European actuarial academy

an initiative of the 'Deutsche Aktuarvereinigung', the Dutch 'Actuarieel Genootschap', the 'Schweizerische Aktuarvereinigung' and the 'Aktuarvereinigung Österreichs'

Session 2

Introduction to IBNR-reserving

Agenda

- General data-structure and what to forecast
  - Characteristics of non-life insurance
  - Decomposition of loss ratio
  - Run-off of prior risk years
  - IBNR-reserves
- Description of basic IBNR-methods
  - Chain Ladder method numerically
  - Bornhuetter-Ferguson

  - Chain Ladder method graphically
- Some common data problems

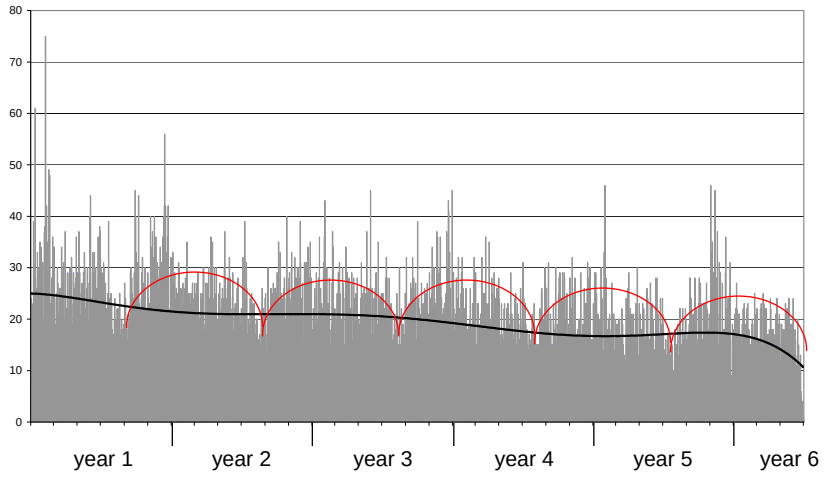
Characteristics of non-life insurance (1)

- Highly competitive and cyclical markets
- Short contract terms compared with life/pensions
- Insurance risk
  - Frequency of claims: strong seasonal variability
  - Size of claims: incidental large claims have strong impact
  - Additional uncertainties: claims reporting lag, settlement of claims

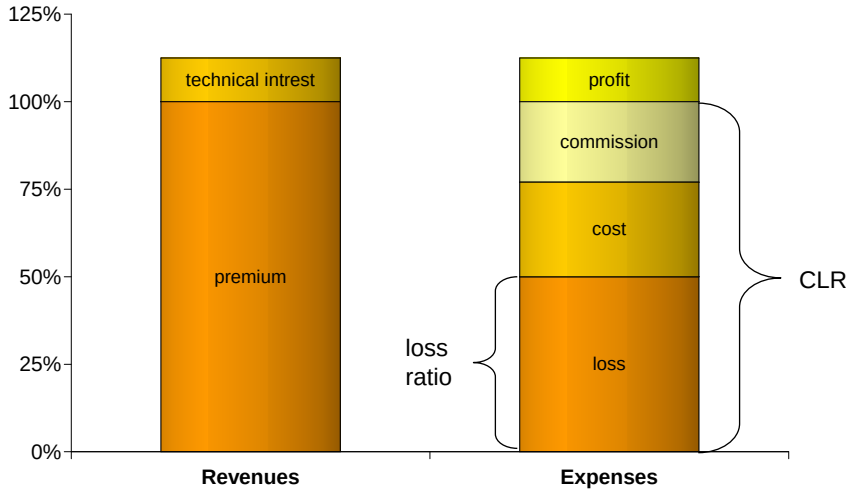
  ⇒ By the end of risk year, still much uncertainty about loss

Characteristics of non-life insurance (2)

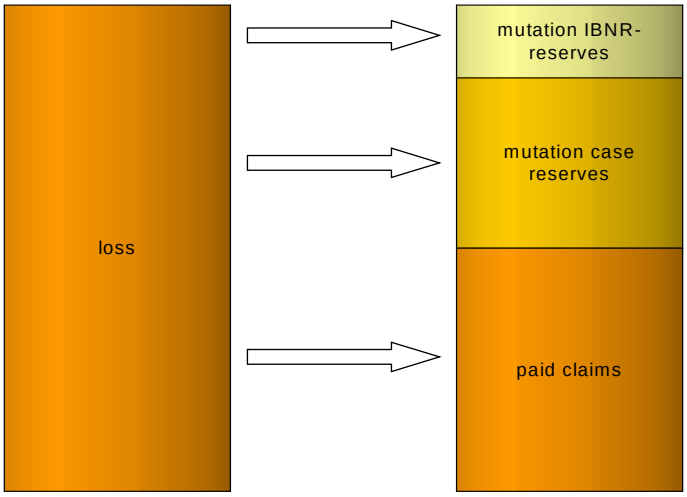
Claims frequency (Car insurance)



