Applying GLMs in Non-traditional Areas

2003 CAS Ratemaking Seminar

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Non-traditional uses of GLMs

- Background on traditional claims modeling for ratemaking
- Variations on claims modeling
  - profitability scores
  - sales channel analysis
- Uses in reserving
  - projecting loss triangles
  - initial reserve estimates

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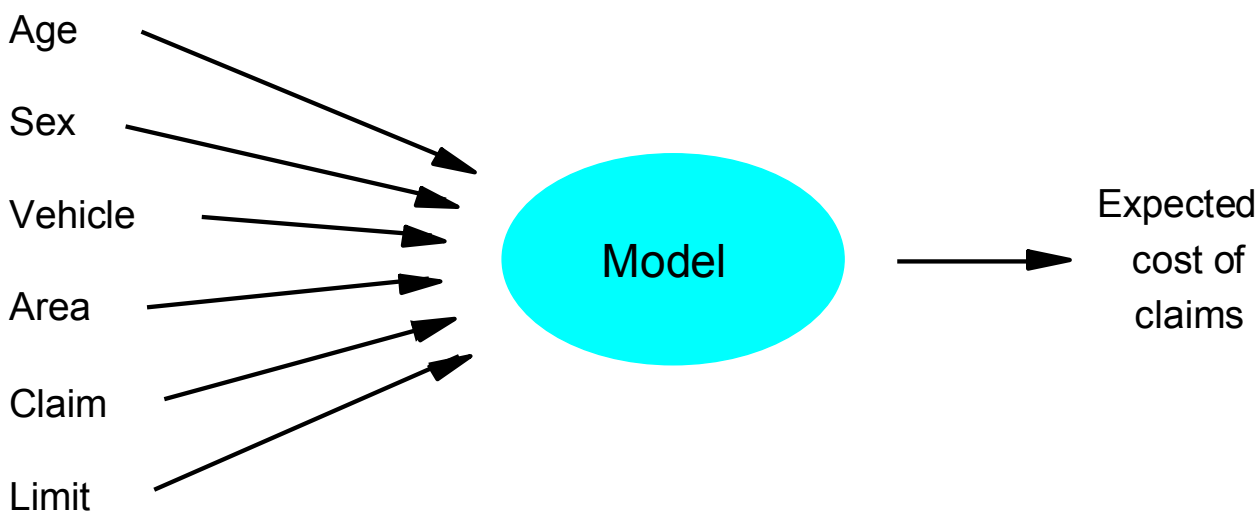
Generalized linear models

- Statistically measure the effect that variables have on an observed item
- In insurance, most often used to determine the effect rating variables have on claims experience



Generalized linear models

$$E[\underline{Y}] = \underline{\mu} = g^{-1}(\mathbf{X}.\underline{\beta} + \underline{\xi})$$

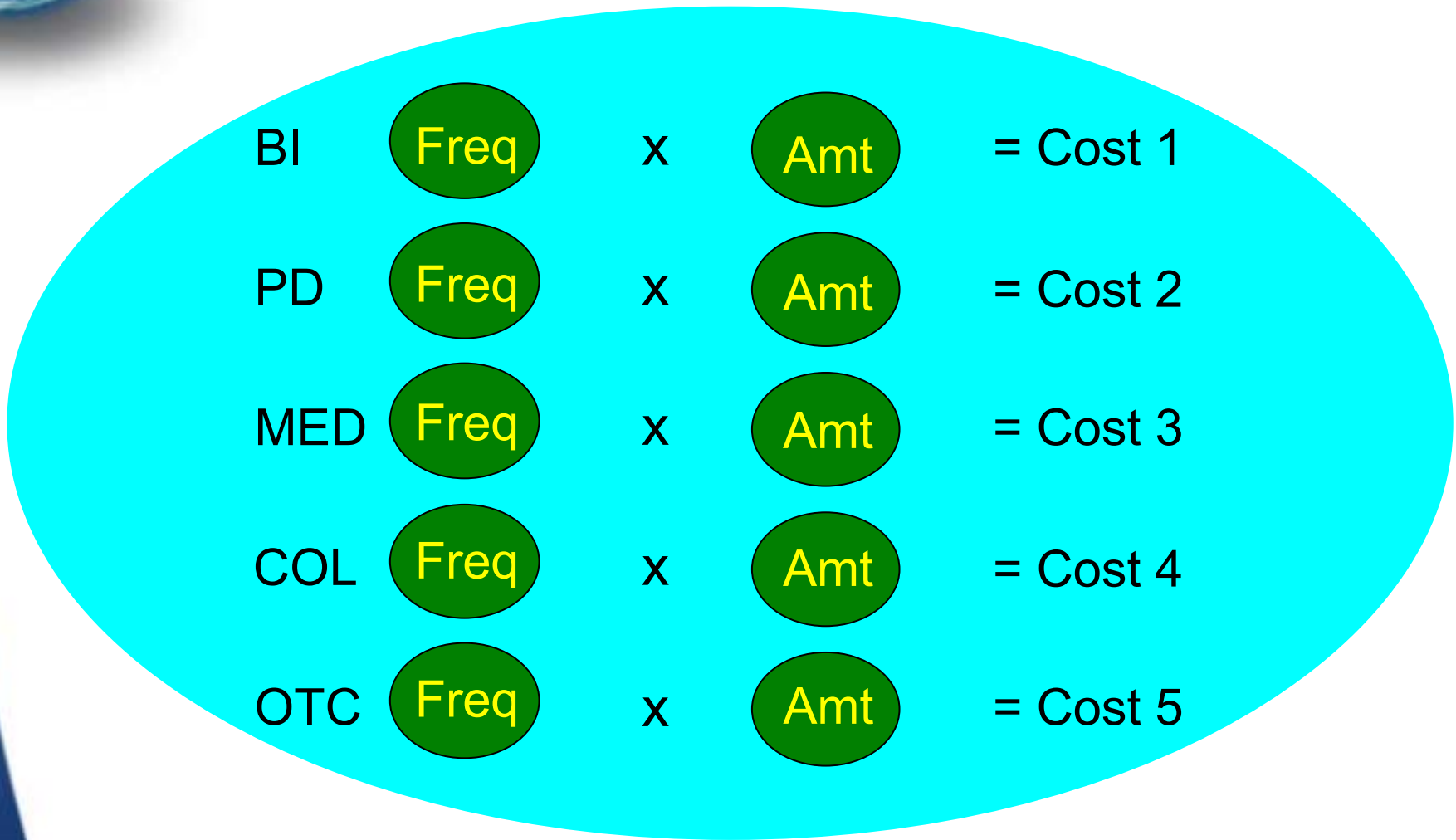
$$Var[\underline{Y}] = \phi.V(\underline{\mu}) / \underline{\omega}$$

