Visualizing Predictive Modeling Results

2006 CAS Seminar on Predictive Modeling

Claudine Modlin, FCAS

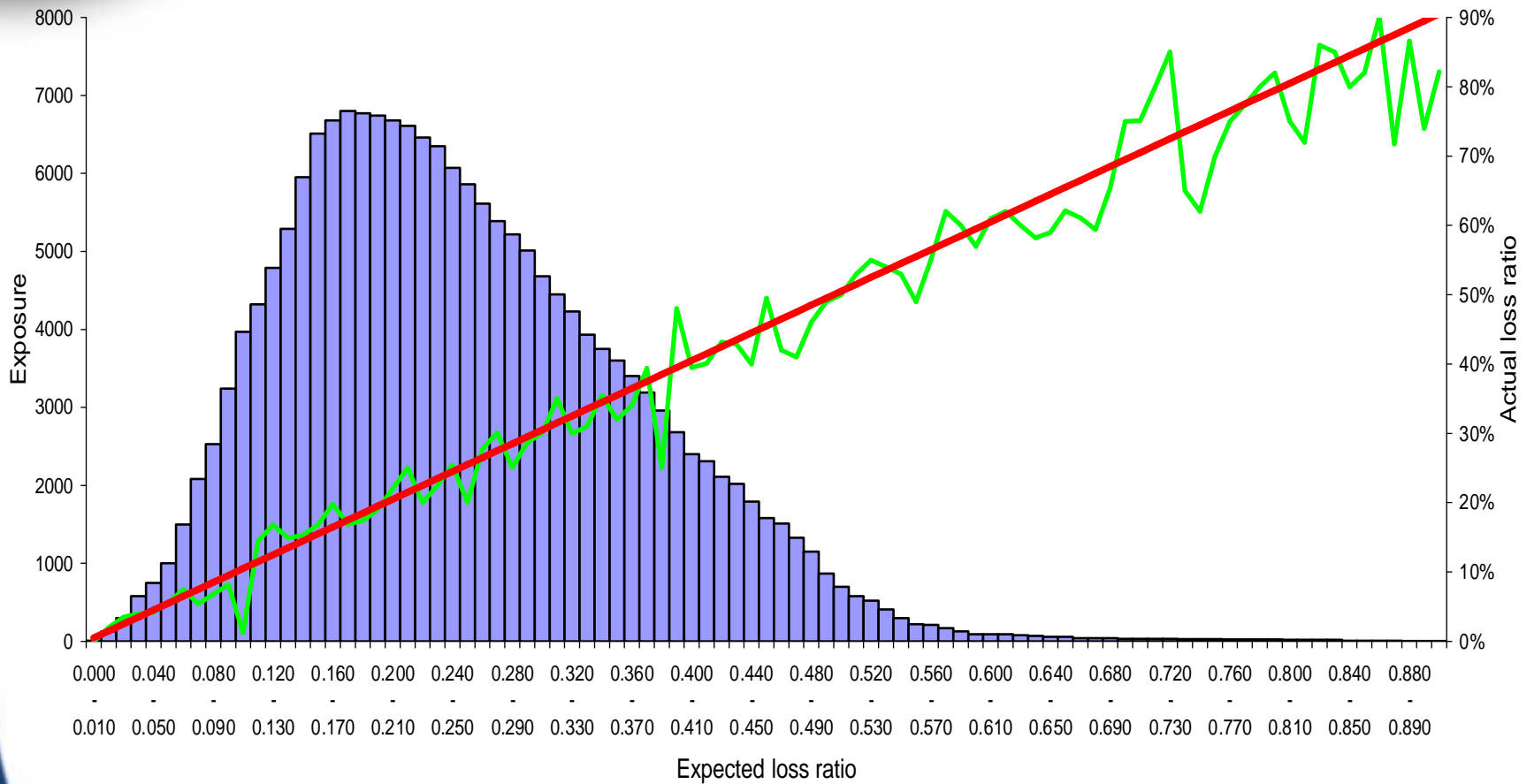**Watson Wyatt Worldwide**

Watson Wyatt
Worldwide

Communicating modeling results visually

- ## Stakeholder approach
  - focus on the value of the results

- ## Technical / actuarial approach
  - tell the story of the model development in a chronological fashion
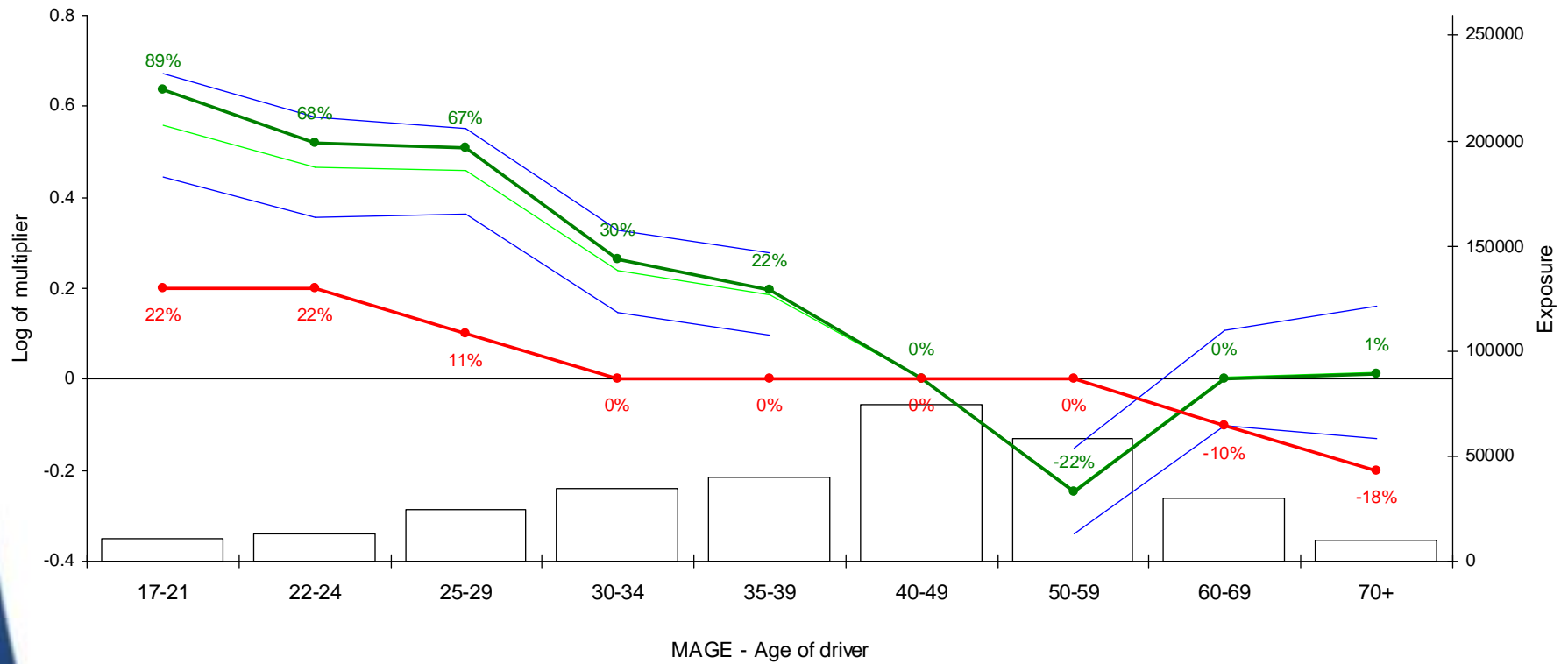
Loss ratio impact

Factor effect analysis

Demonstration job

Run 10 Model 2 - Third party material, standard risk premium run - Unsmoothed standard risk premium model
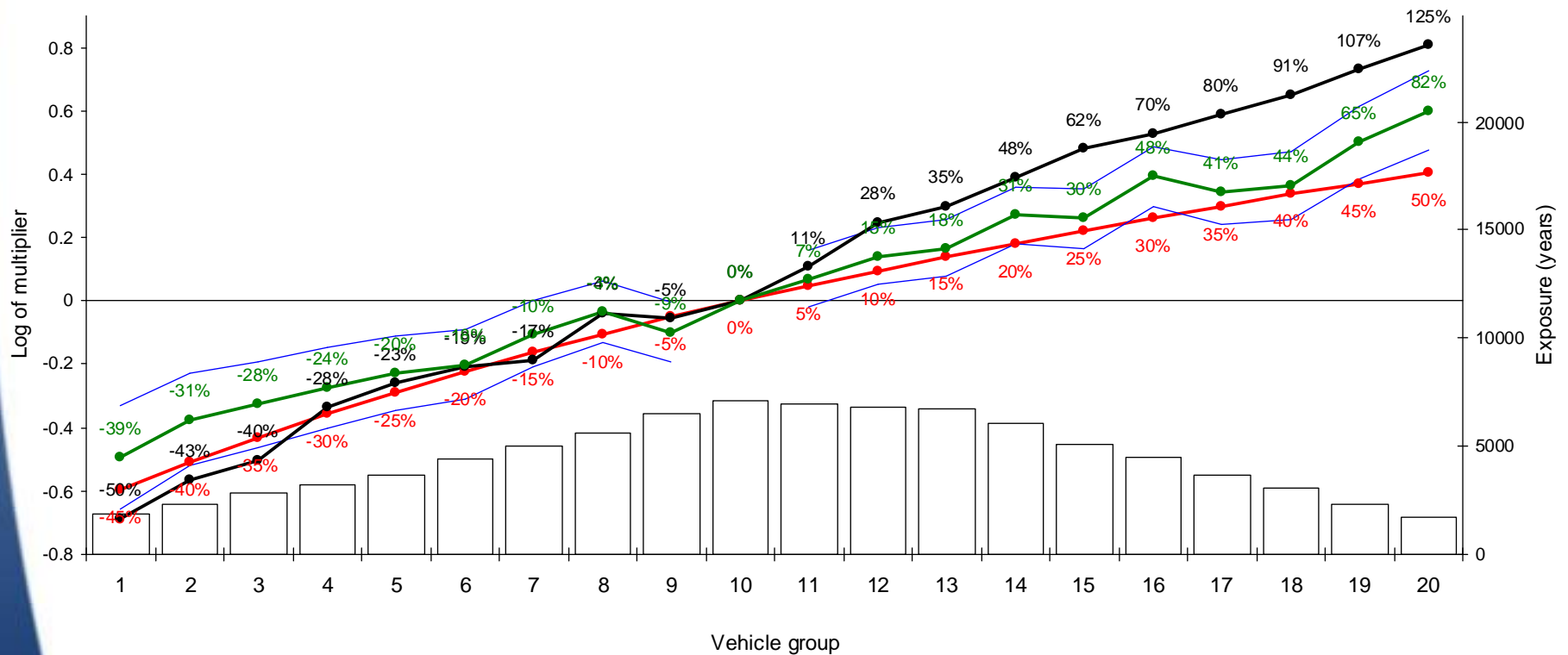
Considering current rates and the competitive position

Example of competitor analysis

Third party cover

Log of multiplier (left axis) vs **Vehicle group** (x-axis), **Exposure (years)** (right axis)

Legend:
- ● Current rates (red)
- Approx 95% confidence interval (blue)
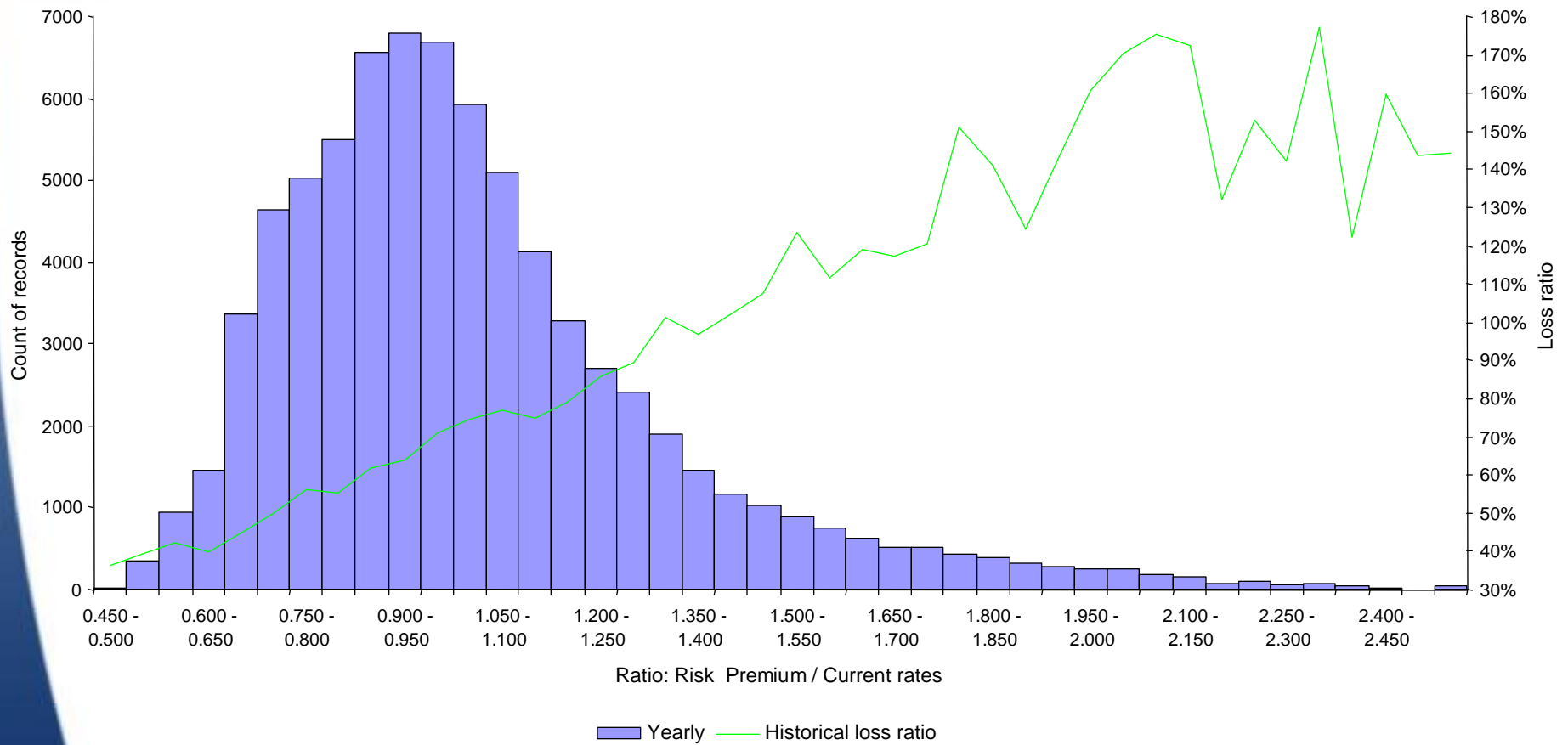- ● Third cheapest market quote (black)
- ● Smoothed estimate (green)

