Asset Returns, Uncertainty and the Adequacy of Future Pension Benefits

Very preliminary version

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Abstract

Supplementary funded pensions benefits will have an increasingly important role in Italy in order to guarantee an adequate income level for current and future workers when they will retire. At the same time economic and financial literature has emphasized that returns' riskiness is the element that more characterizes funded pension systems. In fact, in a funded Defined Contribution systems the annuity depends directly on the amount of contributions paid over the life-cycle, pension fund's realized returns and life expectancy at the start of retirement period. Hence, negative stock market performances affect immediately pension annuities, which depend not only on different contribution levels but also on the timing of the payment of benefits (before or after a financial crisis) and the ability of pension funds' managers to obtain good performances. In this paper we analyze the time series characteristics of financial returns of several OCSE countries (G7 plus Sweden) in the last 30 years. By adopting a recent econometric methodology widely used in the risk management industry (Barone-Adesi, Giannopoulos and Vosper, 1999) and also in a context of financial risk and pensions (d'Addio, Seisdedos and Whitehouse, 2009), we attempt to provide plausible forecasts of future financial returns and volatility. Then, with a simple representative agent based simulation model, we verify what are the implications of our forecasting analysis and the related return variability on the adequacy of future benefits in a funded pension system.

1. Introduction

Starting from 90s Italy has been one of the countries in which pension reforms have been more intense. The reforms of the last 15 years have greatly changed the level of contribution to the public pension system, the expectations about future pension benefits and retirement age. At the same time, the Italian legislator has defined the legal setting needed to develop a private supplementary pension pillar, based on funded mechanisms, in order to guarantee adequate pension benefits also to future generations. In particular, with the 2004 and 2007 reforms, the investment-based funded pension pillar seems to have started developing among workers, after many years of stagnation.

In a context where supplementary pensions will have an increasingly important role, the riskiness of financial investments and his measurement become crucial elements. The recent economic and financial crisis and his impact on private pension funds (Antolin and Stewart, 2009) is an illustrative example of the importance of this issue, which assumes more importance with the size of the share of risky financial assets contained in individuals’ retirement portfolios. Several questions arise. What about the effects of stock markets fluctuations on the adequacy of future (private) pension benefits? What about the effects on income distribution? Is there a role for public sector?

Such issues are of great interest, in particular because they concern the well-being of the elderly, a fraction of the population that is in the final stage of his life-cycle and therefore has reduced possibility to work and a few time to recover possible setbacks in his financial retirement investments. Since many years economic and financial literature has emphasized that returns’ riskiness is the element that more characterizes funded pension systems (Stiglitz and Orszag, 1998; Barr, 2000; Diamond, 2002). In fact, the volatility of financial returns (equity returns in particular) may have relevant consequences on pensions’ temporal dynamics and on contributions for funding them, independently of the mechanisms on which pension system is based (defined-contribution (DC) or defined-benefit (DB) based mechanism). It is well known (Musgrave, 1981) that the choice between the two computation methods mentioned above only implies a different sharing of the risk between active and retirement generations and pension fund, but it does not rule out the presence of the risk associated with financial returns’ volatility. In the case of Italian pension funds, the choice of DC based systems introduces future perspectives where asset returns’ riskiness bears totally upon pensioners.

In fact, in DC systems the annuity depends directly on the amount of contributions paid over the life-cycle, pension fund's realized returns and life expectancy at the start of retirement period. Hence, negative stock market performances affect immediately pension annuities, which depend not only on different contribution levels but also on the timing of the payment of benefits (before or after a financial crisis) and the ability of pension funds' managers to obtain good performances. Different proposals have been made in order to solve this problem. Among them, we recall that of Modigliani, recently recovered and refined by Grande and Visco (2009). This proposal prefigures the creation of public forms of minimum return guarantees, which can be seen as instruments for contrasting poverty among elderly or, in alternative, as forms of intergenerational financial risk sharing. However, in the present work we do not investigate the technicalities needed for realizing such objectives.

Rather we analyze the time series characteristics of financial returns of several OCSE countries (G7 plus Sweden) in the last 30 years. By adopting a recent econometric methodology widely used in the risk management industry (Barone-Adesi, Giannopoulos and Vosper, 1999) and also in a context of financial risk and pensions (d'Addio, Seisdedos and Whitehouse, 2009), we attempt to provide plausible forecasts of future financial returns and volatility. Then, with a simple representative agent based simulation model, we verify what are the implications of our forecasting analysis and the related return variability on the adequacy of future benefits in a funded pension system.

Our basic simulation results point out in particular the following aspects. In the case of the balanced retirement portfolio (50% stocks-50% bonds), we find that 80% of the time the simulated future real return should be between 3.7% and 8% a year; in the case of the risky retirement portfolio (75% stocks-25% bonds), we find that in 10% of cases, an annual return lower than 3.3% would be expected, while in 10% of cases this should exceed 9.4%; in the conservative scenario (25%-75%), it results that 80% of the time the simulated future real return should be between 3.8% and 6.8% a year. Such results, if compared for example with those of d'Addio et al. (2009), point out a higher level of investment riskiness. This discrepancy is likely to arise because of the different time horizon chosen: in our case, the inclusion of the period 2006-2009 (which includes the recent financial crisis) implies a significant reduction of the average level of future asset returns.

Taking also into account the parameters of the Italian pension fund legislation and estimating a measure of administrative costs (which reduces real returns on investments) the picture for future pensioners becomes less optimistic. In particular a non negligible share of investments (and therefore pensions) will not be able to allow future pensioners to reach a situation where adequacy is obtained.

The next step of this piece of work will be to introduce results and estimation on variability of investment returns on the CAPP_DYN model in order to verify if the qualitative results obtained will also be replaced in a more realistic heterogeneous model.

2. Previous Literature

Many authors have proposed different contributions in order to investigate the uncertainty involved in stock market returns and the related measurement issues. Dimson, Marsh and Staunton (2002), Siegel (2003) and Shiller (2005) propose several contributions where they collect a large amount of long-run statistical data aimed at providing an exhaustive picture of the dynamics of past returns. In particular Shiller's work emphasizes the importance of the "irrational exuberance" in explaining investors' behaviour on stock markets.

However, such analyses share the goal of highlighting some empirical regularities of past financial returns by largely using a descriptive approach. In sum, these works indicate that, in the long-run (80-100 years or more), real asset returns (equity returns in particular) are higher than returns of an unfunded public pension system. Results regarding the return variability are more controversial.

For example, Dimson et al. (2002) study financial returns since 1900 and find a real annual average equity return of 5.2% for the UK and 6.3% for the USA. For bonds, they find a return of 1.3% for the UK and 1.9% for the USA. Siegel (2003), on summing up the basic results of his research, argues that for long time periods, equity returns are higher than all other financial assets (on average he finds an annual real return of 7% over all sub-periods in the period 1802-2001) and also that they are higher and less volatile than bond yields. Therefore, equities are the best investment for investors who like the "safe" growth of their investments into the long-run. Siegel concludes arguing that even if equity returns may face periods of high variability, they however remain the best investment for those who desire a constant return in the long-run (it is natural thinking of retirement saving).

The literature also contains works that try to evaluate the uncertainty of future returns dynamics by using an approach based on simulations and representative agents. Among these works there are, for example, Burtless (2003, 2007) and d'Addio, Seisdedos and Whitehouse (2009).

Burtless uses historical and simulated data on the stock market performances of 5 countries (USA, UK, Japan, Germany and France) for evaluating market risks faced by workers who adhere to a funded pension system, accumulating their savings in private retirement accounts (pension funds). Burtless goes on to consider the pensions paid to workers on the basis of stock market performances in the period 1927-2002. Burtless' empirical analyses show that the financial risks of funded pension systems are quite large in all the countries considered and they may have sizeable long-run distribution implications: the gap between the accumulation of the luckiest and the unluckiest saver is not as large in Europe or the United States but in all five countries the gap is big enough for it to produce dramatic differences in workers' initial replacement rates.

D'Addio et al. (2009) propose an empirical investigation for evaluating the impact of the uncertainty of financial returns on future pensions. By adopting an econometric approach, they model the dynamics of monthly bond and equity return time series data for the period 1980-2006, for several OCSE countries (G7 plus Sweden). Then they use the relative parameter estimates for forecasting future returns (45 years ahead) and obtaining a simulated distribution of returns for different retirement investment profiles. They find that the median real return on a portfolio equally weighted between equities and bonds (averaging across the countries studied) is 7.3% a year. The degree of uncertainty, even with the relatively long investment horizons of pensions, is found to be quite large. In 10% of cases, an annual return of less than 5.5% would be expected, while in 10% of cases, this should exceed 9.0%. As stressed by d'Addio et al. (2009), "*compounded over the time horizon for pension savings of 40 years or more, such differences in rates of return amount to enormous sums of money*". But taking into account administrative and management costs of pension funds (which lower asset returns), they obtain even more restrictive results: for 80% of the time, the balanced investment return on pension savings should be between 3.2% and 6.7% a year.

