Longevity Risk in Notional Defined Contribution Pension Schemes: a Solution

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What is a NDC Pension Scheme?

	PAYG	Funding
DB	Classical social security	Classical employee benefit DB plan
DC	NDCs	Pension saving accounts

→ NDCs attempt to reproduce the logic of a financial defined contribution pension plan within a pay-as-you-go framework.

What is a NDC Pension Scheme?

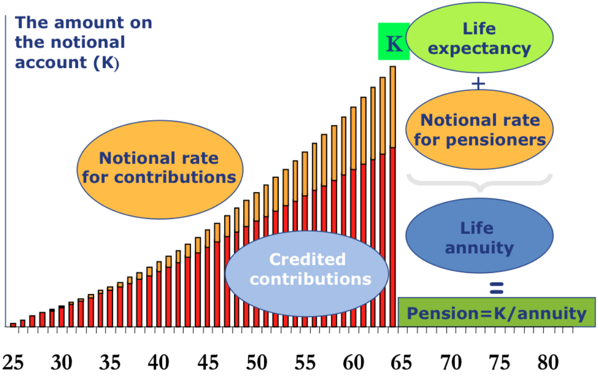

Figure: Principle of NDCs

What is a the survivor dividend?

- In most NDC countries, when a death occurs prior to the retirement age, the accumulated capital of the deceased person is kept by the scheme.

- Sweden is the only country that distributes the accumulated capital of the deceased person among the survivors of the same birth cohort.
  $\rightarrow$ Survivor Dividend (or inheritance gains)

[Boado-Penas and Vidal-Meliá(2014)]

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How can we use the survivor dividend?

- Distribute it to the survivors, as in Sweden.
- Accumulate some financial reserves for other purposes.
  $\rightarrow$ Can we use it to finance longevity improvements?

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Aim

To determine if the amount of the survivor dividend is sufficiently large to cover the aggregate longevity risk faced by NDC pension schemes.

The Lee-Carter model

$$\ln \mu_{(x,t)} = \alpha_x + \beta_x \kappa_t + \epsilon_{(x,t)}$$

[Lee and Carter(1992)]

Assume mortality rates are observed up to year T:

$$\begin{aligned} \ln \hat{\mu}_{(x,T+1)} &= \hat{\alpha}_x + \hat{\beta}_x \hat{\kappa}_{T+1} \\ &= \ln \hat{\mu}_{(x,T)} + \hat{\beta}_x \left(\hat{\kappa}_{T+1} - \hat{\kappa}_T \right) \\ &= \ln \hat{\mu}_{(x,T)} + \hat{\beta}_x \gamma \end{aligned}$$

More generally,

$$\ln \hat{\mu}^*_x = \ln \hat{\mu}_x + \hat{\beta}_x \gamma$$

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Pension amount if the survivor dividend IS NOT distributed

[Boado-Penas and Vidal-Meliá(2014)]

$$P^{nd}_{(x_e+A,t)} = \frac{K^{nd}_{(x_e+A,t)}}{\ddot{a}^{\lambda}_{x_e+A,g}}$$

with

$$\begin{aligned} P^{nd}_{(x_e+A,t)} &= \text{initial pension;} \\ K^{nd}_{(x,t)} &= \text{accumulated notional capital at time } t \\ &\quad \text{for an individual age } x; \\ \ddot{a}^{\lambda}_{x,g} &= \sum_{k=0}^{\infty} \left(\frac{1+\lambda}{1+g} \right)^k \cdot {}_k p_x \\ &= \text{whole life annuity-due indexed at rate } \lambda, \\ &\quad \text{with a technical interest rate equal to } g, \\ &\quad \text{for an individual age } x. \end{aligned}$$

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Expenditure if the survivor dividend IS NOT distributed

$$
\begin{aligned}
E_t^{nd} &= \sum_{k=0}^{\infty} P^{nd}_{(x_e+A+k,t)} \cdot l_{(x_e+A+k,t)} \\
&= \sum_{k=0}^{\infty} P^{nd}_{(x_e+A,t)} \cdot l_{(x_e+A,t)} \cdot {}_k p_{x_e+A}
\end{aligned}
$$

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Pension amount if the survivor dividend IS distributed

$$P_{(x_e+A,t)} = \frac{K_{(x_e+A,t)}}{\ddot{a}^{\lambda}_{x_e+A,g}} = \frac{K^{nd}_{(x_e+A,t)} + D^{ac}_{(x_e+A,t)}}{\ddot{a}^{\lambda}_{x_e+A,g}}$$

with

$P_{(x_e+A,t)}$ = initial pension;

$K_{(x,t)}$ = accumulated notional capital at time t for an individual age x;

$D^{ac}_{(x,t)}$ = accumulated survivor dividend at time t and age x.

