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SEVERANCE PAY OR PENSION FUNDS?

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Abstract

The paper aims to analyze the determinants of the individual choice of contributing to pension funds, particularly by focusing on individual preferences towards the annuitization of the accumulated pension capital. The analysis is performed in the light of the latest reform of social security in Italy, converting the severance pay scheme (the so-called *TFR*) into a fully funded scheme of pension funds. The model describes the behavior of a representative agent belonging to a representative generation in steady state, in a partial equilibrium setting with mortality risk as well as uncertainty on wages and financial market returns. Investing in riskier but potentially more rewarding pension funds, paying out annuities from retirement onwards, turns out to be slightly welfare improving with respect to contributing to a severance pay scheme eventually paying out a lump-sum amount. Nonetheless, the welfare-based value of insurance provided by private annuities from pension funds is relatively low, mainly due to *a)* the pre-existence of (sizeable) public annuities, and *b)* constraints imposed by annuitization on both saving and consumption behavior after retirement. These findings provide further insights into the "annuity puzzle" issue.

Keywords: Social Security Reforms; Uncertainty; Fully Funded Pension Schemes
JEL Classification: E62, G23, H31, H55

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Acknowledgements

1 Introduction

In the last decades, most developed countries have experienced substantial changes both in the demographic structure and in the growth rates of the economy. As a result, the prospective financial sustainability of social security systems is put at risk, inducing many countries to reform public Pay-As-You-Go (PAYG) pension systems and to supplement (or partially substitute) them with fully funded complementary private pension schemes. Italy is quite a neat example of this trend. In order to reduce the projected imbalance of social security, two main reforms were introduced in Italy during the early 1990s, turning the public PAYG system from a Defined Benefit (DB) to a Notional Defined Contribution (NDC) scheme, and considerably reducing the prospective replacement rates that it will be plausibly capable of providing.[1] A further pension reform, the so-called Maroni reform introduced in Italy in 2004 (implemented in 2007), was aimed at boosting the fully funded pension pillar, by providing fiscal incentives for workers choosing to invest their severance pay contributions (*"Trattamento di Fine Rapporto"*, TFR) into private Defined Contribution (DC) pension funds.[2]

The reform basically lets agents choose between investing in a (almost) safe asset paying out a lump-sum amount at the end of employment (severance pay scheme), and a riskier but potentially more rewarding asset that provides annuities from retirement onwards (pension funds). Important drivers of this choice, among others, appear to be the risk-aversion of workers and their preference towards more liquid assets, both potentially favoring the investment of contributions in the severance pay scheme (Cesari, Grande and Panetta, 2008). Conversely, an important argument in favor of pension funds is the provi-

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[1] The average gross replacement rate of private-sector employees, for instance, is projected to decrease from around 70% in 2010 to roughly 50% in 2060 (Covip, 2008).

[2] In Italy the value of assets in private pension funds as a percentage of GDP (4.1% in 2009) is still by far among the lowest levels in OECD countries (OECD, 2011). Despite the favorable fiscal conditions provided by the Maroni reform, relatively few workers chose to switch contribution from TFR to pension funds: by 2008 this choice was made by approximately 1/3 of private sector employees, according to Cesaratto (2011).

sion of annuities that may otherwise be difficult to find in the market, protecting against the longevity risk, namely the risk of workers outliving their savings after retirement (Barr and Diamond, 2006). In fact, annuity markets are actually narrow in real economies. In particular the size of the Italian annuity market is currently tiny (Guazzarotti and Tommasino, 2008). Such narrowness of annuity markets seemingly contradicts predictions of the traditional life cycle model, according to which individuals facing uncertain lifespan and without a bequest motive should fully annuitize their wealth (Yaari, 1965).[3] The main explanations provided by the literature for this "annuity puzzle" are: low yields on annuities (also due to costs related to adverse selection); presence of a bequest motive (Friedman and Warshawsky, 1990); alternative risky investments that are more attractive than annuities, in case of labor supply flexibility (Benitez-Silva, 2003, building on Bodie, Merton and Samuelson, 1992); pre-existence of annuitized wealth, notably public pension wealth; general availability of nominal annuities not hedging against inflation risk; irreversibility of the annuity investment combined with retirees being liquidity constrained and facing uncertainty about future expenditure needs (Brown and Warshawsky, 2004). As specifically regards the payment form of accumulated pension capital at retirement, empirical studies have also confirmed that workers tend to choose lump-sum over annuitized payments, with few exceptions (Bütler and Teppa, 2007), which reveals an underlying general demand for liquid retirement assets. Therefore, as in many countries fully funded complementary private pension schemes are becoming ever more important, a key issue is whether (and to what extent) annuitization should be mandated.

This paper aims to evaluate the individual behavior in contributing to supplementary private pension schemes. The main goal is to investigate the determinants of this behavior, particularly by focusing on individual preferences towards alternative payout forms at

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[3]Annuitization provides insurance against the risk of outliving one's savings, as well as insurance against the risk of dying with assets that have not been consumed while alive. Moreover, the return on annuities also yields a mortality premium, reflecting the possibility that the individual dies before receiving future payments.

retirement, i.e. either lump-sum or annuities, with reference to the phenomenon of the "annuity puzzle". The concurrent presence of both payout alternatives makes Italy an appropriate case study to the purposes of this paper, in the light of the 2004 pension reform.

The paper uses simulations from a life-cycle model of a representative agent belonging to a representative generation in steady state, within a partial equilibrium setting with mortality risk and uncertainty on factor returns. By applying the main features of the Italian public NDC pension system (the so-called "first pillar", as modified by the 1995 reform) to a calibrated model reproducing stylized facts of the Italian economy, the paper performs a welfare comparison between the scenario where the representative individual chooses to contribute to the severance pay scheme on the one hand, and the scenario where the individual contributes to pension funds on the other hand (the so-called "second pillar"). Based on this comparison, the investment in the fully funded DC pension scheme turns out to be slightly preferred. In case pension funds are assumed to pay out benefits after retirement in a lump-sum fashion (instead of annuities), *ceteris paribus*, the welfare gain to the complementary fully funded pension scheme is even larger. Pension funds are then assumed to provide the same risk-return combination as the severance pay asset, so that the analysis boils down to a comparison between annuities and lump-sum payments. In this case the previous relations reverse in that contributions are preferably kept with the severance pay scheme rather than being invested in pension funds. These findings suggest firstly that the risk-return combination of pension funds is potentially preferable, and acts as the unique driver of the overall individual preference towards pension funds. Secondly, the longevity-risk insurance effect is outweighed by preference towards more liquid retirement assets. Consistently with these intuitions, the optimal mix of the two schemes turns out to lean towards pension funds, while however preserving a small fraction of contributions within the severance pay fund. Investigating more in depth the specific

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individual choice between lump-sum and annuitized payout within pension funds, it turns out (in line with the above findings) that individuals prefer receiving most of the funds' capital in lump-sum fashion upon retirement. The pre-existence of sizeable annuitized wealth in the form of the public pension system proves to play a crucial role in "crowding out" a substantial part of the individual demand for private annuities. This implies that additional longevity-risk insurance from private annuities is valued relatively less than the opportunity of immediately cashing out most of the pension funds' capital. Besides this crowding-out effect, another key factor turns out to explain the low demand for annuities, providing further insights into the "annuity puzzle" debate in the literature. Annuities prove indeed to impose (welfare-decreasing) constraints on desired saving and consumption behavior of individuals after retirement. Notably, a lump-sum payout would allow individuals to enjoy a relative welfare gain (with respect to annuities) by means of investing considerable resources out of the withdrawn amount in rewarding financial markets upon retirement.