Other interesting works in line with those discussed above, but that exploit a microsimulation approach, are for example Feldstein and Ranguelova (2001) and Miles (2000). In particular, the work of Feldstein and Ranguelova examines the risk aspects of an investment-based DC social security plan for US investors. In their model individuals deposit a fraction of wages to a pension fund, invest these funds in a 60:40 equity-debt portfolio and in a similarly invested annuity at age 67. The value of the assets follows a random walk with mean and variance of a 60:40 equity-debt mix over the period 1946-1995, a mean log return of 5.5% (net of administrative costs of 0.4%) and a standard deviation of 12.5%. Then, the authors study the stochastic distribution of this process by doing 10,000 simulations of the 80-year experience of the cohort that reached age 21 in 1998 (therefore from 1998 to 2077). On these grounds, Feldstein and Ranguelova obtain the following outcomes. For example, an individual who saves 6% of his earnings during his working years from 21 to 66 (with a 5.5% mean log return) has a 50% chance of receiving an annuity at age 67 that is at least 2.1 times the benchmark level of Social Security benefits (and about 70% of pre-retirement pre-tax wages) and only a 17% chance that that annuity is less than the benchmark Social Security benefit. Hence, for the US case, a pure DC plan with a 6% saving rate invested in a 60:40 equity-debt pension fund can cut the individual's cost of providing a retirement annuity to one-third of the projected 18% PAYG tax, while leaving the retiree exposed to relatively little risk that the resulting annuity will be less than the benchmark level of Social Security benefits projected in current law.

With reference to the literature discussed above, the methodology illustrated in what follows and implemented in our work, is in line with d'Addio et al. (2009): the subsequent aim will be to move to a microsimulation approach in order to relate forecasted simulated returns to the adequacy of future pension benefits.

3. Data and the Construction of Retirement Investment Portfolios

We use data from the DATASTREAM database and focus on monthly asset returns of equities and government bonds concerning G7 countries (the USA, UK, Japan, Germany, France, Italy and Canada) plus Sweden for the time period 1985-2009. The sample period is constrained by the availability of data, in particular those on government bonds. We consider equities and government bonds because they are representative of a retirement portfolio of a hypothetical private pension account (fund).

As to equities, we consider the Total Return Indexes (TRI), which include gross dividends and their re-investment over time. The TRI is calculated by DATASTREAM by following several criteria. Indices are calculated on a representative list of stocks for each market. The number of stocks for each market is determined by the size of the market (in terms of capitalization). The sample covers a minimum of 75-80% of total market capitalization. Suitability for inclusion is determined by market value and availability of data: the largest value stocks for each market are included. Stocks with more than one equity issue are valued on each issue. The selection process ignores such factors as liquidity, non-public holdings of shares and cross-holdings. Unless a new issue is regarded as of exceptional significance (for example a major government privatization), it will not be added until the following quarterly review. There are several excluded securities: fixed-interest stocks, temporary issues, warrants, unit trusts, mutual funds and investment funds.

Also in the case of government bonds we take into account the TRI, therefore including coupons and their re-investment over time. We consider government bonds with maturities that range from 1 to 30 years. We use the so-called benchmark indexes, based on single bonds. The bond chosen for each series is the most representative bond available for the given maturity band (3, 5, 10 years etc.) at each point in time. Benchmarks are selected according to the accepted conventions within each market. Usually, the benchmark bond is the latest issue within the given maturity band; consideration is also given to yield, liquidity, issue size and coupon.

We compute real returns for equities and bonds and then, for each country, build three different retirement investment portfolios: a risky portfolio (75% equities with 25% bonds), a balanced one (50-50) and a conservative one (25-75). The basic idea is to replicate the possible scenarios of a hypothetical pension fund. We calculate returns for every country and for an area denominated OCSE-8 (G7 plus Sweden). In what follows, we focus in particular on the three portfolios of the OCSE-8 area by assigning an equal weighting to all countries in calculating the average portfolio returns.

Table 1 shows some statistical evidence about such returns in the various scenarios. We report the annualized average arithmetic return and the relative annualized volatility (in percentage terms). We have, in general, relatively high values. This fact depends primarily on the type of data considered (TRI), which takes into account the re-investment of dividends and coupons; moreover, returns are gross of tax and administrative costs.

By observing Table 1 we see that returns are declining as we move from the risky to the conservative portfolio; in general this behaviour holds also for the volatility measures. Italy is an uncharacteristic case as, during the period 1989-2009, the bond return is surprisingly greater than the equity return (6.4% versus 5.3%). This behaviour might depend on both the large bond risk-premium of that period (due to low inflation) and the poor performance of the Italian stock market in the same period.

Table 1
Returns and standard deviations for different investment profiles; average annual real values, 1985-2009

Country	**Stocks 100%**		**Risky P**		**Balanced P**		**Conserv. P**		**Bonds 100%**	
USA	6.8	20.1	5.7	16.0	4.6	12.7	3.5	10.8	2.4	11.1
UK	6.7	18.7	6.2	14.8	5.7	11.6	5.2	9.8	4.6	10.3
Japan	5.1	23.4	4.4	18.8	3.8	14.9	3.1	12.4	2.4	12.3
Germany	8.9	21.8	7.9	16.2	6.9	10.8	5.9	5.9	4.9	4.2
France	10.3	20.2	9.3	15.1	8.3	10.3	7.3	6.0	6.3	4.7
Canada	7.8	21.2	7.1	17.1	6.5	13.8	5.8	11.9	5.2	12.2
Sweden	13.1	24.9	11.0	19.1	8.9	13.7	6.9	9.2	4.9	7.7
Italy*	5.3	24.0	5.6	17.4	5.9	11.8	6.2	6.7	6.4	4.7
OCSE-8	8.4	17.3	7.3	13.2	6.4	9.4	5.4	6.2	4.6	5.4
OCSE-8 **19**85-2006	10.8	16.4	9.1	12.6	7.7	9.1	6.3	6.2	4.9	5.4

Our calculation on Datastream data (%). *1989-2009; the equity return in the period 1985-2009 is 8.8%.

Returns fall constantly but to a small degree over the different portfolios: this depends crucially on the fact that, in the period we consider, bond yields are only marginally lower than equity yields. For example, for Germany and France, we have a constant reduction of 1%, for the US a reduction of 1.1%, for the UK a fall of 0.5%, for Japan one 0.6/0.7% and the same for Canada. For Sweden the constant reduction is 2/2.1%.

We note that in Table 1 a comparison in terms of the equity premium is not correct because the bond return only partly takes account of the "true" risk-free rate (3 month T-bill) used for calculating the size of the equity risk premium. Otherwise, if we consider the so-called "*equity-bond premium puzzle*" (cfr. Campbell, 2003) we can see that only Sweden has a large differential (8.2%), i.e. one equal to the historical empirical equity premium and also to the long-term spread (between stocks and long-term government bonds) registered by Burtless (2007)[1] and Campbell (2003); the other countries indeed display much smaller spreads. Regarding this phenomenon, an important role is played by the time horizon we considered of only 25 years (the analysis of Burtless, 2007 is conducted over the long period 1927-2005).

[1] See Magi and Mazzaferro (2009).

The data seen above suggest several possible cautions about the investment strategies of pension funds. Opting for a riskier portfolio does not imply, on average, a much higher return with respect to the other two options;[2] but such a choice implies an increase (often more than a twofold increase) in the investment's volatility. We thus have a trade-off between return and volatility as is typical of any financial investments over a given time horizon.

4. *Econometric Model and Returns' Forecasting Methodology*

Given our aim to quantify the risk deriving from investors' future pension investments, we implement the so-called *Filtered Historical Simulation* method (Barone-Adesi et al., 1999), which has been widely adopted in risk-management practice for measuring the *Value at Risk* of an asset portfolio. Such a methodology is based on the parametric estimate of the data generating stochastic process in order to then calibrate the estimated parameters in the forecasting model.

