Population heterogeneity in Defined Contribution Pension Schemes

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- The Defined Contribution Pension Scheme
- The Mortality Heterogeneity
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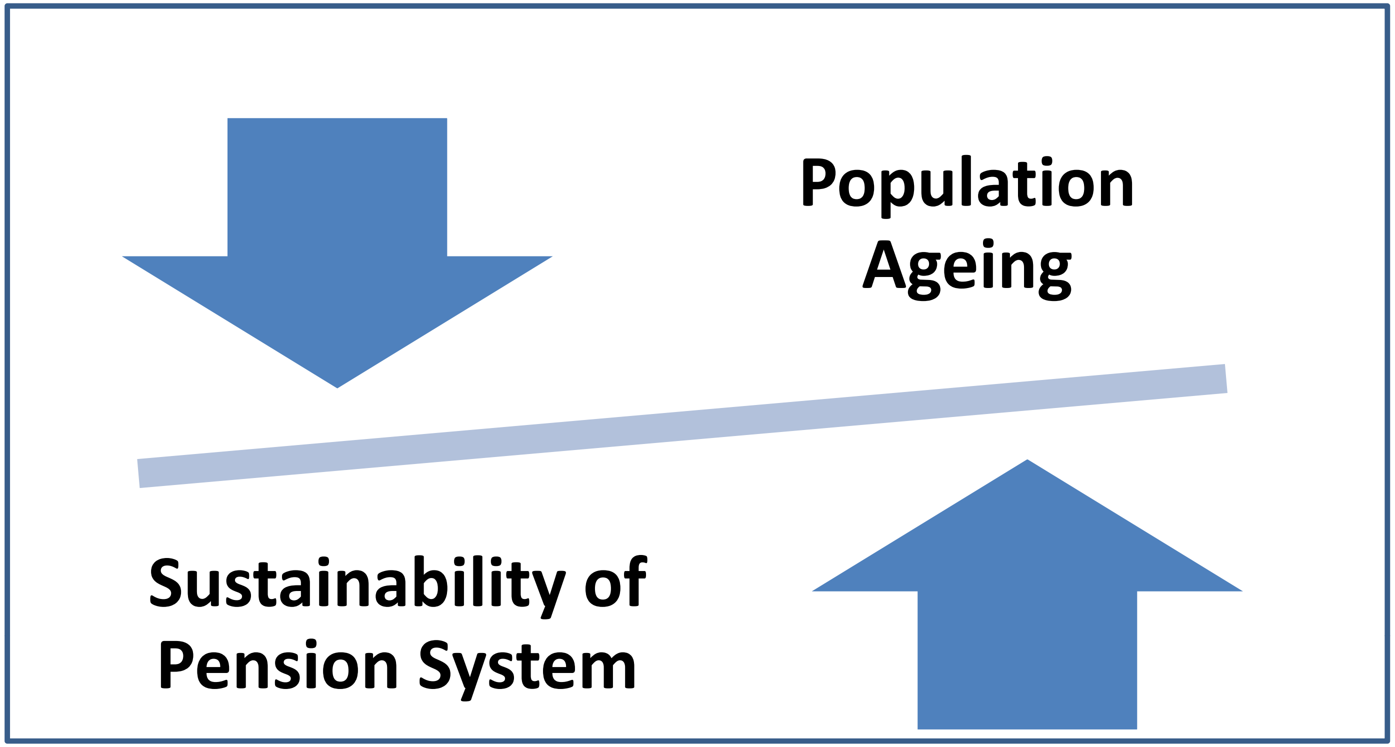
The aim

To catch mortality heterogeneity and to value its impact on Pension system



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The Defined Contribution Pension Scheme

- L 335/1995: Notional Defined Contribution (NDC)

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notional accumulated contributions on individual accounts are converted into an annuity at retirement

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- Total amount of contribution paid during the working life
- Life expectancy at retirement
- Survivors' benefits

The Defined Contribution Pension Scheme

$$P(x) = \left[c_a + \sum_{i=1}^{a-1} c_i \prod_{j=1}^{a-1} (1 + \overline{g}_j) \right] \delta_x$$

where

x is the retirement age

c_i is the contribution paid at seniority *i*,

a is the seniority at retirement ,

$\overline{g}_j$ is the geometric mean of GDP growth rate according the 5 years preceding j

δ_x is the transformation coefficient

The transformation Coefficient

$$\delta_x = \left(\frac{\sum_{s=m,f} dir_{x,s} + ind_{x,s}}{2} - \gamma \right)^{-1} ; \quad x \in [57,65]$$

$$dir_{x,s} = \sum_{t=0}^{(\Omega - x)} \frac{l_{x+t,s}}{l_{x,s}} \left(1 + g_f\right)^{-t}$$

$$ind_{x,s} = \theta \sum_{t=0}^{(\Omega - x)} \frac{l_{x+t,s}}{l_{x,s}} \left(1 - \frac{l_{x+t+1,s}}{l_{x+t,s}}\right) \left(1 + g_f\right)^{-(t+1)} a_{x+t+1}^{W}$$

where

γ is a factor fixed by law to take into account different frequencies in pension payment

g_f is the long-run expected GDP growth rate

θ is the part of pension revertible to widow(er)