The paper is organized as follows. Section 2 presents the model and the institutional framework. Section 3 illustrates the policy experiments that are considered, and presents the main findings. Section 4 concludes. A final Appendix provides more technical details on the calibration and the simulation method.

2 Model and Institutional Framework

2.1 Model

The paper considers a steady-state partial equilibrium model in a discrete time setting (every period in the model corresponds to one year in real life), representing an economy where stochastic wages and financial returns are exogenously determined by foreign

markets.[4] The pre-tax income of individuals in the economy in every period t is thus 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. The model considers yearly average wage growth, both at the aggregate level (growth rate of labor productivity g) and at the cohort-specific 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 stochastic dynamics of wages w_t.

Individuals in the economy live from age 1 to at most T years, surviving at every age t (with $t = 1, ..., T$) to age $t + 1$ with a given (age-dependent) conditional survival probability. The economy in every period is populated by T generations, each consisting of an infinite number of agents.[5] Total population mass is assumed to grow at a deterministic constant rate m. Individuals ex-ante (i.e. at time $t = 0$, prior to entering the economy) maximize expected discounted lifetime utility with respect to within-period consumption and within-period leisure:

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

where β in the above formula is the subjective time discount factor; ψ_t is the conditional survival probability from age $t-1$ to t, with $\psi_1 = 1$ and $\psi_{T+1} = 0$; c_t and l_t are respectively consumption and leisure entering the utility function of agents at age t. The within-period

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[4]Italy can be approximately regarded as a small open economy worldwide and, by further approximation, in the European Union. The paper assumes that real financial returns and wages in Italy are determined by European capital and labor markets. This assumption is quite realistic as regards interest rates. As for wages, it is less realistic because the European labor market is not integrated. However, the paper further assumes that markets are competitive, so that the high-level integration in the European markets of goods can be thought of as influencing the determination of Italian real wages through the prices of tradable goods, in the wake of the Stolper-Samuelson theorem.

[5]In each period, a constant fraction of individuals passes from each age to the next (respectively, dies) according to constant survival probabilities (respectively, according to constant mortality probabilities). Since the model is considered in steady state under the assumption of partial equilibrium, the whole analysis throughout the paper will focus on a single representative individual belonging to a representative generation, instead of considering all overlapping generations through time. With reference to this single representative individual, both time periods and the individual's age are denoted by t (with $t = 1, ..., T$).

utility function takes the CES form:

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

where $\frac{1}{\rho}$ is the intertemporal elasticity of substitution between consumption of different years, $\frac{1}{\sigma}$ is the intratemporal elasticity of substitution between consumption and leisure, and γ_t represents the time-varying leisure preference parameter following the formula:

$$\gamma_t = 1 \qquad \text{for } t = 1, ..., \tilde{t}$$

$$\gamma_t = (\frac{1}{\psi_t} - (\frac{1}{\psi_{\tilde{t}}} - 1))^{\theta} \qquad \text{for } t = \tilde{t}+1, ..., T$$

The leisure preference parameter is constant (normalized to 1) until a given period $\tilde{t}$ in lifetime, and increases thereafter. This assumption represents the utility from leisure (disutility from work) as being constant during the initial part of working life when individuals are younger, and then increasing when individuals are older and less healthy.[6]

In every period t individuals are provided with a given time endowment $\bar{T}$, and choose consumption c_t and labor supply $\bar{T} - l_t$. Individuals work and receive a wage w_t for each unit of time spent working, i.e. overall $w_t(\bar{T} - l_t)$, at every age t (if alive) until they endogenously choose to retire at age t_{ret}. After retiring individuals are assumed to no longer go back to work in subsequent periods. While working, individuals pay in social security contributions at a rate h out of their gross labor income. After retirement they receive a public pension benefit p_t (linked to their working-life wages) at every age t if alive until death at T. During working life individuals are also mandatorily required to contribute at a rate h' out of their labor income, either to their firm-based severance pay scheme (namely, the termination indemnity) or to external private pension funds. Accordingly, after retirement individuals enjoy an additional source of income, consisting of either a lump-sum amount at t_{ret} (the severance pay, denoted by SP) or a further annuitized payment at every age t if alive until death at T (the complementary private

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[6]Survival probabilities in the model can be considered as a proxy for individual health conditions, worsening as individuals become older. The leisure preference parameter is therefore assumed to be inversely proportional to survival probabilities (from a given age onwards).

pension from pension funds, denoted by PF_t).

Denoting gross labor income in every period t, i.e. $w_t(1+g)^{t-1}(1+sw)^{t-1}(\bar{T}-l_t)$, as W_t, in case the additional working-life contributions (paid at rate h') are left by the firm-based severance pay scheme, the within-period budget constraint of a given individual at every age t would read as follows:

$$A_{t+1} = A_t(1+r_t) + (1-h-h')W_t - c_t \qquad \text{for } t = 1, ..., t_{ret} - 1$$

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

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

In case the additional working-life contributions (paid at rate h') are instead invested in the private fully funded pillar (pension funds), the within-period budget constraint would read as follows:

$$A_{t+1} = A_t(1+r_t) + (1-h-h')W_t - c_t \qquad \text{for } t = 1, ..., t_{ret} - 1$$

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

In the above formulas A_t represents the beginning-of-period asset holdings of the individual aged t.

Agents are assumed to be borrowing constrained:

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

The model assumes there is no bequest motive, therefore for individuals living until the last possible age T it holds that $A_{T+1} = 0$. Accidental bequests of individuals dying before reaching age T are assumed to be destroyed and provide no utility to other living individuals.[7]

Markets in the model are assumed to be incomplete. Firstly, agents are borrowing constrained. Secondly, annuity markets are assumed to be missing, except for complementary

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[7]This assumption is made for the sake of considerable computational simplification. 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.

private pensions.

2.2 Institutional Framework

The Italian public pension scheme considered in the model reproduces the main features of the system introduced by the so-called Dini reform in 1995. The Dini reform transformed the Italian public PAYG pension system from a DB into a NDC scheme. Pension benefits under this regime are computed by "notionally", i.e. fictitiously, capitalizing social security contributions at a rate that is linked to the growth rate of the economy during working life (depending on the growth rate of productivity and population, respectively denoted by g and m in the model). The amount accumulated in this way at retirement is turned into annuities through multiplying it by statutory annuity rates (so called "transformation coefficients", denoted by tc). Individuals are allowed to choose their retirement age (denoted by t_{ret} in the model) from any age between 57 and 65 real-life years (corresponding to respectively 37 and 45 years in the model), with a minimum required number of years of contribution.[8] 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.[9] The contribution rate (denoted by h in the model) currently in force is 33%. Denoting gross labor income in every period t, namely $w_t(1+g)^{t-1}(1+sw)^{t-1}(\bar{T}-l_t)$, as W_t, the formula of the public pension benefit annuity can be represented as follows:

$$p = tc \cdot \left\{ \sum_{t=1}^{t_{ret}-1} h \cdot W_t \cdot [(1+g) \cdot (1+m)]^{t_{ret}-t} \right\}$$

where tc is increasing with retirement age, from 0.047 when $t_{ret} = 37$ to 0.061 when

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[8]Each age t in the model corresponds to age $t+20$ in real life. Hereafter in the paper, retirement age t_{ret} is expressed in terms of *model* periods. Corresponding real-life age therefore equals the model age plus 20.