We adopt a MA(1)-GARCH(1,1) time series specification:

$$r_t = c + \theta_1 u_{t-1} + u_t \qquad \text{MA(1)}$$
$$u_t = \sigma_t \epsilon_t \quad \text{with} \quad \varepsilon_t \sim iid(0,1)$$
$$\sigma_t^2 = \alpha_0 + \alpha_1 u_{t-1}^2 + \beta_1 \sigma_{t-1}^2 \qquad \text{GARCH(1,1)}$$

where the MA(1) equation models the monthly mean return while the GARCH(1,1) equation describes the dynamics of return volatility. The basic idea of this econometric specification is to use a simple parsimonious model able to match the most important features of our dataset: persistence and variability. The moving average (MA) component makes explicit the impact of current and past stochastic disturbances (u_t and u_{t-1}) in determining current financial returns. The GARCH component models the dynamics of the conditional variance of returns. A vast amount of literature (see for example Engle, 1982; Bollerslev, 1986; Bollerslev, Engle and Nelson, 1994) has shown that several characteristics of high-frequency financial returns are matched by GARCH modelling, where past volatility and past stochastic disturbances affect current conditional volatility.

The specification of the "mean equation" of the model (the MA(1) component) follows a typical "pure" statistical approach, relatively easy and with not a great deal of economic intuition. However, it can be used beneficially when the task is to obtain parameter estimates to be implemented in forecasting exercises (Hamilton, 1994). In fact, this methodology has the advantage

[2] However, it is important to highlight that also a small differential of 1-2 percentage points, when projected over long horizons, may be decisive in producing an adequate or insufficient pension saving.

to provide easy and robust forecasts, primarily based on the behaviour of past data and, concerning the "variance equation", in line with the modern econometric techniques widely used to forecast and manage stock market risk nowadays. Otherwise, it is a methodology based on a standard time series approach, and as such it shares all the limitations of such analyses (in particular data accuracy and possible structural breaks).

Once we have estimated the model (maximum likelihood estimates) for the OCSE-8 area and for the three different portfolios (risky, balanced and conservative), we obtain the outcomes reported in Table 2 (*z-statistics* in brackets). The results bring out the statistical significance of the constant terms and MA(1) coefficients. Regarding the GARCH part of the model, the constants are not significant while ARCH and GARCH coefficients are, in particular the last one.

In performing our forecasting exercises, as mentioned above, we use the so-called FHS methodology. This procedure exploits the standardized residuals of the previous MA(1)-GARCH(1,1) estimates together with the same parameter estimates to make a future projection of the model's estimated variability. Residuals can indeed be interpreted as estimate errors of the model, i.e. as a proxy of the measure of variability estimates, while the estimated parameters drive the past data generating process. If we combine these two elements (for technical details, see Barone-Adesi et al., 1999 and d'Addio et al., 2009) by using the MA(1)-GARCH(1,1) equations shifted several periods ahead, we obtain forecasts of future returns.

Table 2
Estimates of the MA(1)-GARCH(1,1) model

OCSE-8 (G7 + SWEDEN)				
Dependent variable: R		Risky P	Balanced P	Conserv. P
Constant	C	0.0067 (2.47)	0.0056 (2.88)	0.0046 (3.48)
MA(1)	θ_1	0.156 (2.56)	0.20 (3.23)	0.266 (4.35)
Constant	α_0	0.000187 (0.92)	0.000094 (0.64)	0.000037 (0.76)
ARCH Coeff.	α_1	0.045 (1.72)	0.033 (1.60)	0.0062 (1.23)
GARCH Coeff.	β_1	0.823 (4.82)	0.832 (3.52)	0.872 (4.87)

We assume an investment future horizon of 45 years and we simulate a very large number of forecasting paths (10,000); we then study the statistical features of the resulting return probability distribution. We obtain 10,000 future returns for every future month over 45 years. We can thus calculate their annual geometric mean and their volatility for each year. We can also calculate an annual geometric mean over all 45 years for every simulation and then, given the 10,000 simulations, we can calculate the relative probability distribution for every hypothetical retirement portfolio (risky, balanced, conservative).

5. *Simulated Future Returns: Basic Results*

In this section we present our simulation results. Table 3 reports the arithmetic mean of geometric simulated annual returns and their volatility over 45 years for each investment profile. The differences between the three scenarios are in line with historical sample data.

Table 4 reports, for any portfolio, the value of returns for several percentiles of the simulated distribution of returns. For example, the value in the upper-left cell indicates that the return of the conservative portfolio that is in the first percentile of the simulated distribution is equal to 2.6%. The outcomes of Table 4 are important because they account for the model's ability to simulate the returns variability for any investment profile.

Table 3
Forecast over 45 years of the Annual Geometric Return and Volatility for the 3 Portfolios, gross of tax and admin. charges .
OCSE-8 Area

Return and Std. Dev.	**Rr**	**DS_r**	**Rb**	**DS_b**	**Rc**	**DS_c**
Arith. Mean	7.5	15.9	6.5	11.4	5.6	7.9

Our calculation on Datastream data (10,000 simulations)

Rr: risky P return; Rb: balanced P return; Rc: conservative P return

DS_r: std. dev. of risky P; DS_b: std. dev. of balanced P; DS_c: std. dev. of conservative P

Table 4
Simulated distribution of annual returns (%)
(gross of tax and administrative costs) for the 3 portfolios - OCSE-8

Percentiles	**1**	**10**	**25**	**50**	**75**	**90**	**99**
Rc	2.6	3.8	4.5	5.3	6.0	6.8	8.1
Rb	2.0	3.7	4.7	5.9	7.0	8.0	10.0
Rr	1.0	3.3	4.8	6.4	8.0	9.4	12.0

Our calculation on Datastream data (10,000 simulations)

By using the OCSE-8 area data, the highest levels of future simulated returns and their volatility lie in the risky portfolio and they decline when we move towards the conservative one. If we consider the differences for every case between the 10° and 90° percentile (Table 4), we obtain a gap of 3.0 percentage points in the conservative case, 4.3 in the balanced one and 6.1 in the risky one (as expected, the level of the gap increases as the investment's riskiness rises).

This means that according to our simulations, for example in the case of the balanced portfolio, 80% of the time the simulated future real return should be between 3.7% and 8% a year; in other words, in the case of the risky portfolio for example, it results that in 10% of cases, an annual return lower than 3.3% would be expected, while in 10% of cases this should exceed 9.4%; in the conservative scenario, it results that 80% of the time the simulated future real return should be between 3.8% and 6.8% a year.

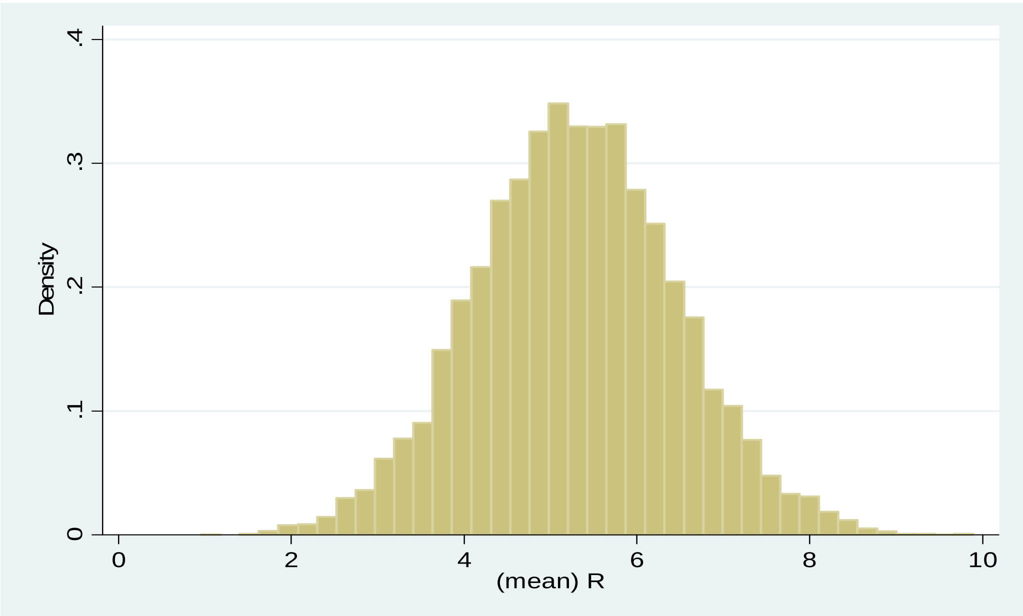
The results described above, if compared with those of d'Addio et al. (2009), point out a higher level of investment riskiness. In fact, for the three scenarios studied, d'Addio et al. (2009) find that for 80% of the time, future returns should be between 5.2% and 7.3% (conservative case), between 5.5% and 9% (balanced case), and between 5.4% and 10.8% (risky case). This discrepancy between the outcomes of the two works is likely to arise because of the different time horizon chosen: in our case, the inclusion of the period 2006-2009, i.e. the possibility to take into account the effects of the financial crisis, implies a significant reduction of the average level of future returns in any portfolio. Another important element is the return differentials among the three scenarios, with the risk premium that seems to be relatively low: at the 50th percentile, the risky return is 6.4%, while at the same percentile the conservative return is slightly lower (5.3%).