P value = 0.0%
Rank 9/11

Impact analysis

Example job

Impact analysis

Example job
Age of driver
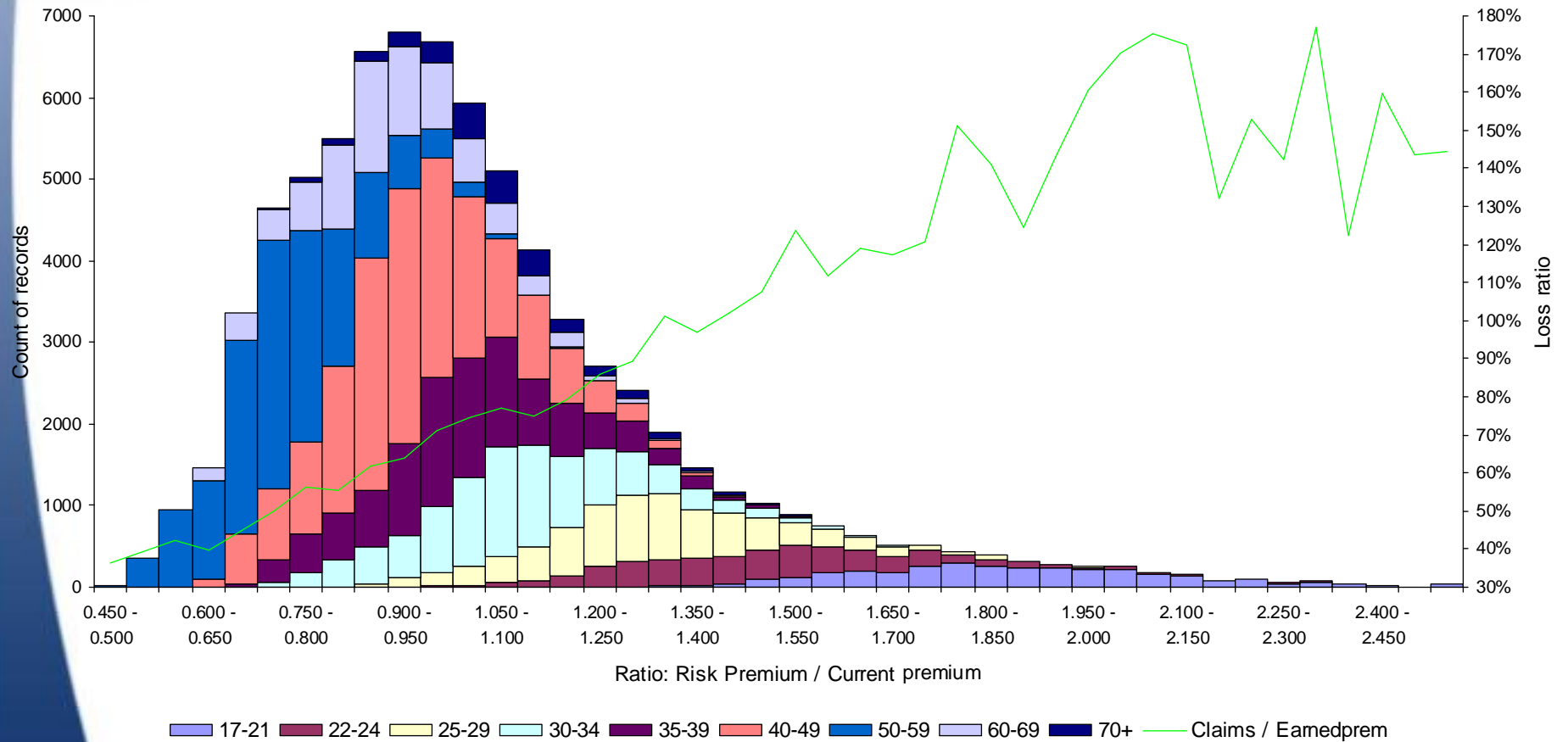
Comparison with competitors

Percentage of contracts (y-axis: 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20)

Percentage change in premium (x-axis: -60, -50, -40, -30, -20, -10, 0, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100, 110, 120, 130, 140, 150, 160)

Legend:
- Zone A
- Zone B
- Zone C
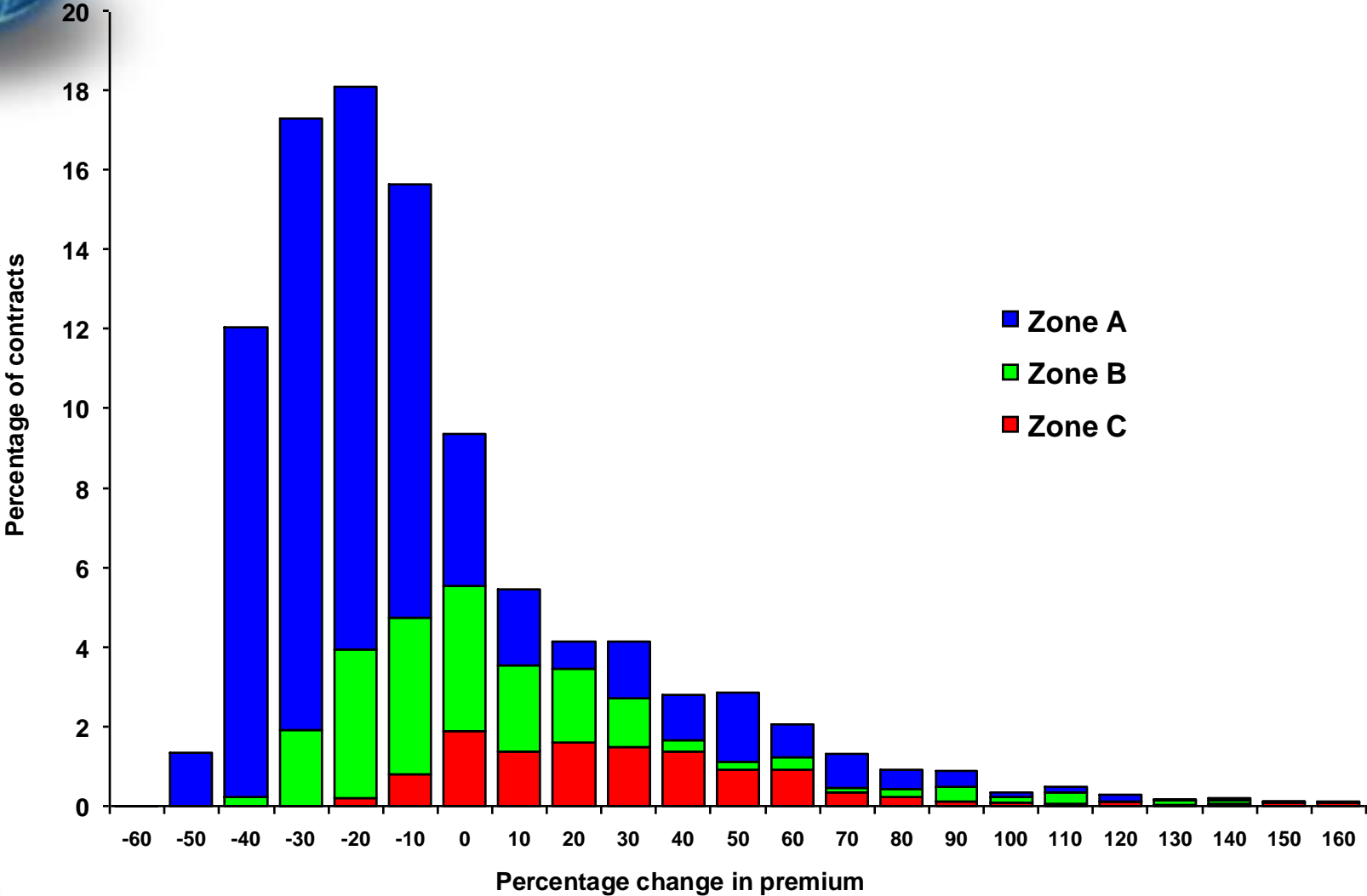
Moving toward competitive / profitable (Before)
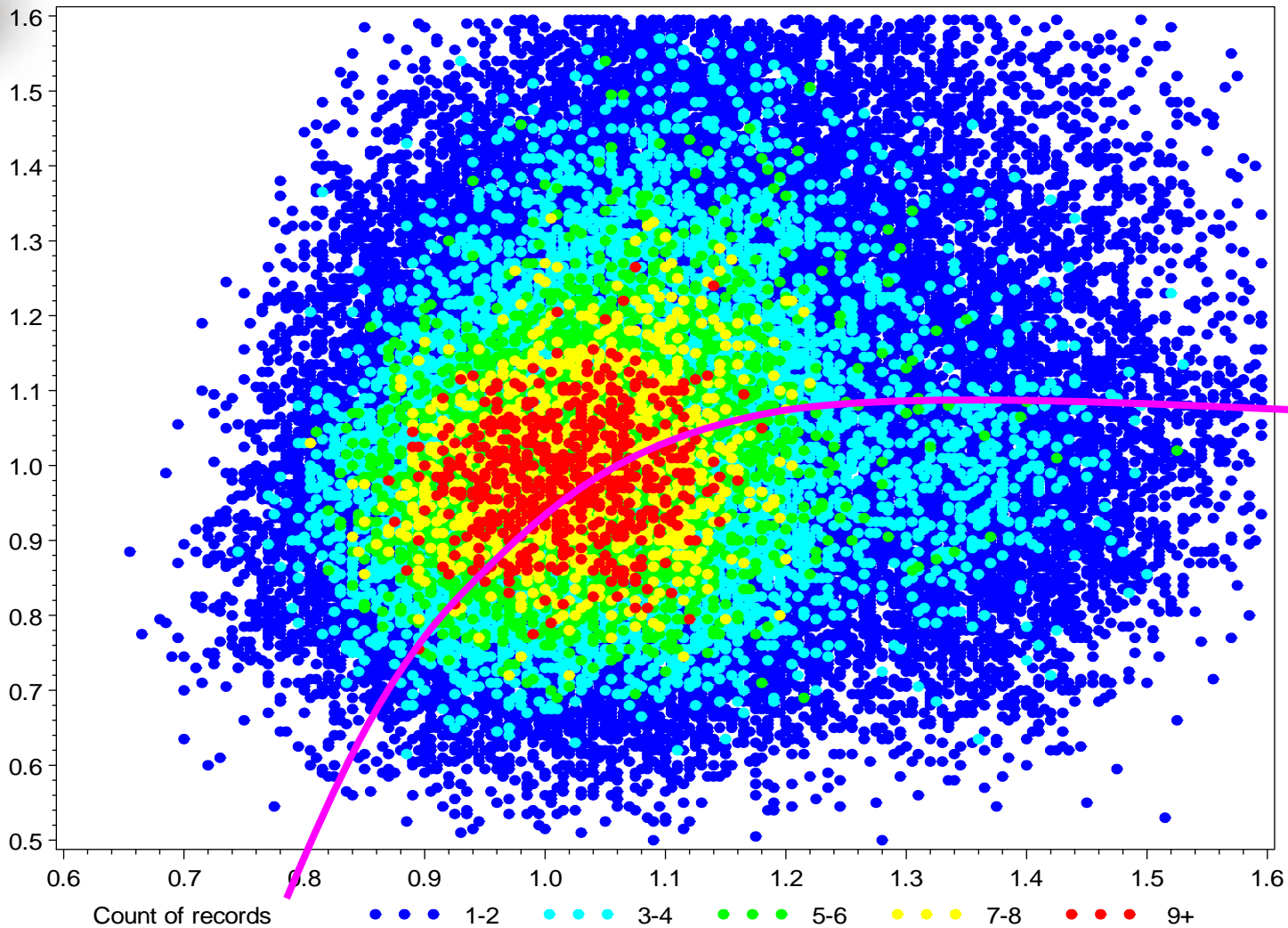
Moving toward competitive / profitable (After)
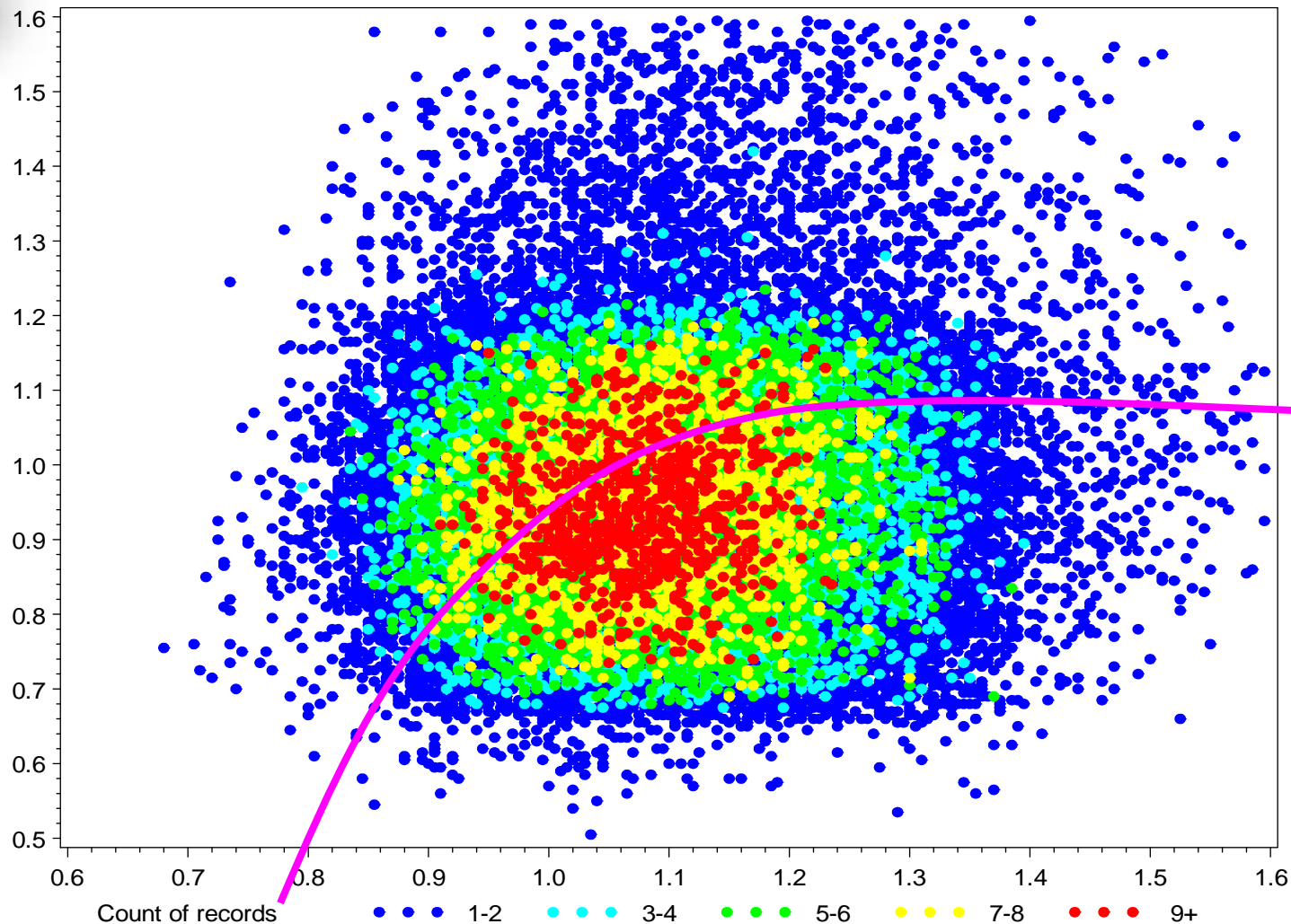
Quantifying cross subsidy