[9]Individuals may also choose to retire after 65 real-life years: in this case the annuity rate (transformation coefficient) used in the benefit rule remains constant thereafter, and equal to the annuity rate applied in case of retirement at 65. The 1995 reform also provided that statutory transformation coefficients should be revised every ten years, in order to account for changes in the (average) life expectancy of population, however the first actual revision occurred in 2010 instead of 2005.

$t_{ret} \geq 45$.[10]

The latest reform introduced in Italy in 2004, the so-called Maroni reform, largely preserved the public pension system *à la* Dini, by only applying some marginal changes (such as a gradual increase in the minimum retirement age, from 60 years in 2008 to 62 years in 2014 onwards) that are not considered in the model. The Maroni reform affected more deeply the private pension pillar, in that it provided fiscal incentives for workers to invest their severance pay contributions into pension funds, on an individual voluntary basis.[11] The reform (as detailed by the application law in 2005, and actually implemented as of 2007), provided that workers would have to choose whether to leave their future contributions for severance pay (so-called "*Trattamento di Fine Rapporto*", TFR) by their firm-based saving fund, or to (irreversibly) devote those contributions to fiscally-favored investment in complementary pension schemes (the private fully funded DC pension pillar).[12] The contribution rate to both schemes (denoted by h' in the model) is 6.91% of gross labor earnings.[13]

Contributions to the TFR fund yield a (nearly) safe return equalling a fixed 1.5%

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[10]A transition period for the 1995 reform was set by law. Whoever at the end of 1995 had contributed for more than 18 years, is not affected by the 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 pensions determined pro-rata (proportionally to time spent contributing before and after 1995). The paper does not consider this transition phase, and only focuses on the fully applied Dini regime.

[11]The paper however does *not* consider fiscal incentives to investment in pension funds, sice the focus is only on comparing the very features of alternative schemes, abstracting from taxation favoring specific investment forms over others.

[12]This choice has to be made within six months from employment. The choice of leaving the TFR contributions with the firm can be reconsidered in the future, whereas the investment of contributions in pension funds is irreversible. The paper does *not* consider scenarios where individuals pay in contributions to the TFR scheme until a certain working-life period and in pension funds thereafter, since individuals in the model are only allowed to invest in one of the two alternatives during their whole working life.

[13]The statutory contribution rate to the TFR scheme is indeed 6.91%. This same amount can be alternatively diverted to pension funds, based on individual choice. The paper only focuses on these two scenarios, without considering any further investment in pension funds. In reality, besides possibly diverting the mandatory TFR payment, additional contributions to the fully funded pension pillar can be voluntarily paid by both employees and employers.

nominal rate plus 75% of the inflation rate; the revaluated total amount is paid out in a lump-sum fashion at retirement (or upon leaving the firm). For the sake of simplicity the *real* return on severance pay contributions, denoted by r_{SP}, is treated in the model as a *fixed* (i.e. completely safe) return amounting to 0.55%, given its very low variance derived from a mere 25% of the (usually fairly stable) inflation rate.[14]

The severance pay (SP) received at retirement can be therefore represented as follows:

$$SP = \sum_{t=1}^{t_{ret}-1} h' \cdot W_t \cdot (1 + r_{SP})^{t_{ret}-t}$$

Contributions to private pension funds (PF) instead yield a risky financial market return (the average financial return denoted by r_t in the model); the capitalized total amount is paid out in the form of annuities from retirement onwards.[15] The annuity rate for private pensions (denoted by tc' in the model) is actuarially determined as inversely depending on conditional survival probabilities (denoted by ψ_t in the model) discounted at rate $\bar{r}$:

$$tc' = \Big(\sum_{t=t_{ret}}^{T} \frac{\prod_{k=t_{ret}}^{t} \psi_k}{(1+\bar{r})^{t-t_{ret}}} \Big)^{-1}$$

As expected, tc' is increasing with retirement age, for instance it equals 0.0374 when $t_{ret} = 37$, and 0.0502 when $t_{ret} = 45$. The discount rate $\bar{r}$ used for private pension annuities in the model is zero.[16]

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[14]Denoting by inf_t the inflation rate in period t, the *nominal* return on TFR contributions measured in period t would equal $0.015 + (0.75 \cdot inf_t)$, and the corresponding *real* return would thus approximately equal $0.015 - (0.25 \cdot inf_t)$. Since all variables in the model are expressed in real terms and there is no inflation, for the sake of simplicity, the per-period inflation rate is assumed to be constant and is equalized to the average inflation rate in period 1990-2004 (consistently with the reference period for other macroeconomic data used in the paper), that is about 3.8%. Consequently, r_{SP} in the paper is a fixed return rate equal to $0.015 - (0.25 \cdot 0.038) = 0.0055 = 0.55\%$. Such simplifying assumption of constant r_{SP} is quite realistic, since the series of real returns obtained by applying the 1990-2004 series of inflation rates shows a very low variability. Defining R_t as the real severance pay yield, $0.015 - (0.25 \cdot inf_t)$, with reference to actual 1990-2004 data, the sample variance of R_t is indeed 0.000017. This variance value equals 0.3% of the R_t sample mean (0.0055), and just 0.4% of the variance of the risky financial market returns in the model (0.004).

[15]Law provisions after the 2004 reform mandate annuitization of at least half of a worker's pension fund capital. The baseline model in the paper considers complete annuitization under pension funds. This assumption is relaxed in further analysis allowing for individual choice on the optimal annuitization share within pension funds.

[16]In this paper, competition among different private pension funds is not explicitly taken into

The private pension benefit annuity can be represented as follows:

$$PF = tc' \cdot \{\sum_{t=1}^{tret-1} h' \cdot W_t \cdot [\prod_{k=t}^{tret-1}(1 + r_k)]\}$$

Basically the stylized Italian pension system reproduced in the paper consists of the mandatory public first pillar, supplemented by the mandatory part of the private second pillar (constituted by one of the two alternative schemes, i.e. either the severance pay saving fund or pension funds, based on individual choice).

2.3 Calibration and Optimization Problem

The main parameters of the model, notably those preference-related, are assigned specific values resulting from calibration aiming to replicate stylized facts of the Italian economy, notably lifetime labor and consumption paths of individuals.[17]

The baseline calibration is characterized as reported in Table 1. The representative individual is assumed to enter the economy when 21 years old, corresponding to the first lifetime period ($t = 1$) in the model. This reflects the real average entry age in the labor market in Italy. Assets held by individuals at the beginning of their (economic) life are assumed to be equal to zero: $A_1 = 0$. The representative individual lives at most T periods, equalized to 80 in the model (i.e. when 100 years old in real life), surviving from every period to the next with a certain (conditional) survival probability.[18] Population

account, therefore the second pension pillar resembles the functioning of a single government-operated pension fund. Moreover, pension fund managers actually may also choose to insure themselves against default risk. Consequently, the discount rate $\bar{r}$ is assumed to be zero, reflecting the absence of risk in the payment of private pensions. Following the previous reasoning, administrative costs of pension funds are also assumed to equal zero in the model, while actual administrative costs in the real world tend to be higher under fully funded than under PAYG pension schemes (Lindbeck and Persson, 2003).

[17]The benchmark economy used in the calibration is the Italian economy under the old pension system, i.e. the pension regime before the introduction of the Amato reform in 1992, since the Dini regime is undergoing a long transition phase.