It is important to underline that, in our context, also small differences in future annual returns cause sizeable variations in the final amount of the financial retirement investment. For example, if we assume a spread equal to the difference observed above (6.4% and 5.3%) and an investment of

100 euro a year, after 45 years we have a difference in the accumulated financial wealth of 37% in favour of the risky portfolio. Obviously, larger spreads in returns will imply even bigger changes, with important effects on future pensions.

Figures 2, 3 and 4 show the distribution histograms of simulated returns for the three scenarios, while Figure 5 presents the relative kernel estimates.[3] These figures provide an accurate graphical description of returns' distributions and they can easily be interpreted in probabilistic terms. Figure 5 shows that the risky portfolio return has a larger volatility than the other two portfolio returns, with yields that range over a larger class of values. Kernel estimates also account for the possibility of obtaining negative future returns in the balanced- and risky cases.

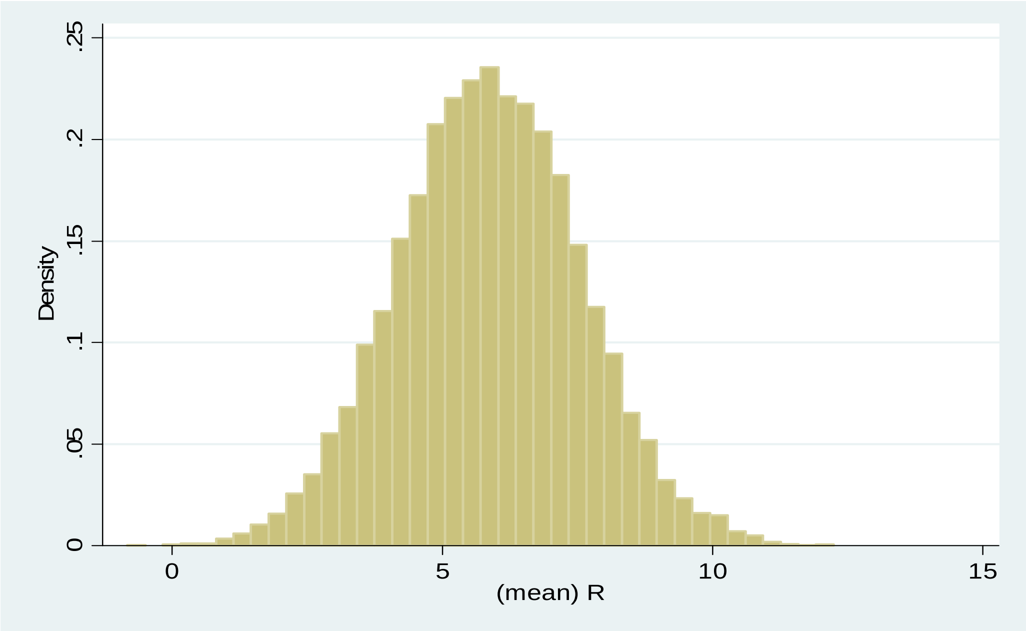
Figure 2
Probability distribution of simulated returns
Conservative Portfolio (25-75)



Our calculation on Datastream data (10,000 simulations)

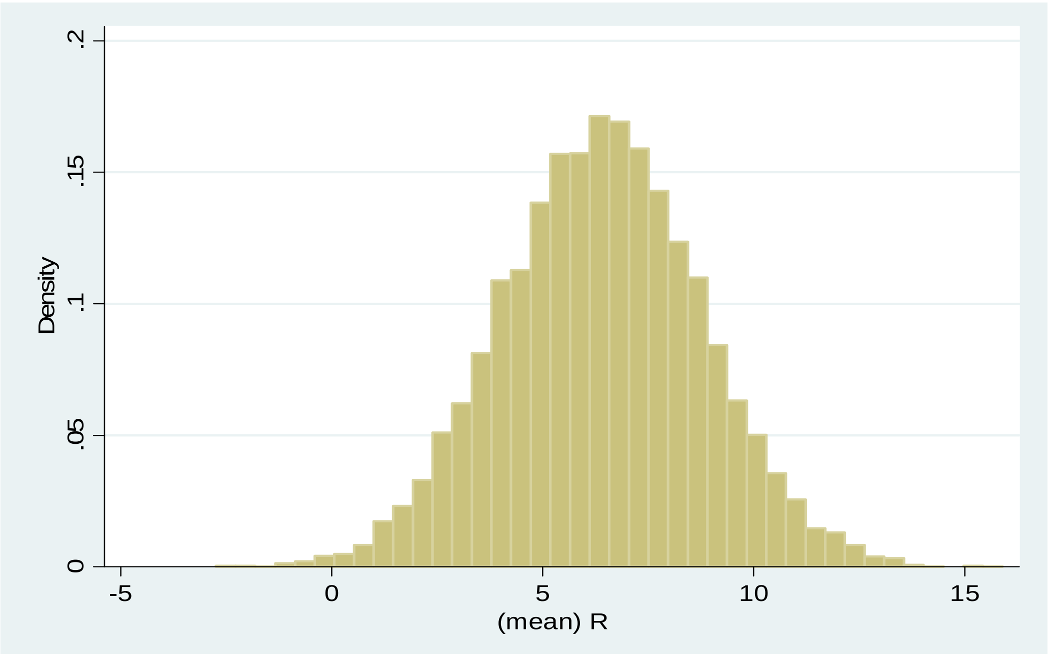
[3] Kernel estimate is a generalization of the histogram. The idea is estimating, in a non-parametric way, the probability density function of an empirical distribution by using weighting methods of observations with different degrees of statistical complexity.

Figure 3
Probability distribution of simulated returns
Balanced Portfolio (50-50)



Our calculation on Datastream data (10,000 simulations)

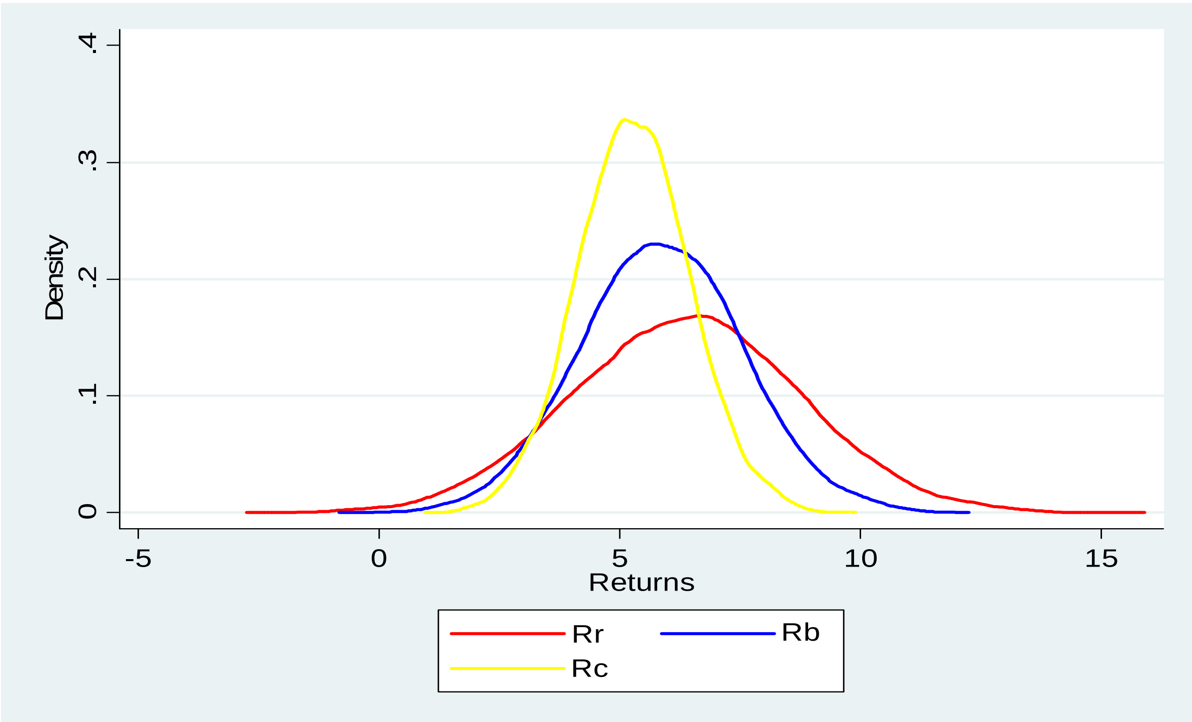
Figure 4
Probability distribution of simulated returns
Risky Portfolio (75-25)



Our calculation on Datastream data (10,000 simulations)

Tables 5, 6 and 7 show annual returns distributions for the eight countries considered, for the three portfolio investments. The biggest differences among the eight countries are in the risky case. This is a relevant aspect if we consider the experiences concerning the real investment policies of pension funds: they do not exploit diversification opportunities provided by international financial markets and concentrate their investments on domestic markets. The riskiness of financial investments seems to be lower for Sweden, France and Germany (in other words, in these countries returns are higher with a larger probability). On the contrary, investment riskiness appears to be very high for Japan and Italy.

