Measuring the Impact of Longevity Risk on Pension Systems: The Case of Italy.

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Introduction

- This paper estimates the impact of longevity risk on the Italian pension system by combining the predictions based on a Lee-Carter (1992) mortality model with the projected pension payments for different cohorts of retirees.
- The novelty in our approach is the use of the uncertainty generated by a mortality model to assess:
  - the impact of longevity risk on pension expenditure

Introduction

- This paper estimates the impact of longevity risk on the Italian pension system by combining the predictions based on a Lee-Carter (1992) mortality model with the projected pension payments for different cohorts of retirees.
- The novelty in our approach is the use of the uncertainty generated by a mortality model to assess:
  - the impact of longevity risk on pension expenditure
  - the impact of social security reforms.

Why a mortality model ?

- The use of mortality models to assess social security policy has two main advantages.
- First, mortality models generate predictions for the evolution over time of population in each cohorts. This is the requirement needed to assess the impact of sequential social security reforms that, by usually not being retroactive, affect differently different cohorts of the population.
- Second, the parameters in a mortality model are very unlikely to be affected by the specific social security policy adopted by the government. Therefore, the econometric specification for mortality used for policy simulation analysis is robust to the Lucas'critique (1976).

Why Italy?

- The Italian economy is characterized by one of the largest world public debt (both as a ratio of GDP and in an absolute terms), a traditionally very generous pension system and one the world's lowest fertility rate (Sartor, (1999)).
- Also, the Italian pension system has been subject to a number of reforms, and the most recent one, implemented initially in 2010 and completed in 2012, has introduced an automatic indexation of the retirement age to expected residual life at retirement.

Research Strategy

Our strategy to assess the impact of longevity risk on the Italian pension system is based on three steps.

- First, we derive the numerosity of each cohort of retirees up to 2050 by using the Lee-Carter mortality model to project future mortality and by applying it to the current population pyramid. As future mortality rates are projected with uncertainty, a confidence interval is associated to future population at each age.
- Second, pension payments to each cohort in the future are projected using institutional information on the Italian pension system.
- Third, total old-age pension expenditure as a ratio of GDP is projected over the horizon 2012-2050 with its associated confidence intervals. The width of our confidence intervals reflects the impact of longevity risk. In fact, an analogue of the concept of Value at Risk in portfolio management can be applied to future pension expenditure by estimating the upper bound with a given probability (namely the upper limit of the 95 per cent confidence interval) of pension expenditure as a ratio of GDP in each year.