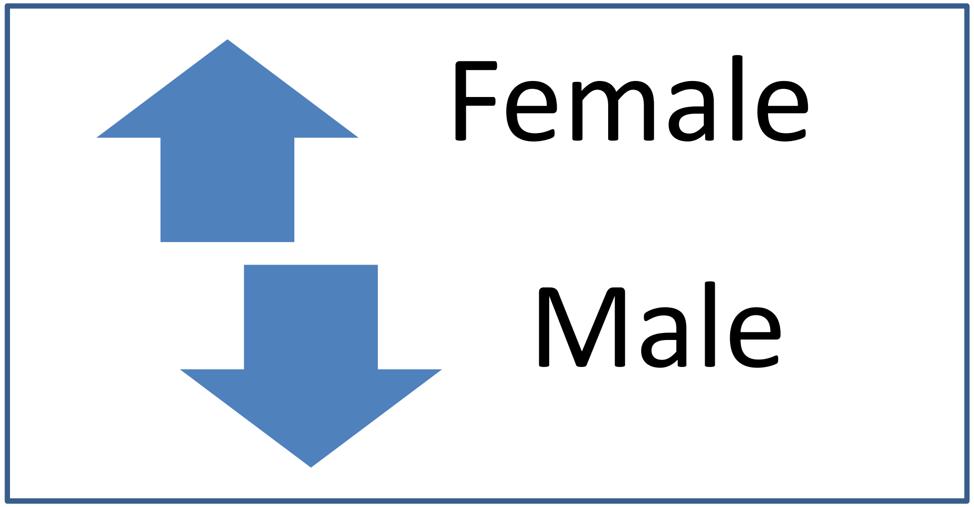
The Law evolution

Law 335/95
transformation coefficients updated every 10 years

Law 247/07
1st of January 2010 new coefficients are applied

Next revision of criteria will take place in **2013**

Actuarial fairness ?



- differences between genders are averaged out and transformation coefficients are the same for males and females with the same age

- redistribution between genders in a “solidaristic” way

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The mortality heterogeneity

- Individuals are different with respect to mortality due to different race, geographical area and so on

- Individuals at the same age may differ in their endowment for longevity and this differences are important to population-based mortality studies

- The differences in mortality rates can compromise accuracy in the mortality projection

- Actuarial valuation can be warped if heterogeneity is not considered

Some remarks on Heterogeneity

- Important for the NDC systems rules to incorporate in the pension formulae life expectancies

- If the heterogeneity within the population is not taken into account , there is a redistribution from shorter to longer living individuals

- It can be considered desiderable in a “solidaristic” view of PPP, in others it cannot

Our Research

- To provide transformation coefficients for 2013

- To take into account the heterogeneity in the data depending on the geographical area

- To derive different survival probabilities for the different geographical area

- To exploit the obtained survival probabilities for generating more actual transformation coefficients

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The Lee Carter Model

$$\ln\left(m_{x,t}\right) = \alpha_x + \beta_x k_t + \varepsilon_{x,t}$$

where

$m_{x,t}$ is the death rate in the year t for a policyholder aged x

α_x age-specific parameter independent of time

k_t time-varying parameter reflecting the general level of mortality

β_x describes the tendency of mortality at age x to change when the general level of mortality (k_t)changes

$\varepsilon_{x,t}$ error term, assumed to be homoschedastic

The Poisson LC Model

The parameters are estimated under the assumption: $D_{x,t}$ are distributed according to the Poisson distributions

$$D_{x,t} \approx Poisson\left(E_{x,t}\mu_{x,t}\right) \qquad \mu_{x,t} = \exp(\alpha_x + \beta_x k_t)$$

$E_{x,t}$ the number of person years from which $D_{x,t}$ occurred

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Application to Italian mortality rates

- Consider sub-populations (North, Center, South) so that we work on more homogeneous groups
- Implement an iterative regression methodology in R for the analysis of age-period mortality data
- Produce forecasts of future mortality rates and compute the corresponding future life expectancy for North, Center, South
- Estimate transformation coefficients for 2013 by using survival probabilities for area

