The Actuarial Profession
making financial sense of the future

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Impaired Annuities

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Overview

- Market and product features
  - Impaired pension annuities
  - Immediate needs annuities
- Impact on standard annuity market
- Longevity and enhanced annuities
- Pricing

Impaired Pension Annuities – A success story?

- 1995 Stalwart launched a smoker annuity
- 1995 PAFS launched a fully impaired annuity
- 1996 Stalwart launched a lifestyle annuity

Current Providers	
Axa Sun Life	Pension Annuity Friendly Society
Britannic Retirement Solutions	Pinnacle
GE Life	Prudential
MGM	Reilance Mutual
Norwich Union	Scottish Widows

Impaired Pension Annuities – A success story?

- Success in terms of sales
- Represent around 20% of conventional annuities sold under open market options
- Some of the niche players hold significant market share
- Amendments made to product design

Impaired Pension Annuities - Features

- Mortality assessed using factors other age and gender
  - Lifestyle factors – smoking, geographical area residence, obesity
  - Medical impairments
- Lead time from quote to commencement of annuity
- Verification of individual risk factors – medical evidence obtained large number of cases
- Balance additional acquisition costs against the benefit of the enhancement from extra mortality
- Take up rate

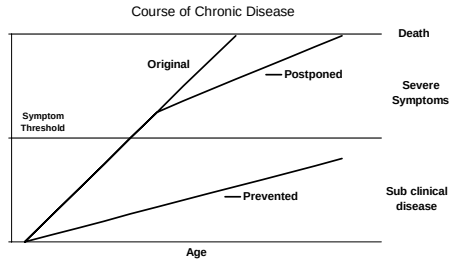
Impaired Pension Annuities – Common Application Form

- Developed over the last couple of years
- Accepted by most providers
- Most IFAs now accustomed to completing a single form
- Medical evidence from the GP is shared
- Any additional medical information is obtained by the provider directly

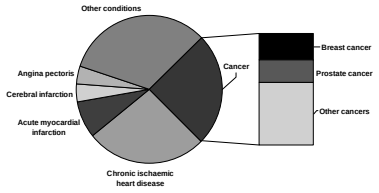
Impaired Pension Annuities - Longevity

- For a significant enhancement the extra mortality needs to be
  - significant
  - permanent
  - verifiable
- For a significant enhancement mortality improvements
  - act over only a few years
  - also due to improvements in conditions other than the main impairment
- Mortality improvements for people with less serious conditions or with lifestyle impairments are important

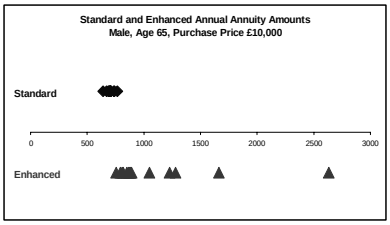
Impaired Pension Annuities - Longevity



Impaired Pension Annuities – Potentially severe conditions



Pension Annuities – Range of Market Rates



Impaired Pension Annuities – Impact on standard rates

Impairment	*Proportion of Pension Policies*	*Uplift in Annuity p.a.*	*Implied Extra Mortality*
Severe	2%	50%	+190%
Moderate	3%	35%	+125%
Slight	5%	15%	+40%
None	90%	0%	-11%
Weighted Total	100%		0%

- Aggregate mortality for all pensions annuities is +0%

Impaired Pension Annuities – Impact on standard rates

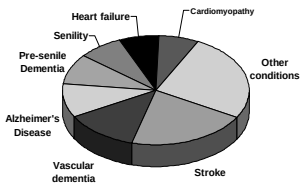
Impairment	*Proportion of Pension Policies*	*Uplift in Annuity p.a.*	*Implied Extra Mortality*
Severe	4%	50%	+190%
Moderate	6%	35%	+125%
Slight	10%	15%	+40%
None	80%	0%	-24%
Weighted Total	100%		0%

- Increased proportion of impaired pension annuities
- Annuity payments for non-impaired lives reduced by about 5%

Immediate needs Annuities - Providers

Providers	
Britannic Retirement Solutions	Pension Annuity Friendly Society
BUPA	PPP Lifetime Care
GE Life	Scottish Widows
Norwich Union	