Some facts on longevity

Figure 1: Longevity for over-65 in Italy

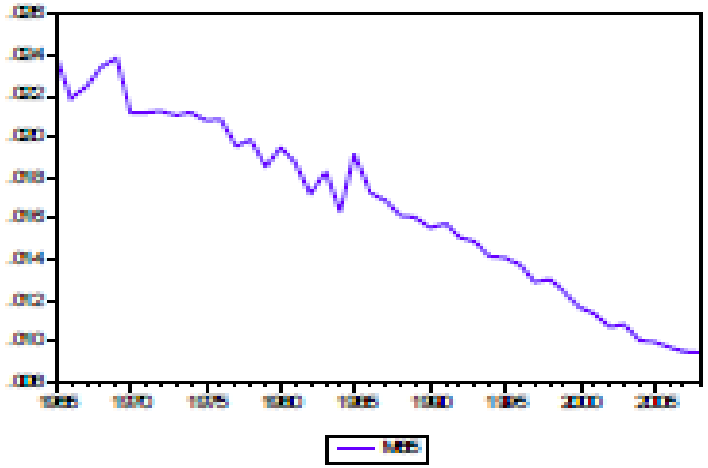


Figure 1.1: Mortality rates

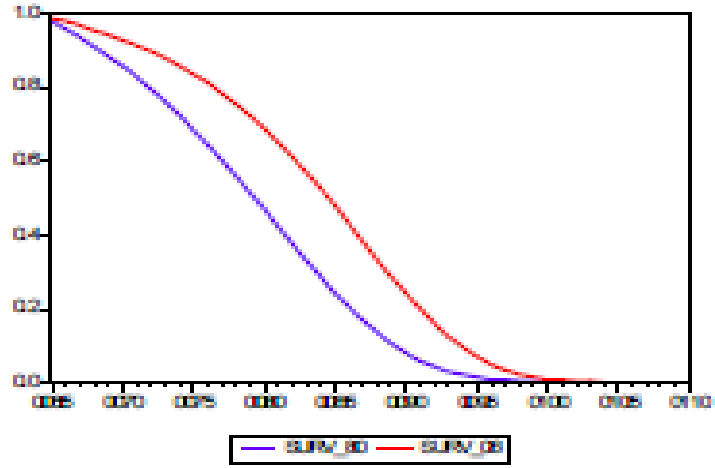


Figure 1.2: Survival probabilities

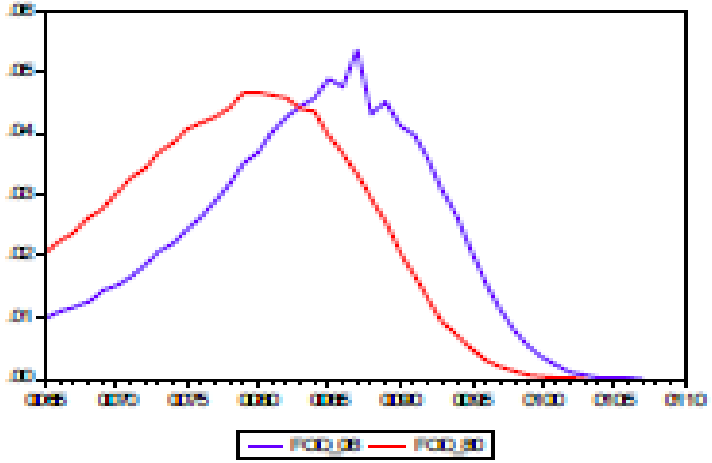


Figure 1.3: Frequencies of death

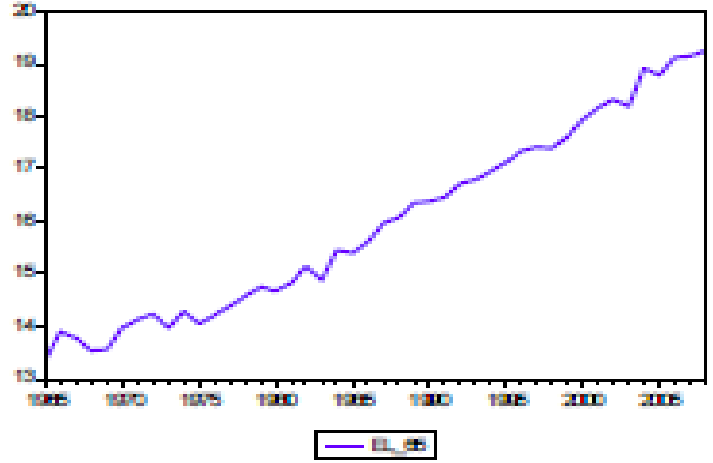
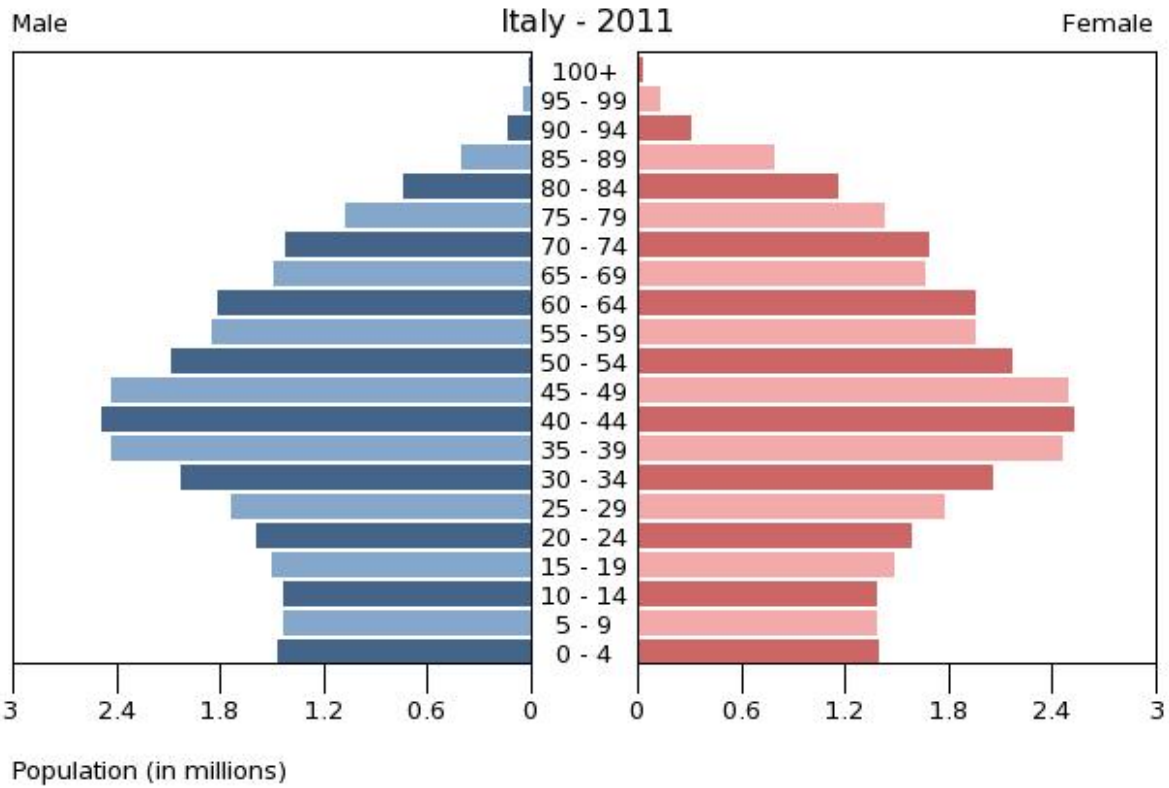