The LC Poisson fitted on Italian Data

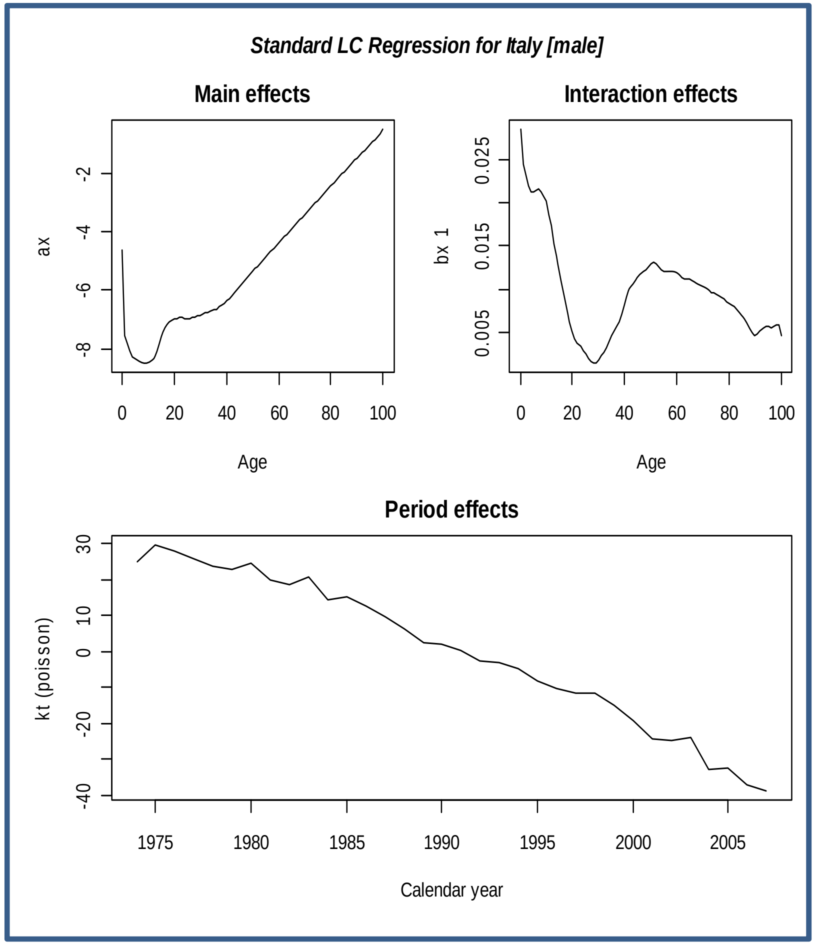


Figure1: The parameter estimates of LCP on Italian male mortality data

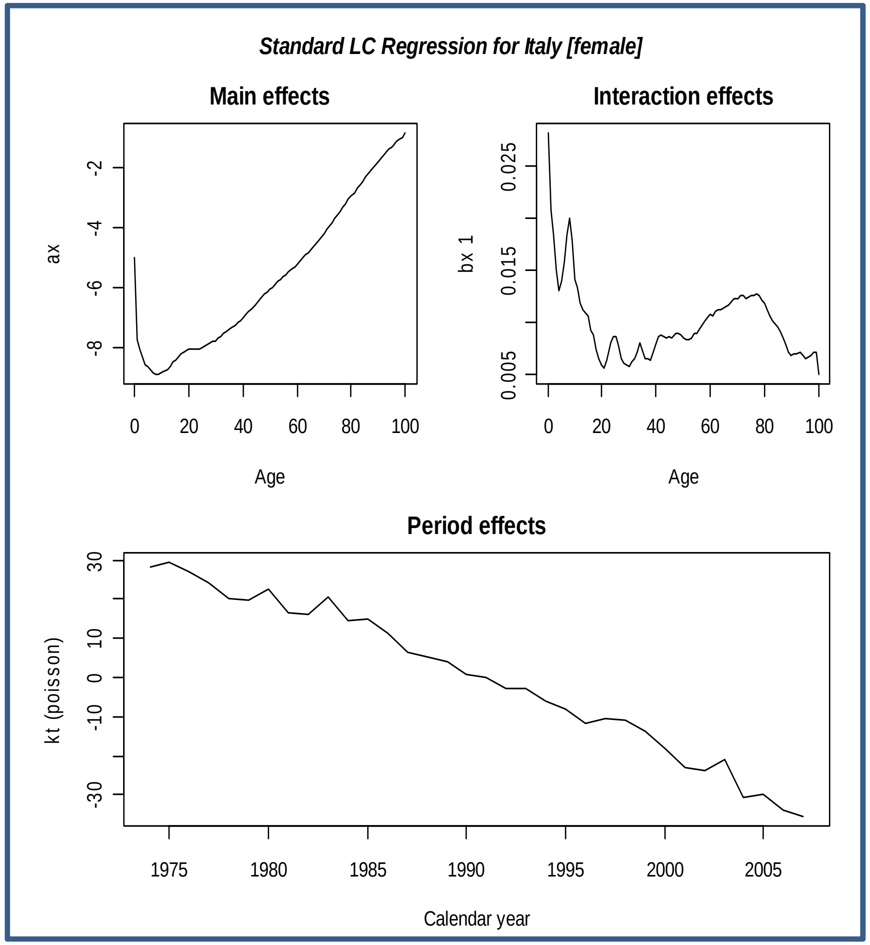
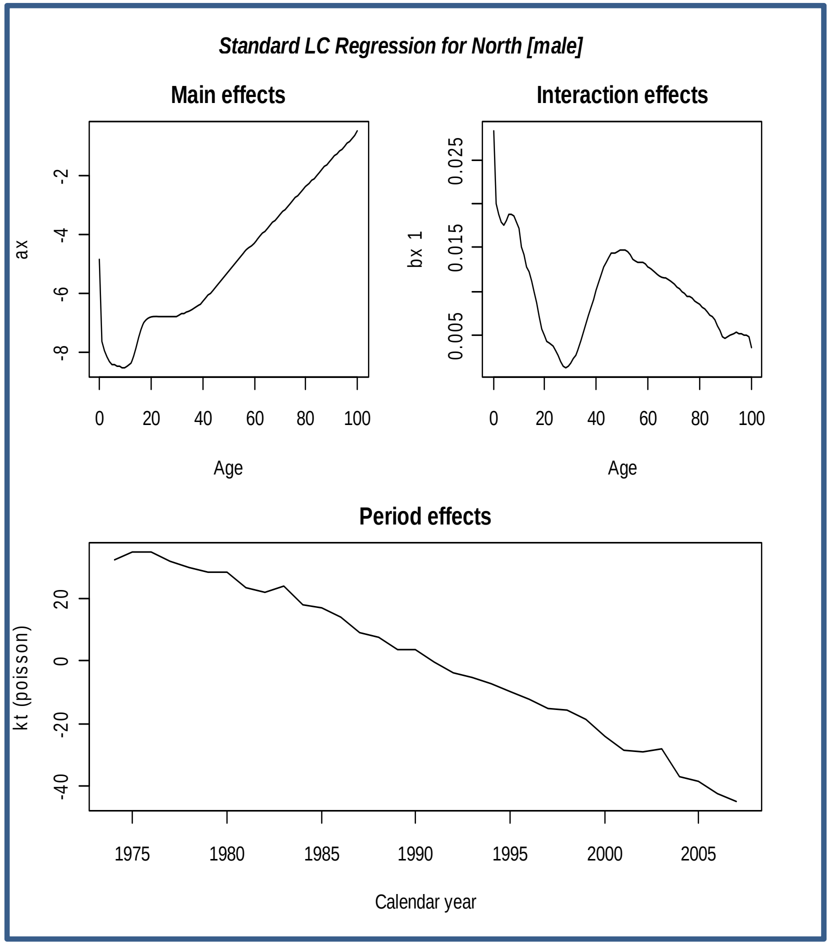