Expected Loss Ratio

■ Cross subsidy —— Exposure in years
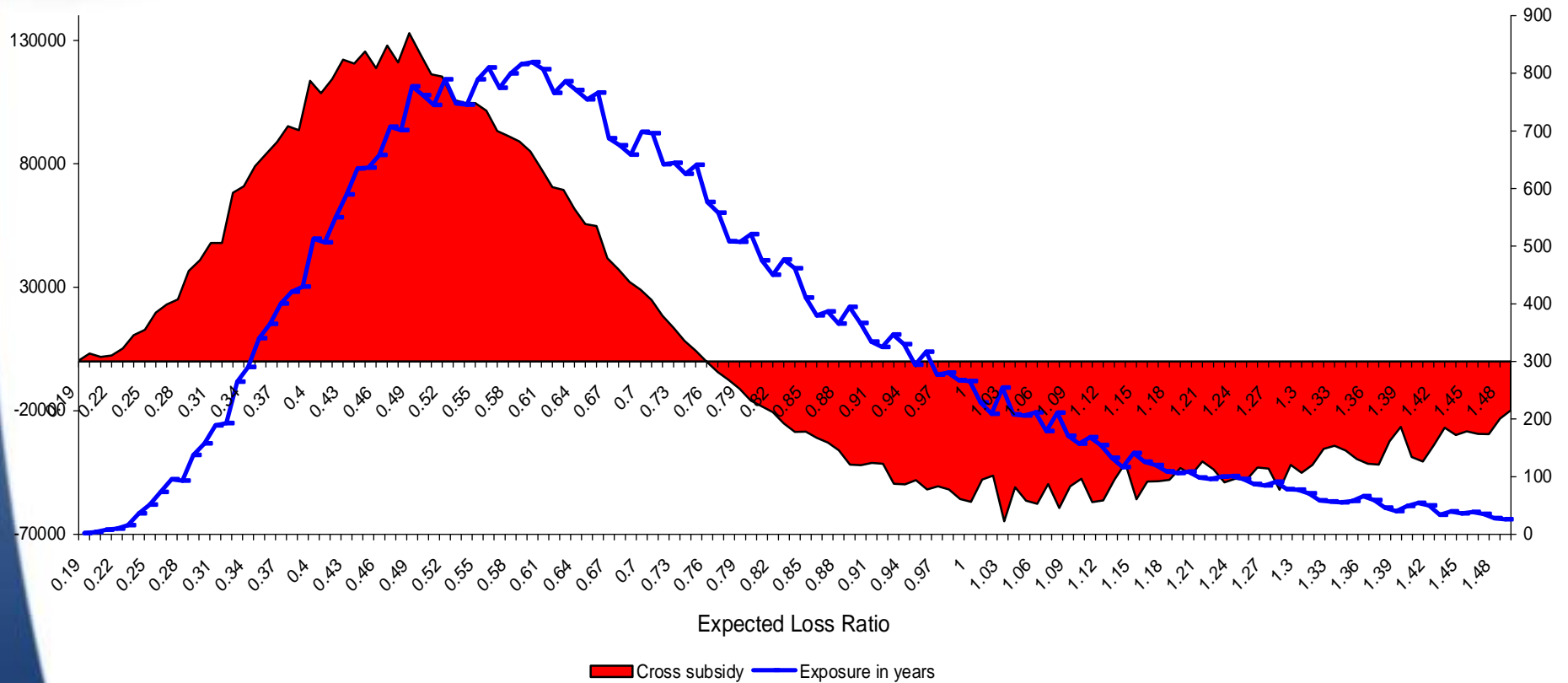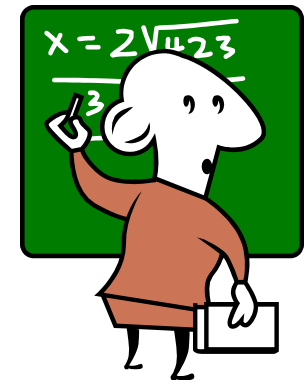
Communicating modeling results visually

- Business approach
  - lead with the value of the results

- Technical / actuarial approach
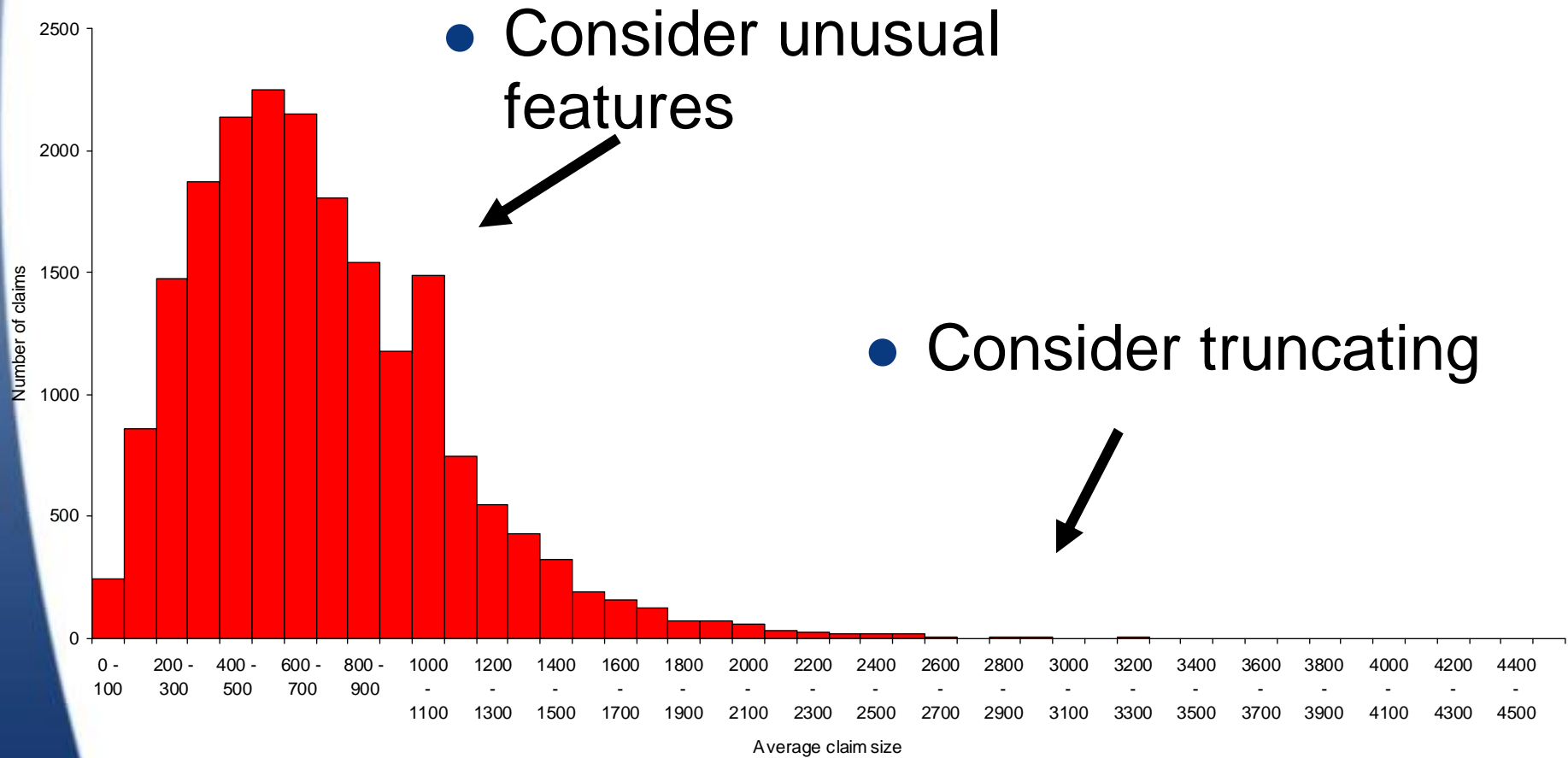 - tell the story of the model development in a chronological fashion

Technical stories

- Portfolio analysis

- Deviance tests vs graphical results

- Consistency with time

- Interactions (deciding which to test & detecting significance)

- Residual diagnostics and leverage

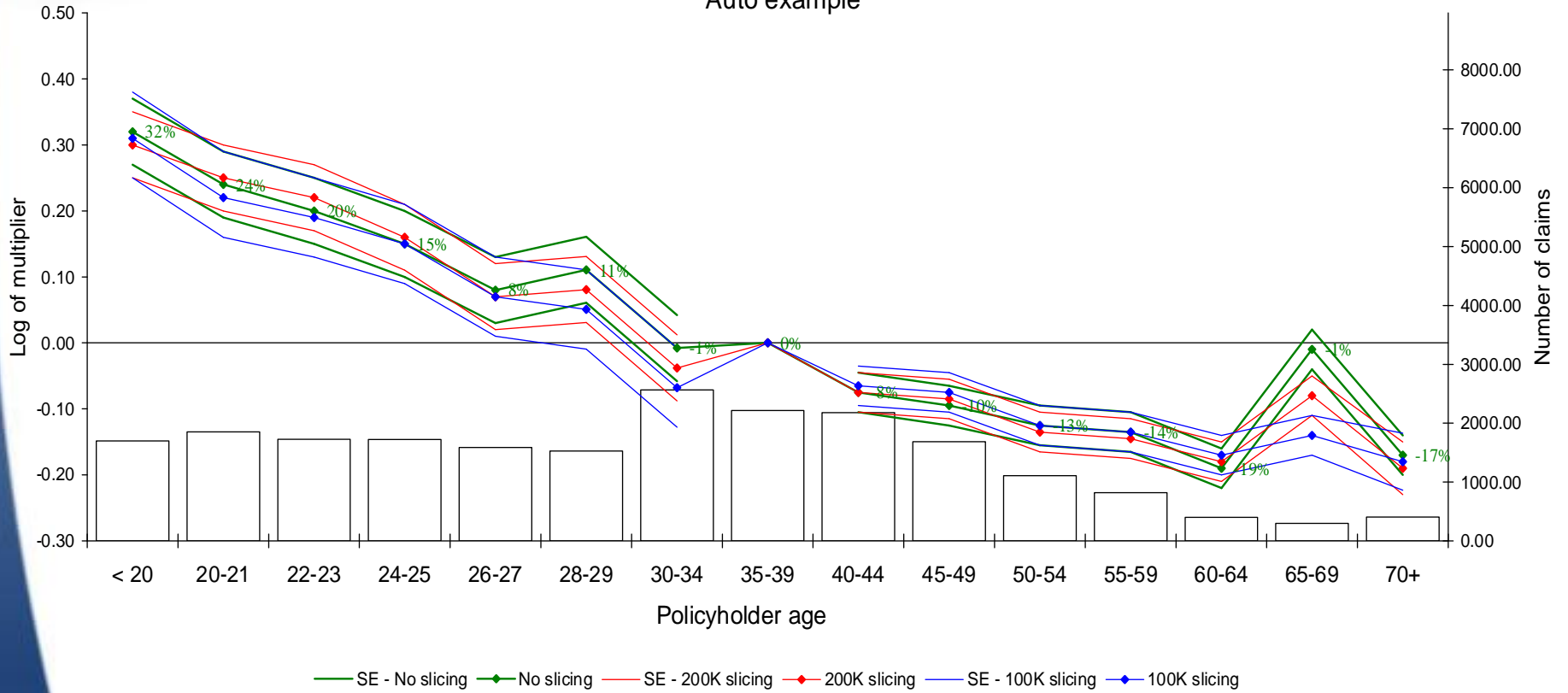- Measuring the effect of commercial decisions

- Validating models

- Maps

Claim size distribution analysis

- Consider unusual features

- Consider truncating

Large loss sensitivity testing

Third Party Liability - Severity
Auto example

Technical stories

- Portfolio analysis

- **Deviance tests vs graphical results**

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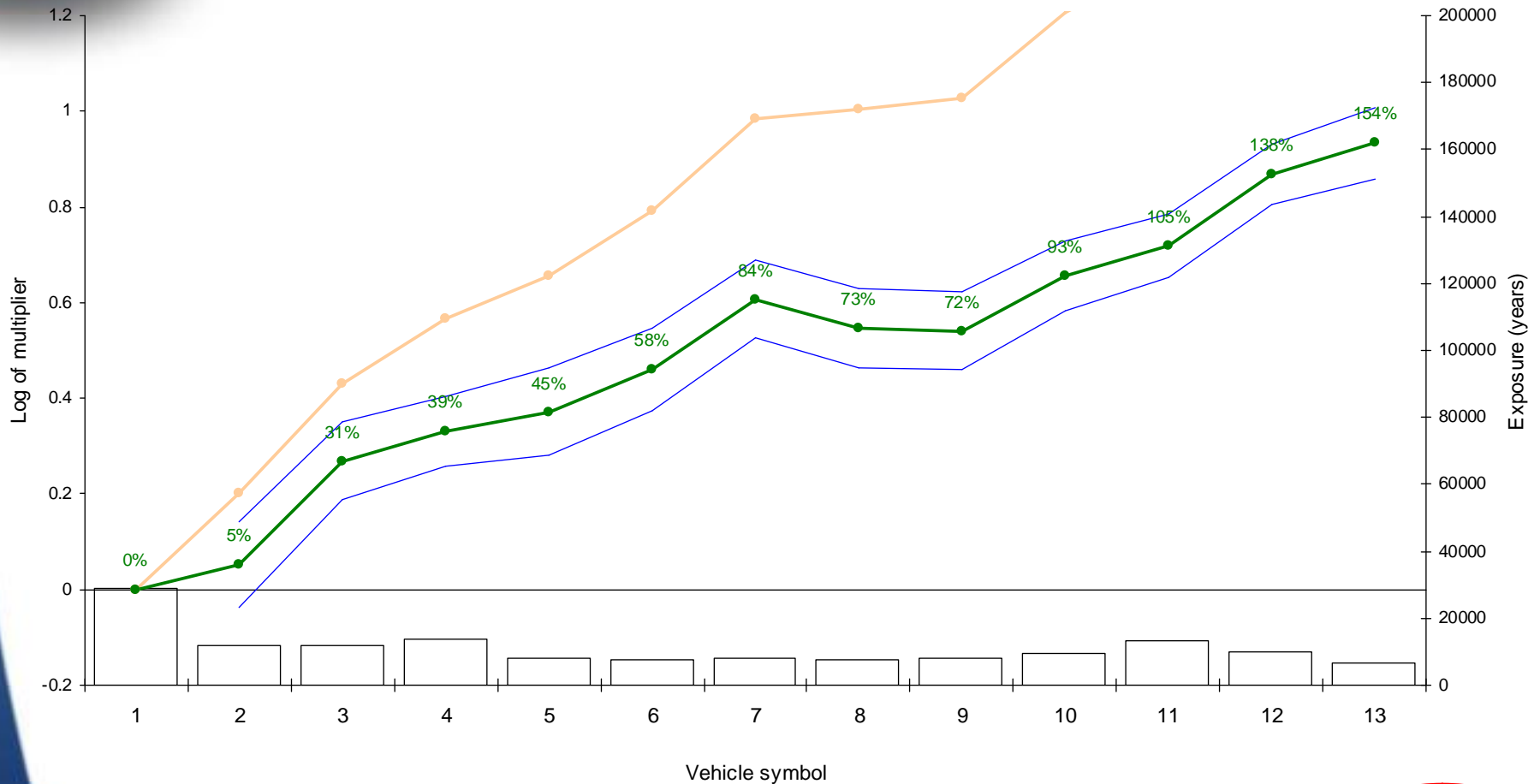
- Validating models