[18]The sequence of conditional survival probabilities $\{\psi_t\}_{t=1}^T$ is computed as the weighted average of survival probabilities per cohort of Italian males and females in 2004, reported by the yearly demographic balance of Istat (Italian National Institute of Statistics). The year 2004 is one of the last years for which data are available, and is in line with the 1990-2004 time span of macroeconomic

mass of the whole economy in every period is normalized to one, i.e. yearly population growth rate (denoted by m) is equal to zero. This is in line with recent demographic trends and with demographic projections for Italy.[19]

Econometric analysis has been performed on Italian real wages (normalized around their mean) and financial market returns (computed as weighted average of returns on government bonds, corporate bonds issued by Italian banks, and listed shares issued by Italian companies) between 1990 and 2004 (for further details see the Appendix). The resulting estimated processes underlying wages w_t and market returns r_t can be represented as follows (standard errors in parentheses):

$$w_t = \underset{(10.273)}{35.253} + \underset{(0.103)}{0.645} \cdot w_{t-1} + ew_t$$

where ew_t is the error term, normally, identically and independently distributed with mean zero and variance (denoted by σ_w^2) estimated to equal 2.436;

$$r_t = \underset{(0.008)}{0.054} + er_t$$

where er_t is the error term, normally, identically and independently distributed with mean zero and variance (denoted by σ_r^2) estimated to equal 0.004. The covariance between the error terms (denoted by σ_{wr}) is estimated to equal 0.03.

The deterministic yearly growth rate (denoted by g) of aggregate real wages is assumed to be zero. This is in line with the average yearly growth rate of aggregate real compensations per employee in period 1990-2004, that was roughly zero.[20] The only source of deterministic wage variation through time is a cohort-specific component tracking changes in wages due to career dynamics, namely to seniority-driven (contractual) increases in

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data utilized in the calibration.

[19]According to the Istat demographic balance, 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%.

[20]According to OECD (2008) data for Italy, average growth rate of real compensations in 1990-2004 was approximately equal to -0.04%.

wages. This per-period *cohort-specific* "seniority" growth rate in real wages, denoted by sw, is set at 2% (for further details see the Appendix) and is assumed to remain constant across the entire individual working life, as well as throughout all subsequent cohorts, so that it is also consistent with an *aggregate* growth of real wages (g) equal to zero.[21]

Calibration of preference parameters is as follows. Although the literature does not provide estimates for the elasticity of intertemporal substitution in Italy, the value assigned to ρ (1.0001) lies in ranges that are suggested by various studies, such as between 0.5 and 1.5 (Battistin et al. 2009). The value assigned to the reciprocal of the intratemporal elasticity of substitution, i.e. σ (0.999), is very close to 1, implying that consumption and leisure in the calibrated model are substitutable to a very little extent. This matches the well-known fact that some consumption goods are substitutes and other consumption goods are complements with leisure. The value assigned to the subjective time discount factor β (0.96) is in line with values commonly used in the literature, notably with values referred to Italy ranging from e.g. 0.9 in Ventura (2003) to e.g. 0.985 in Fonseca and Sopraseuth (2005). The time-profile of the leisure preference parameter γ_t resulting from values assigned to θ (90) and $\tilde{t}$ (35) is such that the representative individual in the calibrated model is willing to retire at an age that is comparable with the actual retirement age in the presence of social security.

The reported parameter values (Table 1) allow the calibrated model resulting from simulations to reproduce the following stylized facts of the Italian economy. The simulated consumption drop at retirement under the old pension system in the model lies between 4% and 5%, and is comparable to the drop empirically measured for Italy (Battistin et al., 2009; Miniaci, Monfardini and Weber, 2010) under the old regime (prior to the 1992 Amato reform and as modified by the Amato reform).[22] The calibrated lifetime

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[21] As a consequence of the above assumptions, the representative individual belonging to the representative generation (cohort) considered in the model enjoys a deterministic growth of wages by 2% per period.

[22] Analogously to Battistin et al. (2009), consumption drop is measured as the percentage vari-

consumption path increases in line with wage growth (at rate $sw = 2\%$) during working life, and drops around retirement. Moreover, the calibration yields a working-life labor supply profile that is equal to the normalized value of 1 in each working-life period until retirement (t_{ret}), and constantly equal to zero after retirement.[23] In the calibrated model, retirement choice (i.e. choice of the period t_{ret} when labor supply is zero, so that labor supply remains null in all subsequent periods until T) occurs at $t_{ret} = 36$, corresponding to 56 years in real life. This implies that individuals in the calibrated model under the old pension system choose to retire as soon as they are statutorily allowed to (i.e. after 35 years of work and contribution). This retirement choice in the model approximately matches the actual average retirement age of Italian workers under the old pension regime, around their mid-50s, mainly due to high effective replacement rate, and favorable eligibility conditions (particularly for public-sector employees).

Based on the calibrated model, the solution to the corresponding optimization problem for the representative individual entering the economy at age $t = 1$ is a sequence of optimally chosen values for consumption ($\{c_t^*\}_{t=1}^T$) and leisure ($\{l_t^*\}_{t=1}^T$), as well as the optimal retirement age t_{ret}, maximizing the individual's expected discounted lifetime utility (measured at time $t = 0$). Solutions are found by numerically simulating (1000 times) the calibrated model. Therefore optimal individual behavior is state-contingent, namely depending on the specific simulated realizations of stochastic variables in each period t. Consequently, lifetime profiles for consumption and leisure ($\{c_t^*\}_{t=1}^T$ and $\{l_t^*\}_{t=1}^T$) result from averaging across 1000 different paths.[24]

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ation between the average consumption level in the 10 years before retirement and the average consumption level in the 10 years after retirement. Battistin et al. (2009) estimate a drop in non-durable consumption at retirement of 9.8 percent, but this fall turns out to be more than halved in case expenditure is deflated by a standard family size measure. Miniaci, Monfardini, and Weber (2010) estimate a drop in nondurable consumption at retirement of around 5.4 percent.

[23]A constant unitary labor supply in the model allows the representative individual to obtain labor earnings (while working) that coincide with wage rates in the model economy.

[24]For the sake of computational simplification, the optimal retirement age t_{ret} is instead computed from an ex-ante perspective, as the age maximizing the expected discounted lifetime utility (namely the value function at the beginning of life).

Parameters	Symbol	Value
Demographic and macroeconomic parameters		
Maximum possible life length	T	80
Growth rate of population	m	0
Variance of wages error term	σ_w^2	2.436
Variance of market returns error term	σ_r^2	0.004
Covariance of wages and market returns error terms	σ_{wr}	0.03
Aggregate growth rate of wages	g	0
Seniority growth rate of wages	sw	0.02
Preference parameters		
Subjective time discount factor	β	0.96
Reciprocal of the intertemporal elasticity of substitution	ρ	1.0001
Reciprocal of the intratemporal elasticity of substitution	σ	0.999
Parameters in the leisure preference formula $\gamma_t = (\frac{1}{\psi_t} - (\frac{1}{\psi_{\tilde{t}}} - 1))^\theta$	θ	90
	$\tilde{t}$	35

Table 1: Calibration

3 Findings

In order to evaluate the individual choice of investing in the fully funded pension pillar (in the light of the 2004 Italian pension reform), comparisons are performed between different scenarios. The main *statutory* features of the schemes considered in the paper are represented in Table 2.