Decomposition of loss ratio (1)



Decomposition of loss-ratio (2)



Decomposition of loss-ratio (3)

Case reserves

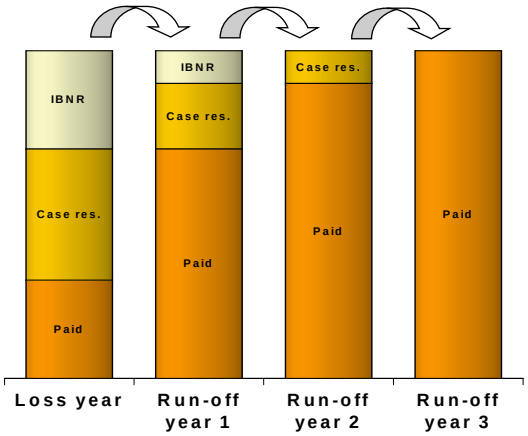
- Small and young claims: standard average amount
- Large and older claims: set by claims handler

IBNR-reserves

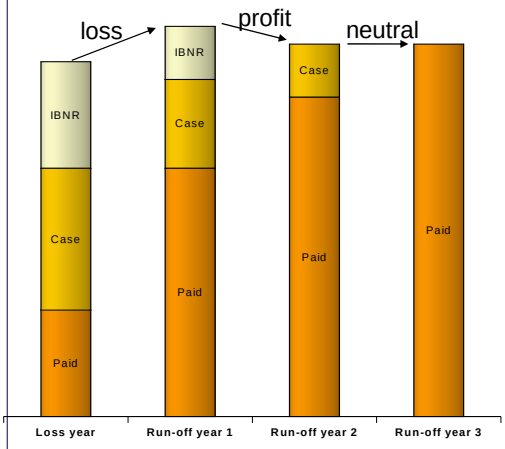
- Incurred But Not Reported (IBNR) claims
  ⇒ claims not known to insurer
- Incurred But Not Enough Reserved (IBNER) claims
  ⇒ if <u>total</u> case reserves are systematicly too high/low

Run-off of prior risk years (1)

Ideal situation: no run-off result (with certainty)



Reality: run-off result through time



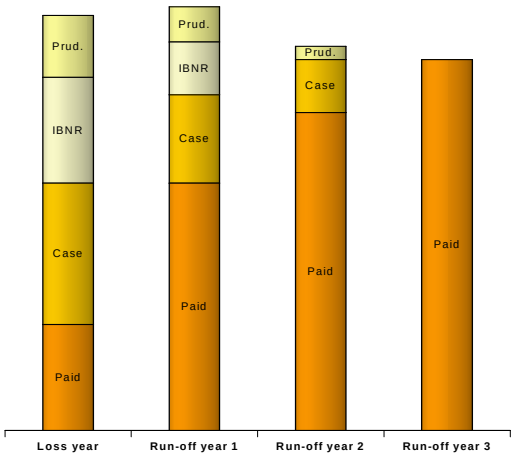
caused by

- randomness of risk process

and unexpected changes of

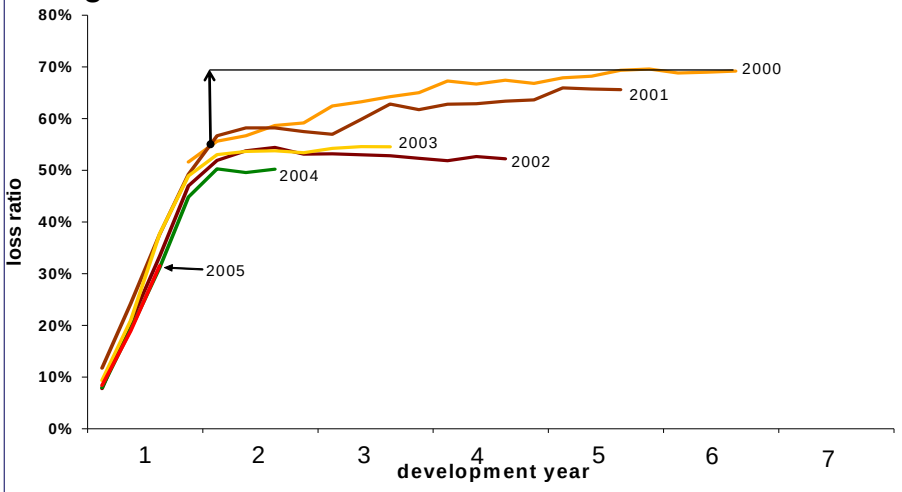
- customer claim behavior
- law, jurisprudence
- payment policy (law suits)
- reserving policy
- claims handling workflow
- underwriting rules

