On The Demographic and Economic Risks of a Pension Plan

Claire Bilodeau

Université Laval

ARC 2000, Quebec City

Outline

- Definition of the risks
- Contexts in which these risks were studied
- New context: pension plan w/ multiple decrements
- Conclusion
- Further research

Definition of the risks

- Demographic risk:
  - variability of results due to random nature of decrements
  - also called insurance risk
  - can be diversified

Definition of the risks

- Economic risk
  - variability of results due to random nature of economic variables
  - also called investment risk
  - cannot be diversified

Contexts in which these risks were studied

- Demographic risk alone, single life
  - mortality only
  - both life insurance and annuity
  - Pollard and Pollard (1969)
  - part of actuarial curriculum
  - easy to extend to multiple independent lives

Contexts in which these risks were studied

- Both risks, single life
  - mortality and rate of return
  - both single life insurance and annuity
  - Pollard (1971)
  - Panjer and Bellhouse (1980, 1981)
  - Beekman and Fuelling (1990)

Contexts in which these risks were studied

- Both risks, portfolio
  - mortality and rate of return
  - mostly life insurance
  - Waters (1978)
  - Frees (1990)
  - Parker (1994)
  - Marceau, Gaillardetz (1999)

Contexts in which these risks were studied

- Economic risk only, annuities or portfolio
  - rate of return only
  - limiting distribution of portfolio
  - Dufresne (1990)
  - Parker (1993)
  - several others in more recent years

Contexts in which these risks were studied

- Economic risk only, pension plan
  - rate of return only
  - contributions and funding level
  - Dufresne (1988)
  - Haberman (1992)

New context: pension plan w/ multiple decrements

- Pension plan characteristics:
  - retirement benefit: 2% * service * final salary
  - all pensions are fully indexed
  - early and postponed retirements:
    - table of factors
    - more generous than actuarial equivalence

New context: pension plan w/ multiple decrements

- Pension plan characteristics (cont'd)
  - death benefit: commuted value of pension
  - disability benefit:
    * waiver of contributions * service accrual
    * indexed salary * pension at 65
  - withdrawal benefit: pension at 65

New context: pension plan w/ multiple decrements

- Demographic variables:
  - mortality
  - withdrawal
  - disability
  - retirement
  - all modeled as multinomial

New context: pension plan w/ multiple decrements

- Economic variables:
  - price inflation
  - rate of return (bills, bonds and stocks)
  - wage inflation
  - modeled as in Wilkie (1986) and Sharp (1993)
  - but fixed salary scale

New context: pension plan w/ multiple decrements

Parker (1997) splits the total risk Var(Z/n) as:

- demographic risk

$$E[Var(Z/n|returns)]$$

- economic risk

$$Var(E[Z/n|returns])$$

where Z is the total cost of n contracts

New context: pension plan w/ multiple decrements

Look at entrants at age 20 only

Simulations only for one individual since…

- investment risk is constant
- insurance risk decreases with number

New context: pension plan w/ multiple decrements

Results for one individual

demographic risk: 7,762,900,056

economic risk: 625,914,682

So, 12.5 individuals equalize the risk!

Conclusion

For relatively small n,
economic risk > demographic risk,
in pension plans.

But these results are preliminary!

Plans of given plan size, 1996

Size of plan	Number	%
0	150	2.2
1-9	2,221	32.2
10-99	2,222	32.3
100-499	1,511	21.9
500-999	322	4.7
1000+	458	6.7

Members in given plan size, 1996

Size of plan	Number	%
0	-	-
1-9	4,871	0.1
10-99	96,826	2.1
100-499	352,974	7.8
500-999	225,224	5.0
1000+	3,855,493	85.0

Further research

- Full-fledged pension plan (different ages)
- Variable number of entrants
- Different tables of decrements
- Different pension plan characteristics
- Analytical results with tractable investment model