	Payout form	Benefit
Public pension (I pillar)	annuity	$tc \cdot \{\sum_{t=1}^{t_{ret}-1}(0.33) \cdot W_t\}$
Private pension (II pillar) from pension funds - PF	annuity	$tc' \cdot \{\sum_{t=1}^{t_{ret}-1}(0.0691) \cdot W_t \cdot [\prod_{k=t}^{t_{ret}-1}(1 + r_k)]\}$
		with $tc' = \frac{1}{\sum_{t=t_{ret}}^{T} \prod_{k=t_{ret}}^{t} \psi_k}$
Severance pay - SP	lump-sum	$\sum_{t=1}^{t_{ret}-1}(0.0691) \cdot W_t \cdot (1.0055)^{t_{ret}-t}$

Table 2: Schemes considered in the paper

The analysis of a steady-state setting with a representative individual belonging to

one representative generation requires considering balanced-budget scenarios. To this end, the social security budget is forced to balance in every period (thus it cannot run either deficits or surpluses) by artificially changing a *statutory* policy parameter, namely the public-pension annuity rate tc, for every given level of the relative contribution rate h.

Comparisons in the paper are carried out by analyzing different settings, from an ex-ante welfare perspective. Firstly the reference scenarios are considered, namely the firm-based severance pay saving scheme (SP) and the fully funded scheme based on pension funds (PF). Secondly, the analysis goes more in depth by considering a hypothetical fully funded scheme paying out financially capitalized contributions in a lump-sum fashion ($LumpsumPF$) on the one hand, and a hypothetical annuity-based fully funded scheme where contributions yield the same fixed (non-stochastic) return rate r_{SP} as the severance pay scheme ($FixedratePF$). All of these four schemes enter the model on top of the public first-pillar pension system.[25]

The results from comparing couples of settings are expressed in terms of "*Compensating Variation*" (CV), defined as the amount of assets that should be given to individuals in a setting (e.g. with individuals contributing to pension funds) before the beginning of their life, in order to let them benefit from the same level of ex-ante expected discounted lifetime utility as they would enjoy in the other setting (e.g. with individuals contributing to the severance pay scheme). Hereafter in the paper, all comparisons between alternative settings are expressed in terms of Compensating Variation normalized by the average wage in the first model period.[26] The main results of the paper (Compensating Variations as well as outcomes from optimality analysis) are summarized in Table 3.

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[25]In comparing different scenarios, the macroeconomic (basically, w_t and r_t in every model period t) and demographic backdrop remains the same, with the only difference being the institutional features under each alternative setting.

[26]The comparison measures, computed in terms of assets, are expressed relative to the average individual wage. In particular, the first-period wage is considered because it is drawn from the stationary (i.e. "steady-state") distribution of wages in the model.

Compensating Variations	
SP vs PF	-0.0568
SP vs $LumpsumPF$	-0.2148
SP vs $FixedratePF$	0.1682
Optimal mix of SP and PF	
SP: α^*	0.07
PF: $(1-\alpha^*)$	0.93
Optimal mix of payout forms within PF	
Annuity: δ^*	0.15
Lump-sum: $(1-\delta^*)$	0.85

Table 3: Main results [Compensating Variations relative to comparisons ($settingA$ vs $settingB$). $CV > 0$ ($CV < 0$) implies $settingB$ worsening (improving) individual welfare with respect to $settingA$]

3.1 Comparison between Severance Pay and Pension Funds

Considering the optimal retirement ages under different schemes (reported in Table 4), it turns out that when individuals opt for leaving their contributions by the firm-based scheme, they wish to retire slightly later than they would when investing in pension funds. This is plausibly due to the return on pension funds being riskier but *on average* substantially more rewarding than the return on the severance pay saving fund, which induces individuals to work longer in order to accumulate a higher amount of severance pay savings.[27] On the other hand, lump-sum payment induces individuals on average to retire earlier than annuitized pensions, for any given risk-return combination.[28] This plausibly results from the need to work longer to accumulate a higher amount of capital, in case it is annuitized and earned gradually later, instead of being immediately received at retirement.

From simulations the resulting Compensating Variation (denoted by CV_{SP_PF}) to be

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[27]The (assumedly) fixed return on severance pay (r_{SP}) is 0.55%, whereas the *average* expected financial market return earned from investing in pension funds is 5.4%.

[28]Since $FixedratePF$ is equivalent to a severance pay scheme paying out annuities after retirement, it is apparent from Table 4 that individuals under either severance pay or pension funds tend to retire slightly earlier with lump-sum than with annuitized payment of the respective accumulated amount at retirement.

	Optimal t_{ret}
SP	39
PF	38
$LumpsumPF$	37
$FixedratePF$	40

Table 4: Retirement ages under different settings

given to the representative individual passing from a setting with the severance pay scheme to a setting with pension funds (both in addition to the first public pillar) turns out to equal -0.0568 (relative to the first-period wage in the economy), as reported in Table 3. The negative sign of CV_{SP_PF} implies that investing contributions in pension funds causes a higher individual lifetime welfare than investing in the firm-based scheme.

This result is qualitatively robust to alternative specifications of preference parameters. Notably, CV_{SP_PF} preserves the negative sign for $\beta \geq 0.89$ and for reasonable ranges of values of σ and ρ around 1. The result is also qualitatively robust to the hypothetical introduction of administrative costs up to 5% of returns within pension funds.[29] Moreover, in case the discount rate $\bar{r}$ used for private pensions were assumed to equal the (almost) safe r_{SP} return (0.55%) instead of being set at zero, the result would be qualitatively confirmed and quantitatively strengthened (CV_{SP_PF} would indeed equal -0.0814), since the annuity rate tc' and thus benefits from pension funds would increase in value *ceteris paribus*.

3.2 Risk-return Combination and Payout Form

In order to shed light on the above general finding ($CV_{SP\_PF} = -0.0568$), additional analysis is performed as follows, allowing a deeper understanding of the role played by

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[29]Administrative costs equalling 5% of financial returns in the paper correspond to an average cost of 0.27% expressed as the difference between gross and net returns (since the average financial market return is 5.4%). Actual costs, reported by Covip (2009), range between 0.1% and 0.4% within closed (collectively agreed) pension funds, between 0.5% and 1.8% within open funds, as computed for a representative 35-year position.

the relative convenience of different risk-return profiles and (particularly) different pay-out methods. Further comparisons are performed between the setting with individuals contributing to the severance pay scheme, and $a)$ the setting with individuals investing in pension funds paying out benefits in a lump-sum fashion ($CV_{SP\_LumpsumPF}$) or $b)$ the setting with individuals investing in annuity-based pension funds yielding a fixed return rate equal to the severance pay return ($CV_{SP\_FixedratePF}$).

From the first comparison, it turns out that the ex-ante welfare gain from shifting to pension funds increases when the fully funded pillar provides pensions in lump-sum form upon retirement: $CV_{SP\_LumpsumPF}$ is indeed negative and larger in absolute value than CV_{SP_PF}, as reported in Table 3. This implies that the preference towards the more liquid lump-sum payment prevails over the longevity-risk insurance provided by annuitized benefits. Consequently, the previous general finding expressed by CV_{SP_PF} (pension funds are overall slightly preferred to severance pay) is *uniquely* driven by the more favorable risk-return combination of the private fully funded pillar reproduced in the model. The fact that the pension fund portfolio is more "efficient" (i.e. provides a better risk-return combination) than the severance pay fund, depends on the substantially higher expected financial return of the former outweighing the lower riskiness of the latter in driving ex-ante welfare gains.

From the second comparison, individual preference towards earlier liquidity is further confirmed by $CV_{SP\_FixedratePF}$ being positive. The positive sign of $CV_{SP\_FixedratePF}$ means indeed that, after equalizing the risk-return properties of the two schemes (to the severance pay risk-return combination), paying out the same capitalized amount in the form of annuities decreases individual welfare with respect to paying it out in the lump-sum form.