- Consider all factors simultaneously
- Allow for nature of random process
- Robust and transparent
- EU industry standard

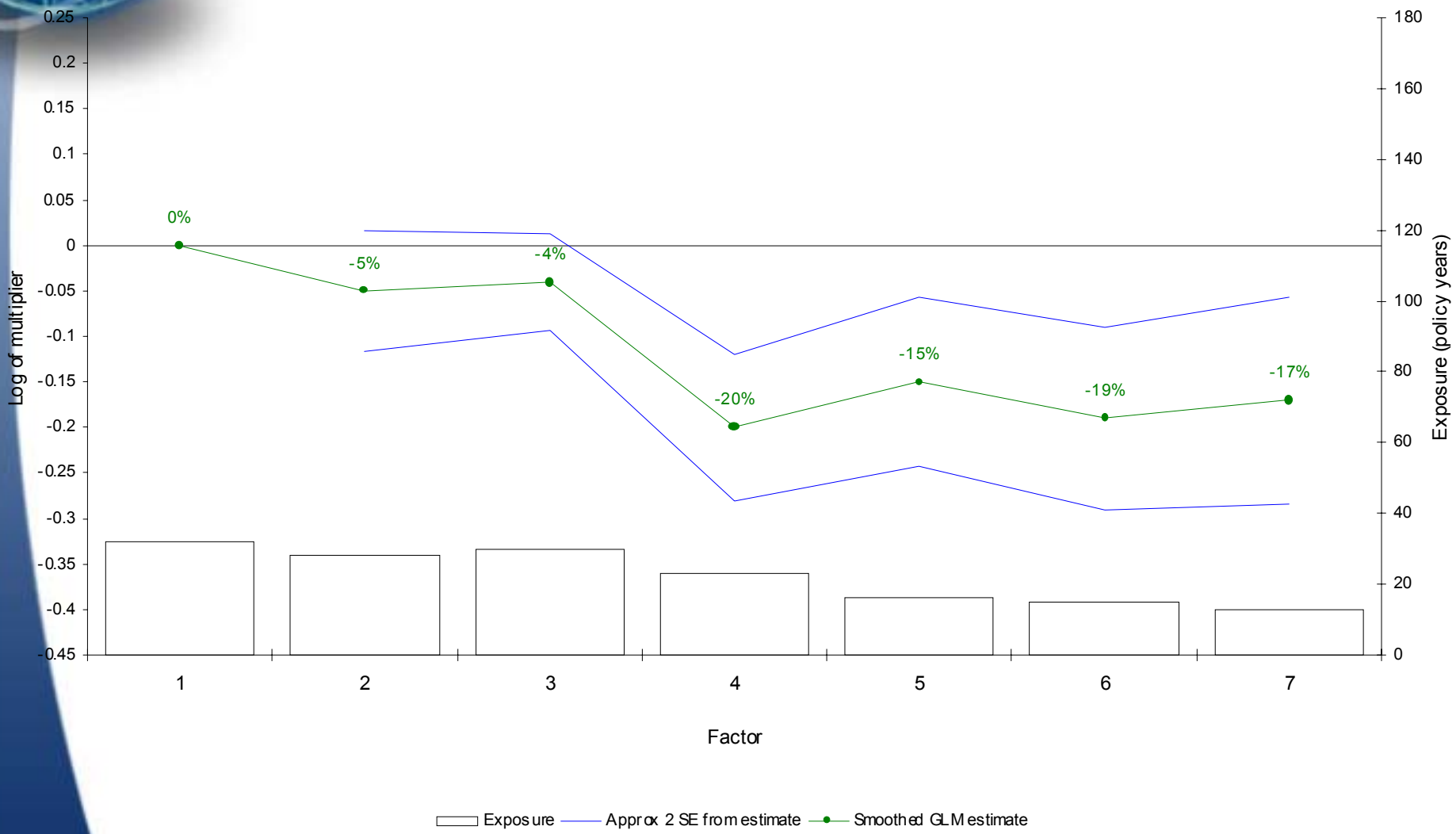
Why GLMs over other methods

- One-way and two-way analyses
  - distorted by correlations, no diagnostics
- Iteratively standardized one-ways
  - no diagnostics, no faster than GLMs, less flexibility for allowance of random process, not always tractable solution
- Neural networks
  - not transparent, hard to interpret, can be unstable with new types of policy, easy to over/under fit
- Cluster analyses / "segmenting"
  - suitable for marketing but less appropriate for assessing continuous risk; does not fit with rating structures

Modeling the cost of claims



Example of GLM output (real UK data)