Figure 1.4: Expected life at 65 years

Projecting future population

Current age structure (http://www.census.gov/population/international/data/idb/country.php)



Projecting future population

The Lee-Carter forecasting model

- Central mortality rate $q_{x,t}$ of age cohort x at time t evolves to the following equation

$$\begin{aligned} \ln(q_{x,t}) &= \alpha_x + \beta_x k_t + \varepsilon_{x,t} \\ k_t &= \gamma_0 + \gamma_1 k_{t-1} + \varepsilon_{k,t} \end{aligned}$$

- k_t is a (unobservable,estimated) mortality index equal for all age cohorts and reflecting the overall decrease in mortality
- Identification is achieved by imposing the restrictions $\sum_t k_t = 0$ and $\sum_x \beta_x = 1$

The goodness of fit of the Lee-Carter Model for Italy

Figure 3: Pseudo out-of-sample (1999-2008) projections

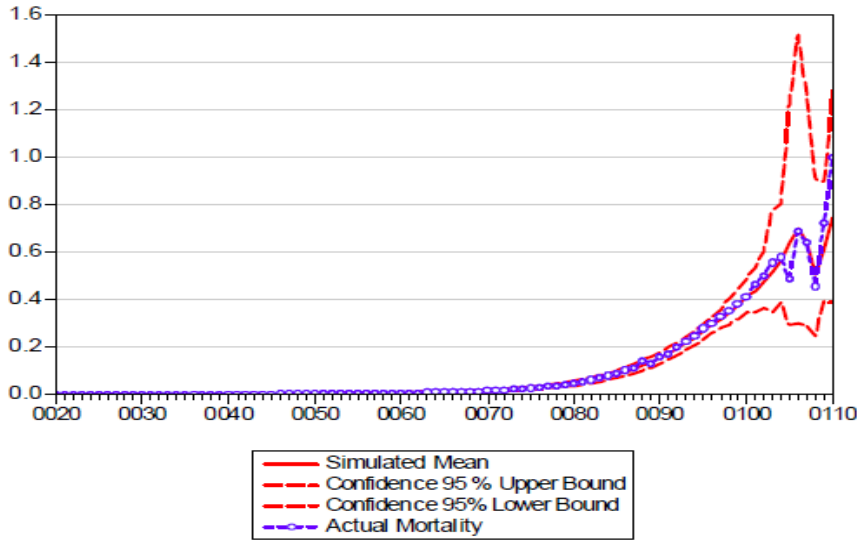


Figure 3.1: Mortality rates in 2008

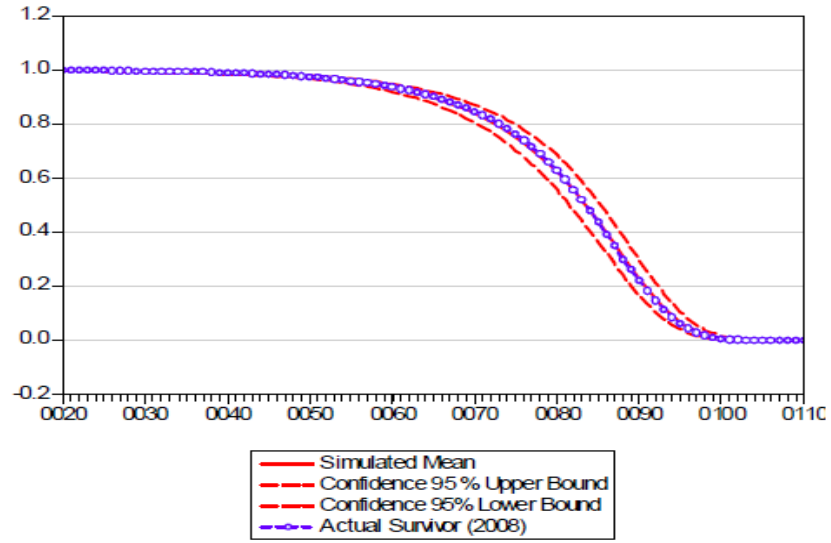


Figure 3.2:Survival probabilities in 2008

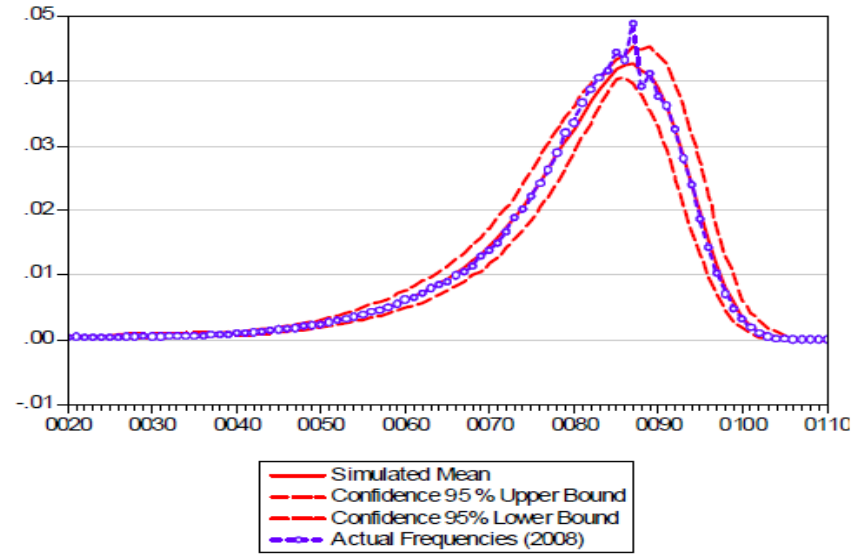


Figure 3.3: Frequencies of death in 2008

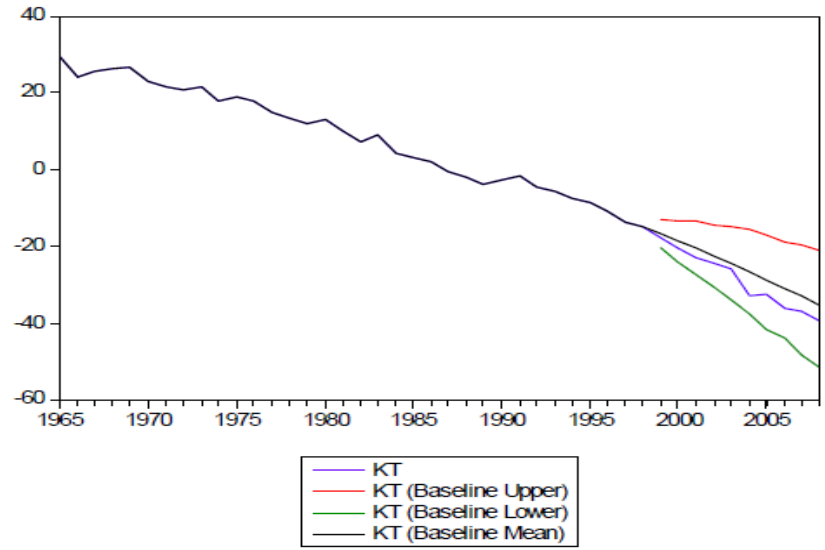
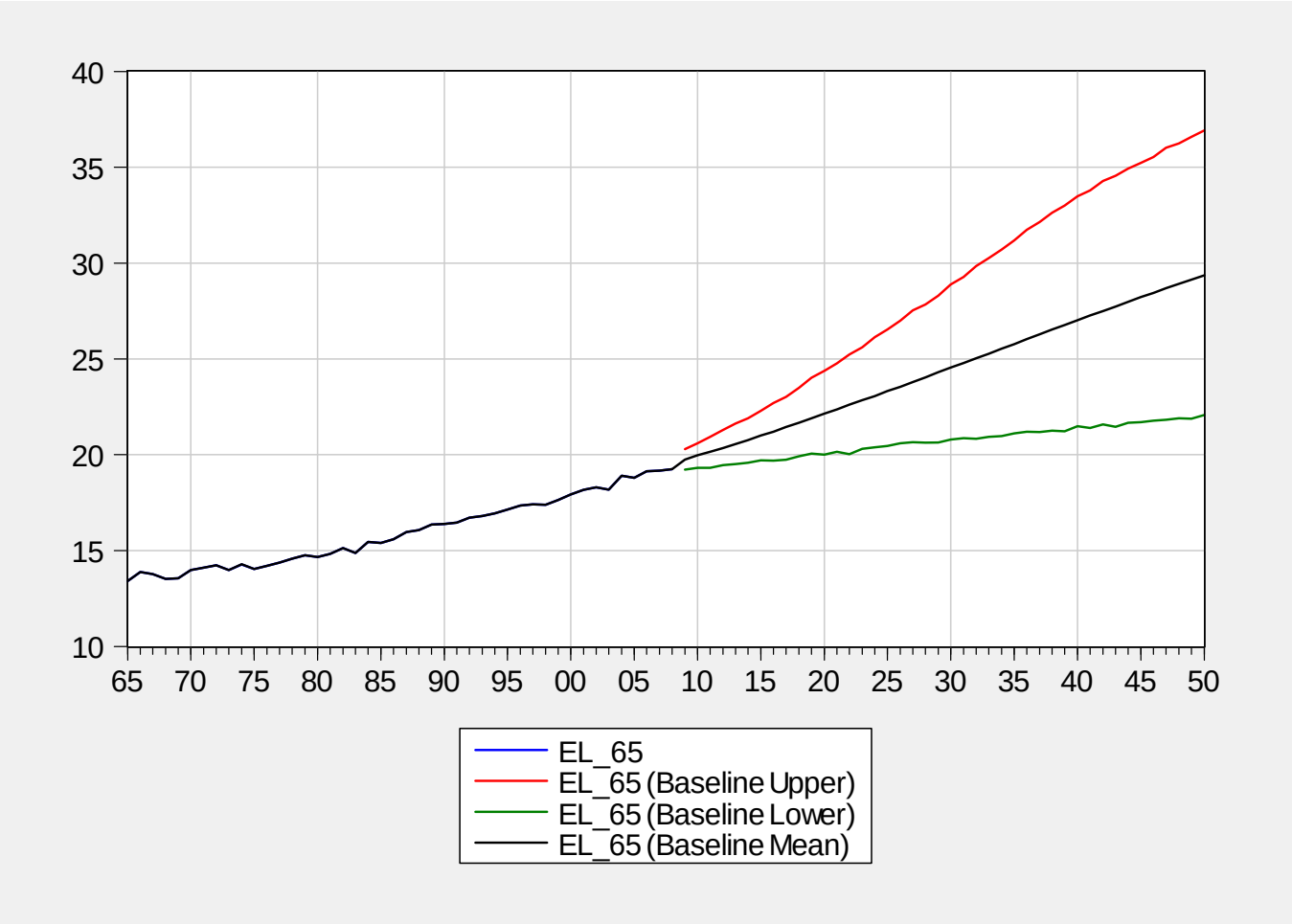


