Institute and Faculty of Actuaries

Data visualisation for business insight

Julian Ellacott, Just Retirement
Paul Teggin, Teggin Consulting

25 October 2013

Topics

- What is data visualisation and why is it useful?
- Principles and practices of data visualisation
  - Illustrated throughout by case studies
- Focus is very practical
  - "Rules and tools" for actuarial staff to help improve day to day communication of information
  - Not intended to imply that some of these methods aren't already in use
  - Not about "MI/BI" data analytics systems / processes
- Huge topic – we can only give a flavour, but have provided lots of references to further material and resources at the end

Institute and Faculty of Actuaries

What is data visualisation?

- *The main goal of data visualization is to communicate information clearly and effectively through graphical means.* (Friedman [1])
- *Important stories live in our data and data visualization is a powerful means to discover and understand these stories, and then to present them to others.* (Few [2])
- *Visualization gives you answers to questions you didn't know you had.* (Shneiderman [3])

Institute and Faculty of Actuaries

Why is data visualisation useful for Life Actuaries?

Boards struggle to understand internal model outputs
Poor communication of the outputs from Solvency II internal models means the results are at risk of being ignored or misunderstood by the boards of insurance companies, according to LCP.

"What are these numbers telling me? And the font is too small – my eyesight isn't what it used to be."
Unnamed UK Chief Actuary

AVOID PRINTING IN SOLID FULL COLOUR
Sign above printer in UK Life Office

"Why is there so little graphical communication of internal model results and how much healthy challenge is missing as a result?"
InsuranceERM article

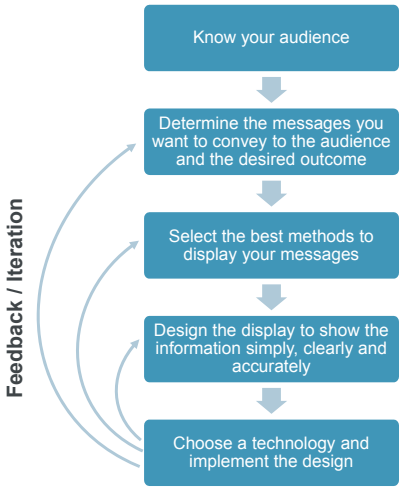
Information [should be] presented in a clear and comprehensible manner
TAS R

Institute and Faculty of Actuaries

Institute and Faculty of Actuaries

Data Visualisation Process

Process Diagram



Narrative and **Purpose**

Methodology

Design

Implementation

Institute and Faculty of Actuaries

Narrative

- The narrative is the "overall message" of a visualisation, in business rather than technical terms
- Even where the objective of an actuarial report is very narrow (e.g. a statutory valuation) it is important to place it in a business context
  - TAS R A.1.2: "*sufficient information is included to enable users to understand the implications of the contents of the reports*"
- Many actuarial techniques can be seen as narratives:

How and why have the numbers changed?	Analysis of Change Analysis of Surplus
How do we know these numbers are reasonable / internally consistent?	Reconciliation Reasonableness testing Sensitivity analysis
How do the numbers break down into component parts?	Capital waterfalls P&L attribution

Institute and Faculty of Actuaries

Purpose of a data visualisation

What is the data?

- Precision
- Clarity
- Simplicity

What does the data mean?

- Context
- Patterns
- Trends

What else can I discover?

- Relationships
- Connections
- Associations

Institute and Faculty of Actuaries

Institute and Faculty of Actuaries

Case Study 1: Governance Approval of a Correlation Matrix

Correlation Matrix: Initial Process

Know your audience	**Technical Committee**
Determine the key messages	**Governance approval**
Select the best methods to display your messages	**Table of values**
Design the display	**Whatever it looks like in Excel**
Implement the design	**Copy from Excel**

Institute and Faculty of Actuaries

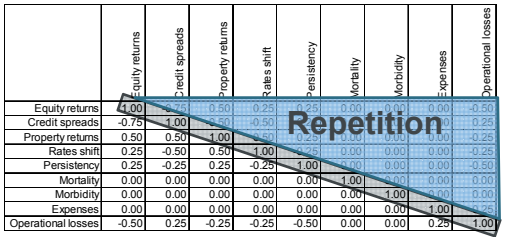
Correlation Matrix: Attempt 1

	Equity returns	Credit spreads	Property returns	Rates shift	Persistency	Mortality	Morbidity	Expenses	Operational losses
Equity returns	1.00	-0.75	0.50	0.25	0.25	0.00	0.00	0.00	-0.50
Credit spreads	-0.75	1.00	-0.50	-0.50	-0.25	0.00	0.00	0.00	0.25
Property returns	0.50	0.50	1.00	0.50	0.25	0.00	0.00	0.00	-0.25
Rates shift	0.25	-0.50	0.50	1.00	-0.25	0.00	0.00	0.00	-0.25
Persistency	0.25	-0.25	0.25	-0.25	1.00	0.00	0.00	0.00	-0.50
Mortality	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00
Morbidity	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00
Expenses	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.25
Operational losses	-0.50	0.25	-0.25	-0.25	-0.50	0.00	0.00	0.25	1.00

Institute and Faculty of Actuaries

Commentary on Attempt 1

- Precise – important since approval being sought
- Symmetry ⇨ repetition
- Mismatch between what's important to the audience and what stands out visually
  - Size and sign of values are important to audience
  - But hard to pick out
  - Leading diagonal looks important, but conveys no information (values are always 1)
- Hard to see patterns and relationships