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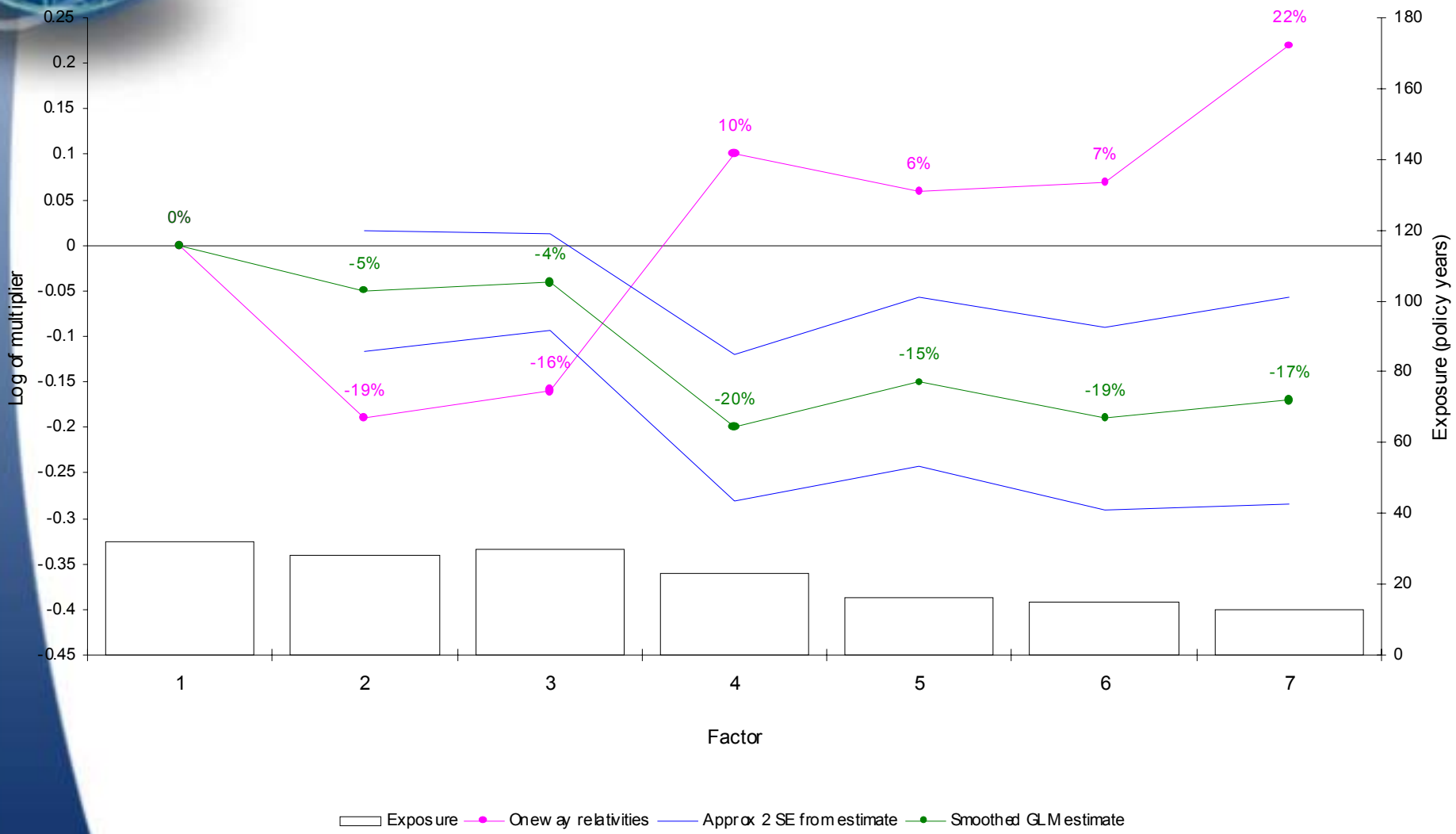