From an overall analysis of all the above findings, it is therefore apparent that the "efficiency effect" (higher expected return relative to riskiness) of pension funds outweighs even

the preference towards more liquid retirement assets, since the investment in annuity-based pension funds is generally preferred to the investment in the lump-sum-based severance pay saving fund (CV_{SP_PF} is negative).

While the severance pay scheme is beneficial to individuals by providing the whole accrued amount immediately at retirement, this effect is thus dominated by pension funds providing a preferred risk-return combination. Such outcome clearly emerges also by analyzing a hypothetical scenario where individuals are allowed to invest in a *mix* of the two schemes. Under this scenario, individuals in the model can choose the optimal share α^* to be invested in the severance pay scheme out of the overall mandatory contribution rate (h'), and thus the corresponding portion $1 - \alpha^*$ of h' to be invested in pension funds. Under this assumption α^* turns out to equal 0.07, implying that the optimal investment mix consists of 7% in the severance pay scheme and 93% in pension funds. A combination of the two schemes, thus of their respective advantages (earlier liquidity and higher financial reward), may therefore increase individual welfare with respect to the (statutory) setting requiring workers to invest in only one of the two assets (at a time). In particular, consistently with the previous findings, the optimal combination shows a clear prevalence (93%) of financially rewarding pension funds, although a minor fraction (7%) would still be kept within the more liquid severance pay scheme, so as to receive a (small) part of the capitalized amount immediately at retirement.[30]

3.3 Optimal Payout Mix in Pension Funds

As suggested by Compensating Variations reported in Table 3, individuals prefer earlier lump-sum payment over the annuitization of benefits. In order to evaluate more in depth the preference of individuals towards alternative payout forms, while abstracting from dif-

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[30]Under the optimal-mix scenario individuals choose to retire at 38, namely at the same age as under pure pension funds, in accordance with the prevalence of this scheme within the optimal mix.

ferences in risk-return combinations, further analysis aims at investigating the optimal mix of lump-sum and annuity payments from pension funds.[31] To this end, the accumulated pension fund capital is assumed to be possibly paid partly (by a share δ) as annuities from retirement onwards and partly (by a share $1 - \delta$) immediately in lump-sum fashion at retirement. Under this scenario, it turns out that the optimal share of annuitization (δ^*) amounts to 15%, and the corresponding optimal lump-sum share ($1 - \delta^*$) equals 85%.[32] This implies that individuals would like to annuitize a minor (though positive) portion of the accumulated pension capital at retirement, consistently with the previously highlighted preference towards earlier liquidity. Such predominant underlying demand for liquid retirement assets is consistent with what is often reported in the literature, regarding the actual preference of most workers for lump-sum payout over annuities.[33]

The clear (85%) tendency towards lump-sum payments may be striking at first. Annuitization provides indeed retirees with insurance against two qualitatively opposite risks (Brown and Warshawsky, 2004): the risk of outliving one's savings (the so-called longevity risk), and the risk of dying with assets that have not been consumed while alive (due to self-insuring by setting aside more than enough wealth). Moreover, annuities yield a mortality premium (due to the individual possibly dying before receiving future payments) besides the risk-free rate. The preference towards lump-sum cash-out may be due to several reasons, some of which are based on rational economic grounds, some others relate to individuals' financial illiteracy or behavioral biases (Brown, 2009). In life-cycle models of rational agents, as the one adopted in this paper, only the first type of reasons is to be

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[31] The relevance of this analysis also relates to the fact that in many cases workers participating in (especially DC) pension funds are offered the opportunity of receiving a share of their accrued pension claims immediately upon retirement. Notably, the Italian law provides workers with the opportunity of receiving up to 50% of benefits from pension funds in a lump-sum fashion.

[32] The optimal retirement age in this case equals 37, namely the same age as under purely lump-sum pension funds (see Table 4).

[33] The finding would be qualitatively confirmed in case the discount rate $\bar{r}$ used for private pensions were assumed to equal the (almost) safe r_{SP} return (0.55%) instead of zero. Under this assumption the optimal share of annuitization (δ^*) would amount to 18%, *ceteris paribus*.

taken into account. In particular, the previously reported low level (15%) of the optimal share of annuitization is due to the following factors:

- the pre-existence of annuitized wealth provided by the public PAYG social security pillar;

- the subjective discounting of future streams of annuitized income, as well as the potential attractiveness of alternative risky investments after retirement;

- the payout schedule of the annuity investment, yielding a fixed stream of income from retirement onwards.

3.3.1 Pre-existence of annuitized wealth

Generally, as sources of annuitized wealth already exist in the individual's portfolio, the value of incremental annuity payments decreases (Brown and Warshawsky, 2004), so that individuals may be willing to forgo (totally or partly) additional annuities in exchange for (substantial) immediate payments. This argument can be shown by artificially changing the size of the public pension system in the model, so as to completely eliminate (as an extreme case) the first pillar. By exogenously setting the public-system contribution rate h to zero, the optimal annuitization share δ^* of the pension funds' capital becomes 50% instead of 15%.[34] This implies that private annuities do increase individual welfare through their insurance properties, nevertheless their importance relatively decreases and is generally overshadowed by preference towards earlier liquidity as long as individuals already benefit from sizable annuitized wealth (namely, the public pension system with contribution rate $h = 0.33$). The partial "crowding-out" effect caused by pre-existing public pensions (in principle, actuarially fair annuities under a NDC system) over pri-

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[34]The optimal retirement age in this case equals 46. Individuals in the absence of the main source of retirement benefits (namely the public pillar) tend to retire later than under the alternative scenarios.

vate annuities therefore acts as a key determinant of the limited recourse to the latter, accounting for 35% non-annuitized wealth within pension funds.[35]

3.3.2 Subjective intertemporal discounting

Subjective intertemporal discounting (implicit within the time discount factor β in the model) may also play a relevant role in evaluating a future stream of annuities with respect to lump-sum payment received immediately upon leaving the job (Warner and Pleeter, 2001). The more patient individuals are, the higher the value they indeed attach to future streams of income. For instance if the subjective time discount factor β (calibrated as 0.96) were assumedly set to 1, the optimal annuitization share within pension funds δ^* would increase to 31%. Intuitively, assuming a unitary value for β implies supposing no subjective preference for present over future consumption, so that individuals attach a higher value (than in the baseline case) to any additional stream of annuities from retirement onwards, *ceteris paribus*.

3.3.3 Convenience of alternative financial investment

Analogously, the risk-free discount rate ($\bar{r}$, set at zero in the model, and usually relatively low in fact) used to compute the annuity rate for private pensions (tc') may also contribute to explaining the preference for lump-sum payout, particularly if the discount rate considered by individuals is higher than $\bar{r}$. Individuals may indeed be better off by receiving (most of) the pension-funds capitalized amount in lump-sum fashion immediately upon retirement, and by subsequently investing it in financial markets gaining a higher expected

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[35]A related issue is the optimal size of either of the two alternative schemes supplementing the public pension system. Assuming that individuals are allowed to voluntarily choose how much to contribute to the private second pillar, under either SP or PF, it turns out that the optimal size (i.e. the contribution rate) of both the severance pay scheme (h'^*_{SP}) and pension funds (h'^*_{PF}) is zero (with individuals choosing to retire at a later age, that is 42, than in the presence of a complementary private fund). Also this individual preference for no supplementary scheme whatsoever is apparently due to the considerable size of the mandatory public pillar, which "crowds out" additional private saving for retirement of any type.

rate than the risk-free yield. Under the hypothesis of 100% lump-sum payout from pension funds, model-predicted individual behavior would optimally invest a sizeable portion of the accumulated pension assets in financial markets upon retirement (gradually dissaving thereafter), thereby gaining risky returns at rate r_t *on average* equal to 5.4%. More than 50% of the lump-sum payment would indeed be invested immediately upon retirement, constituting an amount substantially greater than the corresponding per-period annuity. Therefore, annuitization would generally impose a constraint on individual saving behavior after retirement. This point can be clearly illustrated by hypothetically assuming that the discount rate for computing annuities equals the average financial market return (namely $\bar{r} = 0.054$): in this case the optimal annuitization share δ^* considerably increases to 68%.[36] Such finding suggests that the relative financial convenience of annuities with respect to alternative risky investments (made out of the lump-sum payout) upon retirement plays an important role in driving the individual demand for annuities.