Institute and Faculty of Actuaries

Correlation Matrix: Attempt 2

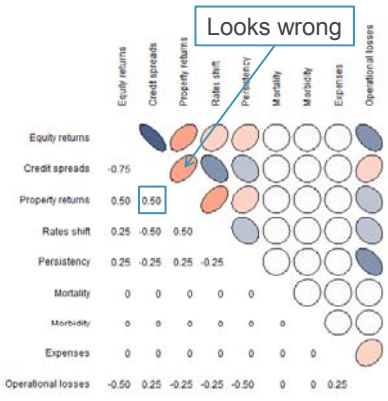
	Equity returns	Credit spreads	Property returns	Rates shift	Persistency	Mortality	Morbidity	Expenses	Operational losses
Equity returns									
Credit spreads	**(0.75)**								
Property returns	**0.50**	**0.50**							
Rates shift	0.25	**(0.50)**	**0.50**						
Persistency	0.25	(0.25)	0.25	(0.25)					
Mortality	0	0	0	0	0				
Morbidity	0	0	0	0	0	0			
Expenses	0	0	0	0	0	0	0		
Operational losses	**(0.50)**	0.25	(0.25)	(0.25)	**(0.50)**	0	0	0.25	

- Gridlines, leading diagonal and upper triangle removed – improves the data/ink ratio
- Bold formatting for larger correlations (|ρ| ≥ 50%) - could also use colours
- Zeros shown without decimal places - unnecessary in this context, zeros now stand out
- Negative values as (x) rather than –x (probably a matter of taste)
- Improving the **design** has started to help with seeing **patterns**

Institute and Faculty of Actuaries

Correlation Matrix: Attempt 3

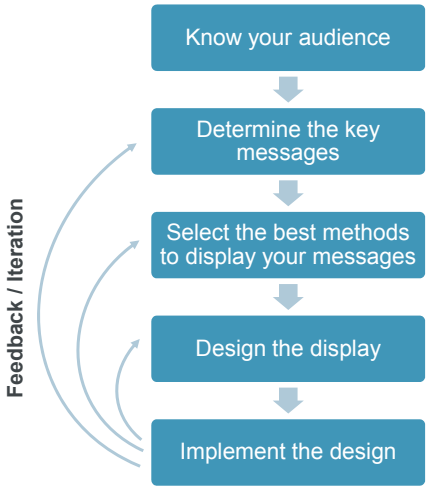
- Still precise since numbers retained
- Use the other triangle to show correlations as ellipses
  - Sign = direction
  - Magnitude = shape and colour
  - Independence = white circles
- Can easily see more patterns and some higher-order relationships
  - Easier to **explain** and **explore** the correlations
  - Colours in top two rows are generally opposites, other than property/credit
  - Indicates a possible sign error



Produced using R

Institute and Faculty of Actuaries

Correlation Matrix: Updated Process



Technical Committee

Governance review, challenge and approval

Hybrid matrix of values and ellipses

Choose appropriate colour scheme

R / VBA

Institute and Faculty of Actuaries

Case Study 1: Lessons Learned

- Methodology
  - Tables are important in actuarial work, to set out numerical values out precisely
  - However, tables are at the Exhibit end of the spectrum, if we want to make it easy for users to Explain or Explore the data, pictures are likely to be useful
  - The Appendix covers the methodologies for tables and charts in more detail
- Design
  - Changing the design of a table can both improve the presentation and suggest improvements to methodology
    - In the case study, creating the white space in the upper triangle prompted the question "what can we do with this?"
    - In order to use the space, we had to develop the methodology further
- Implementation
  - We had to move away from Excel to implement the methodology

Institute and Faculty of Actuaries

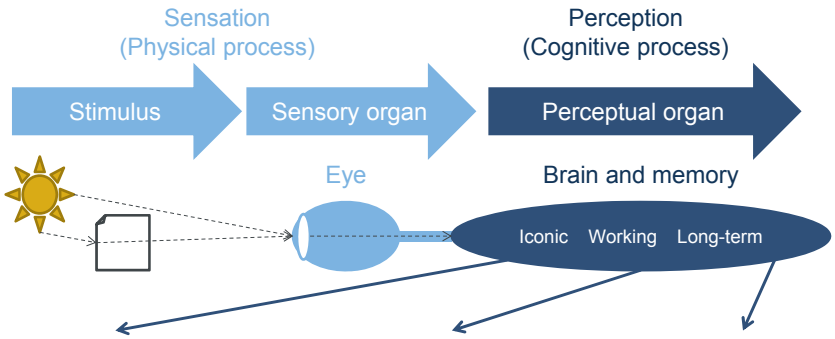
Implementation

- Excel is the obvious tool, familiar to and used by most actuarial staff
- More recent versions (2010, 2013) have more visualisation features:
  - Lots of chart types – but avoid spurious 3-d charts
  - Sparklines (small charts embedded in cells – example later)
- Since Excel is so familiar, it's easy to allow visualisations to be constrained by what it can and can't support, but there are options:
  - http://peltiertech.com/Excel/Charts/ChartIndex.html is an excellent resource for producing additional types of chart in Excel itself
  - The statistical package R has very powerful and flexible charting capabilities – including the correlation matrix ellipses – but steep learning curve initially
  - Bespoke packages (see References)

Try not to let your visualisation ideas be constrained by technology – there will often be a way to do it

Institute and Faculty of Actuaries

Design: Perception and Cognition



Iconic memory

Very short-term (<1 s)

Colour and location

Where things stand out

Working memory

Few seconds only

At most 3-4 items

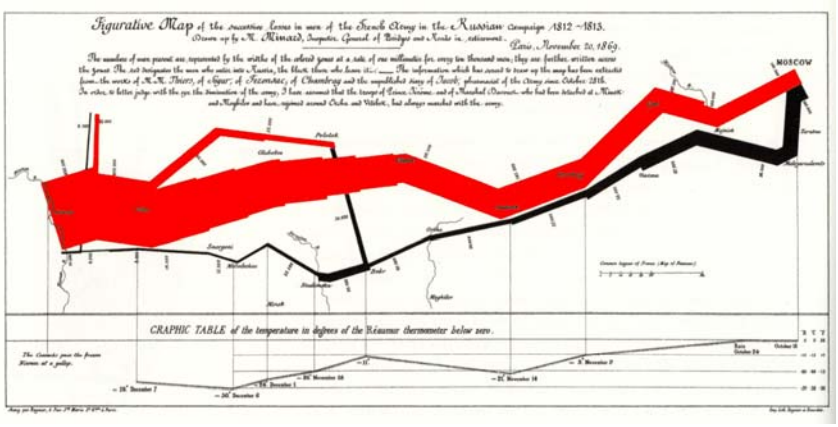
⇨Viewers will need to go back to a legend with 6 entries