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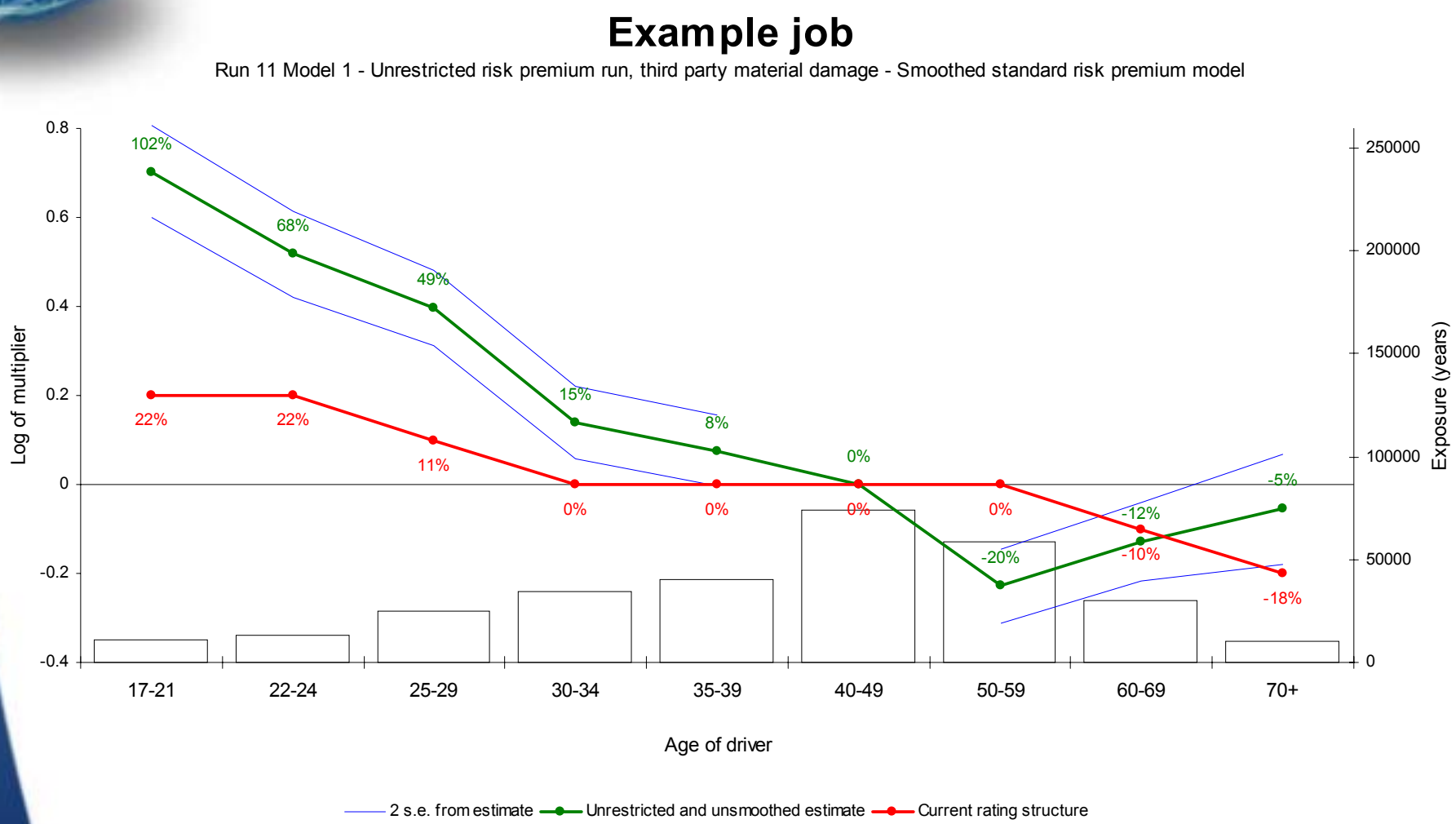
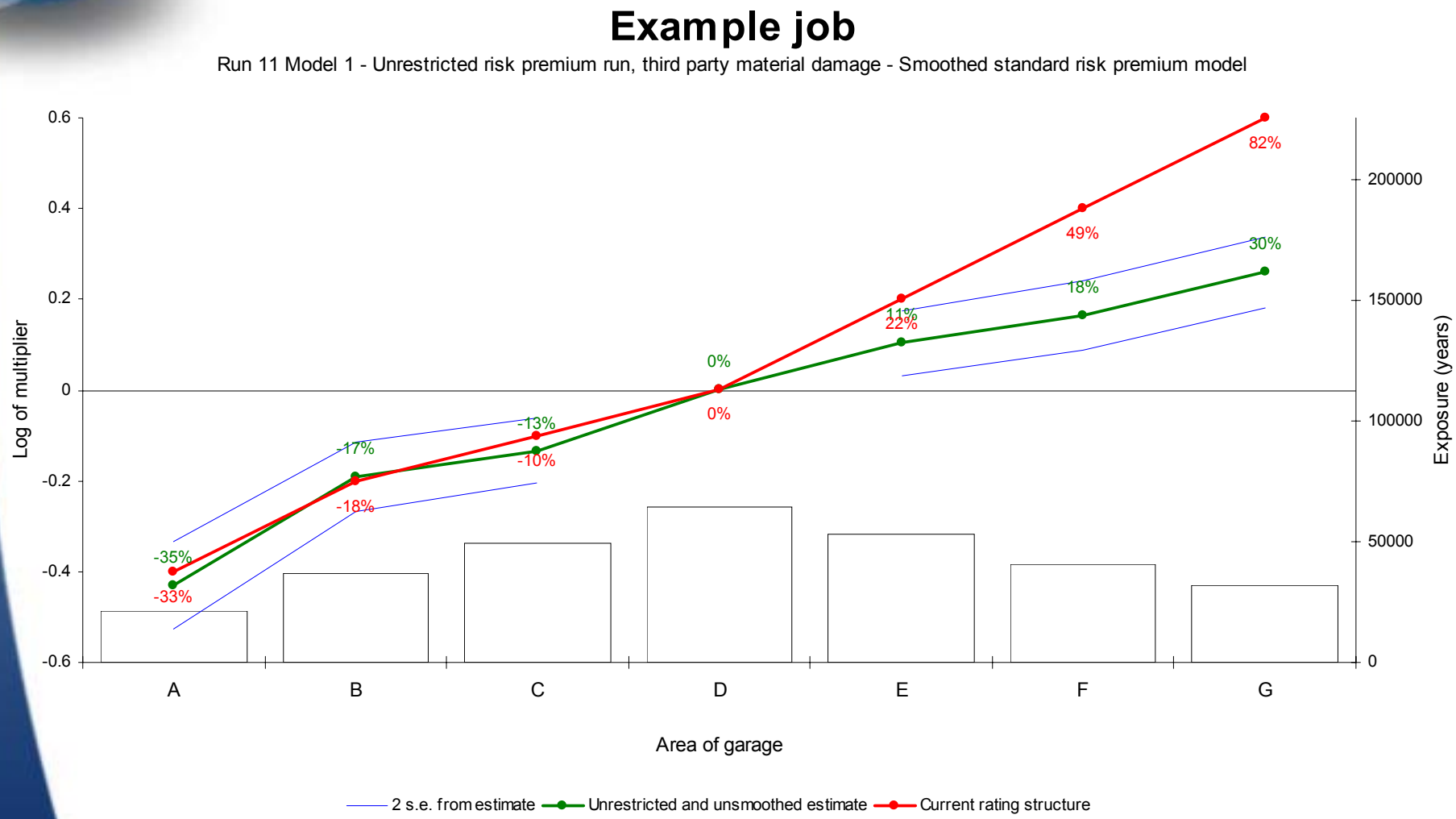
Factor effect analysis