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Expenditure if the survivor dividend IS distributed

$$E_t = \sum_{k=0}^{\infty} P_{(x_e+A+k,t)} \cdot l_{(x_e+A+k,t)}$$
$$= \sum_{k=0}^{\infty} P_{(x_e+A,t)} \cdot l_{(x_e+A,t)} \cdot {}_k p_{x_e+A}$$

→ $P_{(x_e+A,t)} > P^{nd}_{(x_e+A,t)} \rightarrow E_t > E^{nd}_t$

→ The difference between E_t and E^{nd}_t represents the amount saved by the scheme.

→ Which longevity improvement can it finance?

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2 scenarios in 2 different settings

- No growth of salaries and no indexation of pensions
  - Constant improvement in the survival rates, denoted α: $E_t^{nd*} = P^{nd}_{(x_e+A,t)} \cdot l_{(x_e+A,t)} \sum_{k=0}^{\infty}(1+\alpha)^k {}_k p_{x_e+A}$
  - Mortality decrease according to the Lee-Carter model $\rightarrow$ Determine γ
- With growth of salaries and indexation of pensions
  - Constant improvement in the survival rates
  - Mortality decrease according to the Lee-Carter model

Assumptions

- Entry age = 25;
- Retirement age = 65;
- Contribution rate = 16%;
- Last age in the mortality tables = 110;
- Three mortality tables: Poland, Sweden and Latvia.

No growth of salaries and no indexation of pensions

	Latvia	Poland	Sweden
E_t^{nd} (in mill.)	1,324	1,395	1,598
E_t (in mill.)	1,610	1,642	1,710
Increase in Life Expectancy Δe_r	3.65	3.12	1.42
Increase in survival probability a	1.85%	1.53%	0.59%
Maximum mortality decrease	35.32%	31.86%	17.24%
Life expectancy after retirement	16.39	17.10	19.84
Negative interest rate b	-1.81%	-1.50%	-0.58%

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No growth of salaries and no indexation of pensions

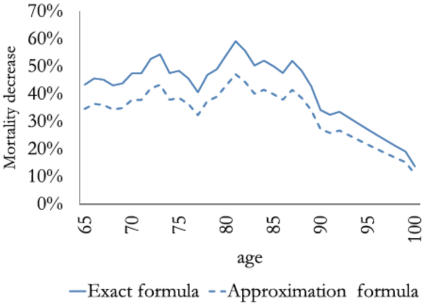

Figure: Age-specific mortality decrease according to the Lee-Carter model, Latvia

No growth of salaries and no indexation of pensions

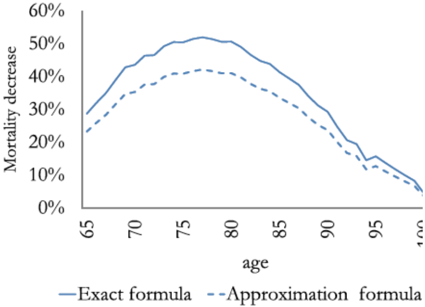

Figure: Age-specific mortality decrease according to the Lee-Carter model, Poland

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No growth of salaries and no indexation of pensions

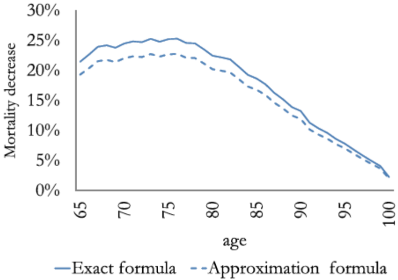

Figure: Age-specific mortality decrease according to the Lee-Carter model, Sweden

Retrospective analysis

	Latvia	Poland	Sweden
$E_t^{nd(t)}$ (in mill.)	1,324	1,395	1,598
$E_t^{nd(1980)}$ (in mill.)	1,217	1,279	1,453
Difference $E_t^{nd(t)} - E_t^{nd(1980)}$ (in mill.)	107	116	145
Survivor dividend (in mill.), using 1980 tables: $D_{(65,t)}^{ac(1980)}$	310	290	203
Is $E_t^{nd(t)} - E_t^{nd(1980)} < D_{(65,t)}^{ac(1980)}$?	Yes	Yes	Yes

Note: $t = 2009$ for Poland and $t = 2011$ for Latvia and Sweden.

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Concluding remarks

If the survivor dividend is kept by the system, some reserves are accumulated.

- These reserves can be used to finance some unexpected mortality improvements;
  - Latvia: 35.3%
  - Poland: 31.9%
  - Sweden: 17.2%

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Concluding remarks

- An increased salary growth and a reduced pension indexation result in more important mortality improvements that a NDC scheme can cover;
- The survivor dividend could have financed the mortality improvements over the last 30 years, and even more.
  - What about a minimum pension providing a minimum standard of living for the pensioners?
  - What about an automatic balancing mechanism to re-establish the liquidity and/or the sustainability in pay-as-you-go pension systems?

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Thank you for your attention!

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