Figure 3.4: Mortality Index k_t

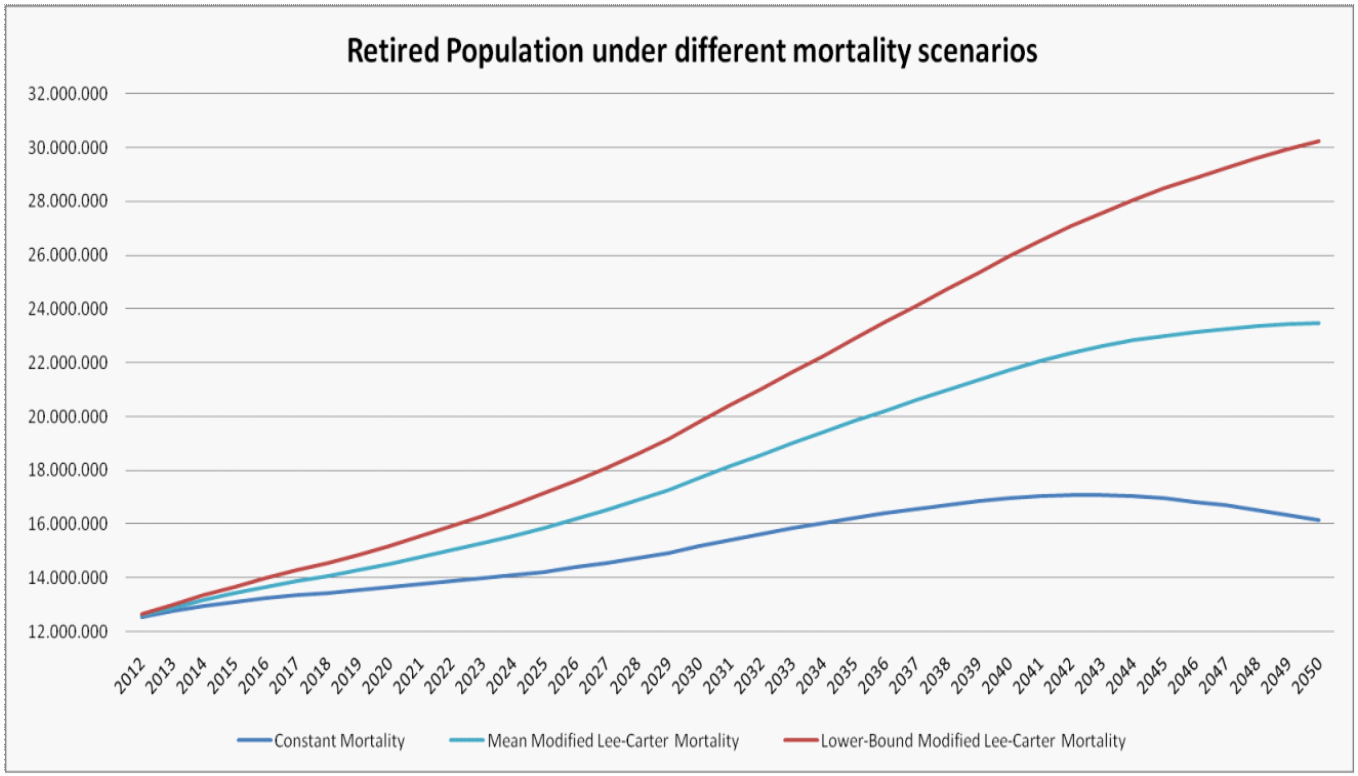
Mortality rates' projections, 65-years, 2012-2050