- Maps

Deviance tests

- Single figure measure of goodness of fit

- Try model with & without a factor

- Statistical tests show the theoretical significance given the extra parameters
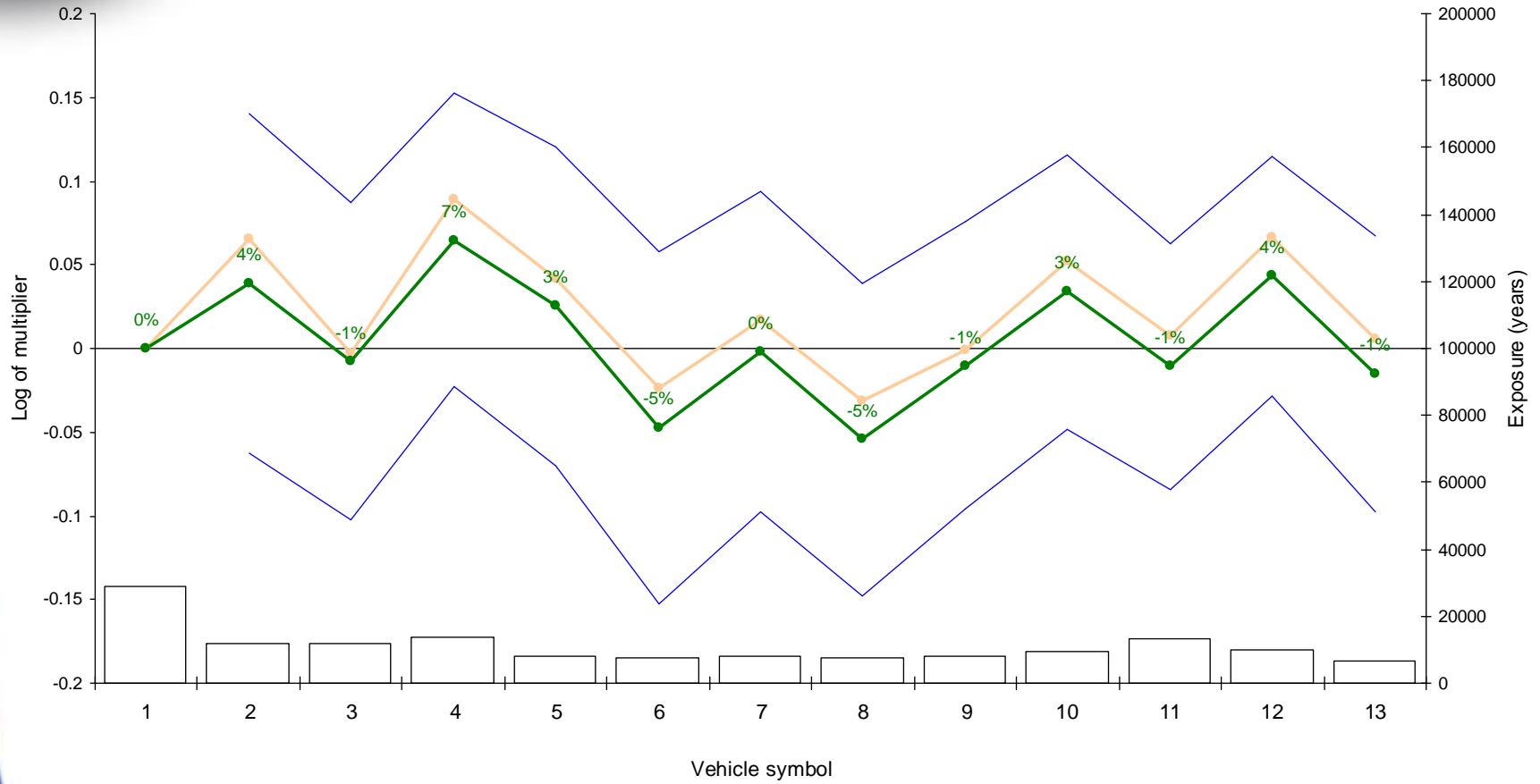
GLM output (significant factor)

GLM output (insignificant factor)

Deviance tests vs graphical results

Factor regarding billing information
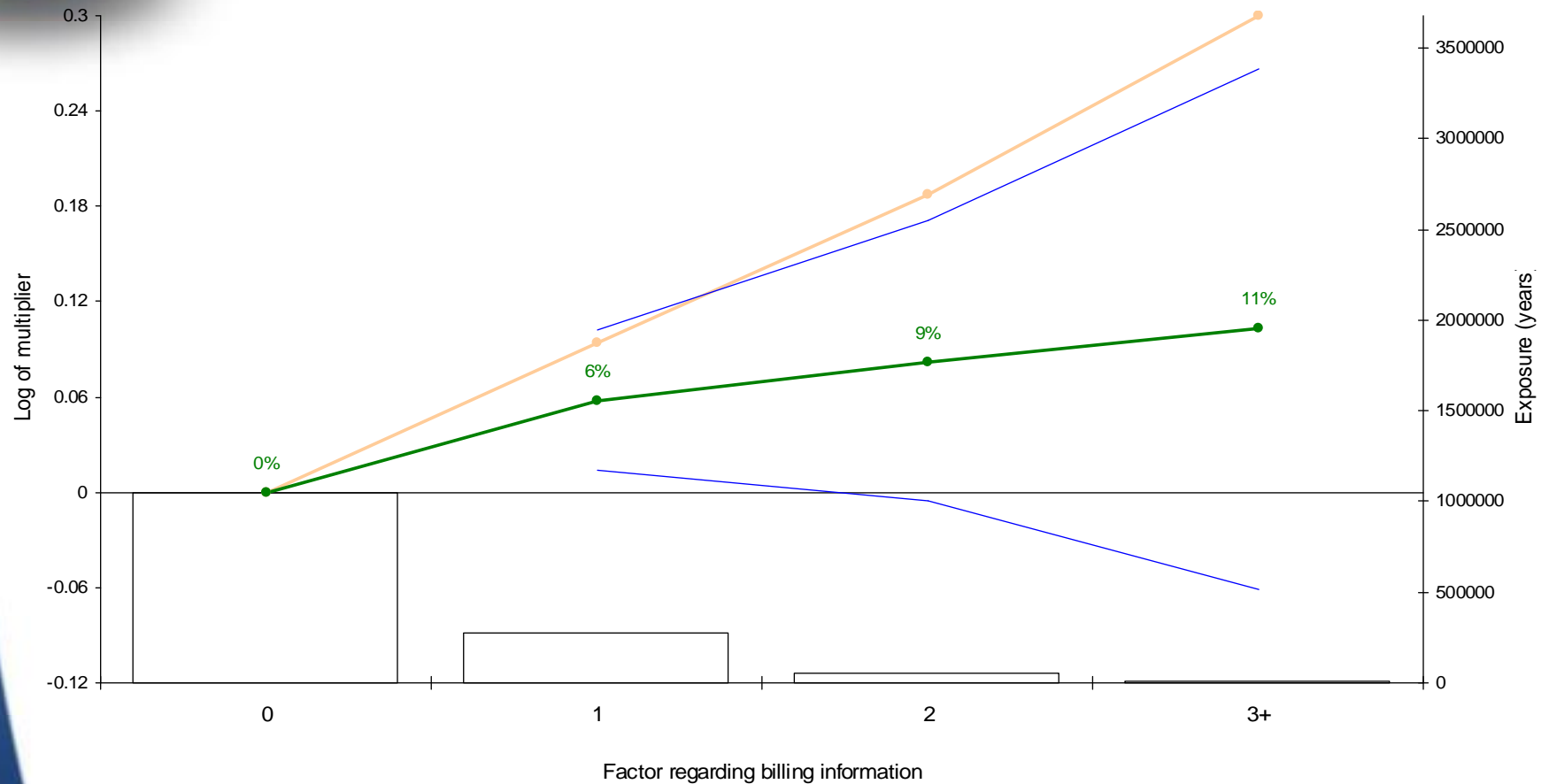
- Oneway relativities
- Approx 95% confidence interval
- Unsmoothed estimate
- Smoothed estimate

P value = 0.8%
Rank 14/34

Deviance tests vs graphical results

Factor regarding theft rate

Oneway relativities - R51M1 — Approx 95% confidence interval — Parameter estimate
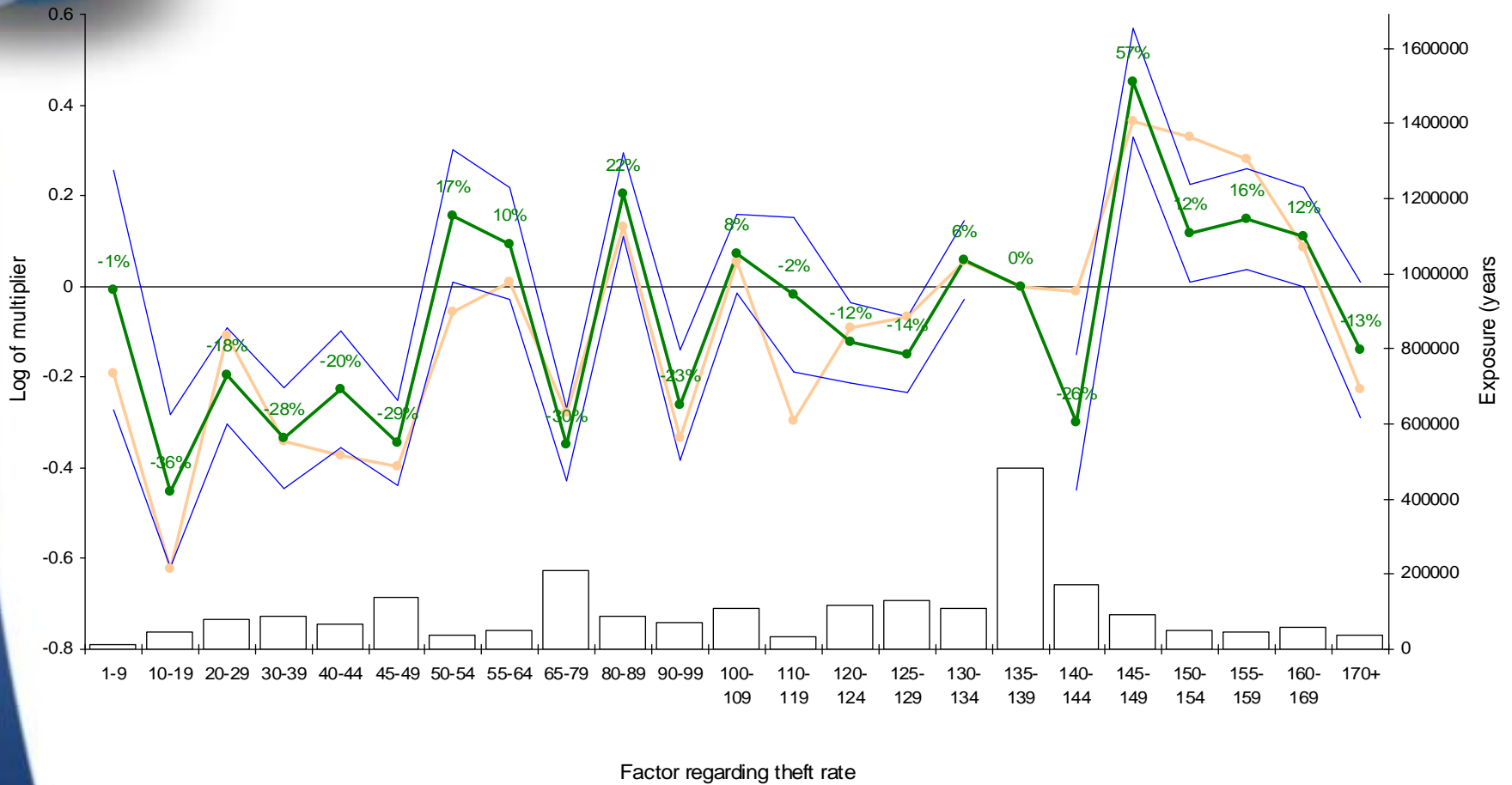
P value = 0.0%
Rank 35/35

Deviance tests vs graphical results

- Consider deviance test alongside parameter estimate graph

- In general
  - p-value >5% rejection
  - not automatic inclusion for p-value<=5%

- Consider other diagnostics
  - consistency with time
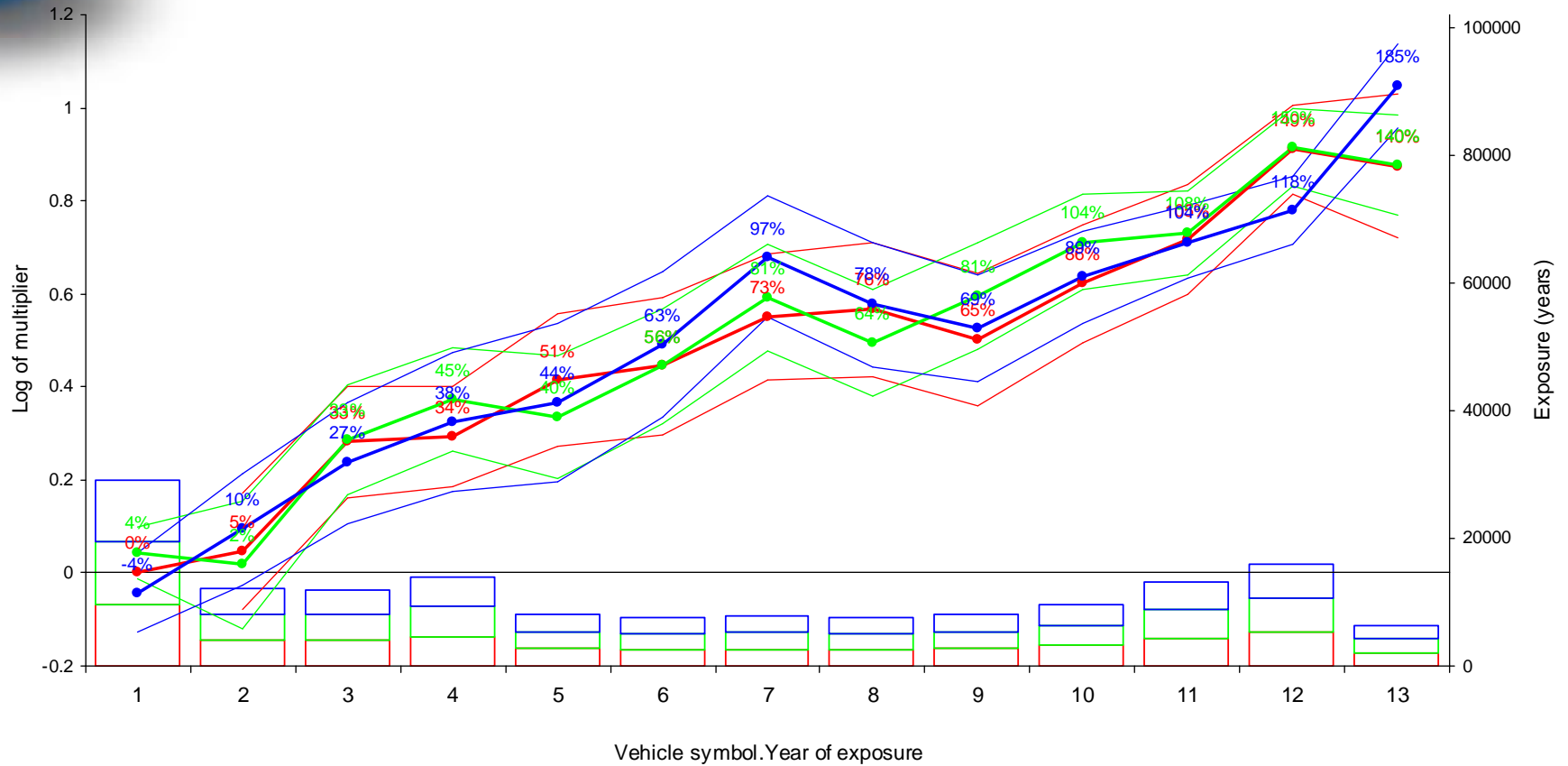 - examining results on other claim types, other statistics

