8 Selection

Insurance company desires lives insured to be

homogeneous with respect to:

- **mortality**
- **morbidity**
- **any other characteristic of interest**

Also, when a policyholder purchases a policy, they:

- **wish to pool their risks with similar risks**
- **are not likely to pool risks with significantly higher risks**

Example: An insurance company insures 6 lives, where the expected loss is:

- 5 for 3 lives; and
- 10 for 3 lives

Consider the following:

Scenario A: Company treats them as a single homogeneous population. **The premium the company should charge is 7.5**

Scenario B: Company treats them as two homogenous groups for pricing. **The premium the company should charge is 10 and 5 accordingly.**

Pricing based on heterogeneous populations raises questions of:

- equity (fairness)
- anti-selection

Examples of a population include

(a) **the 'national' population of a country**

(b) **lives insured under whole life policies**

(c) **lives aged 30 when they purchased insurance from Company Z in 1972**

(d) **drivers of four year old cars insured by**

company Z in city M

In practice no population is homogeneous. All populations are heterogeneous to some extent and the causes of heterogeneity are varied and depend on the population being discussed.

If subgroups of a population are heterogeneous (different) with respect to factors that affect, say, mortality, then **the subgroups may have different mortality rates.**

This heterogeneity is referred to as **selection.**

We consider:

(a) Temporary initial selection
(b) Time selection
(c) Class selection
(d) Adverse selection
(e) Spurious selection

8.1 Temporary Initial Selection

Definition: Temporary initial selection is **the difference in mortality due to differences in the duration since policy inception.**

An example of this can be seen in the mortality rates of ‘Permanent Assurance (whole life and endowment) policyholders 1991–94’ (C.M.I.R. 17 1999). The rates given in the table pertain to male policyholders.

Table 1: Mortality rates.

age	Duration 0	Duration 1	Duration 2+
30	0.000476	0.000558	0.000590
50	0.001971	0.002434	0.002508
70	0.016582	0.022210	0.024783

Notes:

- The mortality for lives who have more recently joined the insured population **is lighter.**

  A possible explanation is that underwriting
  ensures that only **healthy lives are able to take out insurance**

- As duration since policy inception increases some lives become **less healthy**
- The difference between the mortality of lives with different duration **decreases as duration increases**
- After a period (called the select period)
  differences in duration since policy inception are **assumed to have no impact on mortality rates.**
- In the U.K. a 2-year select period is used, while in North America 10 to 15 years is common for the select period.

Reverse selection, the opposite of temporary
initial selection, is when the mortality rates for new members are **worse than for existing**

members.

In the table below consider the claim rates for **IPI for deferred periods 1 week and 26 weeks for Males, individual policies 1987–94.**

Deferred

period	Duration 0	Duration 1	Duration 2+
D1	2.068	0.983	0.953
D26	1.631	0.938	0.955

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Although there are large standard errors

associated with these transition intensities there is **clear evidence of reverse selection.**

Reverse selection can also be found in **the mortality of 'ill-health' pensioners.**

8.2 Time selection

Definition: Time selection refers to **differences in mortality rates (or other characteristics of interest) due to differences in the time in history they lived.**

As an example we consider the mortality rates for Males, Permanent Assurances (CMIB graduations) in the table below.

Note the values are for lives of the same **age, sex and duration.**

	$q_{[x]}$		q_x	
		AM92		AM92
Age	A67/70	91/94	A67/70	91/94
30	0.00044	0.00048	0.00065	0.00059
50	0.00286	0.00197	0.00479	0.00251
80	0.02531	0.04383	0.09703	0.06930

This shows that **mortality changes over time.**

Reasons for changes:

(a)
- **medical advances**
- **improving hygiene standards**
- **changes in standard of living**
- **changes in levels of education**

(b) changes in influences of mortality like:
- **lowering of infant mortality**

- **rise in teenage deaths**
- **AIDS epidemic**

(c) changes in:

- **office policy and underwriting**
- **types of policyholders**
- **mix of offices contributing data**

Impact of Changes

Unexpected mortality improvements may have a significant **adverse impact on annuities.**

The insurance company needs to allow for
changing longevity in **pricing and reserving for annuitants.**

Limiting the impact of time selection

Two of the ways in which effects of time selection can be minimised are:

(a) Use of **short time periods for mortality**

investigations (eg 3–5 years).

For example when estimating transition intensities $\mu_x = \frac{\theta_x}{E_x^c}$ it is usual to calculate θ_x and E_x^c from data spanning 3–4 years. The idea is to **minimise the scope for time selection**

(b) **Model the trend.**

This allows data over longer periods of time to be used but with the added requirement that **the trend, in addition to the rates, has to be modelled.**

8.3 Class selection (or Stratification)

Definition: Class selection is due to **differences (in mortality) due to some permanent feature**
separating the populations.