Life expectancy at 65

Projecting the age structure of the Italian population

Italian retired population estimates, 2012-2050

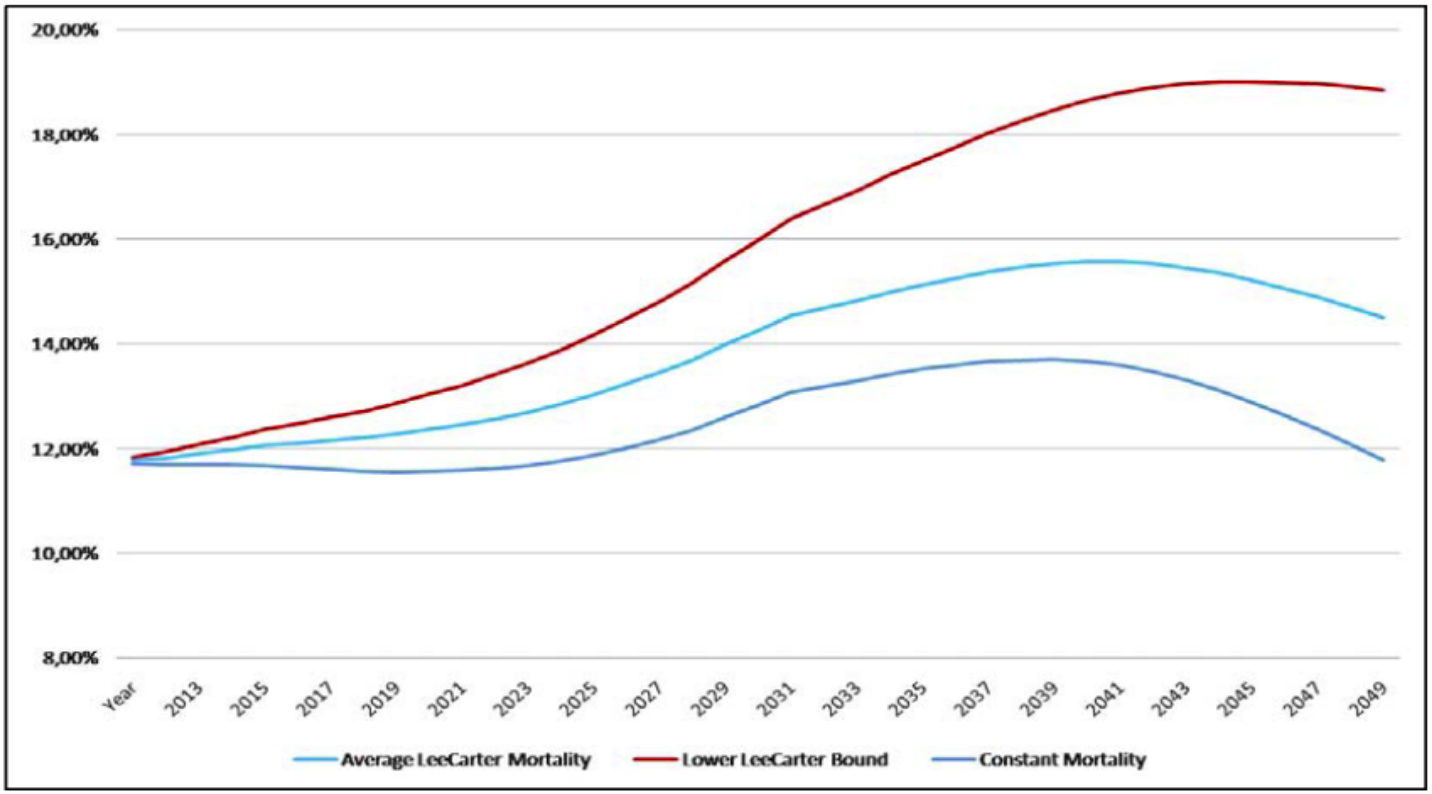


Retired population (65+) increasing from 12.5 million in 2012 to 30.3 million in 2050 (+140% in 40 years) in the upper-bound longevity scenario