Figure2: The parameter estimates of LCP on Italian female mortality data

The LC Poisson fitted on Sub-Populations



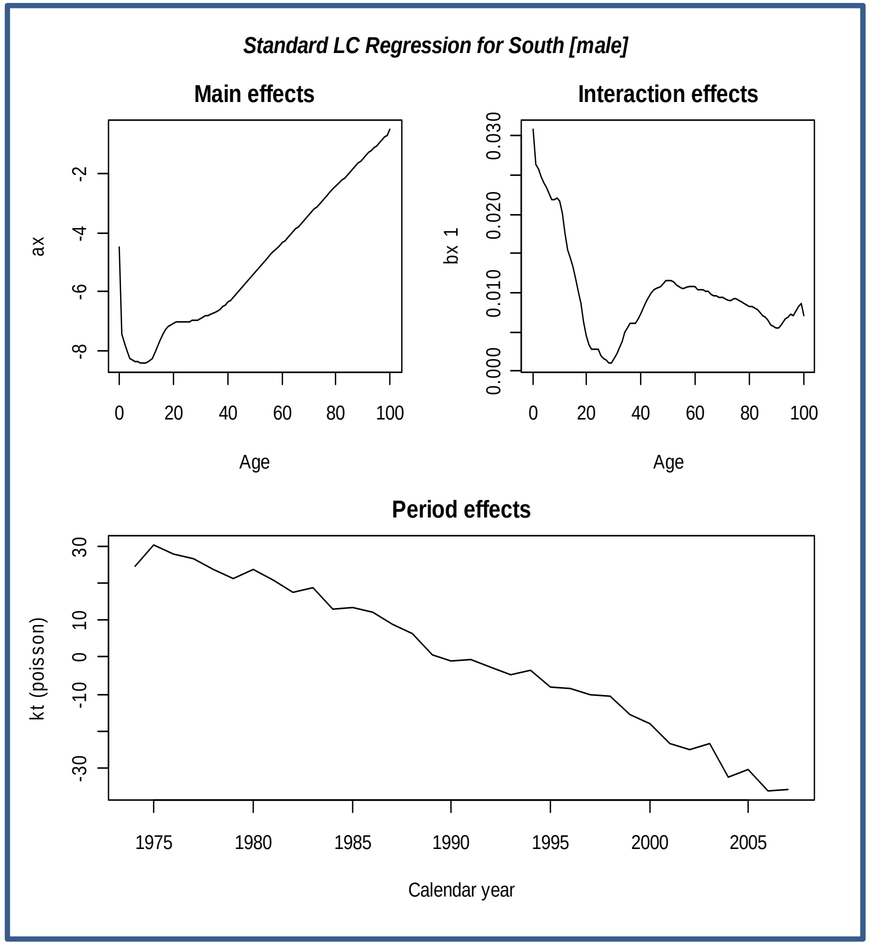


Figure1: The parameter estimates of LCP on North male mortality data

Figure2: The parameter estimates of LCP on South male mortality data