Additional reason of run-off result: prudency margins



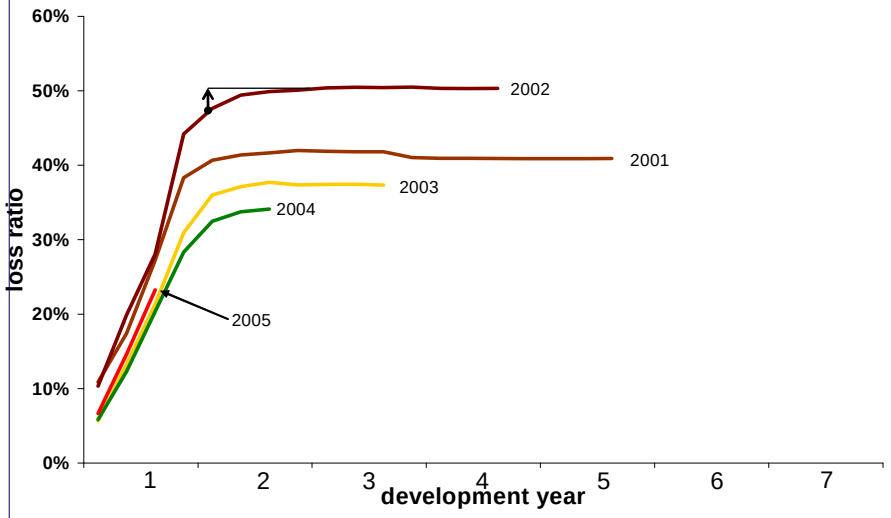
IBNR-reserves (1)

Long tail business



IBNR-reserves (2)

Short tail business



IBNR-reserves (3)

Amount of reserves depends on

- Type of business: long/short tail
- Development of portfolio: growth/shrinkage
- Size of portfolio
- Reserving policy (prudency level)

IBNR reserves – example loss-triangle (1)

Claim administration end of 2006

Claim nr.	Date-of-loss	Reporting date	Incurred loss
1.	19-05-2006	02-06-2006	100

Loss-year \ Run-off year	0	Total
2006	100	100

IBNR reserves – example loss-triangle (2)

Claim administration end of 2007

Claim nr.	Date-of-loss	Reporting date	Incurred loss
1.	19-05-2006	02-06-2006	100
2.	23-10-2007	15-11-2007	80
3.	21-07-2006	03-03-2007	50

Loss-year \ Run-off year	0	1	Total
2006	100	50	150
2007	80		80

IBNR reserves – example loss-triangle (3)

Loss-year \ Run-off year	0	1	Total
2006	100	50	150
2007	80		80

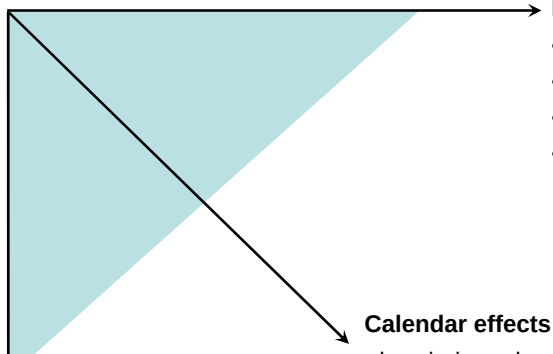
Some ‘conclusions’:

- Accounting result for loss in accounting year 2006: 100
- Accounting result for loss in accounting year 2007: 130
- Loss year 2007 ‘develops’ more favourite: 80 < 100

(Other) Loss-triangle

	1	2	3	4	5	6	…
2001	100	75	25	10	5		
2002	110	70	30	10			
2003	105	80	25				
2004	120	90					
2005	115						

Extrapolation of loss-triangle



Development pattern
- type of business
- payment policy
- reserving policy
- claims handling workflow