Figure 5
Kernel Estimate of the probability distribution of simulated returns
Risky, Balanced and Conservative Portfolios – OCSE-8



Our calculation on Datastream data (10,000 simulations)

Table 5
Simulated distribution of annual returns (%)
(gross of tax and administrative costs) - Conservative Portfolio

Percentiles	**1**	**10**	**25**	**50**	**75**	**90**	**99**
USA	-1.2	0.5	1.4	2.5	3.6	4.6	6.4
UK	-0.2	1.6	2.7	3.8	5.0	6.0	7.9
Japan	-2.2	-0.3	0.8	2.1	3.4	4.5	6.7
Germany	3.6	4.5	5.1	5.7	6.3	6.9	7.9
France	4.2	5.3	6.0	6.8	7.5	8.2	9.4
Canada	0.9	2.6	3.7	4.9	6.2	7.4	9.3
Sweden	2.3	4.1	5.1	6.3	7.5	8.6	10.4
Italy	3.0	4.1	4.7	5.5	6.2	7.0	8.2
OCSE-8	**2.6**	**3.8**	**4.5**	**5.3**	**6.0**	**6.8**	**8.1**

Our calculation on Datastream data (10,000 simulations)

Table 6
Simulated distribution of annual returns (%)
(gross of tax and administrative costs) - Balanced Portfolio

Percentiles	**1**	**10**	**25**	**50**	**75**	**90**	**99**
USA	-1.1	1.0	2.2	3.7	5.2	6.5	8.8
UK	-0.2	2.1	3.4	4.8	6.2	7.5	9.9
Japan	-3.0	-0.8	0.6	2.1	3.7	5.1	7.7
Germany	2.4	4.2	5.3	6.5	7.6	8.7	10.6
France	2.8	4.8	5.9	7.2	8.4	9.5	11.6
Canada	-0.3	2.2	3.6	5.2	7.0	8.6	11.2
Sweden	2.1	4.8	6.5	8.2	10.1	11.7	14.4
Italy	-1.9	1.1	2.5	3.9	5.2	6.5	8.9
OCSE-8	**2.0**	**3.7**	**4.7**	**5.9**	**7.0**	**8.0**	**10.0**

Our calculation on Datastream data (10,000 simulations)

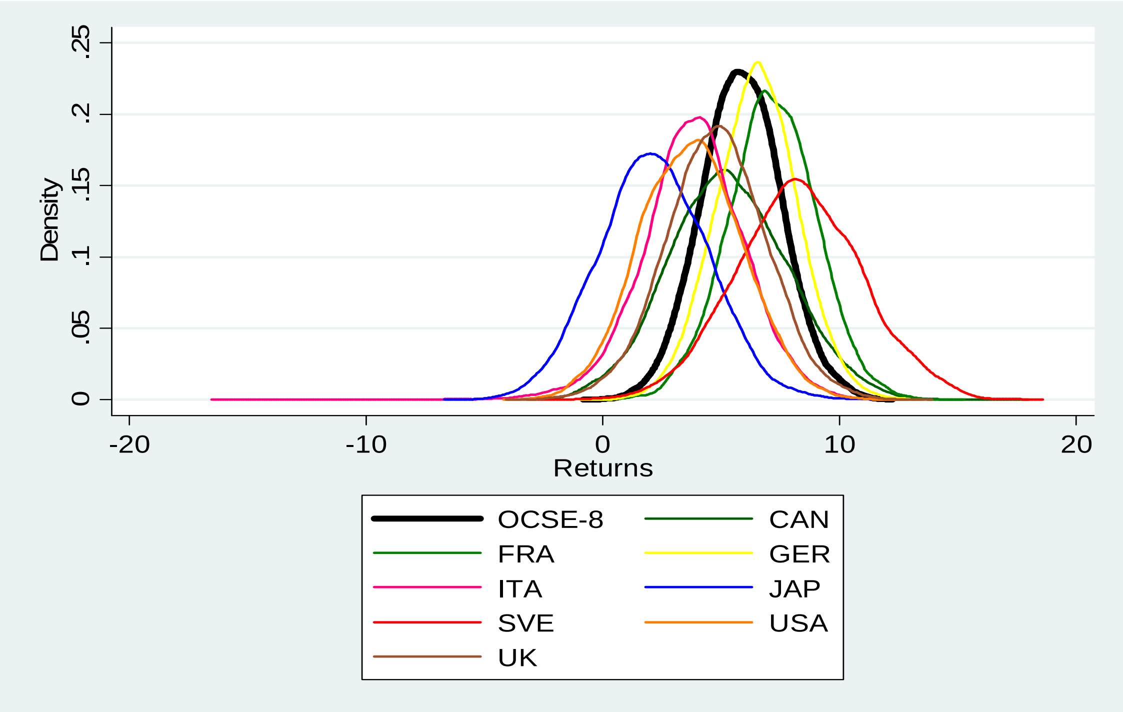
Table 7
Simulated distribution of annual returns (%)
(gross of tax and administrative costs) - Risky Portfolio

Percentiles	**1**	**10**	**25**	**50**	**75**	**90**	**99**
USA	-1.3	1.1	2.6	4.2	5.8	7.3	9.8
UK	-1.7	1.6	3.4	5.2	7.0	8.6	11.5
Japan	-4.5	-1.6	0.1	2.0	3.9	5.7	8.9
Germany	0.7	3.6	5.3	7.2	8.9	10.6	13.4
France	1.0	4.0	5.7	7.5	9.4	11.0	14.0
Canada	-1.4	1.6	3.4	5.4	7.4	9.3	12.5
Sweden	0.7	4.9	7.2	9.7	12.3	14.5	18.4
Italy	-4.0	-0.5	1.2	3.1	5.1	7.1	10.8
OCSE-8	**1.0**	**3.3**	**4.8**	**6.4**	**8.0**	**9.4**	**12.0**

Our elaboration on Datastream data (10,000 simulations)

Figure 6 presents the same comparison between the eight countries for the balanced case, by using kernel estimates. We observe that the German case is the most similar one to the OCSE-8 case. Italy, Sweden and Japan show the highest variability of simulated returns.

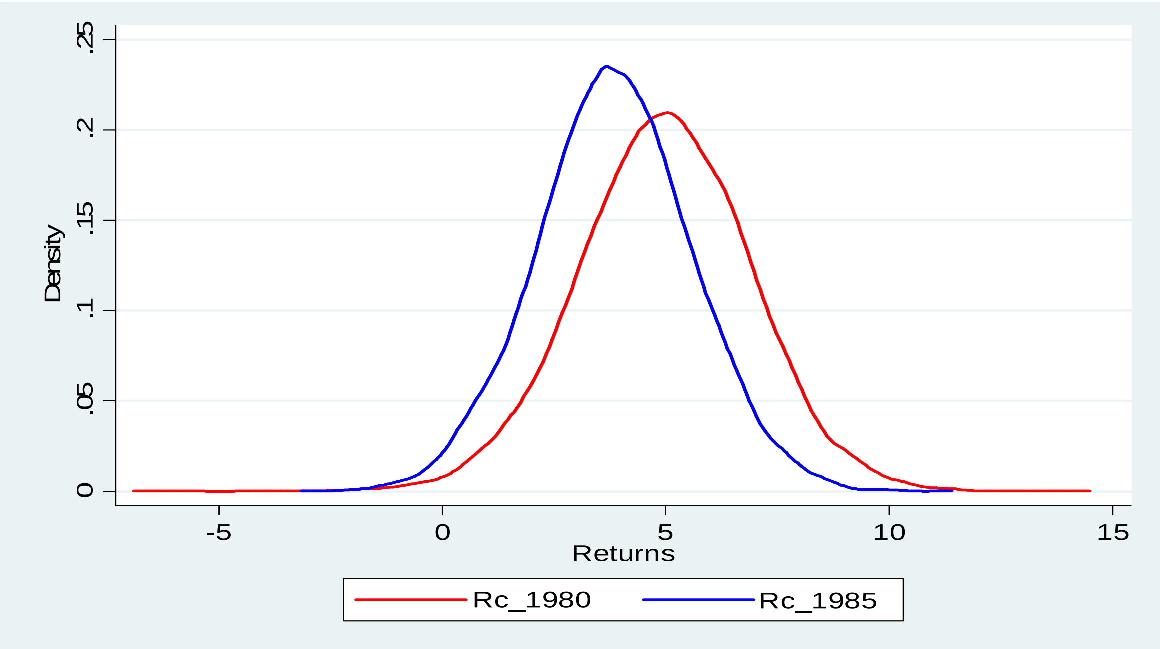
Figure 6
Kernel Estimate of the probability distribution of simulated returns
Balanced Portfolio