3.3.4 Payout schedule of annuities

A related reason why demand for additional (private) annuities can be relatively low is due to the annuity investment usually paying out a constant stream of income (as it is the case under most pension schemes). Therefore individuals after retirement are potentially liquidity constrained, while also facing future financial uncertainty (Brown and Warshawsky, 2004). Specifically, retirees in the model face a further constraint imposed by annuitization on individual behavior. Under 100% lump-sum payout from pension funds, individuals would indeed optimally choose to follow a decreasing (instead of constant) consumption path from retirement onwards. Notably they would consume more than the corresponding per-period annuity in the initial part of their retirement period (benefitting

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[36]Only in case the capital accumulated in pension funds at retirement were allowed to be re-invested in financial markets, a higher discount rate reflecting financial market returns would be used for computing annuities. The assumption of $\bar{r} = 0.054$ is therefore artificially introduced uniquely to isolate this specific effect on individuals' demand for annuitization.

from the substantial withdrawal upon retirement), and less than the corresponding per-period annuity in the final part. Consequently annuities, through providing a fixed stream of income uniformly spread over the post-retirement period, negatively affect individual welfare thereby partially offsetting the positive longevity-risk insurance impact.

Overall, annuities therefore turn out to place welfare-decreasing constraints on both saving and consumption behavior of individuals after retirement. Public and private pension schemes jointly impose a (relatively high) taxation on labor income during working life. This causes individuals in the model to save very little (almost nothing) while working. Consumption during working life is also substantially affected by mandatory pension contributions, so that it basically coincides with net-of-tax labor income (savings being nearly zero). After retirement (as distortions from mandatory contribution are absent), saving and consumption paths may be optimally determined by individuals receiving lump-sum payout. Under the hypothesis of 100% lump-sum payment from pension funds, individuals in the model would optimally start to save significantly at retirement (as taxation no longer affects individual behavior), notably by investing a sizeable portion of the lump-sum payout in financially rewarding markets, while their consumption would follow a decreasing path. In case the accumulated pension-funds capital were instead assumed to be wholly paid in the form of annuities, individuals would fully consume the per-period private annuity (along with the public pension) while saving nothing in each period from retirement onwards, thereby adhering to a constant old-age profile for savings (equalling zero) and consumption (coinciding with public plus private pension benefits).

4 Conclusions

The paper investigates the individual choice of investing in pension funds, particularly by focusing on individual preferences towards the annuitization of pension capital. The

analysis exploits the 2004 pension reform in Italy, whereby workers can choose to divert contributions from the firm-based severance pay scheme to the investment in pension funds (namely, in typical private fully funded DC pension schemes). In comparing the relative convenience of the former scheme with respect to the latter, after allowing for their different risk-return properties (respectively nearly risk-free with low return and riskier with an expected higher return), the main issue that is considered regards their different forms of payout at retirement (respectively lump-sum and annuities). The analysis is performed by using simulations from a life-cycle model of a representative agent belonging to a representative generation in steady state, within a partial equilibrium setting with mortality risk and uncertainty on factor returns. The model is calibrated so as to reproduce stylized facts of the Italian economy.

Investing in the fully funded pension-funds scheme turns out to be slightly welfare-improving with respect to the firm-based saving fund. This welfare gain even increases in case pension funds are assumed to pay out benefits after retirement in a lump-sum fashion (instead of annuities), all the rest being equal. These findings suggest that the long-term ("steady-state") risk-return combination of pension funds is potentially largely preferable to that offered by the severance pay scheme, and as such it is the crucial driver of the general welfare gain from the former with respect to the latter. Furthermore, in driving (ex-ante) utility variations the longevity-risk insurance effect from annuities is outweighed in magnitude by preference towards earlier liquidity, which adds to the "annuity puzzle" debate. In order to investigate more in depth individual preferences between lump-sum and annuitized payment, the analysis focuses on the optimal combination of the two alternative payout forms within pension funds (thus abstracting from differences in risk-return properties with respect to the severance pay scheme). Under this scenario, individuals turn out to prefer obtaining most of the pension funds' capital in lump-sum fashion at retirement. Crucial determinants of this outcome are *a)* the pre-existence of sizeable an-

nuitized wealth from the public social security system, that is shown to "crowd out" a significant portion of the potential demand for additional private annuities; *b)* constraints imposed by annuitization on optimal saving and consumption behavior of individuals from retirement onwards.

Future research will delve into the above findings, firstly by investigating the risk-return conditions under which the investment in pension funds is no longer preferred to the severance pay scheme, as a way to check the robustness of the first general outcome from welfare comparisons in this paper. Secondly, future research will consider the hypothesis of allowing for re-investment of pension-funds capital after retirement, thereby potentially yielding variable annuities linked to financial market yields.[37] This analysis will thus evaluate further the relative convenience of annuitization with respect to lump-sum payout within pension funds.

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[37]This option is offered e.g. by the "premium pension" (personal pension accounts) in Sweden (OECD, 2011).

5 Appendix

5.1 Data and Methodology

Stochastic processes for real market returns and wages have been estimated by considering available historical series for Italy over the period 1990-2004. The reason why a relatively short time span is considered is that for period 1990-2004 almost all needed data are available. In order to obtain better estimates from an econometric point of view, data have been taken at a quarterly frequency.

As for data sources, data on wages have been found in the OECD (2008) data set, with "Compensation per employee in total economy" being the OECD entry that has been utilized, since it is a measure of gross wages in the overall economy (comprising both public and private sector). Average market returns are computed as the weighted average of historical returns on three major financial assets held by Italian households: government bonds, corporate bonds issued by Italian banks, and listed shares issued by Italian companies.

Returns on government bonds have been computed as the non-weighted average yield on two main types of Italian government bonds, namely short-term bonds (BOT - Italian T-bills) and medium-to-long-term bonds (BTP - Italian T-bonds). As for returns on BOTs the source is the "Ministero dell'Economia" web site, providing BOT returns at issue. As regards BTPs return, the Bank of Italy "Rendistato" yield is utilized, since it reflects the average market performance of BTPs traded on the Electronic Bond and Government Securities Market (MOT) of the Italian Stock Exchange.

Returns on corporate bonds issued by banks constitute the great majority of all Italian corporate bonds. Their return is reported by the Bank of Italy "Rendiob" yield, reflecting the average market performance of corporate bonds issued by banks and traded on the Electronic Bond and Government Securities Market (MOT) of the Italian Stock Exchange.

The "Rendiob" index is available only from the end of the 1980s to 2004.

As for stocks, average returns on listed shares have been computed using the COMIT Performance - Total Return index, which includes total returns (both prices and dividends) of all shares listed on the Stock Electronic Market (MTA) of the Italian Stock Exchange.