The LC Poisson fitted on Sub-Populations

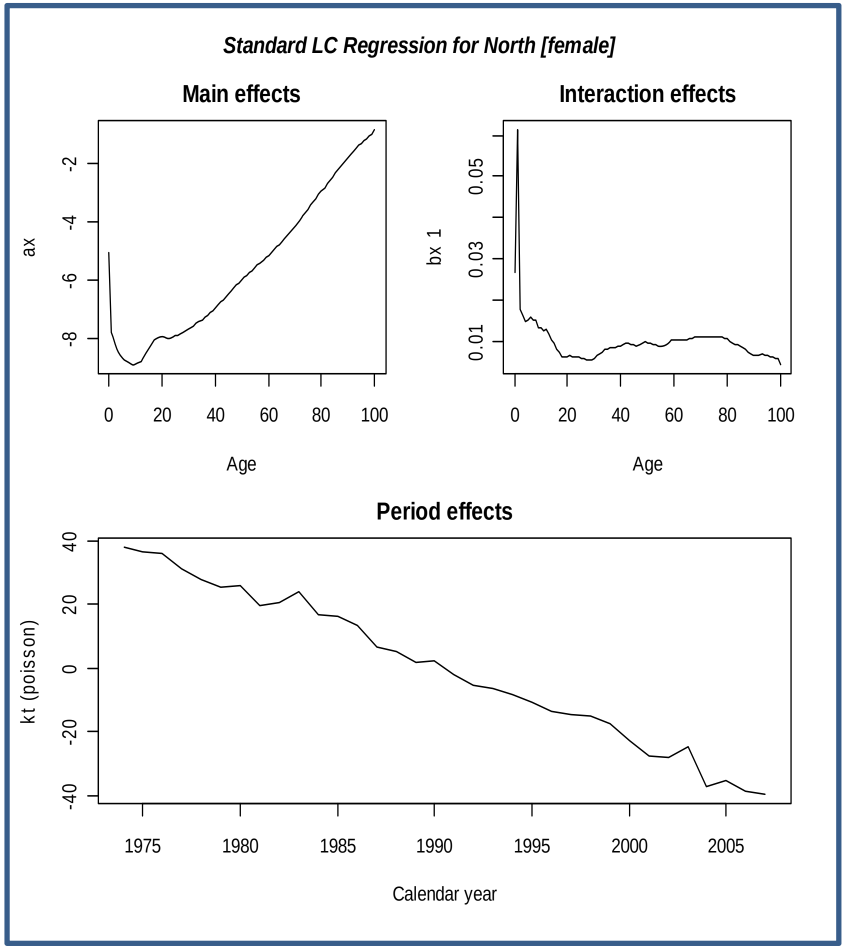


Figure1: The parameter estimates of LCP on North female mortality data

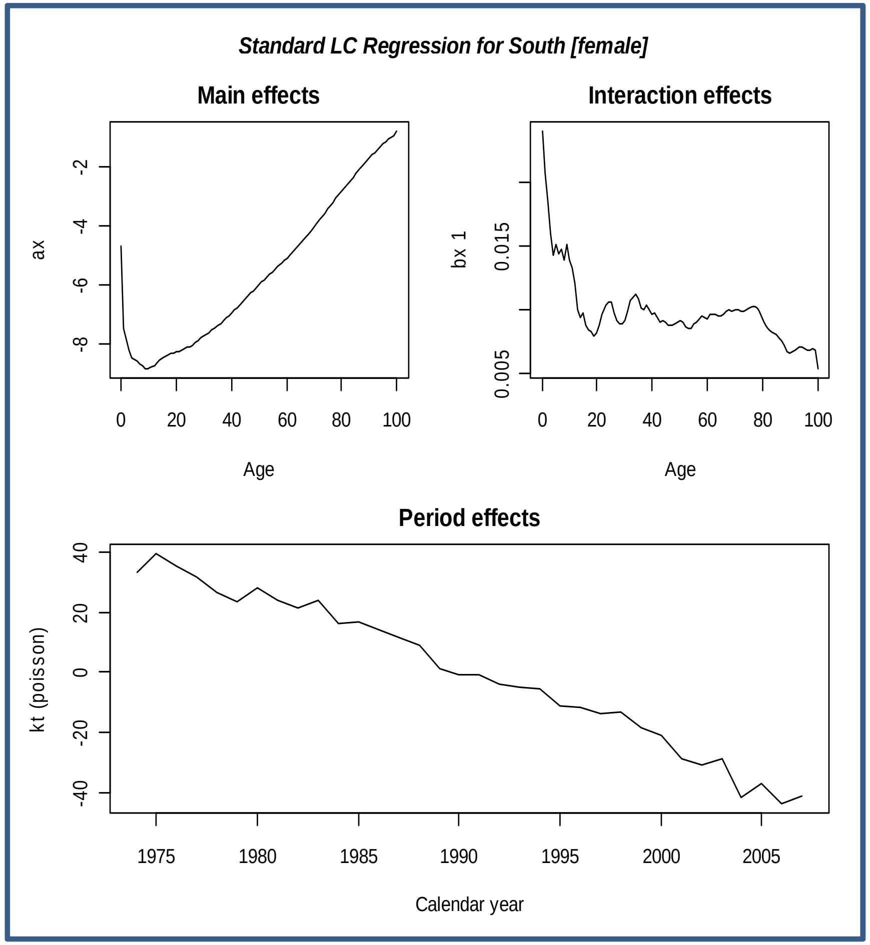
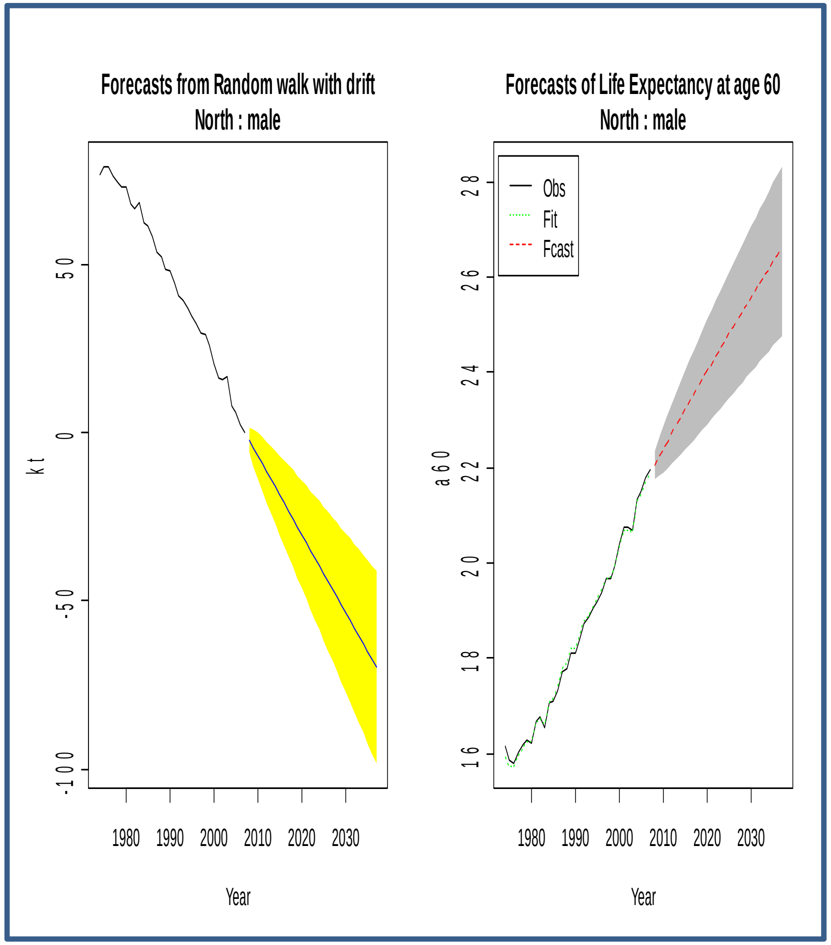