Our calculation on Datastream data (10,000 simulations)

Figure 7 shows the possible implications of using a longer dataset for estimating our model. We have considered the conservative portfolio for UK: in this case, adding five years of data implies a significant increase in the variability of results and also a sizeable increase in average future returns: from 3.8% with data of the period 1985-2009, to 5% with data of the period 1980-2009. Unfortunately, the scarse availability of bond data allows us to conduct such an exercise only for UK, USA and Germany.

Figure 7
Kernel Estimate of the probability distribution of simulated returns for two different data samples: 1980-2009 vs 1985-2009
Conservative Portfolio - UK



Our calculation on Datastream data (10,000 simulations)

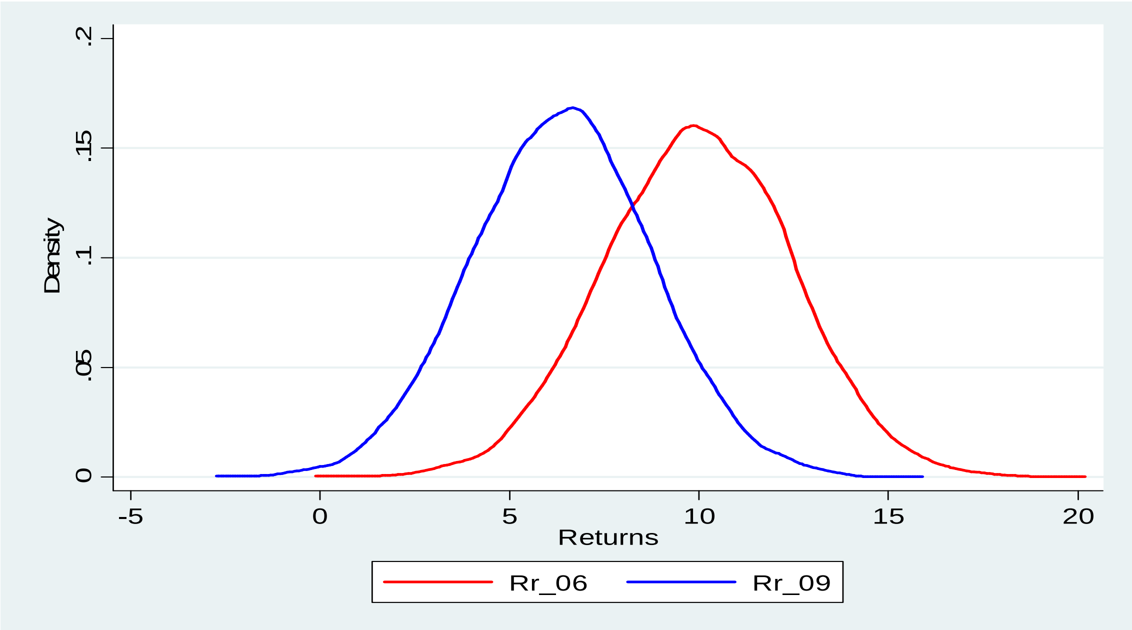
Table 8 reports, for the risky portfolio of the OCSE-8 area, the distribution of returns for two different cases: for the period 1985-2009 and for the period 1985-2006, i.e. before the recent financial crisis. It is clear that the crisis started in 2007 and the related fall in stock market prices markedly reduce the average level of forecasted returns. For instance, by considering the value in correspondence of the 50th percentile of the returns' distribution, the reduction in the future return is 3.6 percentage points, i.e. more of 1/3 of the simulated return when the data do not include the last three years. Figure 8 illustrates the same phenomenon by means of the relative kernel estimates.

Table 8
Simulated distribution of annual returns (%)
(gross of tax and administrative costs)
before and after the financial crisis
Risky Portfolio - OCSE-8

Percentiles	**1**	**10**	**25**	**50**	**75**	**90**	**99**
Rr_2006	4.1	6.8	8.3	10.0	11.7	13.1	15.6
Rr_2009	1.0	3.3	4.8	6.4	8.0	9.4	12.0

Our calculation on Datastream data (10,000 simulations)

Figure 8
Kernel Estimate of the probability distribution of simulated returns
before and after financial crisis(1985-2006 vs. 1985-2009)
Risky Portfolio – OCSE-8



Our calculation on Datastream data (10,000 simulations)

6. From returns to pensions: implications for benefits' adequacy

In this section we propose a simple exercise by using our previous simulated returns, in order to "build" a distribution of future pension benefits that a hypothetical pension fund would be able to pay (supplementary pension). This simulation exercise is based on an artificial population of 10,000 individuals who differ from each other only for the return on their pension investment: each individual is assigned one among the 10,000 simulated returns obtained according to the method described above. The other basic assumptions of this simulation exercise are the following:

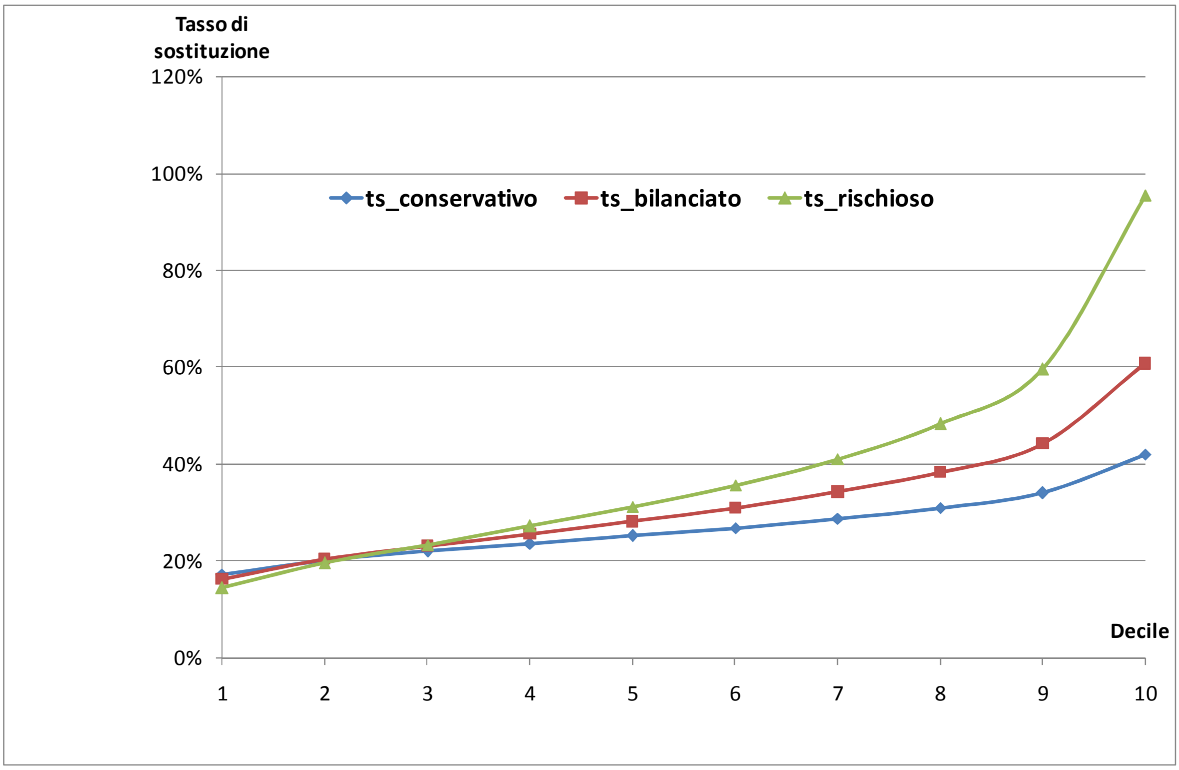
- Career starts at 25 and contributions are constant over career;
- Retirement age at 65, after 40 years of contributions;
- Life expectancy according to ISTAT (Italy Statistics Institute) mortality tables;
- Contribution rate to the pension fund equal to 9%;
- Real discount rate for converting the total wealth into annuity equal to 2.5%;
- Real wage growth rate equal to 2% a year;
- Real annuity constant over the retirement period;
- Administrative charges of the pension fund equal to 2% a year.