Calendar effects
- law, jurisprudence
- claims handling workflow

Risk year effects
- size of portfolio
- underwriting rules
- claim behavior

Data (1)

Source of data

- General ledger: audited, high-level, including special items
- Policy and claims administration: reconciliation with GL?, detailed information, often not total loss amount

Type of claims

- Paid amounts
- Incurred claims: paid amounts + case reserves
  - more information
  - less objective: claims handling policy (changes)
  - negative incremental values (lognormal model)
- Or: simultaneaous
  - Munich chain ladder, IFM (Posthuma partners)

Data (2)

Incremental or cumulative triangle

- Depending on model-assumptions
- Often outcomes are the same

Treatment of large claims

- Low frequency, severe impact on development pattern
- Possibilities:
  - Delete and separate analysis
  - Truncating
  - Smoothing
  - Do nothing

Data (3)

Data frequency

- loss years (⇕) – development years (⇔)
- loss years (⇕) – development quarters (⇔)
- loss quarters (⇕) – development quarters (⇔)

⇒ availability and reliability of data
⇒ information versus stability
⇒ professional judgement of the actuary

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- Description of basic IBNR-methods
  - Chain Ladder method numerically
  - Bornhuetter-Ferguson

  - Chain Ladder method graphically

- Some common data problems

Basic IBNR-methods

- Chain-ladder
- ‘Separation methods’ $\Rightarrow$ not discussed here
- Bornhuetter-Ferguson

Chain Ladder method (1)

Why Chain Ladder technique as a starting point?

- Well-known
- Widely used
- Easy to apply
- Easy to explain

<u>But</u>: other methods may have a better fit to the data.

Chain Ladder method (2)

- CL assumes relationship between columns in a loss-triangle
- By looking at past ('old') risk periods, the chain-ladder method estimates the development of more recent risk years
- Important assumption: all risk-years develop similarly
- CL extends loss-triangle into "loss-square"
- To forecast beyond "loss-square", use tail-factors

Chain Ladder method (3)

Back to basic example (now with cumulative data):

- After a year, the loss of risk-year 2006 increased with 50%
- By assuming the same development as risk-year 2006, we estimate by the end of 2007 that risk-year 2007 will increase by 50% in the next year: 80 * 50% = 40

Loss-year \ Run-off year	0	1	Reserve
		150/100 = 1,5	
2006	100	150	-
2007	80	*120*	*120-80=40*

Chain Ladder method (4)

Loss-year \ Run-off year	0	1	2	3	4	5	Total
		790/520 = 1,52			*500/480 = 1,04*		
2001	100	150	175	195	205	210	210
2002	120	195	255	285	295		295
2003	110	165	220	240			240
2004	100	140	170				170
2005	90	140					140
2006	80						80

Chain Ladder method (5)

Loss-year \ Run-off year	0	1	2	3	4	5	Total
	1,52	*1,26*	*1,11*	*1,04*	*1,02*		
2001	100	150	175	195	205	210	210
2002	120	195	255	285	295	*302*	295+*7*
2003	110	165	220	240	*250*	*256*	240+*16*
2004	100	140	170	*188*	*196*	*201*	170+*31*
2005	90	140	*177*	*196*	*204*	*209*	140+*69*
2006	80	*122*	*153*	*170*	*177*	*181*	80+*101*

Bornhuetter-Ferguson technique

- chain ladder estimate of ultimate loss is replaced by alternative
- e.g. because of external (qualitative) information and professional judgement
- ultimate loss is allocated across development periods by using development factor (reversely)
- related to Bayesian statistics: a priori information

Suppose:
in CL example ultimate loss of 2006 is 200 instead of 181

- expected loss run-off year 4 is: 200/1,02 = 195
- run-off year 3: 195/1,04 = 187
- run-off year 2: 187/1,11 = 169
- run-off year 1: 169/1,26 = 134

Case study ...

Reserve outcomes of the case ...