Pension Payments for different cohorts

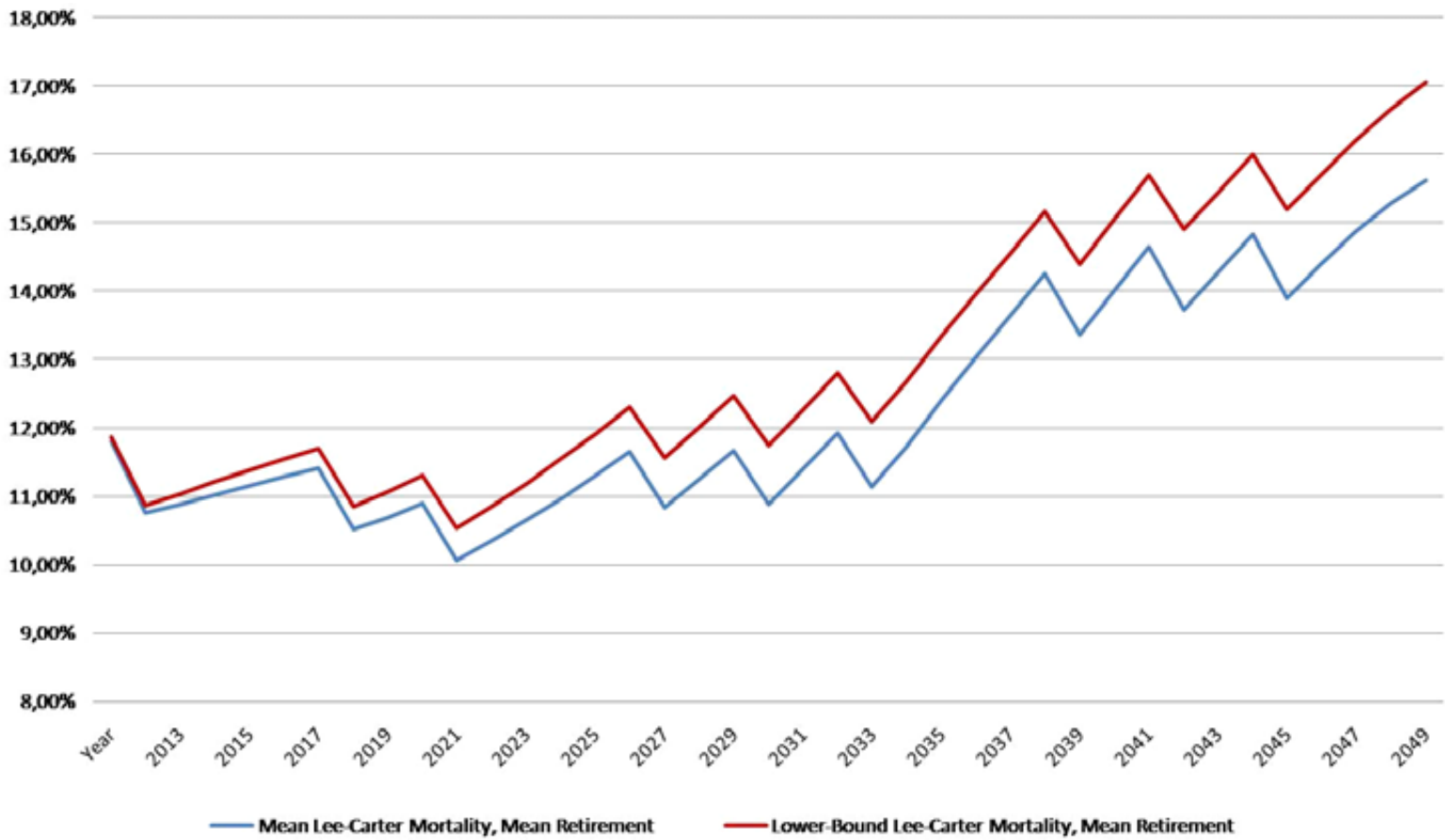
$$
\begin{aligned}
E\left(TP_{2011+j} \mid \Omega_{2011}\right) &= \sum_{i=0}^{45} E\left(POP_{65+i,2011+j} \mid \Omega_{2011}\right) * \\
&\quad * E\left(PD_{65+i,2011+j} \mid \Omega_{2011}\right) \\
E\left(PD_{65+(2012+j-r),2012+j} \mid \Omega_{2011}\right) &= y_r \prod_{k=1}^{2012+j-r} \left(1.01 + \pi_{r+k,r+k-1}\right) \\
\textit{contr. method } y_r &= \beta \bar{I}_{r-5,r} C_r \\
\textit{retr. method } y_r &= \gamma_{r,2012+j} \sum_{t=r-C_r}^{r} \delta I_t (1+gr)^{r-t} \\
\gamma_{r,2012+j} &= \left(\sum_{\tau=1}^{E(L|\Omega_r)} \frac{1}{(1+r_z)^{\tau}} \right)^{-1}
\end{aligned}
$$