Figure2: The parameter estimates of LCP on South female mortality data

The Forecasts



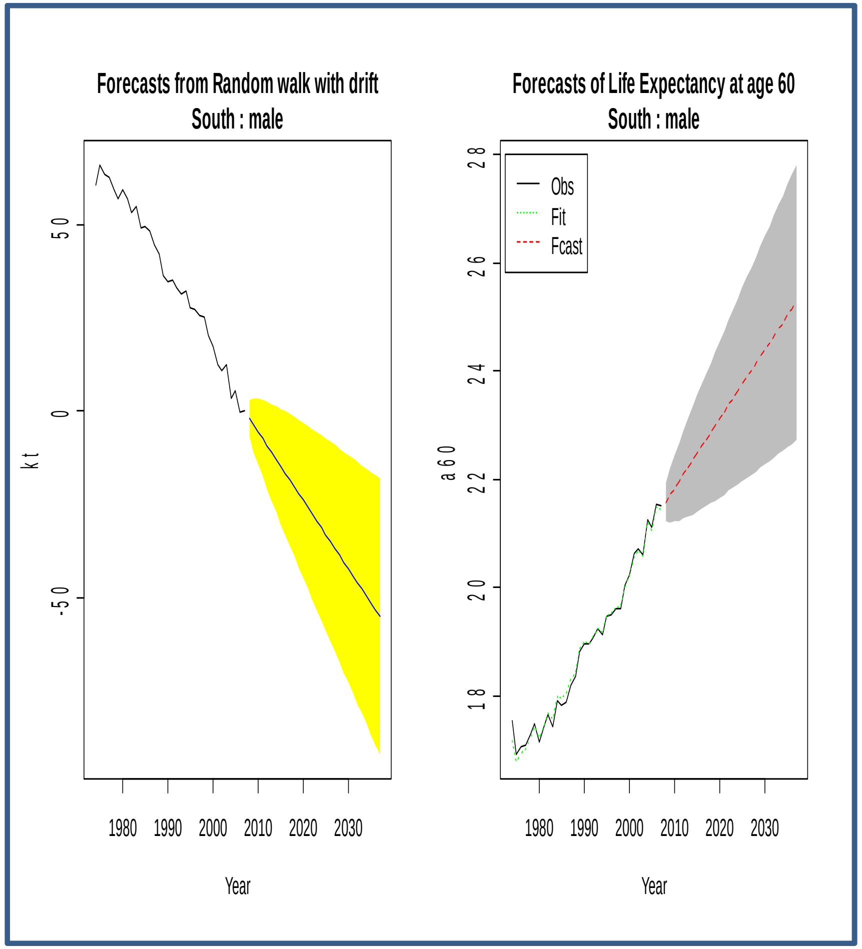


Figure1: Life expectancy at 60 for male (North population)