Technical stories

- Portfolio analysis

- Deviance tests vs graphical results

- **Consistency with time**

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- Residual diagnostics and leverage

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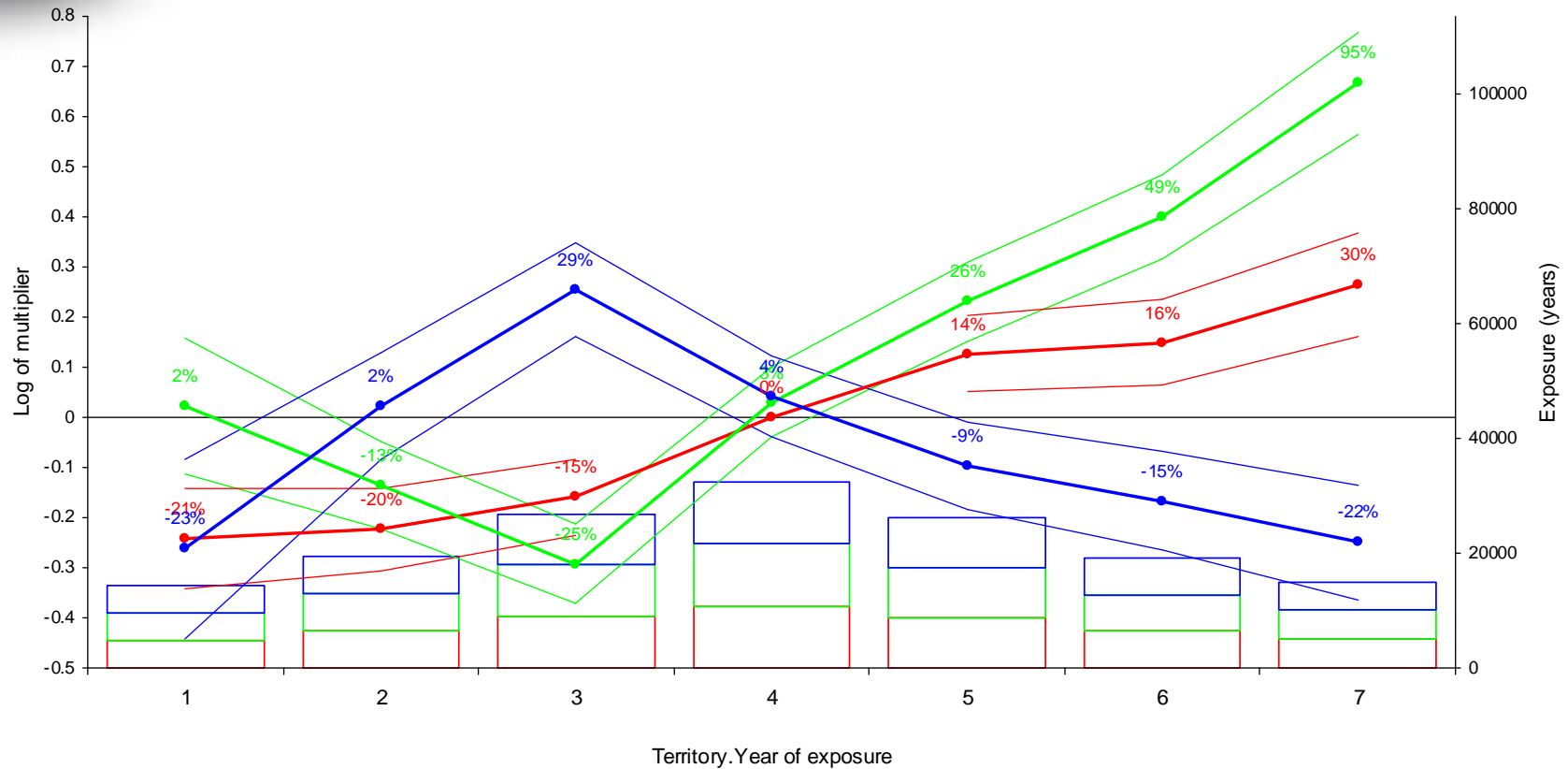
- Validating models

- Maps

Consistency over time

Consistency over time

Consistency over time

Log of multiplier (left axis, scale -0.6 to 1.5)
Exposure (years) (right axis, scale 0 to 60000)

X-axis: Policyholder age.Calendar year
Categories: < 20, 20-21, 22-23, 24-25, 26-27, 28-29, 30-34, 35-39, 40-44, 45-49, 50-54, 55-59, 60-64, 65-69, 70+

P value = 72.2%
Rank 3/10

— Approx 95% confidence interval, Calendar year: 2001   — Approx 95% confidence interval, Calendar year: 2002   — Approx 95% confidence interval, Calendar year: 2003

Technical stories

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- **Interactions (deciding which to test & detecting significance)**

- Residual diagnostics and leverage

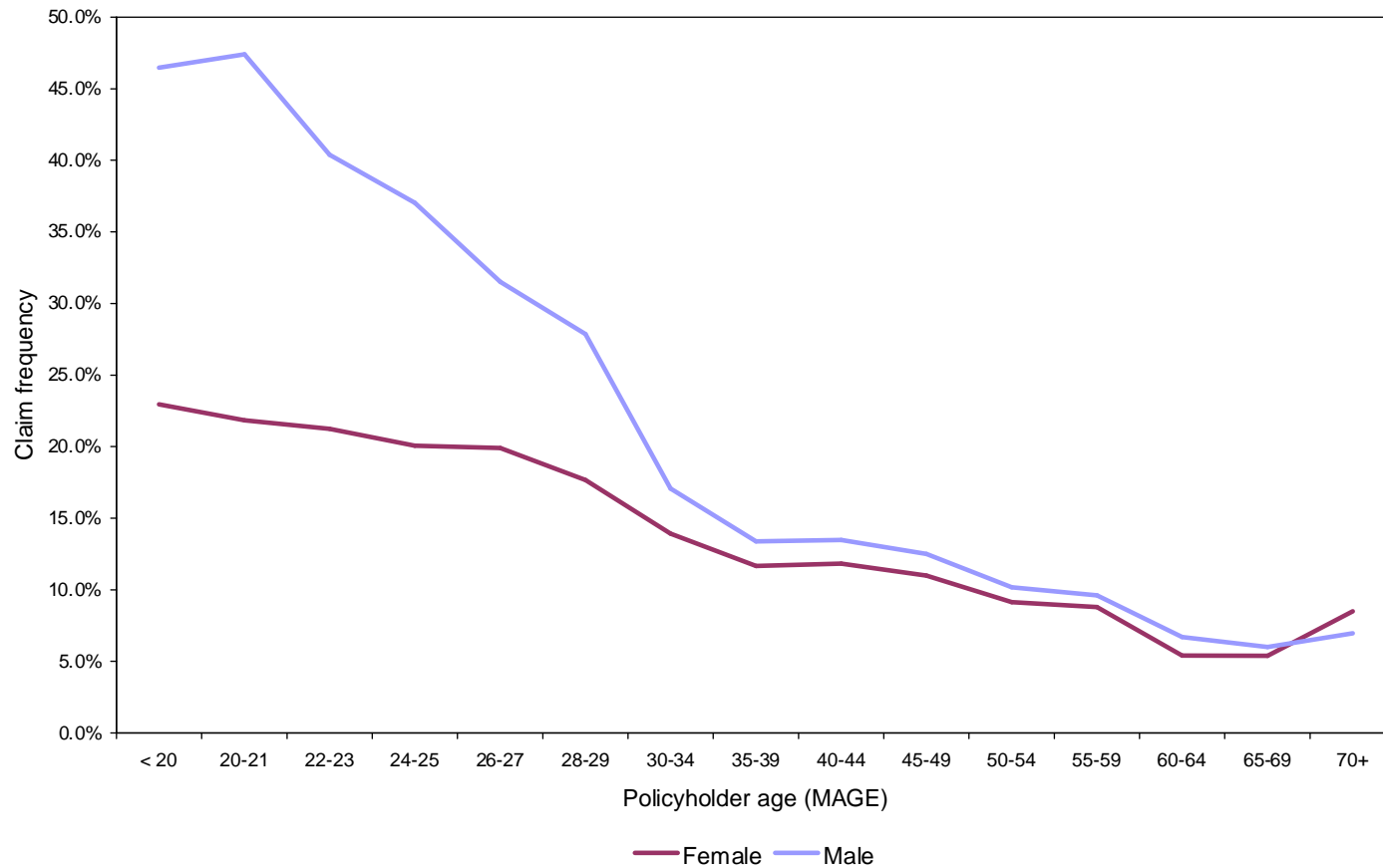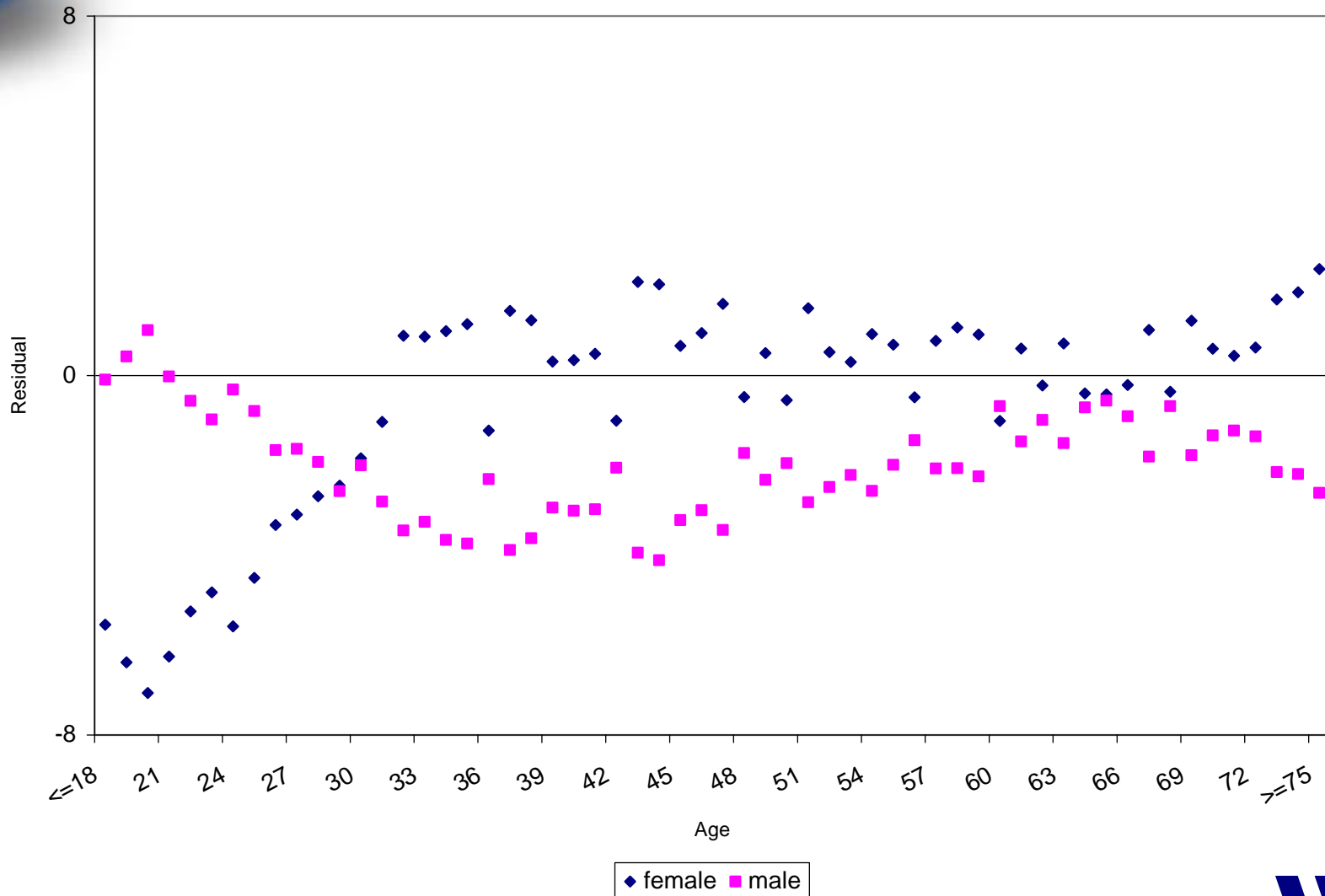- Measuring the effect of commercial decisions

- Validating models

- Maps

Two way frequency

A worked example of the tutorial job
Claim type 1 - Third party property damage
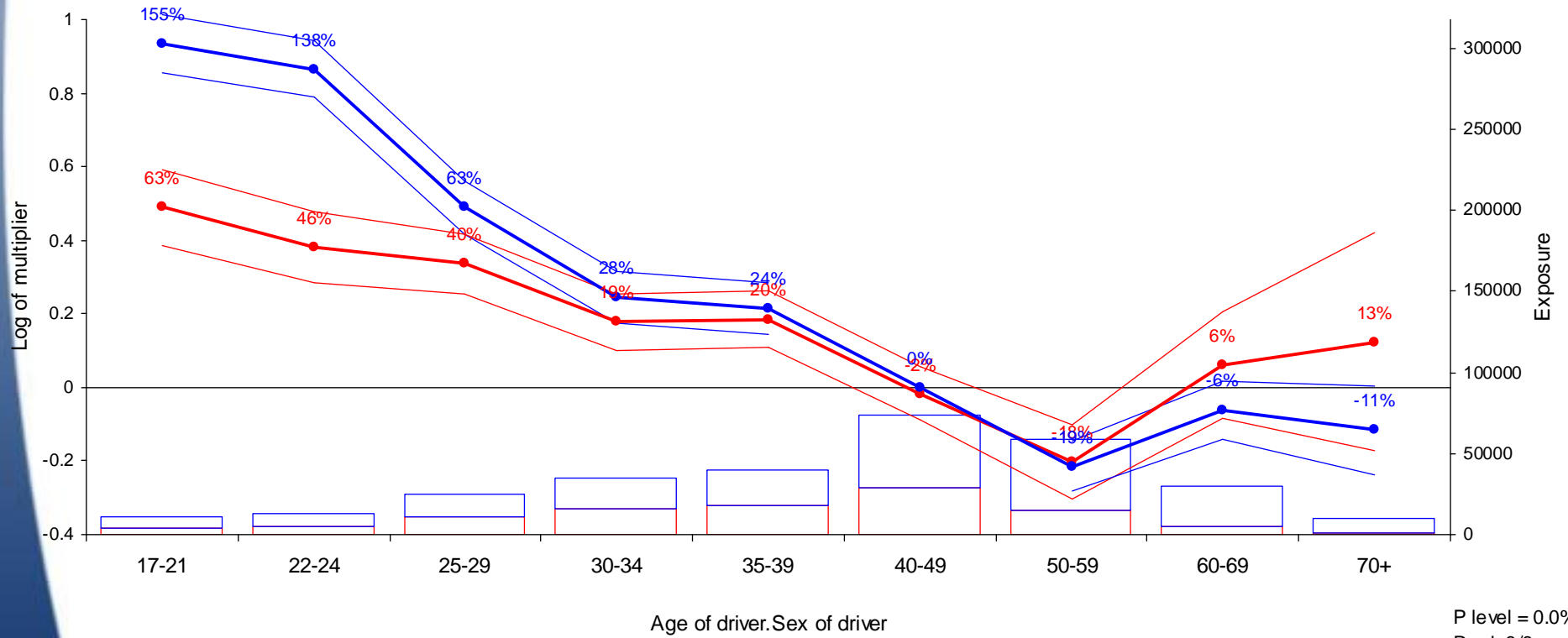### Sex of policyholder (MSEX)