Long-term memory

Stored for later use

Institute and Faculty of Actuaries

Napoleon's 1812 March to Moscow



- Produced in 1869 (!) by Charles Minard
- Red is towards Moscow, black is retreat, width represents size of army
- Temperatures during the retreat are shown at the bottom
- "*It may be the best statistical graphic ever drawn*" (Tufte [6])

Institute and Faculty of Actuaries

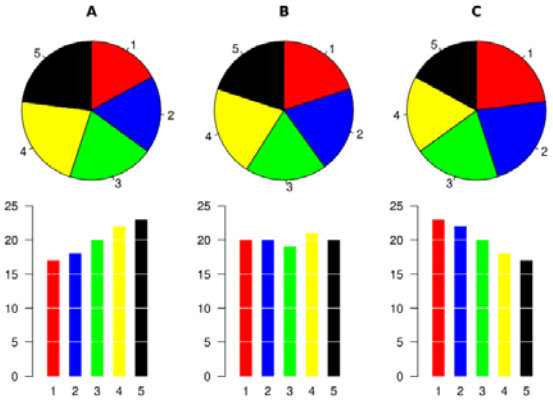
Avoid Pie Charts

The only good pie chart?

- It is difficult to perceive the relative size of areas correctly
- Much easier to see relative sizes using lengths
- Almost always preferable to use a bar/column or line chart
  - Show absolute as well as relative values

Institute and Faculty of Actuaries

Avoid Pie Charts

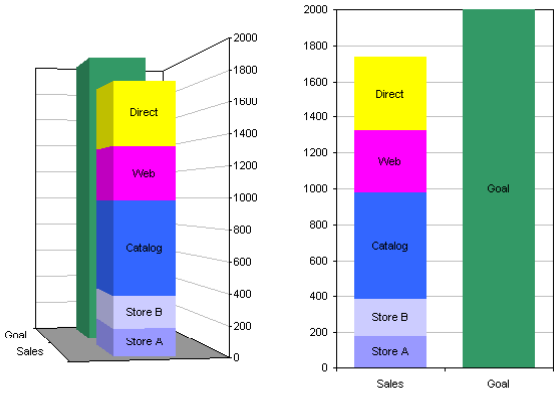


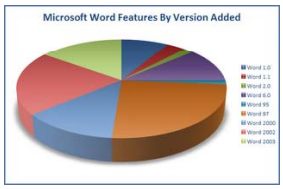
- It is difficult to perceive the relative size of areas correctly
- Much easier to see relative sizes using lengths
- Almost always preferable to use a bar/column or line chart
  - Show absolute as well as relative values

Source: http://commons.wikimedia.org/wiki/File:Piecharts.svg
where author information can be found.
Licensed under the Creative Commons Attribution 1.0 Generic licence.

Institute and Faculty of Actuaries

Avoid Gratuitous 3-D



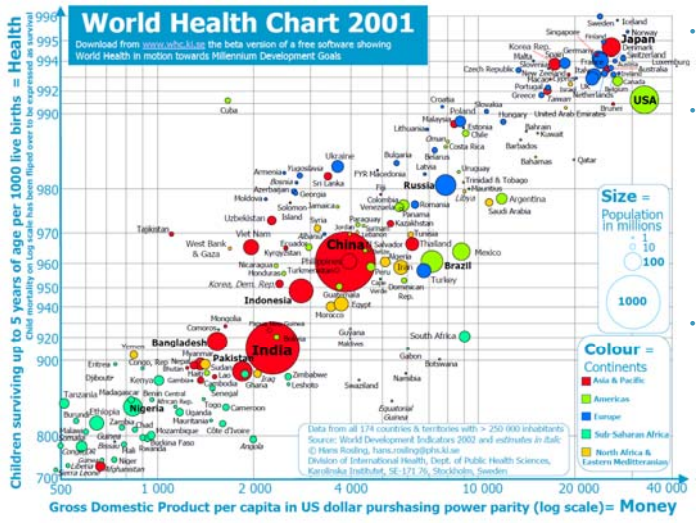


Especially avoid 3-D pie charts with badly-chosen colours!

Source: http://peltiertech.com/WordPress/the-perils-of-being-in-3d/

Institute and Faculty of Actuaries

Encoding 4 variables in 2-D



- Size and colour used to encode 2 more variables
- Axes use log-scales to bring out the roughly linear relationship between transformed Health and transformed Money
- Interactive (and more up-to-date) version available from this link

Institute and Faculty of Actuaries

Design: Overarching Principles

- Remove everything that isn't necessary
- Identify what is data and what isn't
- Make the data prominent and clear
- Make the non-data as unobtrusive as is sensible
  - Non-data are things like axes and grid-lines, which can sometimes be too "busy" – if so, remove or use light grey
- Highlight the information that's most important to your narrative (and vice versa)
- Keep colours and fonts under control
  - 2 or 3 colours will create a sense of unity
  - Different shades and sizes are allowed (within reason)
  - More will distract from the data

Just as a good editor of prose ruthlessly prunes out unnecessary words, so a designer of statistical graphics should prune out ink that fails to present fresh data-information.

Graphical elegance is often found in simplicity of design and complexity of data.

Graphical excellence consists of complex ideas communicated with clarity, precision and efficiency.