To understand the implications of return variability on future pension benefits, we use a standard indicator: the gross *replacement rate*, i.e. the ratio between the first pension annuity and the last annual wage, both gross of tax and social welfare contributions. The results will be presented with reference to a "basic scenario" and for other alternative cases in order to make several sensitivity analyses.

The "basic scenario" is our benchmark case but it does not necessarily represent the case we consider the most likely to happen. In this scenario we describe the evolution of the pension investment of an individual who works for 40 years and pays into his pension fund a salary amount consisting of the severance indemnity (TFR) plus 2% of his annual income. The other parameters of control variables are those considered more plausible on the basis of current information. The sensitivity analyses proposed afterwards aim to evaluate possible changes generated by different job profiles and different lengths of contribution periods.

In Figure 9 we have, for the three investment profiles of the OCSE-8 area, the replacement rates ranked from the lowest to the highest. For every decile of the distribution we have calculated the average replacement rate within every decile. We can see that at the median decile, replacement rates are relatively independent of the chosen investment profile and that their values are about 25-30%. This value is enough in order to face the fall in future replacement rates expected by younger generations as a consequence of the public pension system reforms implemented in the last twenty years. In other words, our simple model states that if in the future pension funds do implement investment diversification policies, on the basis of our forecasting simulation exercises, supplementary pension schemes will be able to compensate for the fall in public pension benefits and will guarantee future pensioners similar living standards as the current ones.

Figure 9
Replacement ratio for different portfolios. Analysis by deciles



However, aside from the central part of the distribution, we have two basic problems. Firstly, the expected replacement rates for the first four deciles are not enough to guarantee adequate pension benefits. Secondly, there are large differences in replacement rates across all the deciles: this is particularly striking in the case of the risky portfolio where, for a replacement rate of 95% in the highest decile, we have a replacement rate of 14% in the lowest decile. These differences are not very justifiable for a tool (supplementary pensions) that should be integrating public pensions in supporting the incomes of the elderly.

We have also calculated the Gini index, which is an indicator of the degree of concentration of a probability distribution. We have calculated it for the three distributions shown in Figure 9. The results, reported in Table 9, indicate a strong sensitivity with respect to the investment profile: moving from the safest to the riskiest portfolio, the Gini index shifts from 14.2% to 32.3%. These values are considerable (in particular in the risky case), also considering the fact that they are derived from a simulated distribution that contains 10 identical observations in terms of wage dynamics, contribution rate, payment year of the benefit and indexation. Hence, the only factor that can explain the differences mentioned above is the return variability.

Table 9
Gini Index of pensions for the 3 portfolios

Portfolio	Conservative	Balanced	Risky
	14.2	21.2	31.3

The next figure (Figure 11) measures the impact of the financial crisis on private pensions distribution and hence on replacement rates. We run the basic simulation in the case of the risky portfolio for two data samples: 1985-2009 and before the crisis (1985-2006). The impact of the recent crisis appears to be important. Whereas before the crisis, the replacement rate at the median decile was 73%, the inclusion of the three next years cut the replacement rate, lowering it to 31.2%. We have even stronger outcomes for higher deciles. Obviously the choice of the risky portfolio as a reference point amplifies the results. Nevertheless, our experiment is very significant as it brings out the importance of having longer time series data in order to write off the effects of the stock market crisis; moreover, it also stresses the need for minimum return guarantees for supplementary pension schemes. In light of our simulation results, the choice of extending the working period during a financial crisis for permitting the recovery of stock markets seems to be problematic.

Figure 10
Replacement ratios bifore and after the financial crisis

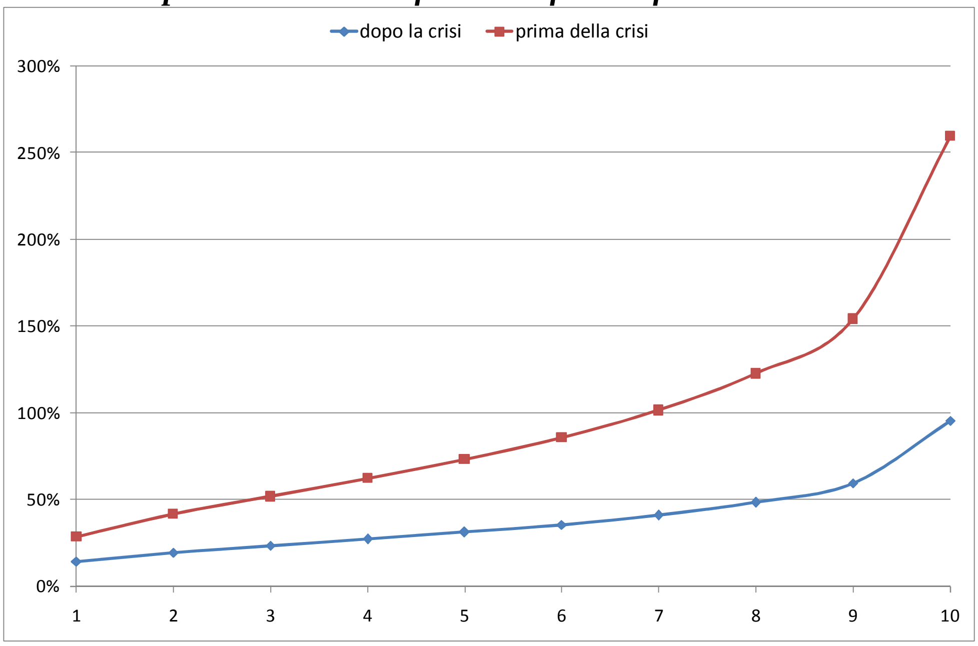
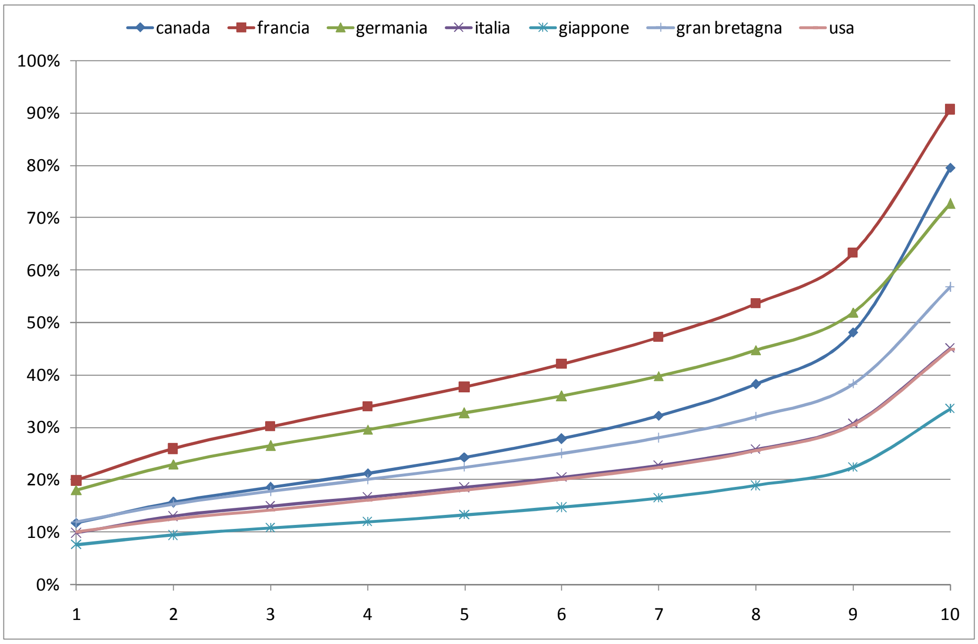


Figure 12 shows replacement-rate distribution for seven countries (G7) in the case of the *balanced* investment profile. The other assumptions of our basic scenario are the same and are hence invariant for the moment. The figure illustrates how the strong return variability affects replacement rates. In the median decile the difference between the highest (France) and the lowest value (Japan) of the replacement rate is about 25 percentage points. In the top deciles of the distribution, this difference exceeds 50 percentage points. This last result is very important in particular in the light of the tendency among many pension funds (also Italian ones) to favour domestic assets to foreign ones. This choice therefore seems to be misleading, in particular from an asset-diversification viewpoint.