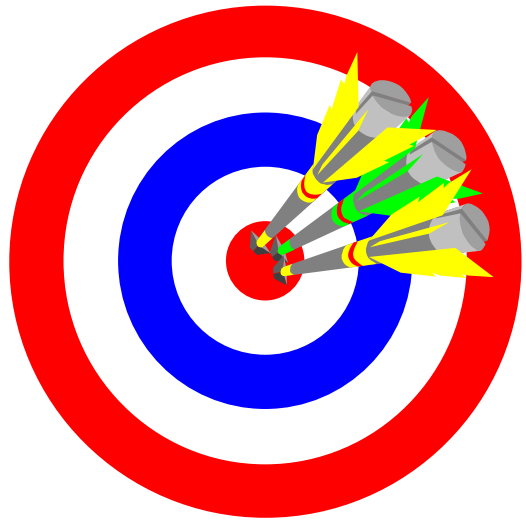
Factor effect analysis



What if rates cannot be changed?

Profitability scoring

- Construct profitability score based on expected loss ratio
- Profitability score can then be used for
  - target marketing campaigns
  - agent incentive schemes
  - profit share arrangements



Producing the score

- Model E(LR)
  - fit standard GLMs by claim type, separately for frequency and severity
  - combine to give expected risk premium model
  - for each record populate fitted risk premium and divide by annualized premium
  - fit model to this value
- Transform additive structure into scoring algorithm (eg 0 to 1000) which can be banded

Example dataset

Risk #	Territory	Age	ECY	# Claims	Losses	Ann Prem	E(N)	E(A)	E(RP)	E(RP) /Prem
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9) = (7)*(8)	(10) = (9)/(6)
1	1	25	1	0	-	206	0.07	1800	130	0.63
2	4	54	1	0	-	136	0.05	1700	90	0.66
3	4	37	1	1	1,200	172	0.06	1675	105	0.61
4	3	40	0.5	0	-	142	0.07	1400	94	0.66
5	9	19	1	0	-	254	0.10	1800	180	0.71
6	1	65	1	0	-	148	0.05	1850	92	0.62
7	3	42	1	2	42,000	188	0.08	1850	145	0.77

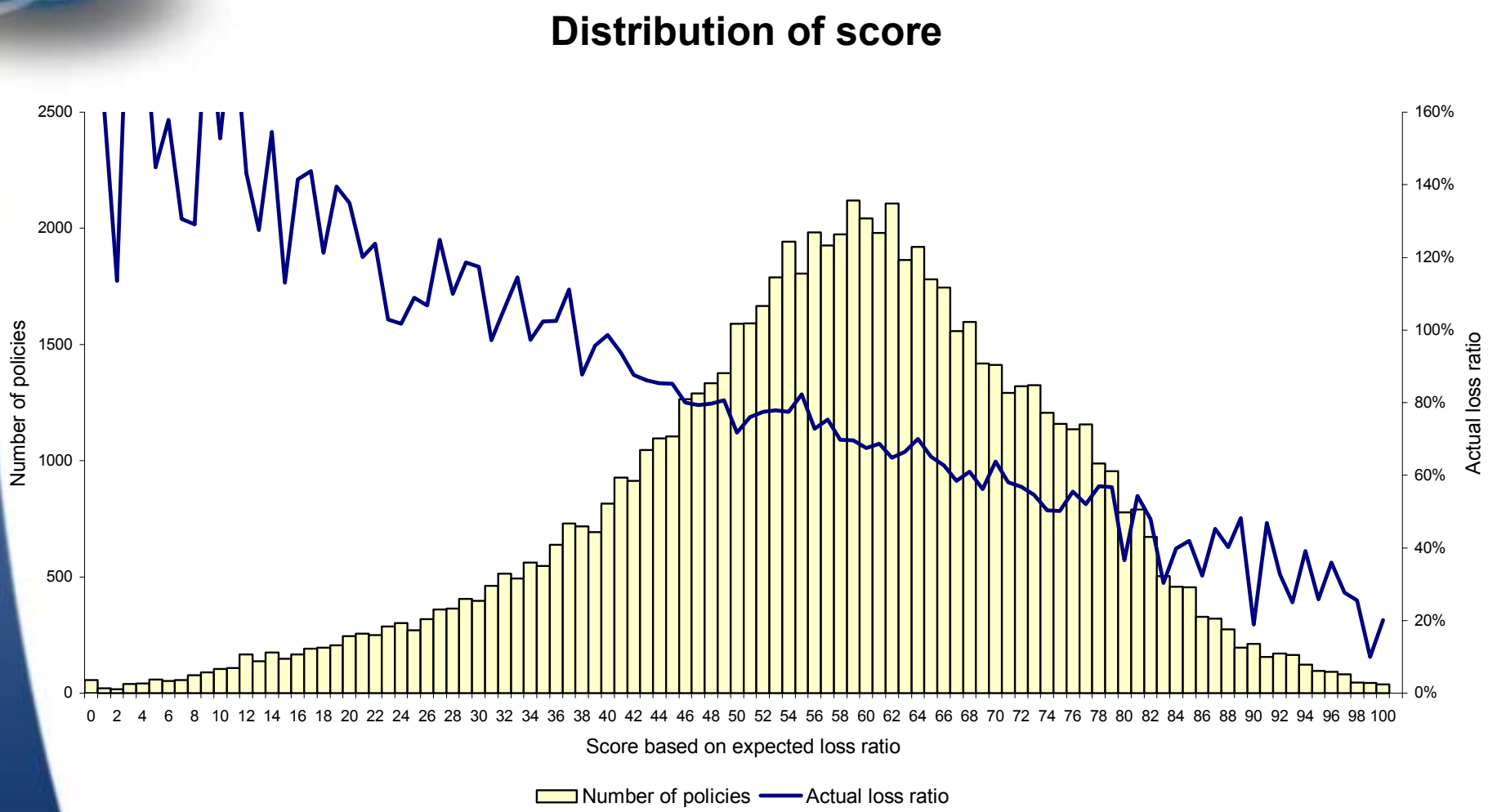
Underlying models

Example dataset (cont'd)