Impaired Needs Annuities – Potentially severe conditions



Immediate Needs Annuities – Pension Annuities Features Compared

	Pension Annuity	Immediate Needs
Compulsory purchase	Yes	No - debatable greater selection
Average age	60-65	80-85
Multiple Impairments	Two thirds	Three quarters
Percentage of standard lives	Lower	Higher
Capital Protection	No	Yes
Purchase price range	Most severe cases for large funds chose income drawdown	Some demand for very large premiums
Common application form	Nearly all	Most providers

Key Factors in Pricing Annuities

- Expected pattern of mortality
- Rate of interest earned
- Expenses
  - Administration
  - Underwriting

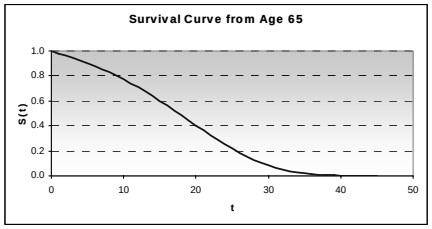
Underwriting Impaired Annuities

- 'Broad Brush' approach
  - Single impairments e.g. smoker annuities
  - Points scoring approach
- Individually underwritten
  - Impairments
  - Symptoms exhibited
  - Date of diagnosis
  - ADL's failed

Mortality data

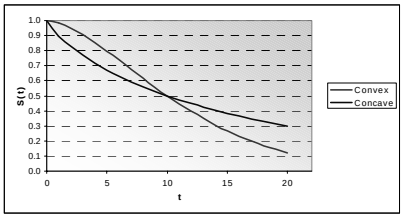
- No standard tables
- Actuarial modelling
- Limited data available
  - Existing blocks of business
  - Scientific research papers
  - Underwriters/CMO judgement and expertise

Survival Analysis S(t)



Shape of Survival Curve

- Survival curves for impaired lives may be concave or convex, depending on the nature of the impairment.



Shape of the Survival Curve

- Concave impairments are those that exhibit high mortality initially, with a subsequent decreasing force of mortality, e.g. stroke, most forms of cancer.
- Convex impairments are those that exhibit low mortality initially, with a subsequent increasing force of mortality, e.g. Alzheimer's
- For a given life expectancy, changing the shape of the curve changes the present value of annuity payments significantly, e.g. 10-20%.
- Insufficient to just have life expectancy of individual

FORM

Form of Survival Model

- There are many different types of model we could use. For example:

Multiple of mortality
$q_x = (1+m) \times q_x$

Addition to mortality
$q_x = q_x + c$

Exponential model
$S(t) = exp(-\lambda t)$

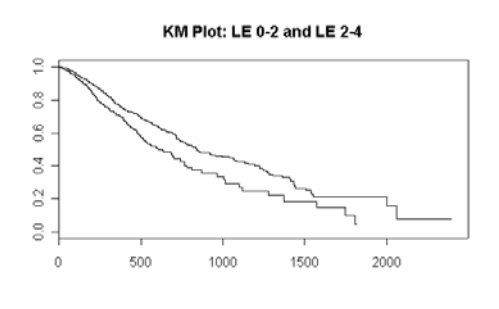
Weibull model
$S(t) = exp(-\lambda t^{\alpha})$

Fitting a model to an existing block of business

- Using a non-parametric model
- Kaplan-Meier Estimation
  - The KM method gives the non-parametric estimate of *S(t)*. This is a step function, with *S(t)* taking a step downward at each time t at which a death was observed in the data.

Using a non-parametric model

Using a non-parametric model



FORM

Fitting a Regression Model

- We notice that survival depends on at least one variable, i.e. the underwriter's assessment of the life expectancy (LE).
- We will allow for explanatory variables by using the Weibull regression model:

$$Y = \ln X = \mu + \sum_{i=1}^{n} \beta_i z_i + \sigma W$$

W is the extreme value distribution function with density function:

$$f_w(w) = \exp(w - e^w)$$

(X=Survival Time; z_i=Values of explanatory variables)

Fitting a Regression Model

- We find the estimates of μ, βi, and σ using a statistics program that can fit linear regression models (e.g. R).
- The survival curve for an individual is then given by:

$S(t) = exp(-\lambda t^{\alpha})$

where:

$\alpha = 1/\sigma$ ← Shape

$\lambda = \exp(-\frac{\mu + \sum \beta_i z_i}{\sigma})$ ← Scale

Fitting a Regression Model

- Let's fit this model to our dataset, using LE as the only variable:

```
> summary(survreg(Surv(survival, status)~1+le,
data=survdata))

Call:
survreg(formula = Surv(survival, status) ~ 1 + le, data =
survdata)
              Value Std. Error     z       p
(Intercept) 6.393     0.1092 58.57 0.00e+00
le          0.260     0.0474  5.48 4.15e-08
Log(scale)  -0.243     0.0381 -6.38 1.76e-10

Scale=0.784

Weibull distribution
Loglik(model)= -3309.7   Loglik(intercept only)= -3327.4
        Chisq= 35.46 on 1 degrees of freedom, p= 2.6e-09
Number of Newton-Raphson Iterations: 6
n= 1065

>
```

μ

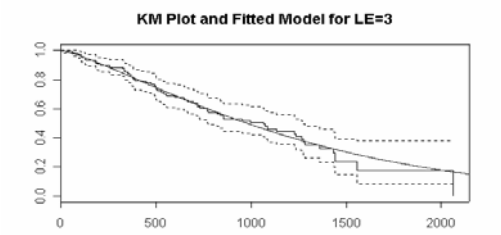
β_i

σ

FITTING

Fitting a Regression Model

- Compare the fitted model with the KM plot, for all cases where the LE is 3:



Fitting a Regression Model

- Our choice of model, using LE as a regression variable, looks to be a good one.
- We can try to improve the model by adding additional variables. We can check how useful each variable is by testing the hypothesis:

  H_0: $\beta_i = 0$

- If we can reject this hypothesis, then z_i has useful predictive power in our model.

Fitting a Regression Model

- In our example, the best regression model was one based on the following variables:
  - Ln(Life expectancy)
  - Number of ADLs failed
  - Age at entry

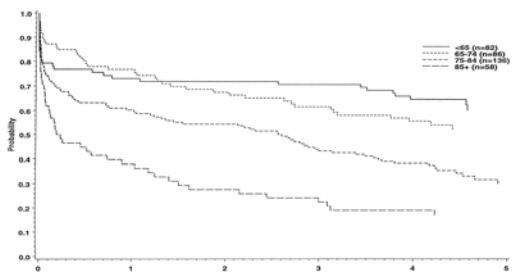
Y = ln X = 2.7134 + 0.4033ln(LE) - 0.0605ADL - 0.0198Age + 0.776W

Data available from Research Papers

- Survival analysis
- Relevance of studies
  - size
  - location
  - study bias
- Multiple impairments
- Conditions not clearly defined such as frailty

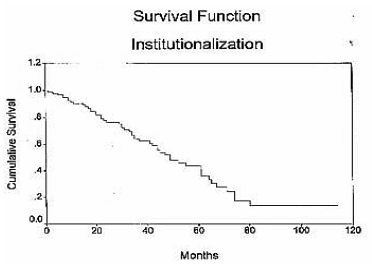
OBSERVATIONS

Probability of survival over 5 years of follow-up in patients with a first ever stroke in 1989-1990



OBSERVATIONS

Probability of survival over 10 years of patients with Alzheimer's disease when institutionalised



Interpretation of Research Papers

- Duration since diagnosis
- Age at diagnosis
- Gender
- Regional variations
- Affect of affluence
- Improvements over time

Future Improvements in Mortality

- Impact of medical advances
- Historical improvements:
  - Breast cancer 1 year survival rate 2% every 5 years
  - Breast cancer 5 year survival rate 4% every 5 years
  - Lung cancer 1 year survival rate 1.5% every 5 years
  - Lung cancer 5 year survival rate 0.5% every 5 years
- Less data available for other disease processes
- Mortality improvement rate has significant impact on annuity value

Significant Factors for Impaired Life Mortality Assumptions

- Life expectancy
- Shape of the survival curve.
- Duration since diagnosis – whereabouts on the survival curve are you?
- Future mortality improvements – are improvements likely to be lower or higher than for standard annuities?

Conclusions

- Important to have confidence in your survival model, because if you get it wrong, this can have a significant financial effect.
- Data collection and analysis of emerging experience is essential