(All from Tufte [6])

In summary: "maximise the data/ink ratio, within reason"

Institute and Faculty of Actuaries

Institute and Faculty of Actuaries

Case Study 2: Presentation of Stochastic Model Results

Stochastic model output is ideally suited to visualisation techniques – lots of high-dimensional data

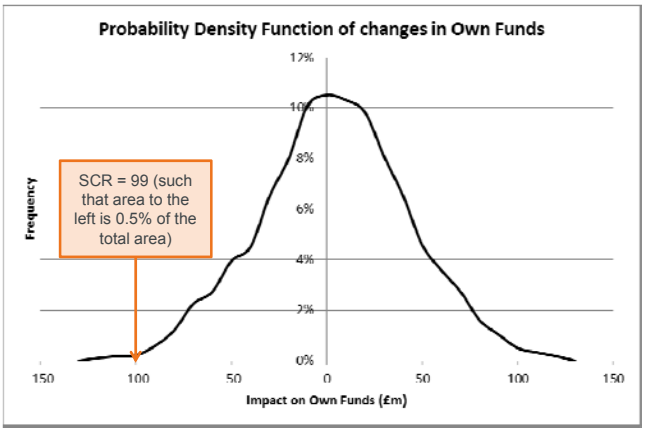
Case study is based on a hypothetical annuity writer backing liabilities purely with corporate bonds

Stochastic Results: Initial Process

Know your audience	**Various, from reviewer through to Chief Actuary**
Determine the key messages	**Governance review, challenge and approval**
Select the best methods to display your messages	**Probability Density Function, scenario results table**
Design the display	**Use default formatting**
Implement the design	**Excel**

Institute and Faculty of Actuaries

Probability Distribution Forecast: Attempt 1

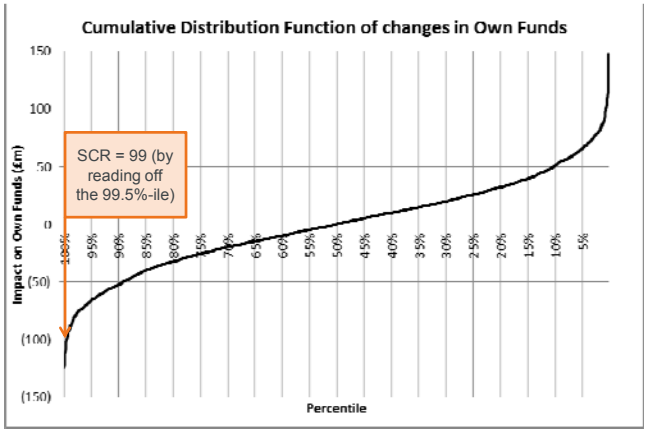


- "Traditional" view
- Probability is represented by area under the curve
- Not straightforward to read off percentiles, or see whether the median is close to 0
- Y-axis is not especially meaningful

Good for: showing overall degree of symmetry/skew, comparisons of shape of different distributions

Institute and Faculty of Actuaries

Probability Distribution Forecast: Attempt 2

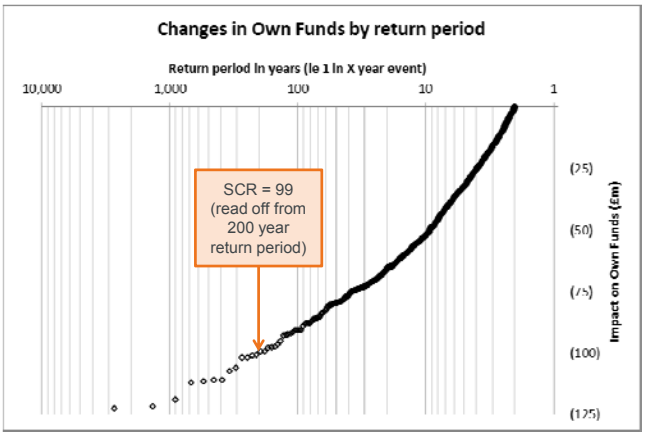


- Percentiles represented along the X-axis
- Straightphtforward to read off percentiles (except in the extremes?), and to see the median impact on own funds
- Gridlines are extra "ink", but facilitate reading off percentiles and impacts

Good for: reading off percentiles across the body of the distribution, showing the contribution of different risks to the total (see later slides)

Institute and Faculty of Actuaries

Probability Distribution Forecast: Attempt 3

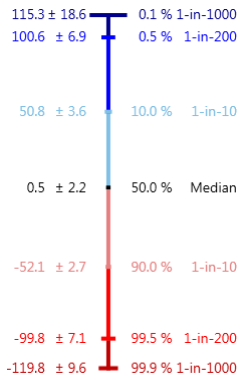


- Percentiles have been converted to "1 in X year" values, and shown on a log scale
- More straightforward to read off values, especially in the tail (where we are most interested)
- "Stretching" of the tail highlights sparseness of extreme simulations, not evident in the previous graphs

Good for: reading off percentiles in the downside tail, showing the granularity of the underlying results

Institute and Faculty of Actuaries

Probability Distribution Forecast: Attempt 4



- "PDF summary plot" – related to box-and-whiskers/ candlestick plots, but with enhancements
- A summary of the PDF may be more useful than showing the whole distribution – this example focuses on 7 key points across the risk spectrum
- On the left-hand side we show the impact at each distribution point, along with an assessment of simulation error
- We can tell quite a lot about the distribution just from these 7 points, so we haven't lost too much by summarising:
  - Distribution is fairly close to symmetrical
  - 1-in-200 events have roughly twice the impact of 1-in-10, like the Normal distribution
  - 1-in-1000 events not much larger than 1-in-200

Good for: minimising data/ink ratio, showing another dimension (eg simulation error), comparing distributions side by side

Institute and Faculty of Actuaries

Scenario Level Results: Attempt 1

Drilling down into the scenario level results:

Percentile	Scenario	All risks change in OF (£m)	Interest rate risk change in OF (£m)	Credit risk change in OF (£m)	Longevity risk change in OF (£m)	Operational risk change in OF (£m)	Implied non-linearity/non-separability (£m)
100.0%	89	-123.74	-0.10	-81.26	-42.23	-0.24	0.10
100.0%	2336	-122.47	3.33	-92.75	-29.48	-0.29	-3.28
99.9%	238	-121.60	-23.18	-73.54	-47.37	-0.05	22.55
99.9%	1540	-119.01	-3.11	-78.76	-40.12	0.00	2.97
99.9%	1105	-111.91	-0.10	-89.79	-21.94	-0.17	0.09
99.8%	2258	-111.39	-5.18	-78.71	-31.75	-0.32	4.56
99.8%	2716	-111.00	2.46	-63.67	-47.55	-0.06	-2.19
99.7%	389	-110.81	-2.98	-82.69	-27.16	-0.59	2.61
99.7%	510	-107.30	-3.41	-90.41	-16.25	-0.12	2.89
99.7%	235	-105.98	0.07	-86.58	-18.98	-0.43	-0.06
99.6%	557	-101.64	3.21	-60.59	-41.42	-0.26	-2.58
99.6%	440	-101.57	5.12	-86.57	-15.70	-0.29	-4.13
99.6%	1365	-100.99	2.38	-71.90	-29.39	-0.18	-1.90
99.6%	2285	-100.58	-2.82	-70.24	-29.07	-0.66	2.20
99.5%	689	-99.19	-1.86	-73.04	-25.65	-0.08	1.44
99.4%	1202	-99.18	-5.21	-100.09	2.19	-0.08	4.00
99.4%	2761	-97.72	2.18	-59.24	-38.97	-0.01	-1.68
99.4%	2274	-97.50	4.76	-50.22	-48.22	-0.13	-3.68
99.3%	640	-97.27	2.28	-52.02	23.52	-70.70	-0.35
99.3%	541	-96.54	4.53	-75.73	-21.77	-0.10	-3.47
99.3%	2879	-94.96	-0.25	-95.03	0.81	-0.68	0.19
99.2%	373	-92.90	1.84	-82.36	-10.86	-0.18	-1.34
99.2%	1948	-92.60	3.91	-79.71	-13.85	-0.09	-2.86
99.2%	1038	-92.23	2.49	-74.69	-18.08	-0.15	-1.80
99.1%	2752	-91.98	-1.16	-70.20	-21.29	-0.16	0.83
99.1%	1083	-91.33	-2.88	-51.47	-39.00	0.00	2.03
99.0%	2355	-90.69	-2.16	-61.66	-27.93	-0.45	1.51
99.0%	1100	-90.63	3.57	-36.60	-54.82	-0.24	-2.54
99.0%	1750	-90.50	-2.94	-66.98	-22.55	-0.08	2.05

- Overly focussed on precise values
- Wasted "ink", eg gridlines, repetitious headings
- Difficult to spot patterns

Institute and Faculty of Actuaries

Scenario Level Results: Attempt 2

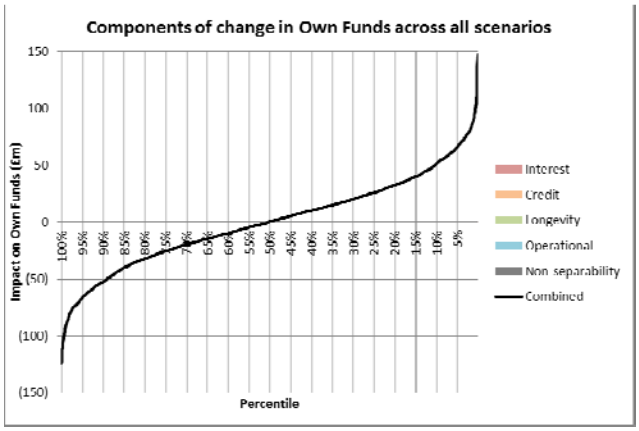
Euler allocation by risk		(99)	1	(75)	(21)	(4)	(0)
		Changes in Own Funds arising from variations in... (£m)					
Percentile	Scenario	All risks	Interest rate risk	Credit risk	Longevity risk	Operational risk	Implied non-linearity & non-separability
100.0%	89	(124)	(0)	(81)	(42)	(0)	0
100.0%	2336	(122)	3	(93)	(29)	(0)	(3)
99.9%	238	(122)	(23)	(74)	(47)	(0)	23
99.9%	1540	(119)	(3)	(79)	(40)	(0)	3
99.9%	1105	(112)	(0)	(90)	(22)	(0)	0
99.8%	2258	(111)	(5)	(79)	(32)	(0)	5
99.8%	2716	(111)	2	(64)	(48)	(0)	(2)
99.7%	389	(111)	(3)	(83)	(27)	(1)	3
99.7%	510	(107)	(3)	(90)	(16)	(0)	3
99.7%	235	(106)	0	(87)	(19)	(0)	(0)
99.6%	557	(102)	3	(61)	(41)	(0)	(3)
99.6%	440	(102)	5	(87)	(16)	(0)	(4)
99.6%	1365	(101)	2	(72)	(29)	(0)	(2)
99.6%	2285	(101)	(3)	(70)	(29)	(1)	2
99.5%	689	(99)	(2)	(73)	(26)	(0)	1
99.4%	1202	(99)	(5)	(100)	2	(0)	4
99.4%	2761	(98)	2	(59)	(39)	(0)	(2)
99.4%	2274	(97)	5	(50)	(48)	(0)	(4)
99.3%	640	(97)	2	(52)	24	(71)	(0)
99.3%	541	(97)	5	(76)	(22)	(0)	(3)
99.3%	2879	(95)	(0)	(95)	1	(1)	0
99.2%	373	(93)	2	(82)	(11)	(0)	(1)
99.2%	1948	(93)	4	(80)	(14)	(0)	(3)
99.2%	1038	(92)	2	(75)	(18)	(0)	(2)
99.1%	2752	(92)	(1)	(70)	(21)	(0)	1
99.1%	1083	(91)	(3)	(51)	(39)	(0)	2
99.0%	2355	(91)	(2)	(62)	(28)	(0)	2
99.0%	1100	(91)	4	(37)	(55)	(0)	(3)
99.0%	1750	(91)	(3)	(67)	(23)	(0)	2