E(RP) /Prem (10) = (9)/(6)	Modeled E(LR) (11)	Score (12)	Tier (13)
0.63	0.63	85	3
0.66	0.65	76	4
0.61	0.62	95	1
0.66	0.66	75	4
0.71	0.69	63	5
0.62	0.62	92	2
0.77	0.75	55	6

Fit model to this

Actual loss ratio by score



Case study: UK bank

- Distributed insurance products underwritten by a partner insurance company
- Bank could not easily change rates
- Bank shared in insurance profit
- Bank derived profitability score based on banking factors which were not available at point of sale
- Score then used to market insurance selectively to banking customers

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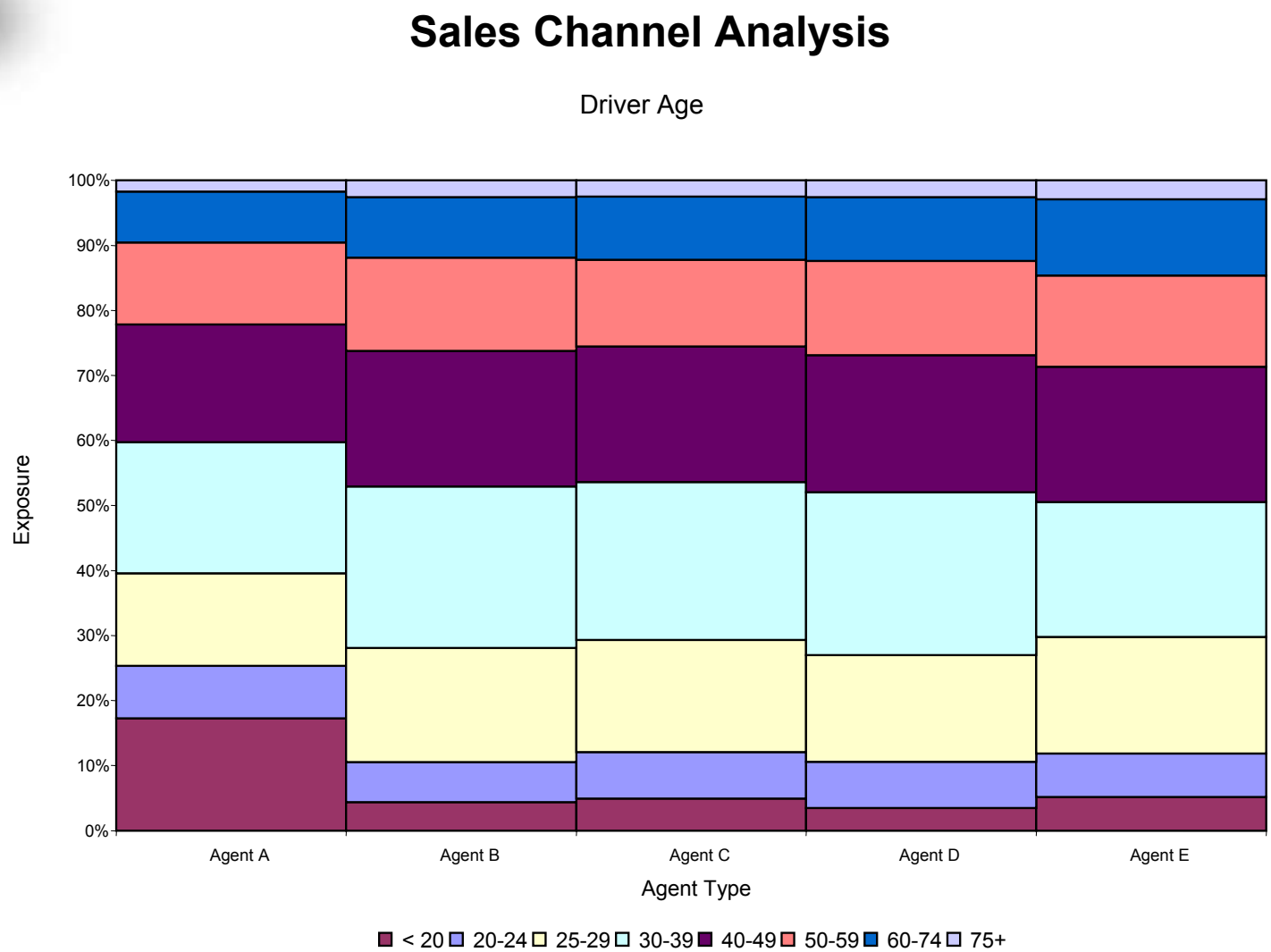
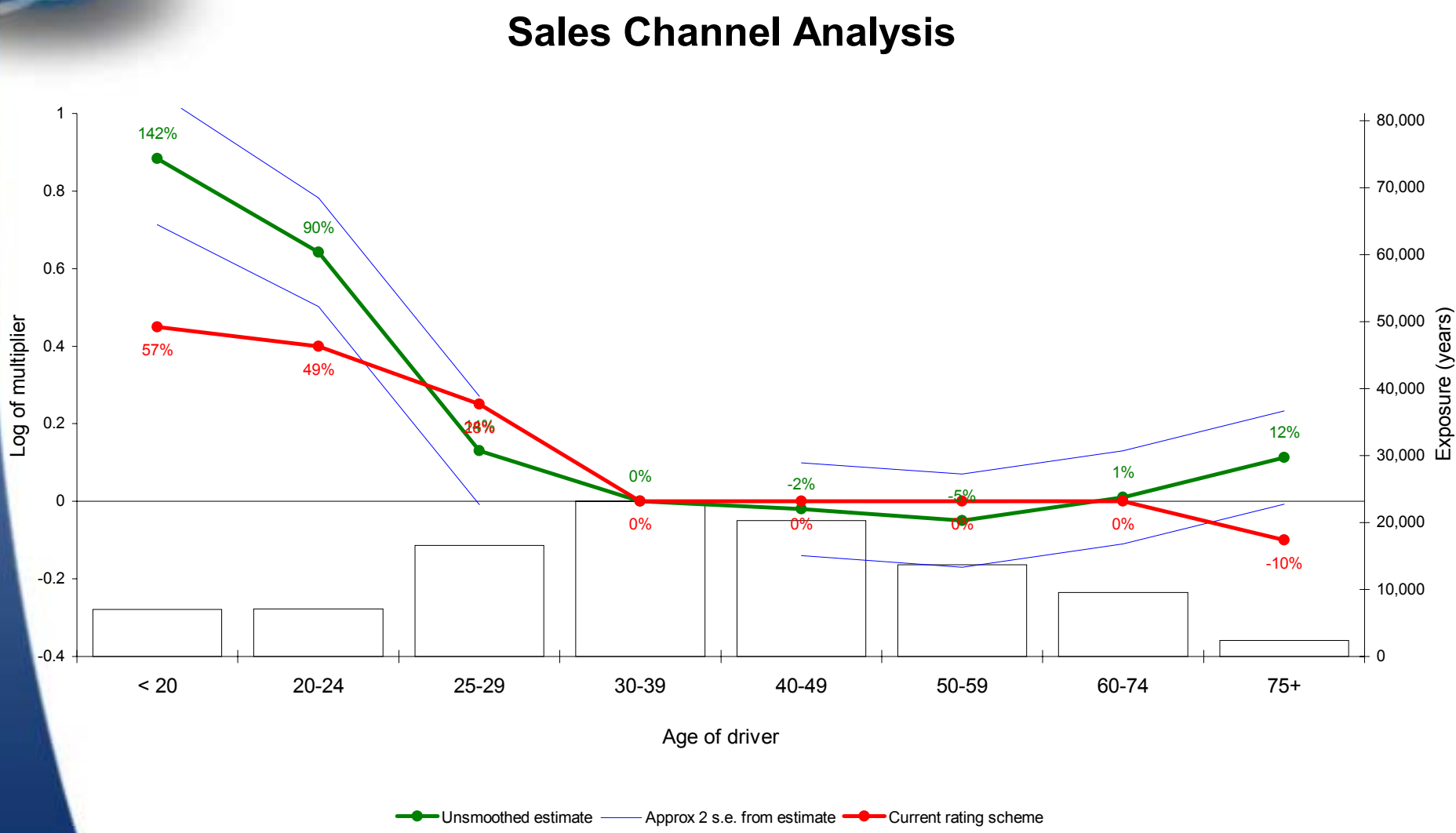
Sales channel analysis