We consider some examples:

(a) Males and females have different **mortality and morbidity experiences.**

Consider the following example:

Mortality rates by sex: population A

	E_x	θ_x	q_x
Male	500	15	0.030
Female	4,500	90	0.020
Aggregate	5,000	105	0.021

Mortality rates by sex: population B

	E_x	θ_x	q_x
Male	3,000	90	0.030
Female	2,000	40	0.020
Aggregate	5,000	130	0.026

(b) Holders of term assurances and permanent assurances have **different mortality experiences.**

Mortality rates by type of policy.

Mortality of Males (Individual policies)

Age	AM92	TM92
30	0.00048	0.00063
50	0.00197	0.00244
80	0.04383	0.07024

(c) People in different socio-economic classes may have different **mortality and morbidity rates.**

This may be due to differences in:

- **housing**
- **diet**
- **medical care**
- **exercise**

Ways of dealing with class selection include

splitting the data by factors that may cause class selection.

To do this more data is required which can be obtained by:

(a) Using **longer periods of investigations**

However, this may lead to **time selection.**

(b) **Pooling data from many offices**

However, this may introduce further class selection due to differences in the offices experiences arising out of differences in:

- **location and target market**
- **underwriting standards**
- **options applicable to the policies**

- **surrender values paid**

8.4 Adverse or Anti selection

Definition: This is the difference in mortality rates between two populations arising out of **the ability of lives in one subpopulation to take actions that are to the financial disadvantage of an insurer.**

This is also known as **'selection against the office'.**

The following are some examples:

(a) Company A requires all applicants to undergo a medical test as part of policy application while Company B does not.

Adverse selection occurs if the mortality experience of Company B is worse than that of A because **lives who know that they may fall ill (such that the premiums charged are low given their risk)**
purchase insurance from Company B.

(b) Smoking is associated with heavier mortality but UK standard tables are not split on smoker/non-smoker basis.

¿From the C.M.I.R. 16 (1991/94) data for permanent assurances:

$$q_x^{smokers} \approx 1.7 q_x^{non-smokers} \qquad \text{for males}$$

$$q_x^{smokers} \approx 2 q_x^{non-smokers} \qquad \text{for females}$$

Until 1981 all offices charged the same premium for smokers and non-smokers.

No problem if:

- proportion of smokers among policyholders is **the same as in the general population; and**
- no company in the industry **offers differentiated premiums**

However in 1981, some offices started offering discounts to non-smokers. The result was that:

(i) non-smokers went to **offices offering discounts**

(ii) the offices not offering discounts **were left insuring increasing proportion of smokers**

(iii) the mortality experience of the offices not offering discounts **worsened and they had to start offering discounts to non-smokers**

(c) A current issue in insurance underwriting is whether insurers should have access to results of genetic tests done on applicants.

There are gene mutations which are known to
increase the risk of disorders like Breast and
Ovarian cancer, Huntington's disease and Alzheimers disease.

Arguments include:

- will mutation carriers use the knowledge of status to **buy more insurance cheaply**
- should insurers be able to ask for **the results from genetic tests previously taken**
- should insurers be allowed **to use family history**

8.5 Selective Decrements

Definition: Selective decrements are categorised by a grouping or selection **in one decrement which affects other decrements in the population.**

We consider examples:

(a) In life insurance policyholders, the most likely people to lapse their policies are those **in good health.**

This affects the resulting mortality of the insured population.

(b) Terms assurances may have the option to renew at the end of the term at normal rates without any evidence of good health:

- healthy lives may exercise the option but **they can also go elsewhere**
- unhealthy lives may not be able to go elsewhere **making this option very**

attractive to them

(c) Consider the mortality of active members (not retired) of a pension scheme. This population:

- increases by **new people employed (mainly healthy people)**
- decreases by the people who **retire early (mainly ill people retire early)**

The selective nature of these 'entrants' and 'leavers' affects the **mortality of the active members.**

8.6 Spurious Selection (or Confounding)

Definition: This is when some feature of a population which appears to be caused by selection is **actually caused by some underlying heterogeneity.**

As an example we consider a lives joining a population at age 30, consisting of two groups A and B whose mortality at ages 30 and 31 are shown in the table.

Mortality rates for groups A and B

Group	No. Joining	q_{30}	q_{31}
A	1,000	0.002	0.002
B	1,000	0.003	0.003

If all members stay in the population we have:

$$q_{[30]} = 0.0025$$

$$q_{[30]+1} = 0.0025$$

If half of group A leave after 1 year then we have

$$q_{[30]} = 0.0025$$

$$q_{[30]+1} = \frac{2}{3}(0.003) + \frac{1}{3}(0.002) = 0.0027$$

This may give the impression that there is

temporary initial selection, but the underlying cause is different.

Some references for Chapter 4 and Chapter 5

(a) Demographic Methods by Andrew Hinde (Arnold 1998)

(b) The British Population. Patterns, Trends and Processes by Coleman D. and Salt J. (Oxford University Press 1992).

(c) The analysis of mortality and other actuarial statistics by Benjamin B. and Pollard J.H. (1993)