulations are run in the same way as in the previous subsection, i.e. by keeping optimal choices (leisure and assets)

eliminate di erences in transfers.[63] In this case the compensating variation from shifting back from the new to the old system (CV_{Old}) is positive, again suggesting some gain in ex-ante terms under the new regime: [64]

CV_{Old} = 0.0132

The actual di erence between the two systems, as previously highlighted, is therefore to be searched for from an *ex-ante* perspective (before life starts i.e. when all lifetime wages and interest rates are not yet realized).

In the case where actual law provisions are applied, the pre-Amato system provides greater ex-ante utility to individuals, due to its advantageous statutory features, i.e. basically due to favorable lifetime transfers. Through further and deeper analysis, i.e. after netting out the pre-Amato system of its advantages, it turns out that the post-Dini regime lets individuals enjoy a greater ex-ante utility. Therefore, Dini reform can bring about improvements and is potentially bene cial to individuals, due to better risk insurance performed by the post-Dini regime.[65]

It is however to be noticed that the welfare gain to individuals under the new system is quite small (i.e. CV is very small in absolute value as compared to assets accumulated by individuals in the model), meaning that risk-insurance properties di er only slightly under the pre-Amato and the post-Dini regime.

In order to further delve into this point, a comparison can be made between the post-Amato/pre-Dini system and the post-Dini system. If such a comparison is performed, after eliminating all di erences causing di erent transfers under the two systems [66], and taking as reference point the post-Dini system, it turns out that CV ($CV_{NewAmato}$) to individuals for passing from the post-Amato to the post-Dini system is equal to zero:

$CV_{NewAmato}$ = 0

This means that, after accounting for all di erences in transfers, the post-Amato and the post-Dini system do not di er as regards ex-ante risk-insurance properties, whereas the post-Dini regime (as well as the post-Amato) turns out to be slightly ex-ante welfare

[63] This is done by imposing on the old system the same contribution rate (h=0.33), the same retirement age, and the same pension bene t level (by increasing the replacement rate to roughly 93%, instead of utilizing the statutory rate 80%) as under the new system.

[64] In this case, the gain to the new system is probably overestimated, because of a loss in individual utility under the old system derived from non-optimal retirement age.

[65] To further stress this point, it is noteworthy that actually realized (*ex-post*) values of per-period utility across the whole life of individuals are exactly the same under the pre-Amato as under the post-Dini regime. In other words, after accounting for di erences in lifetime transfers paid or received, the very di erence between the two regimes rests on their di erent ex-ante uncertainty-insurance capacities.

[66] Contribution rate, pension bene t level and retirement age under the post-Amato system are kept the same as those under the post-Dini system. The contribution rate under the post-Amato setting is thus set equal to h = 0.33, the replacement rate is set at 1.33 (instead of the statutory 0.8) in order to equalize pension bene ts, and retirement is exogenously xed at t = 45. As in the previous comparison, the elimination of di erences in lifetime transfers induces individuals to make the same (or negligibly di erent) consumption and leisure choices, so that no (or negligible) changes in individuals' behavior occur when shifting from the post-Amato to the post-Dini system.

improving with respect to the old (pre-Amato) regime. The explanation for that has to do with risk diversification properties of social security. Rather than enhancing portfolio diversification between wages and market returns (brought about also under the pre-Amato system), both Amato and Dini reform cause an improved diversification of wage risks, by tying pension benefits to all wages (or contributions) earned during working life. That is to say, both the post-Amato and the post-Dini system provide pension benefits based on all working-life wages (or contributions, proportional to wages, at a fixed contribution rate), and therefore are ex-ante superior to the pre-Amato system (providing pension benefits based on just the last working years' wages), because of improved risk diversification over a longer series of wages.

All of the three pension systems analyzed above provide annuitized benefits, that can be equalized in their amount by appropriately changing policy parameters. Thus all of the three systems provide individuals with a shelter against mortality and longevity risk, compensating for missing (or underdeveloped) annuity markets. Moreover, all systems allow diversification between wages and market returns at retirement through wage-based benefit rules. Therefore, from an ex-ante risk insurance perspective, what seems to mostly differ across systems is the degree of ex-ante risk diversification over uncertain working-life wages, depending on the number of yearly wages (contributions) entering benefit rules. The longer the working period (wages or contributions) entering the pension benefit formula, the lower the variance in pension benefits [67] (the higher the wage risk diversification) and thus the greater the ex-ante expected utility to risk-averse individuals.[68]

The above findings from comparing different pension systems are robust to different specifications of the model. In particular, these findings are robust to variations in those parameters that are mostly related to uncertainty, such as the level of correlation between wages and financial market returns (σ_{wr}), and the degree of variability of wages (i.e. the variance σ_w^2) and market returns (i.e. the variance σ_r^2). Results are also robust to the specification of the stochastic processes underlying factor returns: the above findings indeed still hold, qualitatively and quantitatively, in case wages are assumed to be serially uncorrelated (instead of autoregressive) and financial market returns are assumed to follow an autoregressive process (instead of being serially uncorrelated).

[67] This effect crucially depends on wages being only *partially* auto-correlated through time, as it seems to be the case in reality.

[68] This reasoning can be further extended to a pension system providing flat-rate benefits. In this case there is, ceteris paribus, a sort of "complete" risk-insurance effect, intuitively due to the elimination of uncertainty on the level of benefit received after retirement. For instance, let us consider the case where individuals retire after 40 years of work, and the pension benefit under the flat-rate system is constant and equal to the average pension level under the statutory system. In this case, it turns out that a small positive Compensating Variation must be given ex-ante to individuals when shifting from a flat-rate system to the pre-Amato system ($CV_{FlatOld}$ = 0.0184). Similarly a (slightly smaller) positive Compensating Variation must be given ex-ante to individuals when shifting from a flat-rate system to the post-Dini system ($CV_{FlatNew}$ = 0.0019). From a purely risk-insurance perspective the new pension system therefore proves better than the old, in that it is closer to the "complete" insurance setting (i.e. the one with flat-rate benefits).

4 Conclusion

The paper has analyzed social security effects in a setting marked by uncertainty at the individual level and at the aggregate macroeconomic level, with reference to the Italian economy.

Analysis has been carried out starting with a preliminary analysis of impacts brought about by the introduction of a PAYG Social Security system, aiming at understanding and quantifying risk insurance that underlies the welfare improvement induced by Social Security. In the statutory setting, allowing social security budget to run within-period deficits, the welfare gain from the introduction of social security is shown to be quite huge.

However, this welfare gain is shown to be mostly due to variations in pension transfers. When forcing social security budget to balance indeed the optimal "size" of both new and old regime, expressed in terms of the contribution rate applied to individual wages, shrinks to zero. Optimality therefore implies the absence of Social Security, and individuals working during their whole lifetime. When retirement age is exogenously set, the optimal size of Social Security turns out to be still much lower than in the statutory setting. Risk-insurance effects from the introduction of Social Security occur, but are largely outweighed by transfer effects.

The research has then investigated the impacts of different pension systems introduced in Italy, particularly by comparing the old (pre-Amato) regime with the new (post-Dini) regime. The main result is that, after accounting for differences in lifetime transfers (due to different statutory provisions across regimes), the so-called Dini reform can bring about ex-ante welfare improvement. This positive effect is due to better risk-insurance properties of the new regime, in that it enhances risk diversification throughout working-life wages.

This finding is robust to several checks performed on relevant parameters of the model.

The post-Dini regime also turns out to provide individuals with stronger incentives to postpone retirement: in simulations where the new regime is fully applied, individuals tend to work longer than under the old regime.

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