- GLMs can help distinguish between effect on profit of
  - mix of business written through a particular channel
  - effect of channel itself
- Simply compare one-way for channel with GLM for channel - the rest results from mix of business

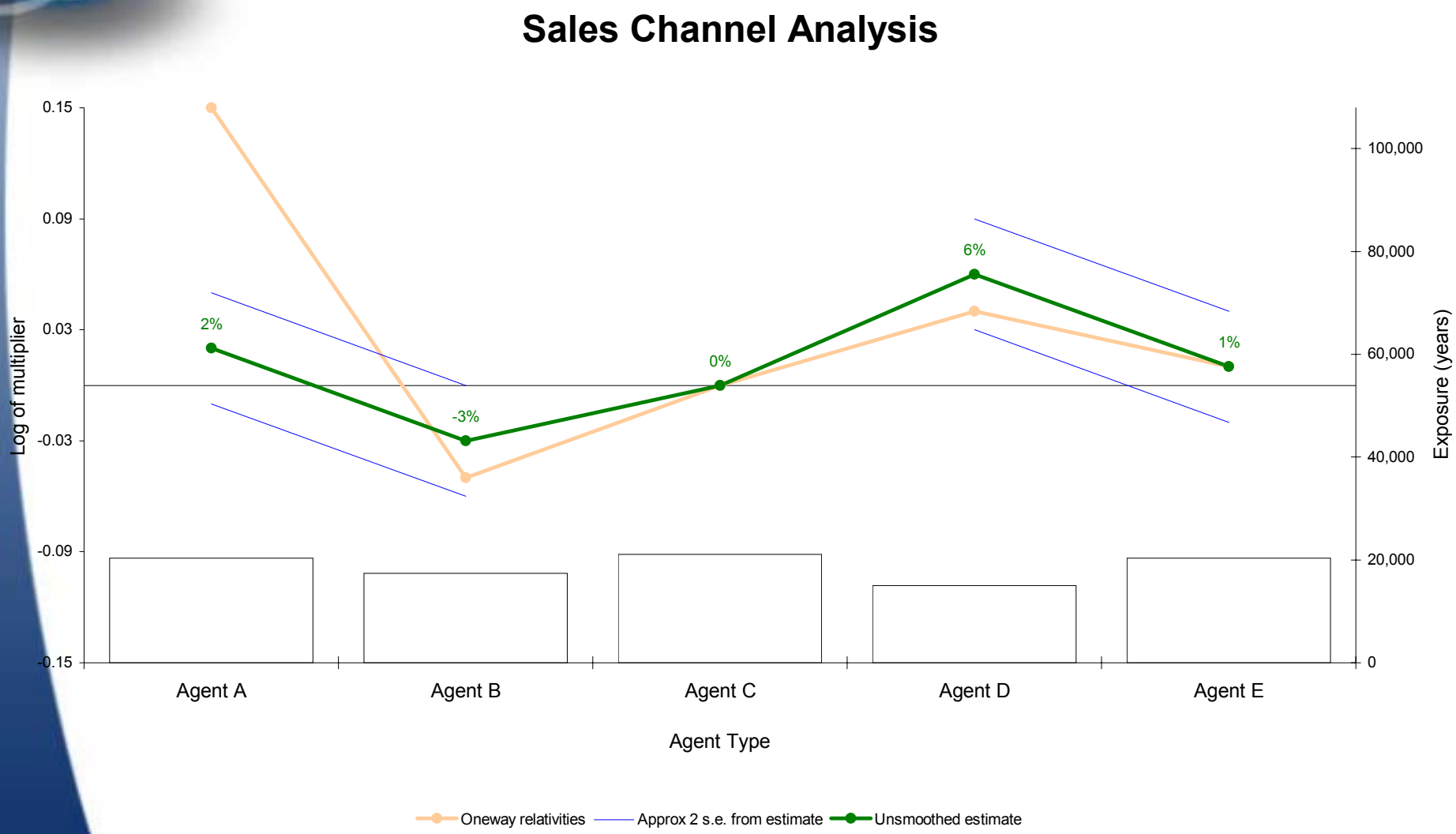
Identifying mix of business



Identifying cross-subsidies



Compare one-way to GLM



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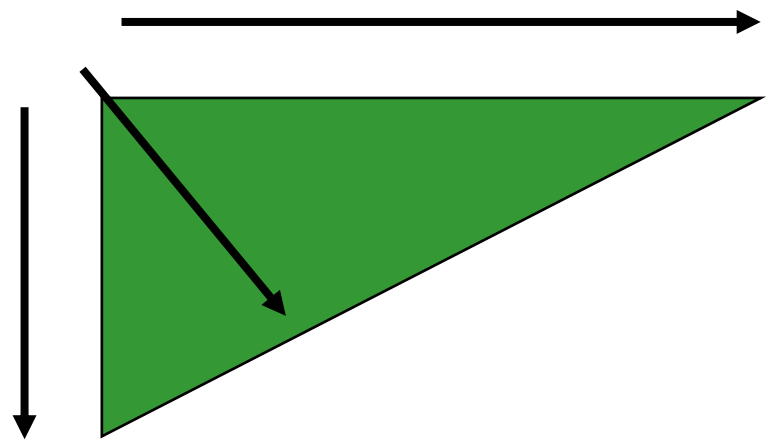
Projecting loss triangles

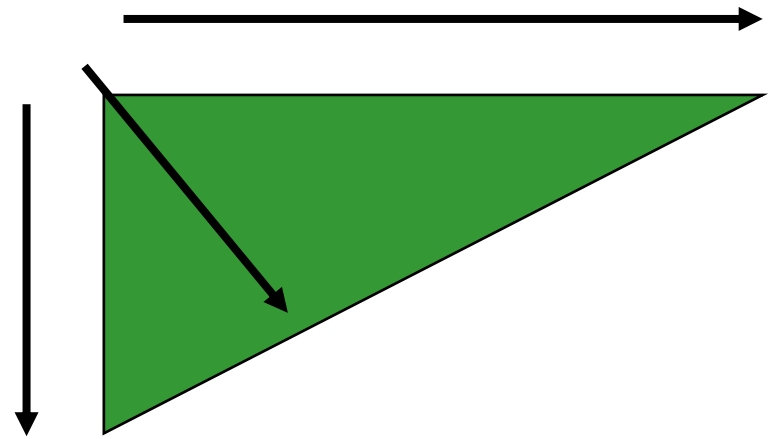
- Attribute discrete claims development to
  - loss or underwriting period
  - development period
  - calendar period



- Care needs to be taken not to over parameterize - there are few observations relative to the number of levels of the three factors
- Make assumption about future calendar years

Projecting loss triangles

- Group loss/underwriting & calendar periods where possible and appropriate



- Consider use of
  - polynomials for development factor (fewer parameters)
  - piecewise linear functions for calendar year factors
- Examine diagnostics carefully

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Initial reserve estimates (a priori)

- Standard ratemaking model
  - when applied to a portfolio of business will give an a priori expected loss
  - could be used with Bornhuetter Ferguson, etc

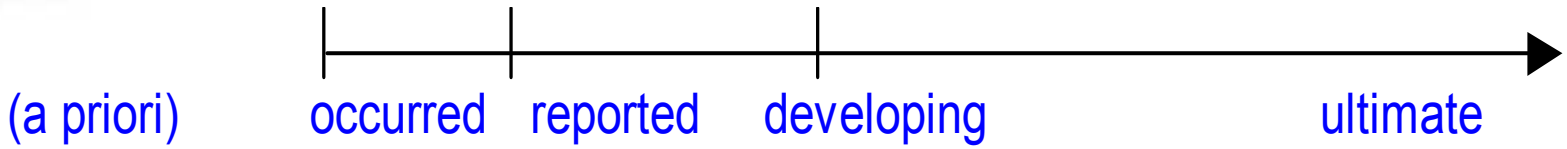
Initial reserve estimates (once reported)

- Model based on information supplied the moment a claim is reported
- Can use claim information such as
  - number of people in vehicle
  - whether anyone declared injured
- This model can then be applied to all recently reported claims to derive a revised reserve estimate

Initial reserve estimates (further development)

- Model based on information supplied later in the life of a claim
  - adding information such as lawyer representation

Initial reserve estimates (at various points in time)



- Important not to double (or triple) count these measurements

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