Expected Pension Expenditure/Nominal GDP, 2012-2050



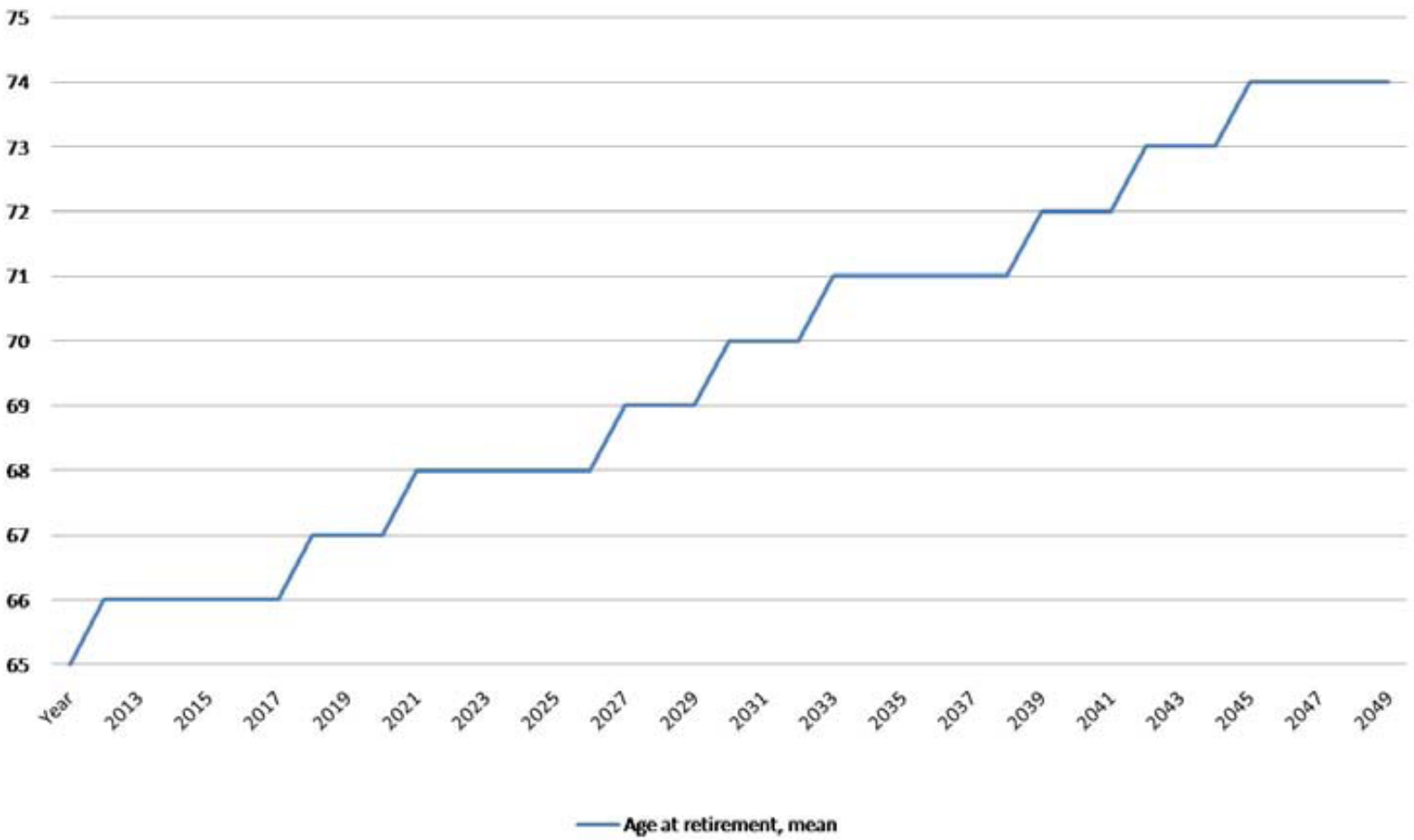
Longevity risk has an average impact on pension payments of 4 per cent of GDP per year over the period 2040-2050

The effects of indexation of retirement age



Longevity risk when retirement age is indexed to the increase in life expectancy to deliver a constant expected retirement period of 20 years

The effects of indexation of retirement age (cont'd)



Age at retirement when indexation applies

Is there a scope for a market for hedging longevity risk?

- Financial instruments to hedge longevity risk are potentially available: there are experiments of longevity bond and longevity swaps
- These instruments have not been so far very succesfull
- Who should issue longevity bonds?

Is there a scope for a market for hedging longevity risk?

- What is the impact on the term structure of the risk-return tradeoff determined by the addition of a longevity-linked security to the set of traditional Stocks, Bonds and T-Bills investment opportunities?.
- Longevity might provide a source of diversification especially at long-horizon
- If this is the case the private sector might benefit from buying longevity risk (i.e. issuing longevity bonds) and therefore providing an hedging instrument to all those institutions espoused to it.

The redistributive effect of longevity risk

- Longevity risk is likely to affect in heterogenous way different groups of populations
- If longevity is positively correlated with income than longevity risk has a regressive impact on pension payments
- If longevity is negatively correlated with tobacco consumptionsm, then longevity risk imposes an (implicit) tax on smokers
- These correlations would pose an interesting questions about hidden redistributive effects of longevity