Figure 11
Replacement ratios for different countries



6.1 Sensitivity Analysis

In this sub-section we present several simulations in order to test the results sensitivity with respect to changes in the crucial parameters described above. We stress the fact that these sensitivity exercises play a fundamental role in our analysis especially because of the unique characteristics of pension funds in Italy. In our basic scenario we assume contributions being made for 40 years and the payment of a proportion of annual wages equal to the total amount of severance indemnity (TFR) (6.9%) plus the contributions of the employer (1%) and employee (1%). But we know that only a fraction of Italian employees will be in such a situation (young private workers). The characteristics of the Italian jobs market, plus available data on those signing up to supplementary pension schemes, indicate that the case studied in our basic scenario is not the most frequent and is not the most likely one to happen. In particular, among young workers, full contributions careers are no longer so common and young workers are the ones with the smallest rates of signing up to supplementary pension schemes.

Moreover, there are other important variables that may affect the results of the simulation: administrative and management costs and individual wage dynamics. Below we present several sensitivity analyses results, assuming that the pension fund follows a *balanced* investment profile and that expected returns are those of the OCSE-8 area.

Figure 12
Replacement ratios and lenght of the contribution period

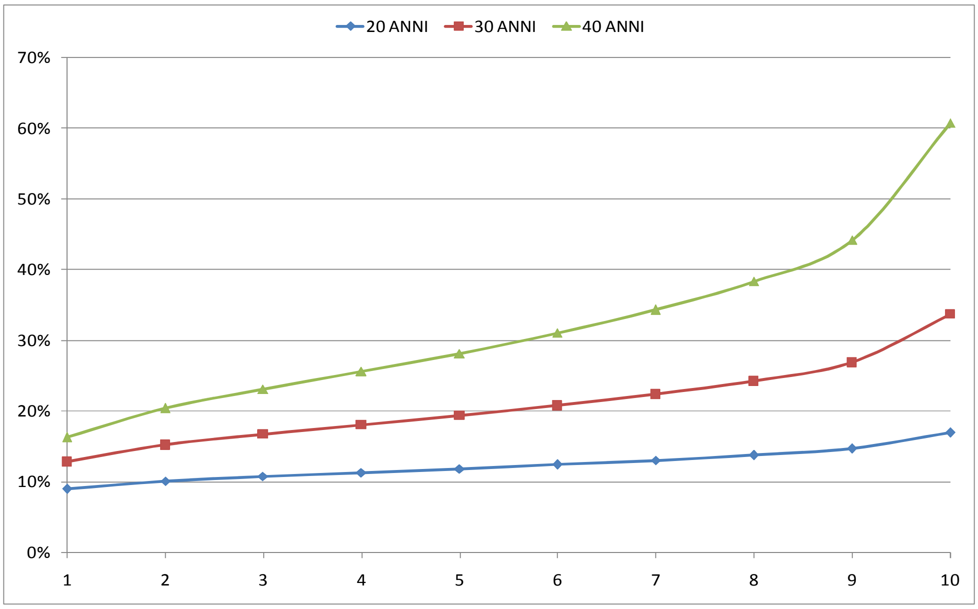
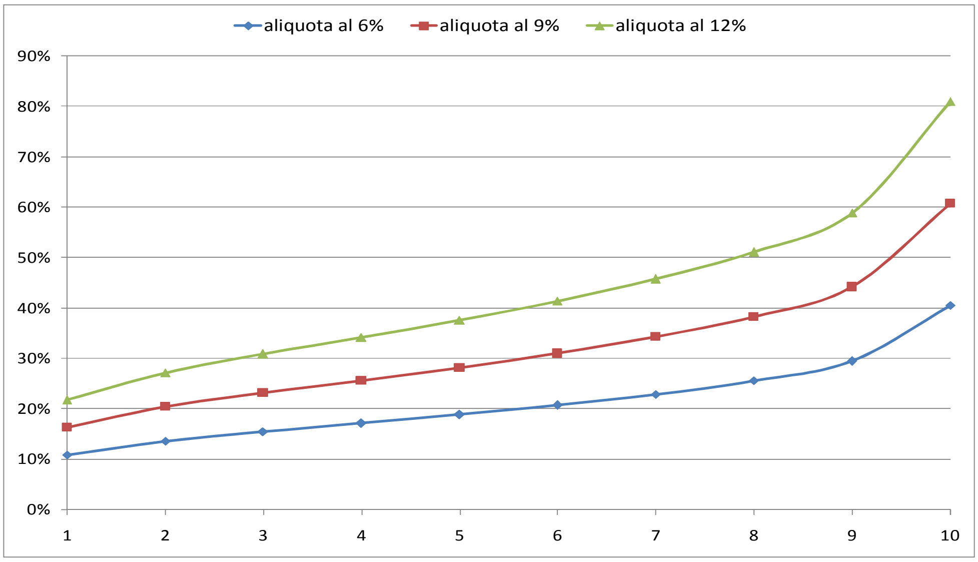


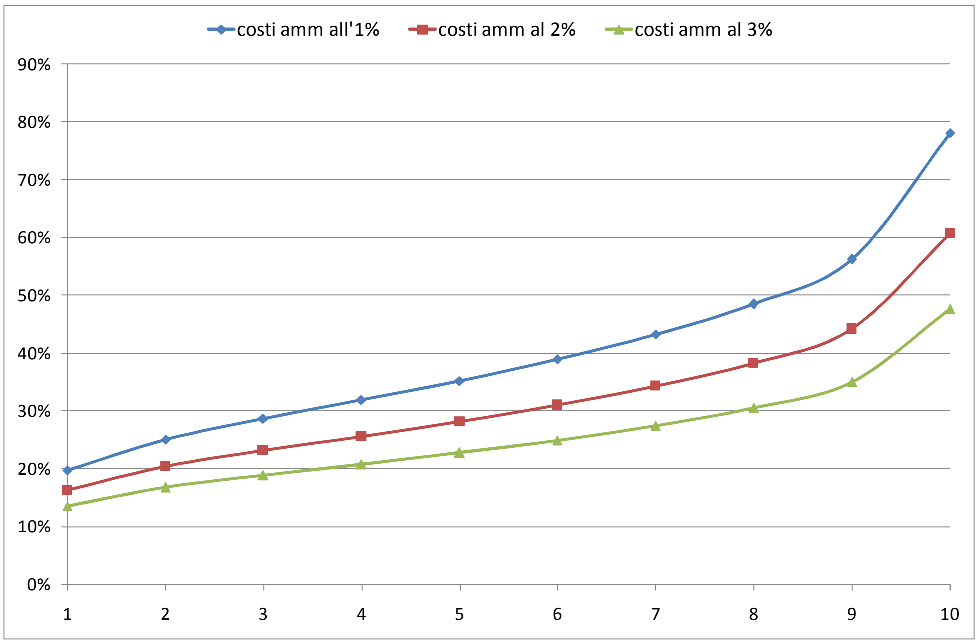
Figure 13 tests the impact of pension investment length on the distribution of replacement rates, by considering three alternative contributive career lengths. We see that only in lucky situations, with pension investments of 20 or 30 years, can the future pension benefits guarantee an adequate coverage to compensate for the fall in the public pension pillar, and this holds in particular for younger cohorts. This outcome gives a rough measure of the possible social costs related to the considerable spread of temporary jobs in the jobs market, and to the delays with which supplementary pension schemes have been introduced in Italy.

Figure 13
Replacement ratios and rate of contribution



Similar results are obtained if we vary the contribution rate to the pension fund (see Figure 14). For example, with a 6% value of the contribution rate, by starting only from the 8th decile of the distribution (therefore for 20% of the possible cases) the replacement rate seems to be enough to cover the fall in the public pension pillar. Otherwise, with a contribution rate of 12%, the simulated distribution would, for 70% of cases, guarantee an average replacement rate of at least 30%.

Figure 14
Replacement ratios and administrative charges



Moving on to analysing administrative costs (see Figure 15), we assume the possibility to deviate negatively or positively by 1% from our basic parameter (2%). The measure of administrative costs provided from COVIP seems to indicate that, for mutual pension funds and PIP, and for time horizons of less than 30 years, our basic estimate is optimistic. Hence, lower values of management costs would imply an increase in the competition between pension funds – a phenomenon which would be very desirable.

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