- Excessive precision removed
- Excel "sparklines" added to bring out patterns
- Data/ink ratio improved
- Enables insight into risk profile

Institute and Faculty of Actuaries

Scenario Level Results: Alternative

Visualising the CDF of overall changes in Own Funds, with its components:



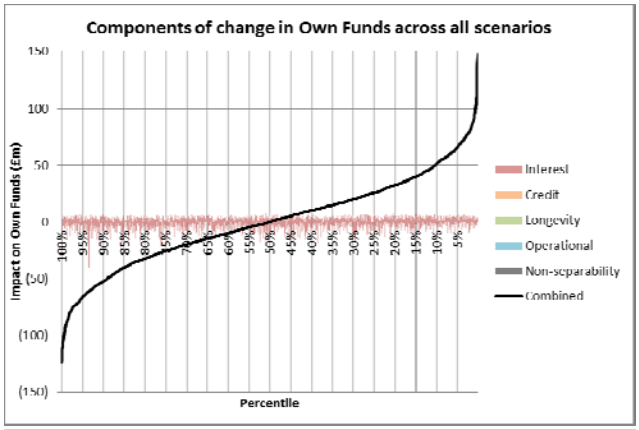
Overall CDF gives some insight, eg into basic symmetry

- Adds contribution of each risk factor to the overall CDF
- Presents a lot of information, on a small scale
- Enables some overall patterns to be discerned
- Could be considered a bit too much for one graph, but "building up" helps

Institute and Faculty of Actuaries

Scenario Level Results: Alternative

Visualising the CDF of overall changes in Own Funds, with its components:



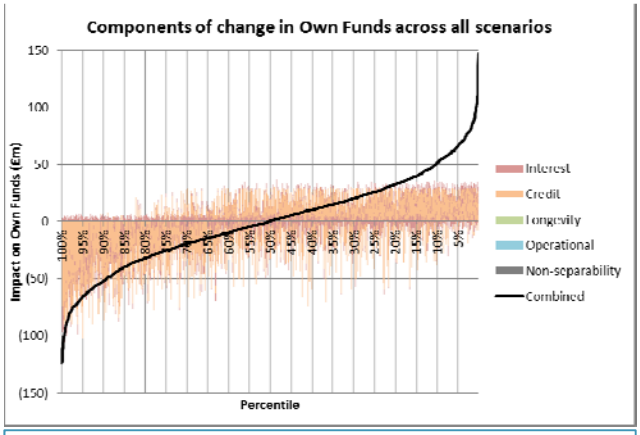
Interest rate risk is relatively low, and symmetric – indicating that hedging is well executed and maintained

- Adds contribution of each risk factor to the overall CDF
- Presents a lot of information, on a small scale
- Enables some overall patterns to be discerned
- Could be considered a bit too much for one graph, but "building up" helps

Institute and Faculty of Actuaries

Scenario Level Results: Alternative

Visualising the CDF of overall changes in Own Funds, with its components:



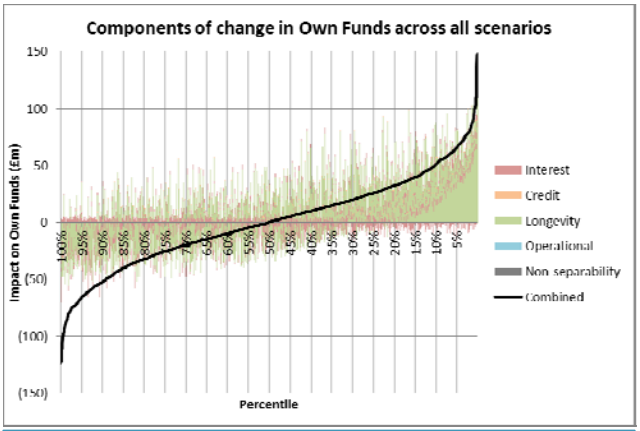
Credit risk is significant, as expected given exposure to corporate bonds. Exposure is asymmetric, with large downside and limited upside.

- Adds contribution of each risk factor to the overall CDF
- Presents a lot of information, on a small scale
- Enables some overall patterns to be discerned
- Could be considered a bit too much for one graph, but "building up" helps

Institute and Faculty of Actuaries

Scenario Level Results: Alternative

Visualising the CDF of overall changes in Own Funds, with its components:



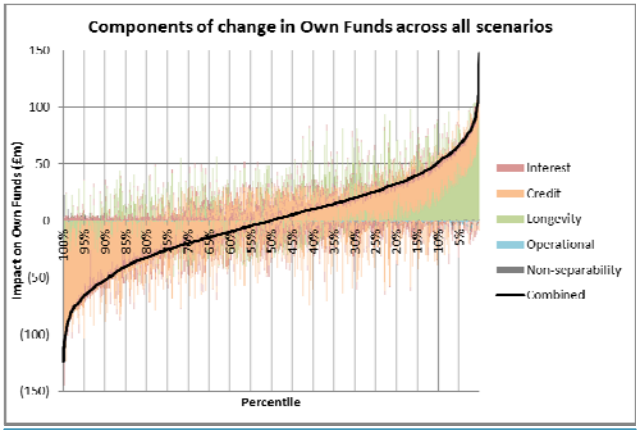
Longevity risk is also significant, unsurprisingly for an annuity book. Downside appears relatively limited, with larger upside variation.