All of the three above mentioned types of returns have then been weighted considering the yearly portfolio composition of Italian households reported by the Bank of Italy (2007), referring to the period 1995 through 2006. Weights are computed as percentages of "Italian government bonds", "Italian corporate bonds issued by banks" and "listed shares issued by residents" in a simplified portfolio held by Italian households, namely a portfolio made up of only those three categories of securities. In the absence of data on portfolio composition relative to the 1990-1994 period, weights for returns in those years have been assumed to be the same as those in year 1995. Moreover, when considering observations at a quarterly frequency, the yearly weights are assumed to be the same throughout all quarters of every year.

All collected wages and financial market returns have been finally expressed in real terms by correcting them for historical inflation growth rates, reported in OECD (2008), so as to obtain the values based on which estimates for w_t and r_t in the model have been carried out.

From the preliminary econometric analysis of data on wages and market returns, it turns out that a statistically significant specification of processes underlying data is as follows:

$w_t = 35.253 + 0.645w_{t-1} + ew_t$

$r_t = 0.054 + er_t$

The stationary normal distributions of wages and returns processes are as follows:

$w \sim N(99.332, 4.172)$

$r \sim N(0.054, 0.004)$

Data used to compute the aggregate growth rate (g) of real wages in Italy in different historical periods have been found in OECD (2008) data source. The average yearly "seniority" wage growth rate sw has been computed as the difference between two terms: the approximate yearly average growth rate of real wages earned by a specific cohort from 1976 to 2004 (Italian workers entering the labor market in 1976 when 21/22 years old); minus the average yearly aggregate growth rate of wages in Italy throughout the period 1976-2004. Computing this difference is aimed at obtaining a cohort-specific measure of "seniority" wage growth. This measure is then assumed to stay constant through time, and through generations, in the model. Data on aggregate wages have been collected from OECD (2008) data base; data on the wage dynamics of the cohort that entered the labor market in 1976 have been deduced from evidence reported by Rosolia and Torrini (2007).

Information about the institutional features of the Italian public pension system, as well as information about the TFR (severance pay) scheme, have been found at INPS (National Institute of social security) web site.

All demographic data and projections are provided by the yearly demographic balance of Istat (National Institute of Statistics) web site.

5.2   Optimization Problem and Simulation Procedure

The model solution is based on optimization following finite-horizon stochastic dynamic programming. Since an analytical solution to the optimization problem can not be obtained, simulations have been run in order to solve the problem numerically. These simulations have been performed by utilizing the numerical simulation software program Matlab.

In order to take into account the fact that wages (w) and market returns (r) are stochastic variables, a randomization has been performed by letting the software program randomly draw 1000 values for w_t and r_t in every period t. Consequently, 1000 optimal assets (thus consumption) and leisure paths have been obtained, as well as 1000 pension

benefit levels.

Wages and market returns in the model have been discretized into three grid values (corresponding to "low", "mean" and "high" state) each, in order to numerically solve the optimization problem. Specifically, stochastic processes for wages and financial market returns (autoregressive and serially uncorrelated, respectively) have been approximated by Markov chains through the Tauchen procedure (Tauchen, 1986) so as to be discretized.[38] This procedure yields stationary transition matrices (representing the conditional probabilities of passing from one state of the world in a given period t to another state of the world in the subsequent period $t + 1$) for both wages and market returns. The (slight) correlation between the stochastic component of wages and market returns is considered in the procedure, by computing transition probabilities for financial returns that are conditional on the three discrete stochastic realizations of wages. Consequently, there are overall $a)$ one transition matrix for wages (denoted by PW) and $b)$ nine transition matrices for market returns (denoted by $PRij$) conditional on realizations of the $i - th$ grid value for w at time $t - 1$ and the $j - th$ grid value for w at time t. These matrices are reported as follows.

$$PW = \begin{bmatrix} 0.6479 & 0.3507 & 0.0014 \\ 0.0953 & 0.8094 & 0.0953 \\ 0.0014 & 0.3507 & 0.6480 \end{bmatrix}$$

$$PR11 = \begin{bmatrix} 0.2438 & 0.6604 & 0.0958 \\ 0.2438 & 0.6604 & 0.0958 \\ 0.2438 & 0.6604 & 0.0958 \end{bmatrix}$$

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[38]Markov-chain approximation has been applied also to financial returns, although they do not follow a Markov chain since they turn out to be serially uncorrelated from estimations.

$$PR12 = \begin{bmatrix} 0.0598 & 0.6116 & 0.3286 \\ 0.0598 & 0.6116 & 0.3286 \\ 0.0598 & 0.6116 & 0.3286 \end{bmatrix}$$

$$PR13 = \begin{bmatrix} 0.0078 & 0.3300 & 0.6622 \\ 0.0078 & 0.3300 & 0.6622 \\ 0.0078 & 0.3300 & 0.6622 \end{bmatrix}$$

$$PR21 = \begin{bmatrix} 0.4452 & 0.5235 & 0.0313 \\ 0.4452 & 0.5235 & 0.0313 \\ 0.4452 & 0.5235 & 0.0313 \end{bmatrix}$$

$$PR22 = \begin{bmatrix} 0.1587 & 0.6827 & 0.1587 \\ 0.1587 & 0.6827 & 0.1587 \\ 0.1587 & 0.6827 & 0.1587 \end{bmatrix}$$

$$PR23 = \begin{bmatrix} 0.0313 & 0.5235 & 0.4452 \\ 0.0313 & 0.5235 & 0.4452 \\ 0.0313 & 0.5235 & 0.4452 \end{bmatrix}$$

$$PR31 = \begin{bmatrix} 0.6622 & 0.3300 & 0.0078 \\ 0.6622 & 0.3300 & 0.0078 \\ 0.6622 & 0.3300 & 0.0078 \end{bmatrix}$$

$$PR32 = \begin{bmatrix} 0.3286 & 0.6116 & 0.0598 \\ 0.3286 & 0.6116 & 0.0598 \\ 0.3286 & 0.6116 & 0.0598 \end{bmatrix}$$

$$PR33 = \begin{bmatrix} 0.0958 & 0.6604 & 0.2438 \\ 0.0958 & 0.6604 & 0.2438 \\ 0.0958 & 0.6604 & 0.2438 \end{bmatrix}$$

Both public and private pension benefits have been discretized into 12 possible states. The choice of using 12 instead of just 3 discrete states for pensions meets the aim of capturing the considerable variability of (particularly) private pensions, that incorporate both wage risks and market return risks.

In numerically solving the optimization problem the choice variables for the individual in every period t are represented by leisure (l_t) and asset holdings at the beginning of the next period (A_{t+1}). The latter variable has been discretized into an exponential grid of points representing different values for asset holdings of individuals. The number of grid points is 10, with the minimum grid value for assets being 0 (individuals cannot borrow in the model economy), and the maximum grid value being 500.

In most simulations within-period time endowment ($\bar{T}$) has been normalized to 2. This normalization of the per-period time endowment to two units turns out to be useful in calibrating the model for computational reasons. Within-period leisure in the model, l_t, has been discretized so as to take on 5 possible grid values, triple-exponentially spaced from zero to (mostly) 2. In the baseline calibrated model individuals choose to work approximately 1 unit of time (enjoying 1 time unit of leisure) during working life, whereas they enjoy the whole time endowment from retirement onwards.

Since all variables are discretized in order to solve the optimization problem, the corresponding simulated paths for consumption, assets and leisure are obtained by interpolating (through the *spline* method) across the discrete values resulting from the simulation-based optimization.

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