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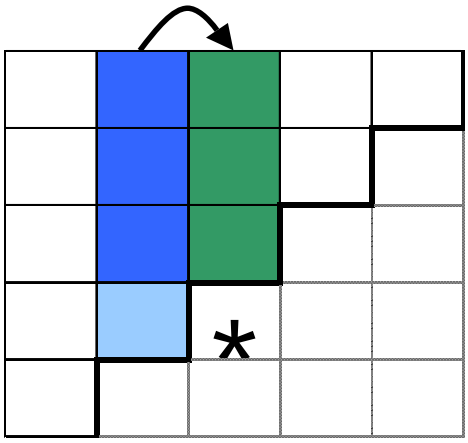
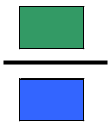
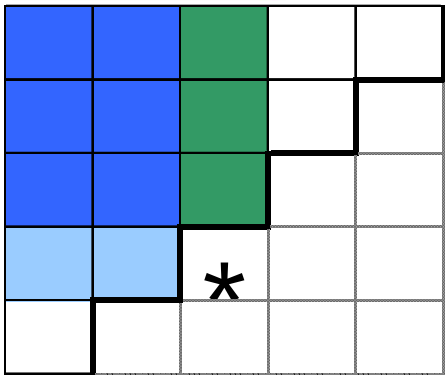
Chain Ladder: Graphical - cumulative data



$f_j =$ 

$* = f_j \times$

Chain Ladder: Graphical – incremental data



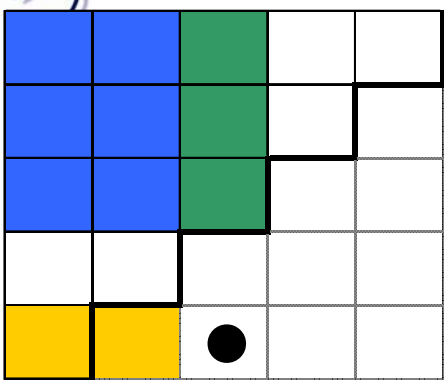
$$f_j = \frac{\square + \square}{\square}$$

$$* = f_j \times \square - \square = \frac{\square \times \square}{\square}$$

Chain Ladder: Grapical - Conclusion

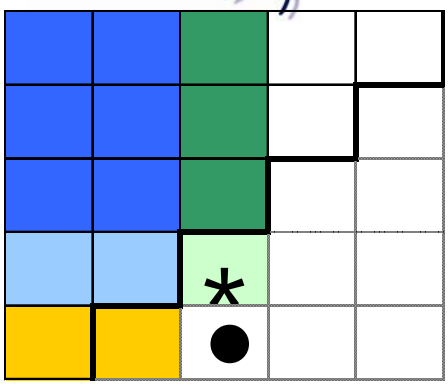
Rows and columns are treated symmetrically

CL Graphical -Projections further ahead



$$\bullet = \frac{\square \times \square}{\square}$$

In that case: also symmetry



$$* = \frac{\square \times \square}{\square}$$

$$\frac{\square}{\square} = \frac{\square + *}{\square + \square}$$

$$\bullet = \frac{\square \times \square}{\square} = \frac{\square \times (\square + *)}{(\square + \square)}$$

CL: Graphical – Symmetry property

Exchanging rows and columns ⇒ same provision

- Renshaw en Verrall: rows and columns are treated similarly.
- Mack: no symmetry, but same reserve.

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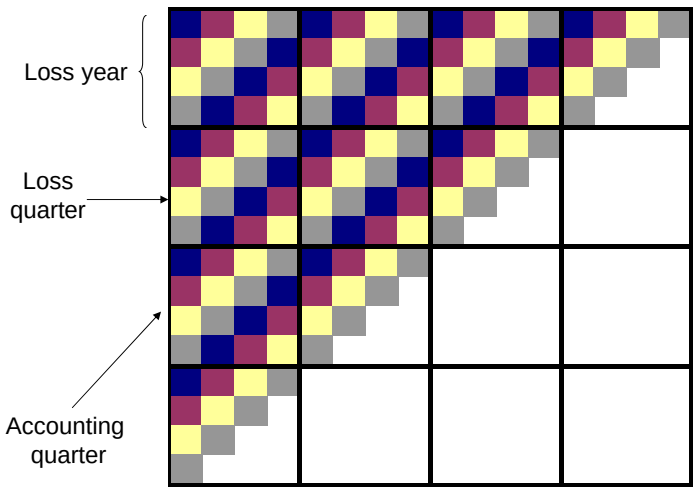
Two common data problems

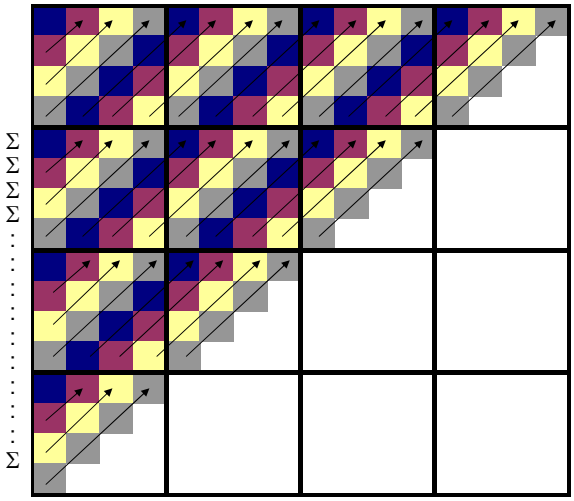
Data problems that frequently arise in practice:

1. Loss years versus development quarters
2. Missing accounting periods

Problem 1 – Loss years versus accounting quarters

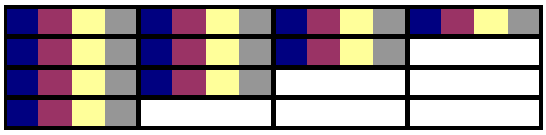


Problem 1 – Loss years versus accounting quarters



Problem 1 – Loss years versus accounting quarters

Resulting triangle:

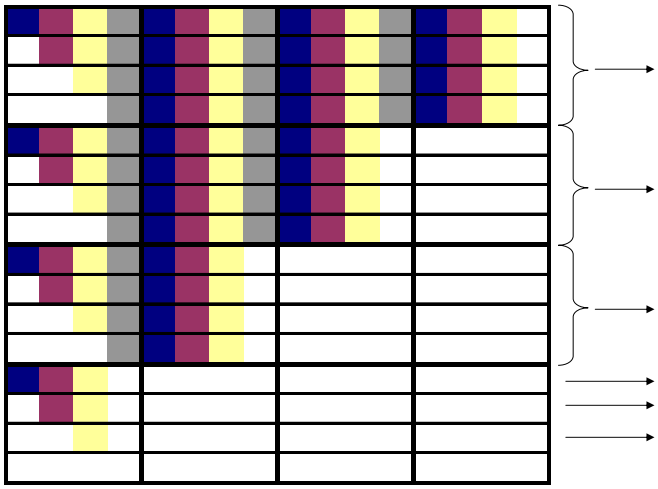


Special treatment of data:

- empty cells
- diagonal-numbering

Problem 1 – Loss years versus accounting quarters

How to calculate reserves per quarter (e.g. Q3)?



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Problem 1 – Loss years versus accounting quarters

Pragmatic approach

- Estimate ultimate loss current loss year
- Multiply with quarter-number/4 (e.g. ¾)
- Subtract incurred loss end-of-quarter

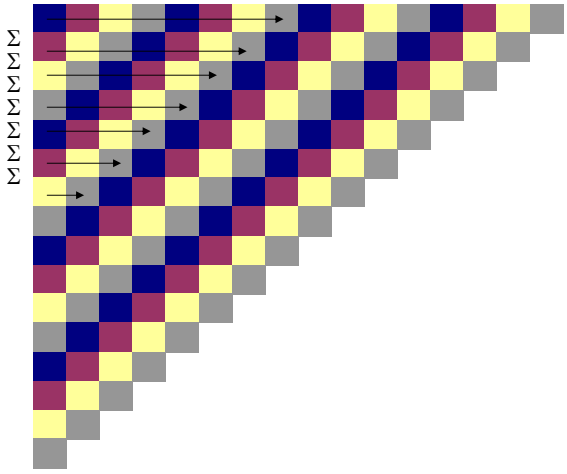
Disadvantage

neglection of run-off pattern within loss year
(retention policyholder, seasonal effects)

Consequence

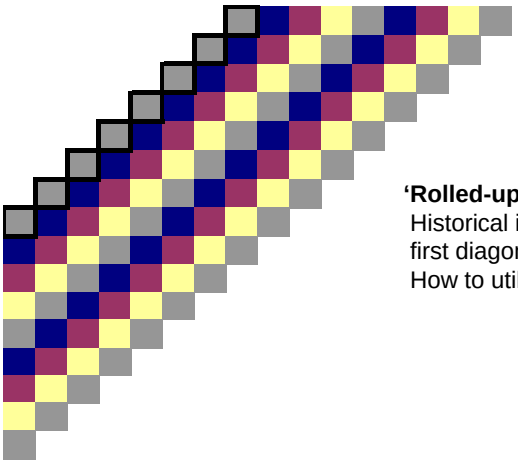
unwanted fluctuation of reserves

Problem 2 – Missing accounting periods



Problem 2 – Missing accounting periods

Resulting triangle:



'Rolled-up tapistry'
Historical information at first diagonal is valuable.
How to utilize it?