Figure2: Life expectancy at 60 for male (South population)

The Forecasts

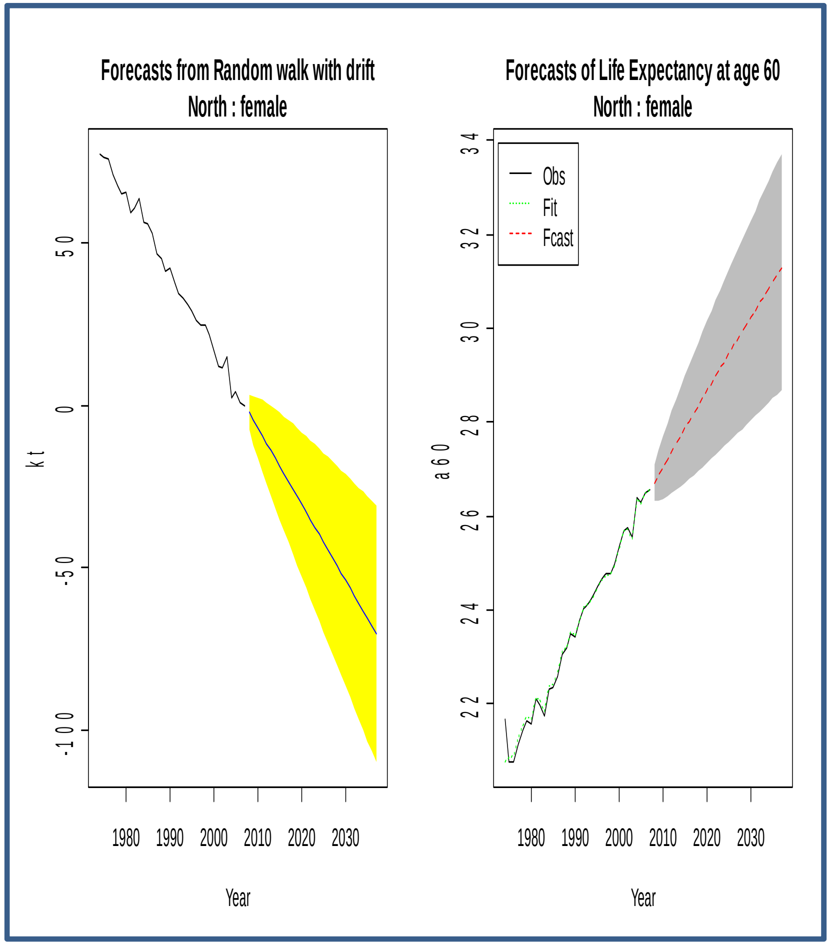


Figure1: Life expectancy at 60 for male

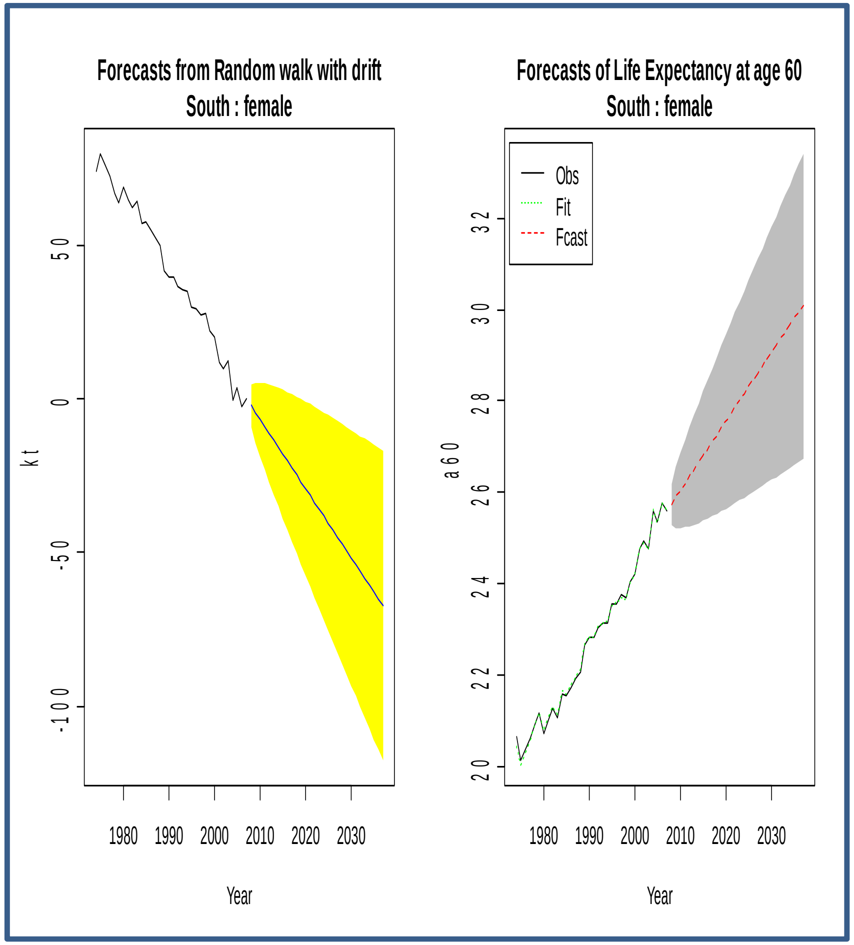


Figure2: Life expectancy at 60 for female

The projected transformation coefficients

Level	Retirement Age								
	57	58	59	60	61	62	63	64	65
nord	4,265%	4,330%	4,397%	4,465%	4,534%	4,603%	4,674%	4,745%	4,818%
centro	4,261%	4,326%	4,392%	4,460%	4,529%	4,599%	4,670%	4,742%	4,814%
sud	4,354%	4,420%	4,488%	4,557%	4,627%	4,697%	4,768%	4,840%	4,912%

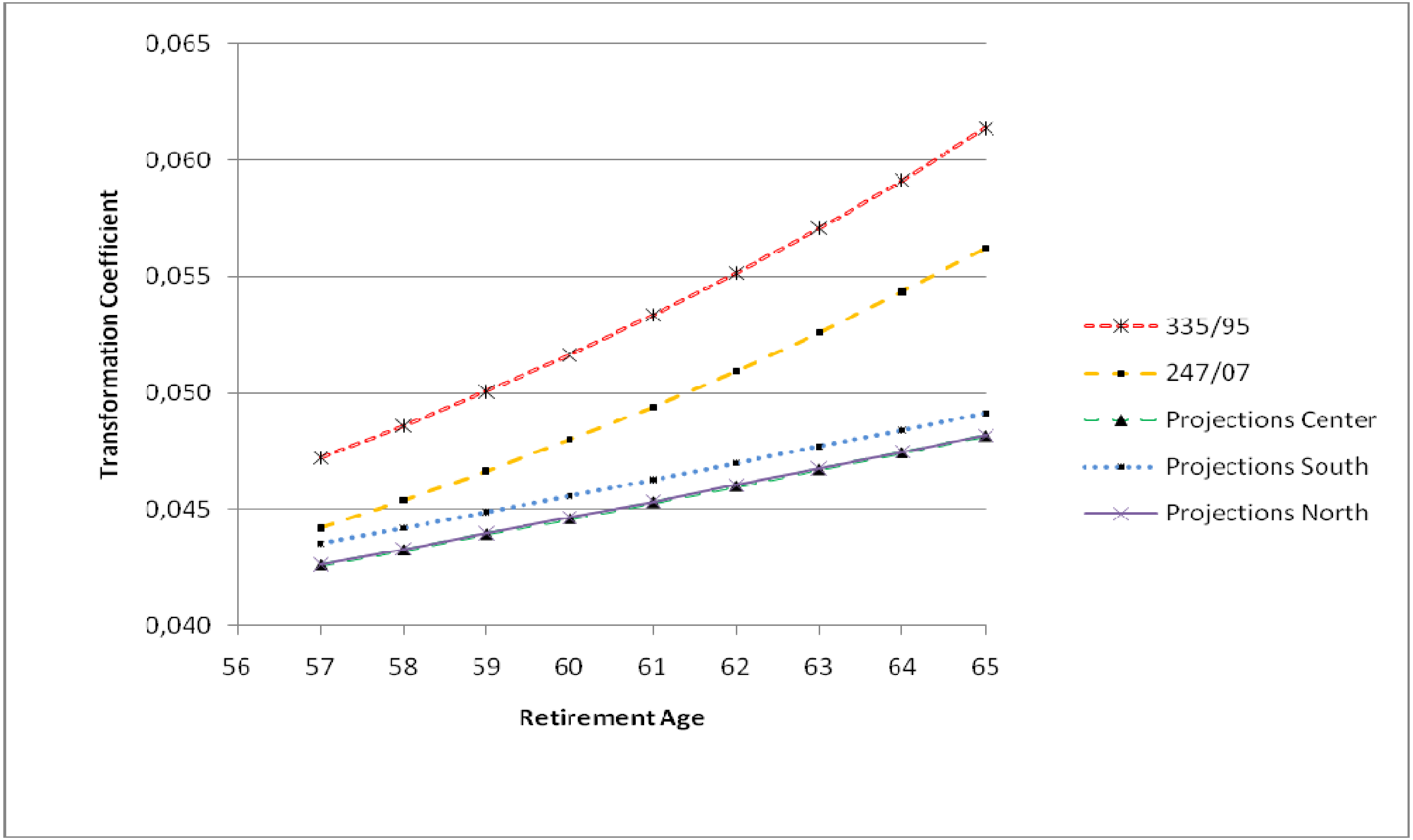
We have derived estimations of coefficients for 2013, setting according to the Law :

$$g_f = r = 0.015$$

$$\theta = 0.6$$

$$\gamma = 0.42$$

The projected transformation coefficients



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Concluding Remarks

- According to the actual Law TC are the same
- If the heterogeneity within the population is not taken into account , there is a redistribution from shorter to longer living individuals
- If we take into account the heterogeneity in the data, higher transformation coefficients should be applied
- To have higher pension for shorter period

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