- Adds contribution of each risk factor to the overall CDF
- Presents a lot of information, on a small scale
- Enables some overall patterns to be discerned
- Could be considered a bit too much for one graph, but "building up" helps

Institute and Faculty of Actuaries

Scenario Level Results: Alternative

Visualising the CDF of overall changes in Own Funds, with its components:



Operational risk and non-separability are not significant. Overall credit dominates in the downside tail, and longevity in the upside tail.

- Adds contribution of each risk factor to the overall CDF
- Presents a lot of information, on a small scale
- Enables some overall patterns to be discerned
- Could be considered a bit too much for one graph, but "building up" helps

Institute and Faculty of Actuaries

Stochastic Case Study: Updated Process

Feedback / Iteration

Know your audience	**Various, from reviewer through to Chief Actuary**
Determine the key messages	**Governance review, challenge and approval**
Select the best methods to display your messages	**Cumulative Distribution Function, add sparklines to table of scenario results**
Design the display	**Use appropriate colours and other formatting**
Implement the design	**Excel (≥2010), PowerPoint**

Institute and Faculty of Actuaries

Case Study 2: Lessons Learned

- Process
  - Trial-and-error is very useful (probably necessary) in improving visualisations
  - Use what you know about the business (e.g. risk profile, investment strategy) to determine whether the visualisation is working or not
    - Also, asking whether you can see things you already know puts you in a frame of mind where you might well notice other aspects not yet thought about
- Methodology
  - Changing the 'units of measurement' (density ⇨ distribution) or the scale (linear ⇨ log) can help bring out the important features
  - Complex visualisations can work better when built up sequentially
    - You can be more ambitious when you can talk the audience through them, whereas written reports need more care
- Design
  - Using colour consistently (e.g. for the different risks) creates a sense of unity across different visualisations

Institute and Faculty of Actuaries

Conclusions

- Conceptual
  - Good visualisations aren't especially difficult to develop and produce
  - The techniques for producing them can be studied and learned
    - Just like the communications exam!
  - It is possible to follow a well-defined process to maximise the effectiveness of your visualisations
    - Much of the content of the case studies resulted from following the process on slide 6
- Practical
  - Trial and error - don't be afraid to try new things, present alternative ways of showing the same information, ask colleagues to critically evaluate your visualisations, and take forward the most popular
  - "**Maximise the data/ink ratio, within reason**" is the simplest principle to remember and apply – it will help drive all sorts of improvements
  - There are lots of resources out there to help

Institute and Faculty of Actuaries

References (1): Books and articles

1. Friedman, Vitaly (2008) Data Visualization and Infographics
   In: *Graphics*, Monday Inspiration, January 14th, 2008.
2. Few, Stephen (2013): Data Visualization for Human Perception.
   In: Soegaard, Mads and Dam, Rikke Friis (eds.) *The Encyclopedia of Human-Computer Interaction, 2nd Ed* Aarhus, Denmark: The Interaction Design Foundation.
3. Shneiderman, Ben (quoted in Kirk, Andy (2012): Data Visualization: a successful design process)
4. Few, Stephen (quoted in Kirk, Andy (2012): Data Visualization: a successful design process)
5. Few, Stephen (2012): Show Me The Numbers
6. Tufte, Edward (2001): The Visual Display of Quantitative Information
7. Cairo, Alberto (2013): The Functional Art: An introduction to information graphics and visualization

Institute and Faculty of Actuaries

References (2): Websites

- http://www.visualisingdata.com/index.php/resources/ (Lots of onward links)
- http://visual.ly/
- http://www.visual-literacy.org/periodic_table/periodic_table.html
- http://datawrapper.de/
- http://spatialanalysis.co.uk/
- http://flowingdata.com/
- http://www.informationisbeautiful.net/ (Accompanying book is useful for idea generation)
- http://www.economist.com/blogs/graphicdetail
- http://www.guardian.co.uk/technology/data-visualisation
- http://peltiertech.com/Excel/Charts/ChartIndex.html (Guidance/tutorials for Excel charts)
- http://www.statmethods.net/ (Guidance/tutorials for producing charts in R)

Links were valid at the time of writing, but may not remain so indefinitely.

Institute and Faculty of Actuaries

Questions

Comments

Expressions of individual views by members of the Institute and Faculty of Actuaries and its staff are encouraged.

The views expressed in this presentation are those of the presenters.

Institute and Faculty of Actuaries

Institute and Faculty of Actuaries

Appendix 1: Methodology

ertise
nsorship
Thought leadership
Progress
Community
Sessional Meetings
Education
Working parties
Volunteering
Research
Shaping the future
Networking
Professional support
Enterprise and risk
Learned society
Opportunity
International profile
Journals
Suppo

Methodology: Tables vs charts

- The choice of method depends on the purpose of the visualisation and the nature of the information to be visualised
- The first decision point is whether to use tables, charts or both.

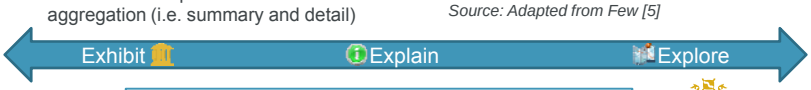
Use tables when

1. Individual values will be looked up or compared
2. Only individual values will be compared, rather than whole series of values
3. Precise values are required
4. Values involve more than one unit of measure
5. Values must be presented at various levels of aggregation (i.e. summary and detail)

Use charts when

1. The message is contained in patterns, trends, and exceptions
2. Entire series of values must be seen in a whole and/or compared
3. To explore relationships, connections and associations

Source: Adapted from Few [5]



It will often make sense to use both tables and charts to display the same information

Institute and Faculty of Actuaries

Tables: Introduction

Year-on-year profit by territory and unit

		Profit (£m)	
Territory	Business Unit	2011	2012
UK	Life	48.3	50.6
	Pensions	75.6	71.2
Overseas	Life	1.2	7.4
	Pensions	0.7	3.5
Total		125.8	132.7