Two way of deviance residual (age and sex)

Age - sex interaction

Example job

Run 5 Model 3 - Small interaction - Third party material damage, Numbers
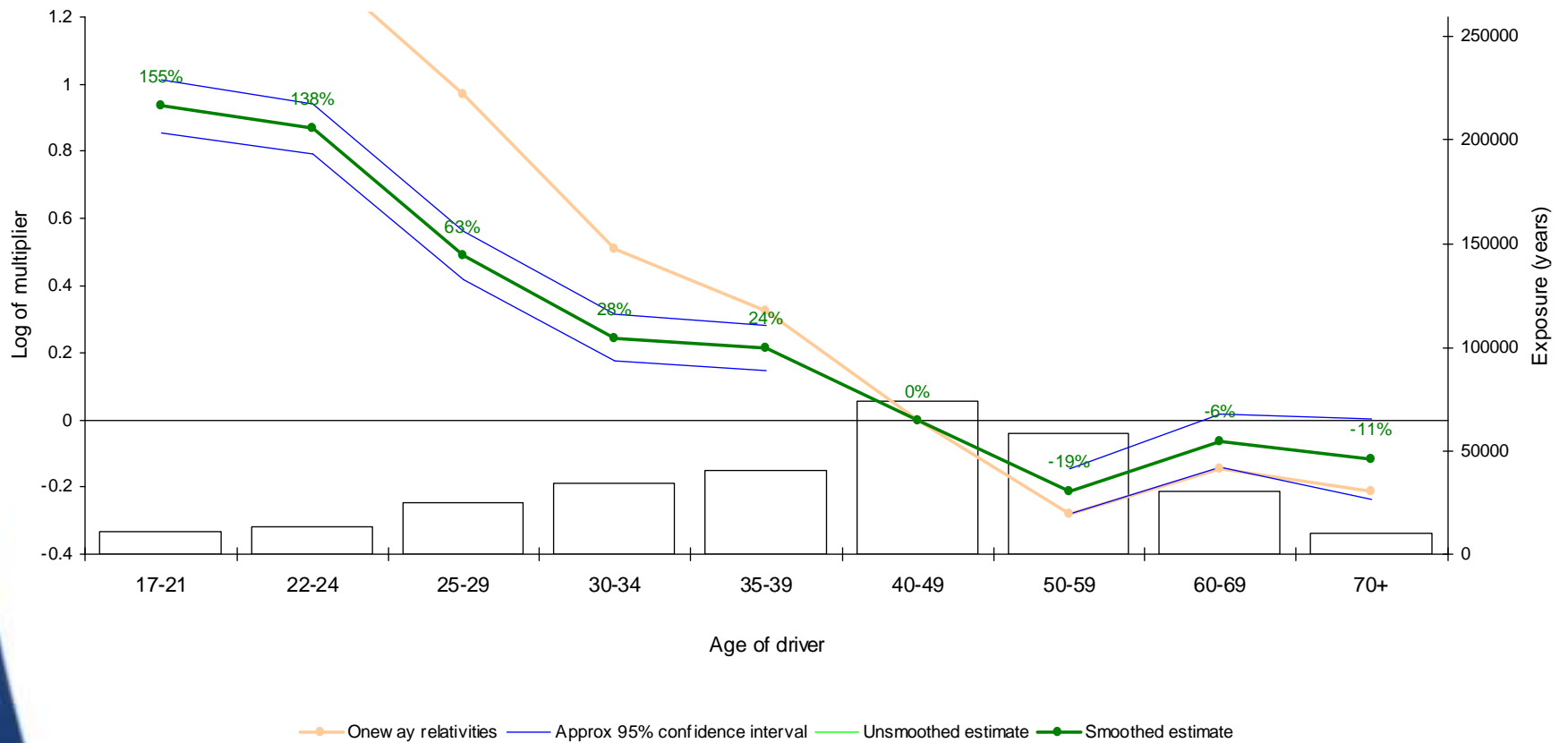

P level = 0.0%
Rank 6/6

— Approx 2 SEs from estimate, Sex of driver: Female — Approx 2 SEs from estimate, Sex of driver: Male — Unsmoothed estimate, Sex of driver: Female
— Unsmoothed estimate, Sex of driver: Male —●— Smoothed estimate, Sex of driver: Female —●— Smoothed estimate, Sex of driver: Male
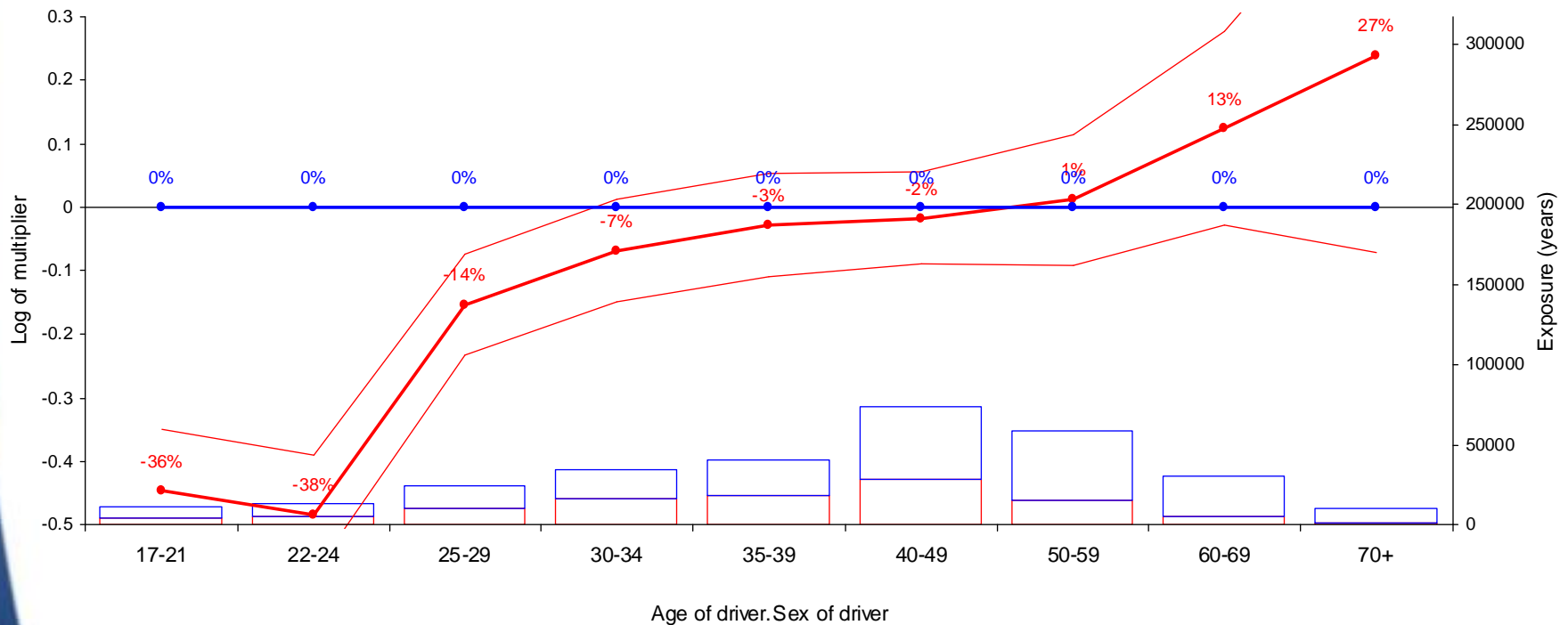
# Marginal interaction: Age effect

Example job

Run 16 Model 3 - Small interaction - Third party material damage, Numbers

Legend: Oneway relativities — Approx 95% confidence interval — Unsmoothed estimate — Smoothed estimate

Marginal interaction: Age.Sex (ie additional female multipliers)

Example job

Run 16 Model 3 - Small interaction - Third party material damage, Numbers

An example of no interaction

Complete interaction of Age of driver and Payment frequency

P value = 0.0%
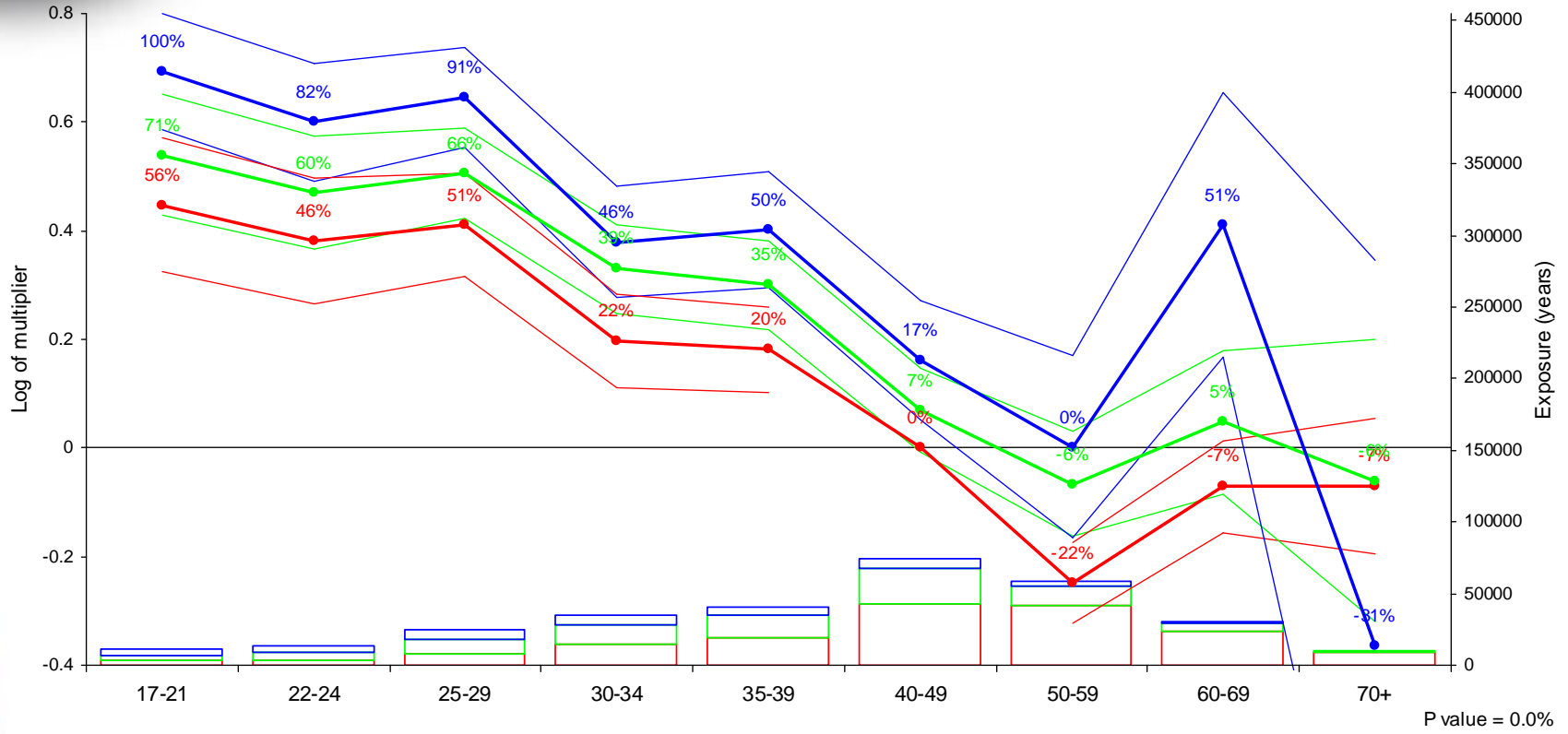
Approx 95% confidence interval, Payment frequency: Yearly
Approx 95% confidence interval, Payment frequency: Half-yearly
Approx 95% confidence interval, Payment frequency: Quarterly
Parameter estimate, Payment frequency: Yearly
Parameter estimate, Payment frequency: Half-yearly
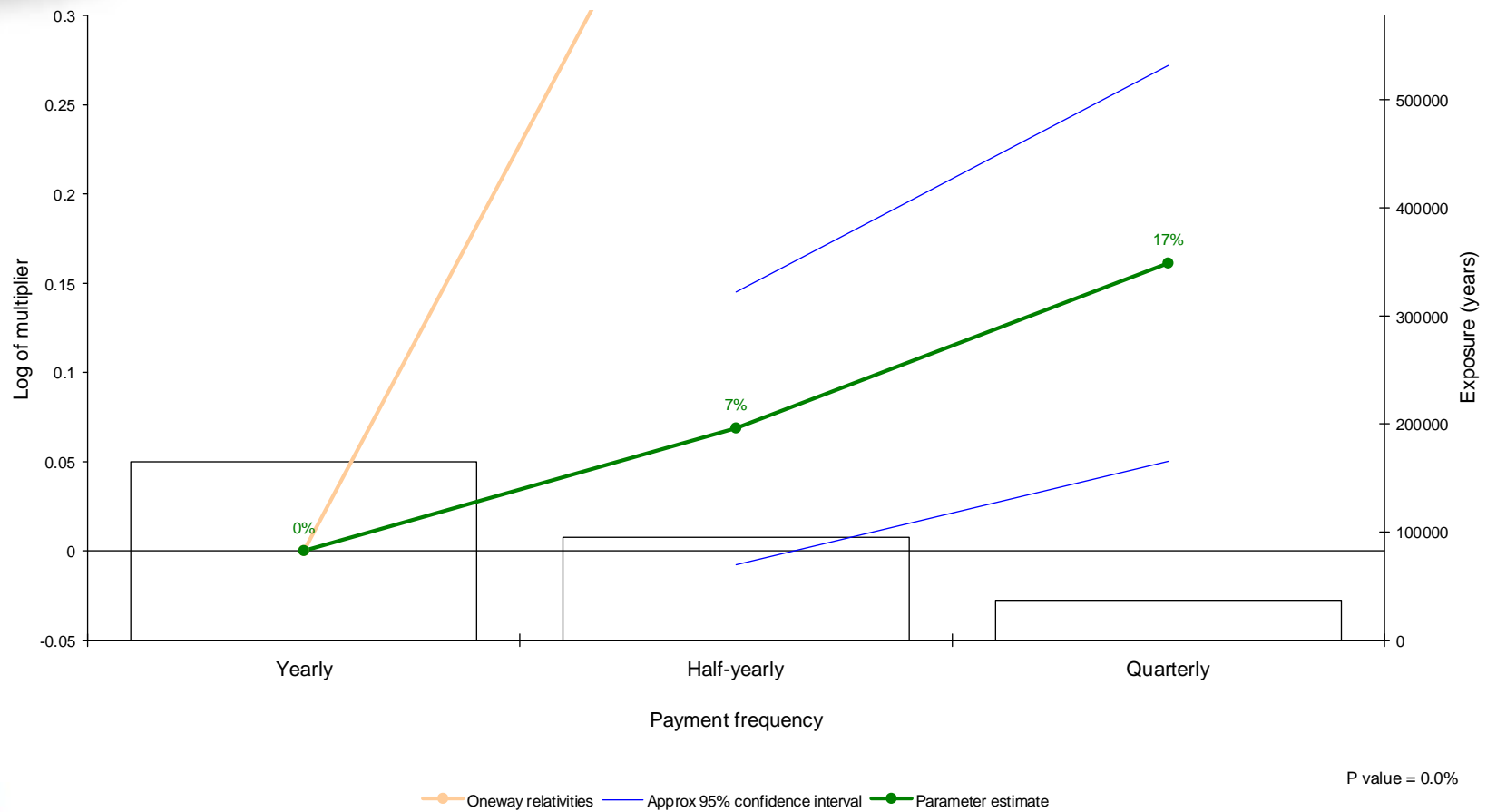Parameter estimate, Payment frequency: Quarterly

An example of no interaction

An example of no interaction

Yearly   Half-yearly   Quarterly

Payment frequency

Log of multiplier

Exposure (years)

0%

7%

17%
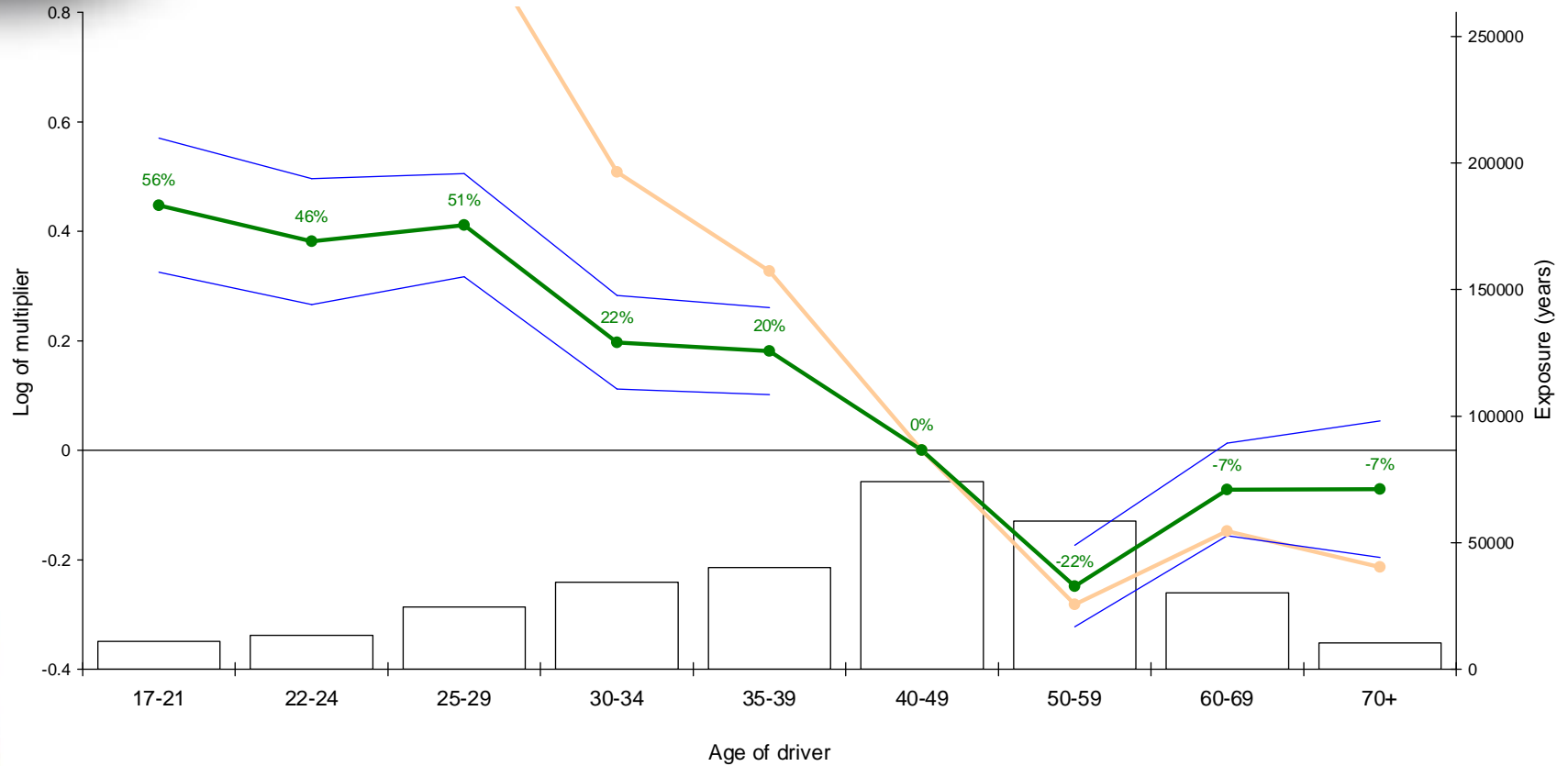
Oneway relativities   Approx 95% confidence interval   Parameter estimate

P value = 0.0%

An example of no interaction

Marginal interaction of Age of driver and Payment frequency

P value = 61.9%

Legend:
- Approx 95% confidence interval, Payment frequency: Half-yearly
- Approx 95% confidence interval, Payment frequency: Quarterly
- Parameter estimate, Payment frequency: Yearly
- Parameter estimate, Payment frequency: Half-yearly
- Parameter estimate, Payment frequency: Quarterly
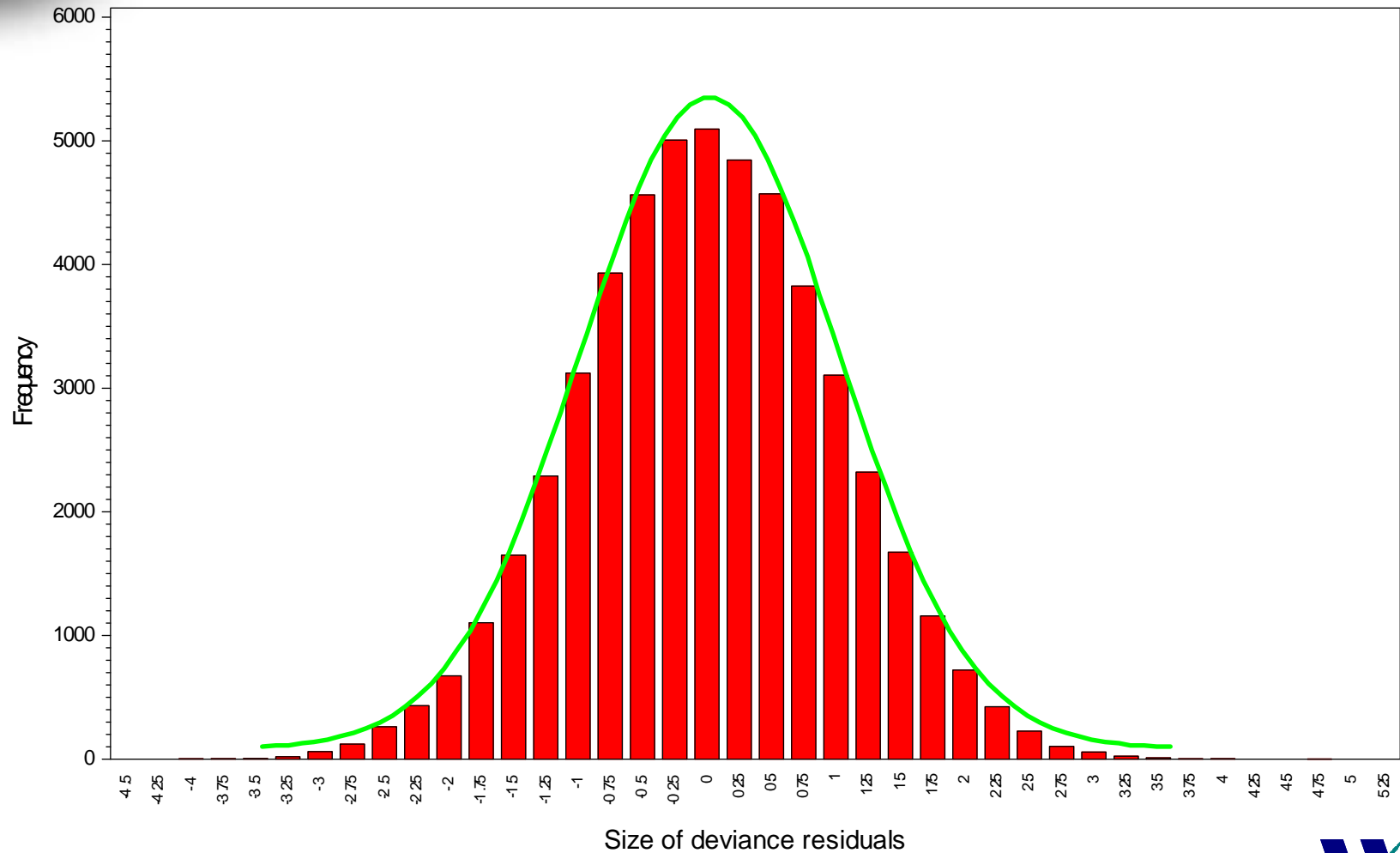
36

Technical stories

- Portfolio analysis

- Deviance tests vs graphical results

- Consistency with time

- Interactions (deciding which to test & detecting significance)

- **Residual diagnostics and leverage**

- Measuring the effect of commercial decisions
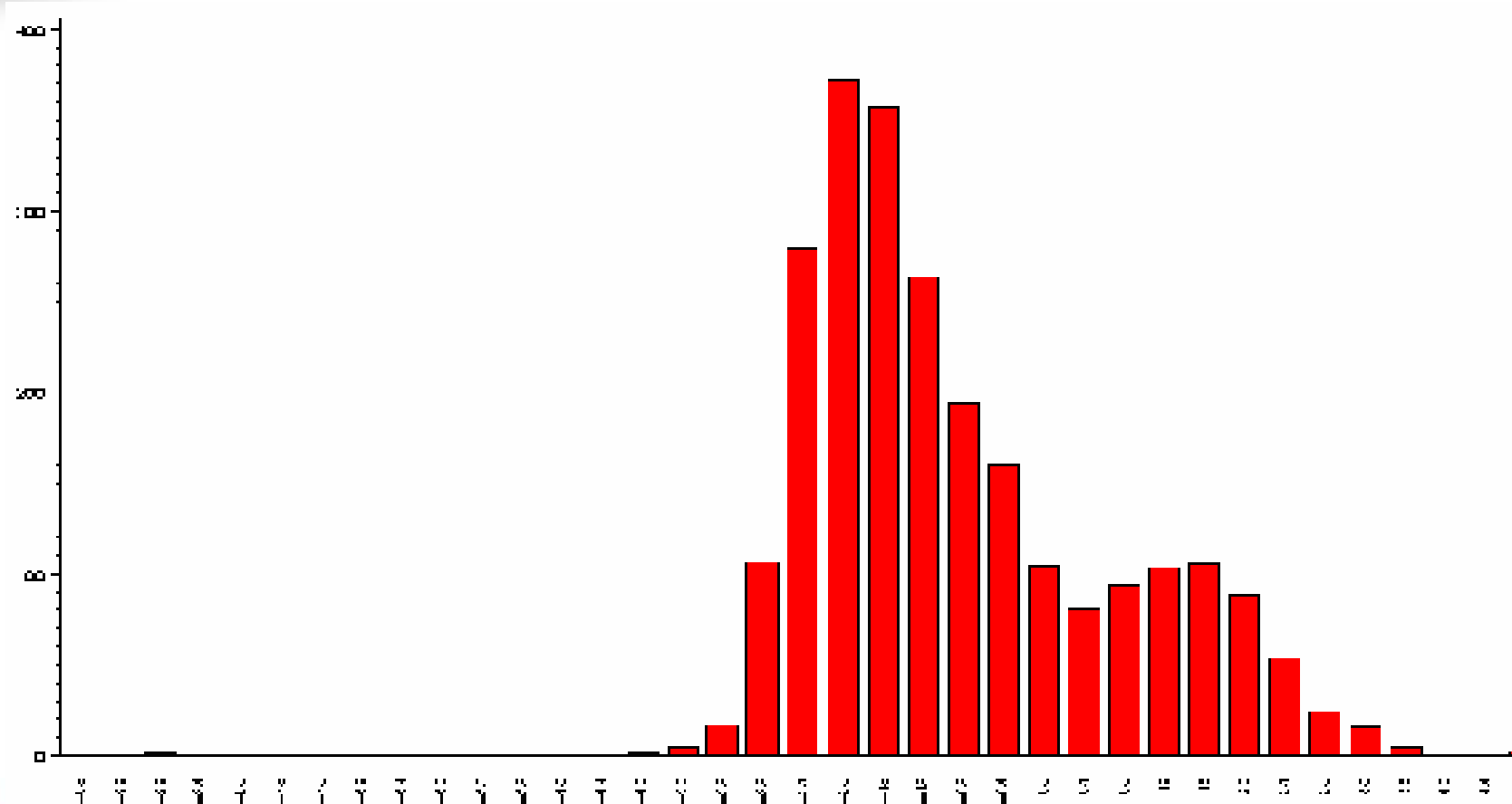
- Validating models