2012 Profit by business unit

Business Unit	Profit (£m)
UK Life	50.6
UK Pensions	71.2
Overseas Life	7.4
Overseas Pensions	3.5
Total	132.7

One kind of value (profit), categorised in different ways

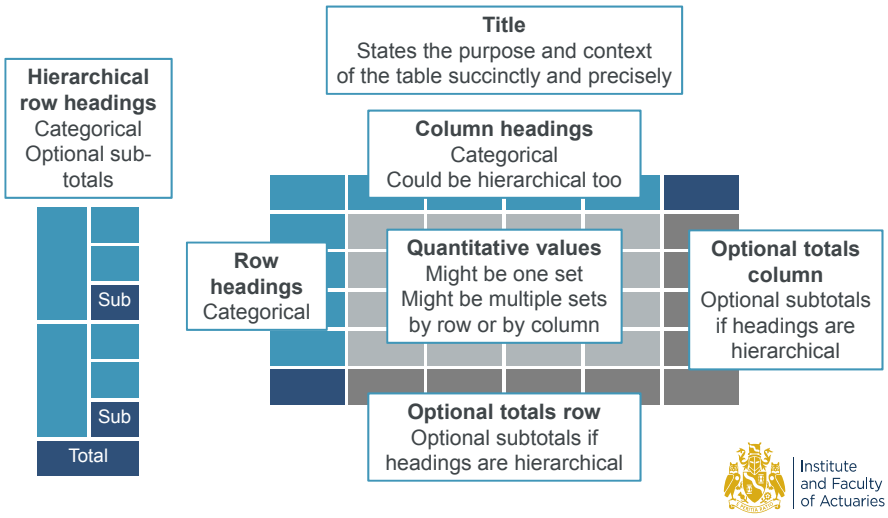
Breakdown of 2012 Profit by territory (£m)

Territory	Revenue	Expenses	Profit
UK	127.9	(6.1)	121.8
Overseas	12.2	(1.3)	10.9

Different kinds of value (revenue / expenses / profit), also categorised

Institute and Faculty of Actuaries

Tables: Components



Institute and Faculty of Actuaries

Tables: Classification

Quantitative values	Categorical items	Examples
Single set	Single set of items	Profit by business unit
Single set	Intersection of multiple categories	Profit by business unit by year
Single set	Intersection of multiple hierarchical categories	Profit by business unit and territory by year
Multiple sets	Single category (possibly hierarchical)	Revenue, expenses and profits by business unit

- Tables can serve one or both of two main functions: **look-up** and **comparison**
  - Look-up: use row and/or column headings to find values
    - "How much profit did UK Life make in 2011?"
    - At the **Exhibit** end of the spectrum
  - Comparison: use the relationship between values to see patterns and trends
    - "Was 2012 more or less profitable than 2011?"
    - Helps to **Explain** the results and set them in context

Institute and Faculty of Actuaries

Charts: Classification

Classification	Purpose	Examples
Categorisation and Ranking	Comparison between relative and absolute sizes of categorical values	Bar/column chart Dot plot Sankey diagram
Hierarchies and part-to-whole relationships	Breakdown of categorical values relative to a population or as elements of a hierarchy	Pie chart/doughnut chart Stacked bar/column chart Waterfall chart
Functions of a single variable	Trends and patterns over time Univariate distributions	Line chart Sparklines Box-and-whiskers/Candlestick
Connections and relationships	Associations and patterns within a multivariate data set	Scatter plot Scatter plot matrix Bubble chart Heatmap Parallel coordinates

Chart types can be used for lots of purposes – these are just selected examples

Institute and Faculty of Actuaries

Institute and Faculty of Actuaries

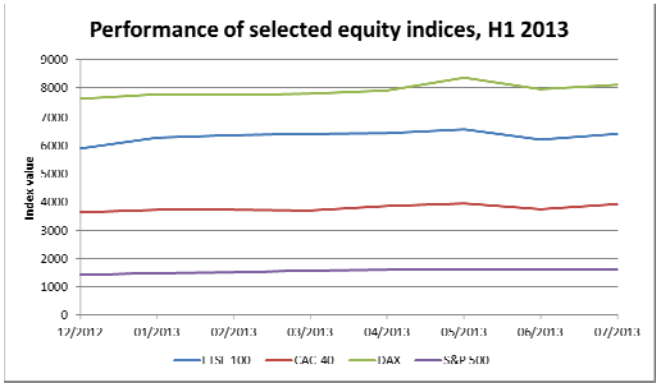
Appendix 2: Audience Case Study

Equity Market Trends: Initial Process

Know your audience	General background to a set of financial results
Determine the key messages	Understand how equities have performed during the period
Select the best methods to display your messages	Line chart
Design the display	Show index values; use default formatting
Implement the design	Excel

Institute and Faculty of Actuaries

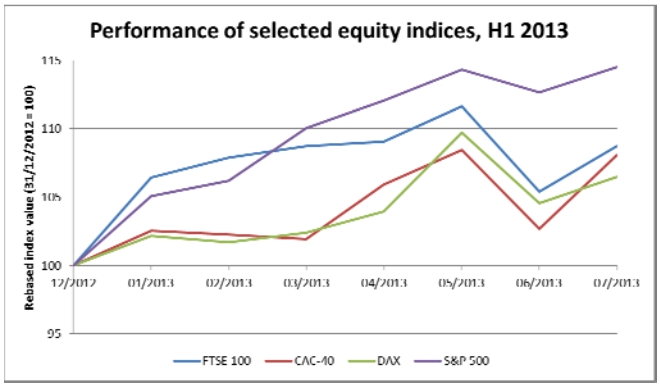
Equity Market Trends: Attempt 1



Strengths?
Weaknesses?
Suggestions for improvement?

Institute and Faculty of Actuaries

Equity Market Trends: Attempt 2



Strengths?
Weaknesses?
Suggestions for improvement?

Institute and Faculty of Actuaries