- Maps

Residuals

Histogram of Deviance Residuals
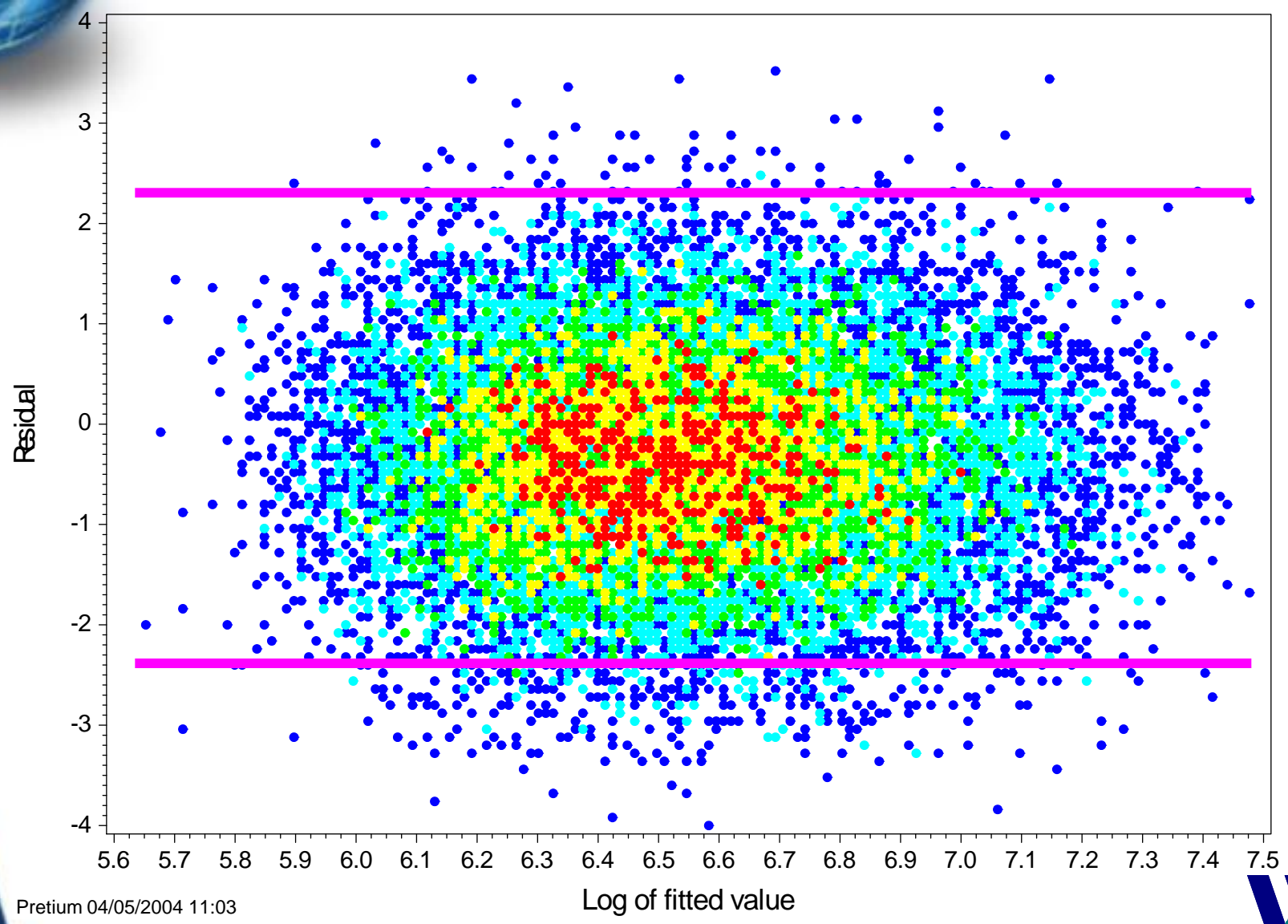### Run 12 (Final models with analysis) Model 8 (AD amounts)

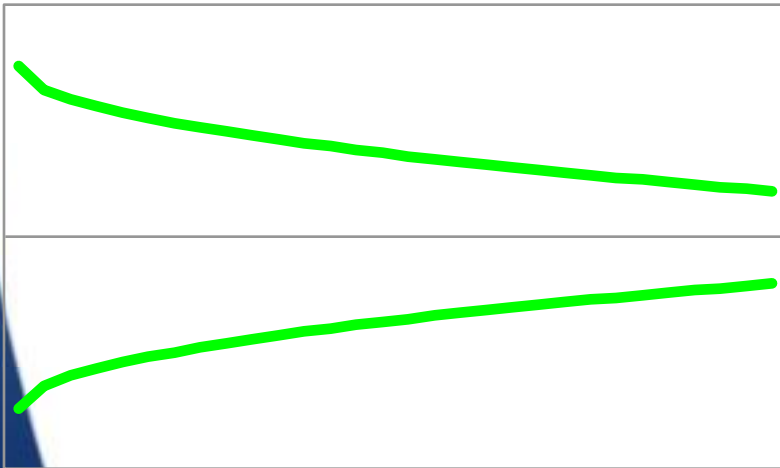Pretium 08/01/2004 12:24

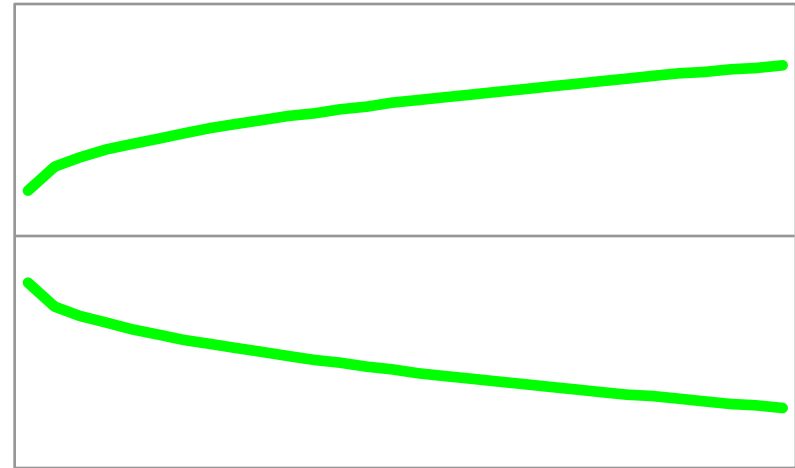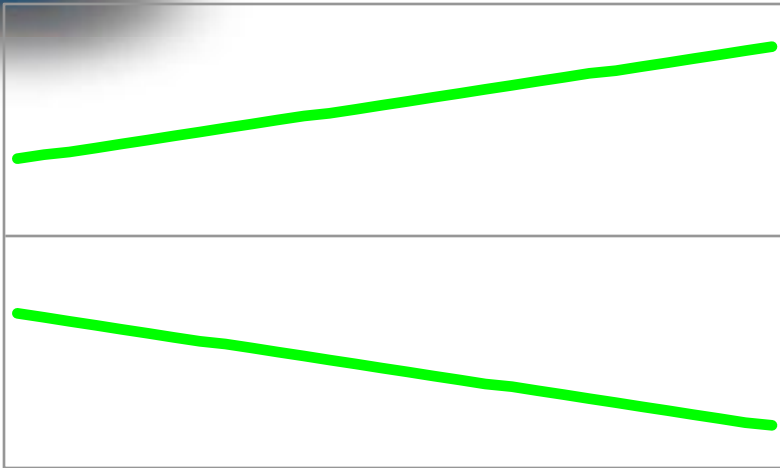# Residuals – example of bimodality
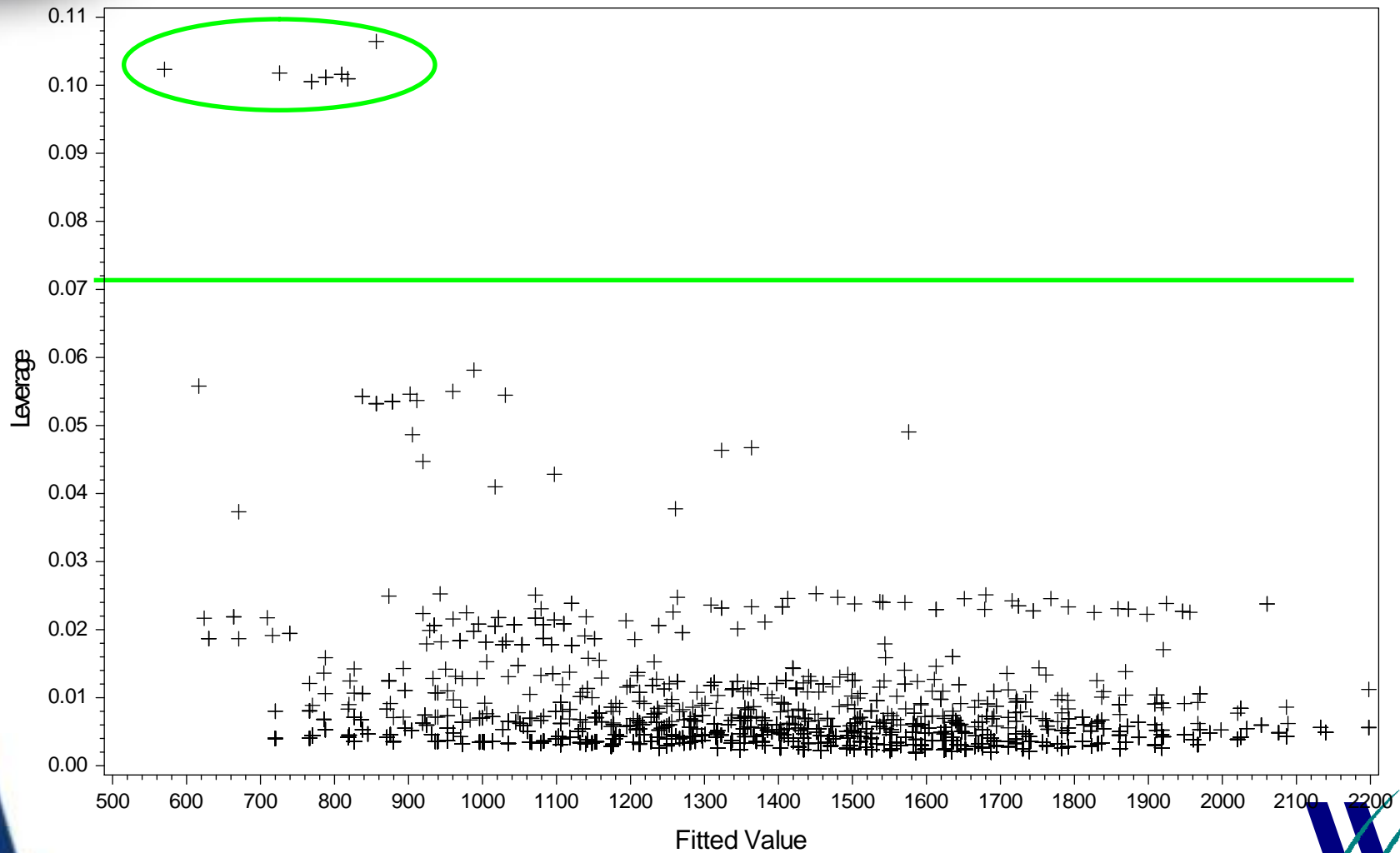
Residuals

Pretium 04/05/2004 11:03

Residuals
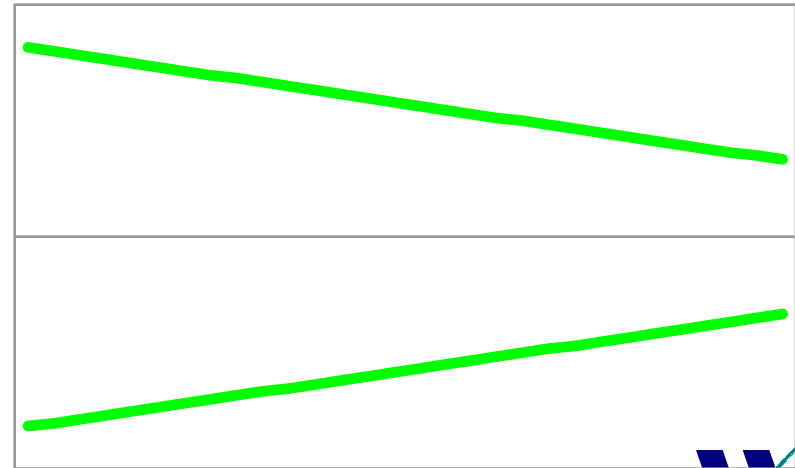
Leverage

Plot of leverage against fitted value
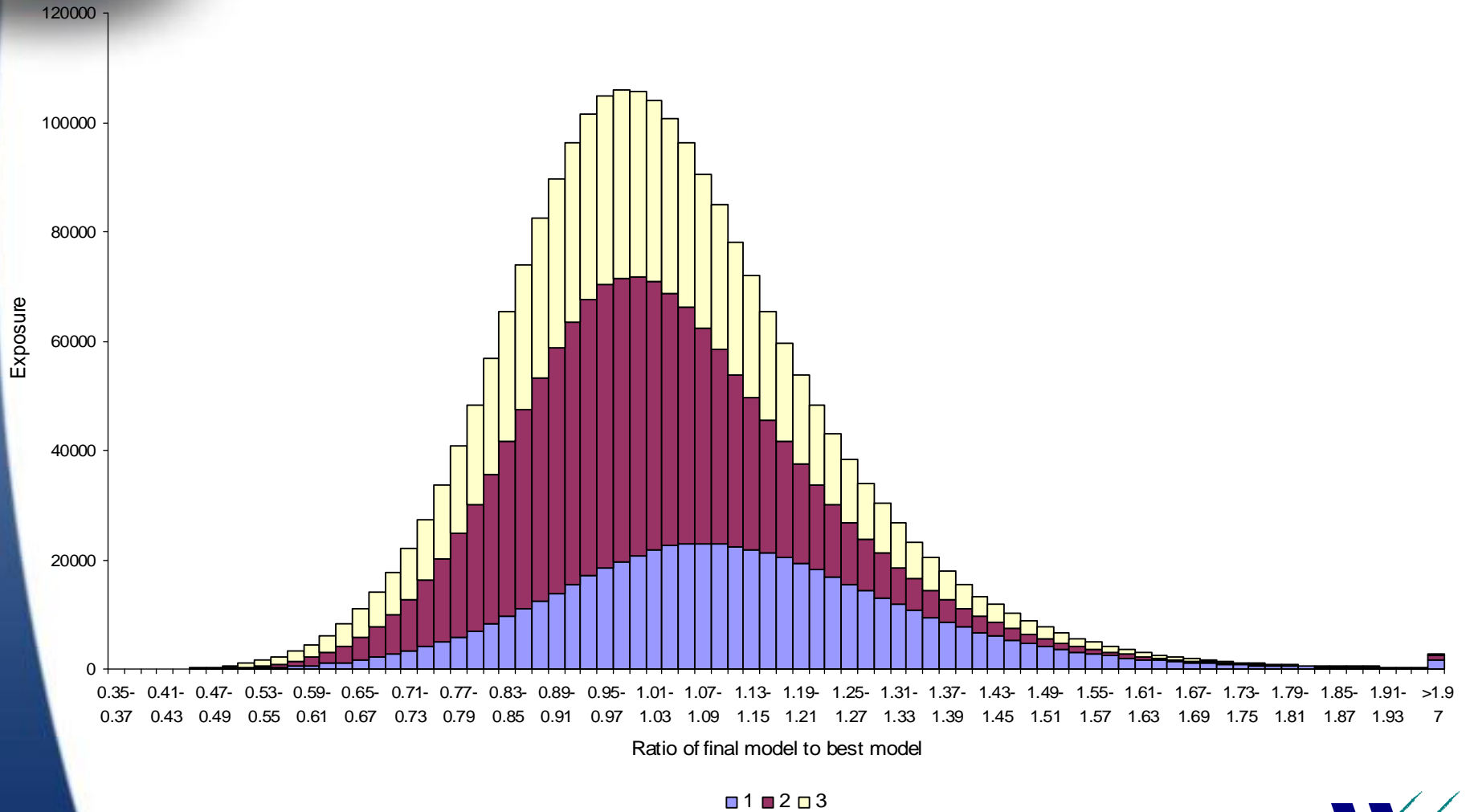Run 12 (All claim types, final models, N&A) Model 6 (Own damage, Amounts)

Technical stories

- Portfolio analysis

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- Consistency with time

- Interactions (deciding which to test & detecting significance)

- Residual diagnostics and leverage

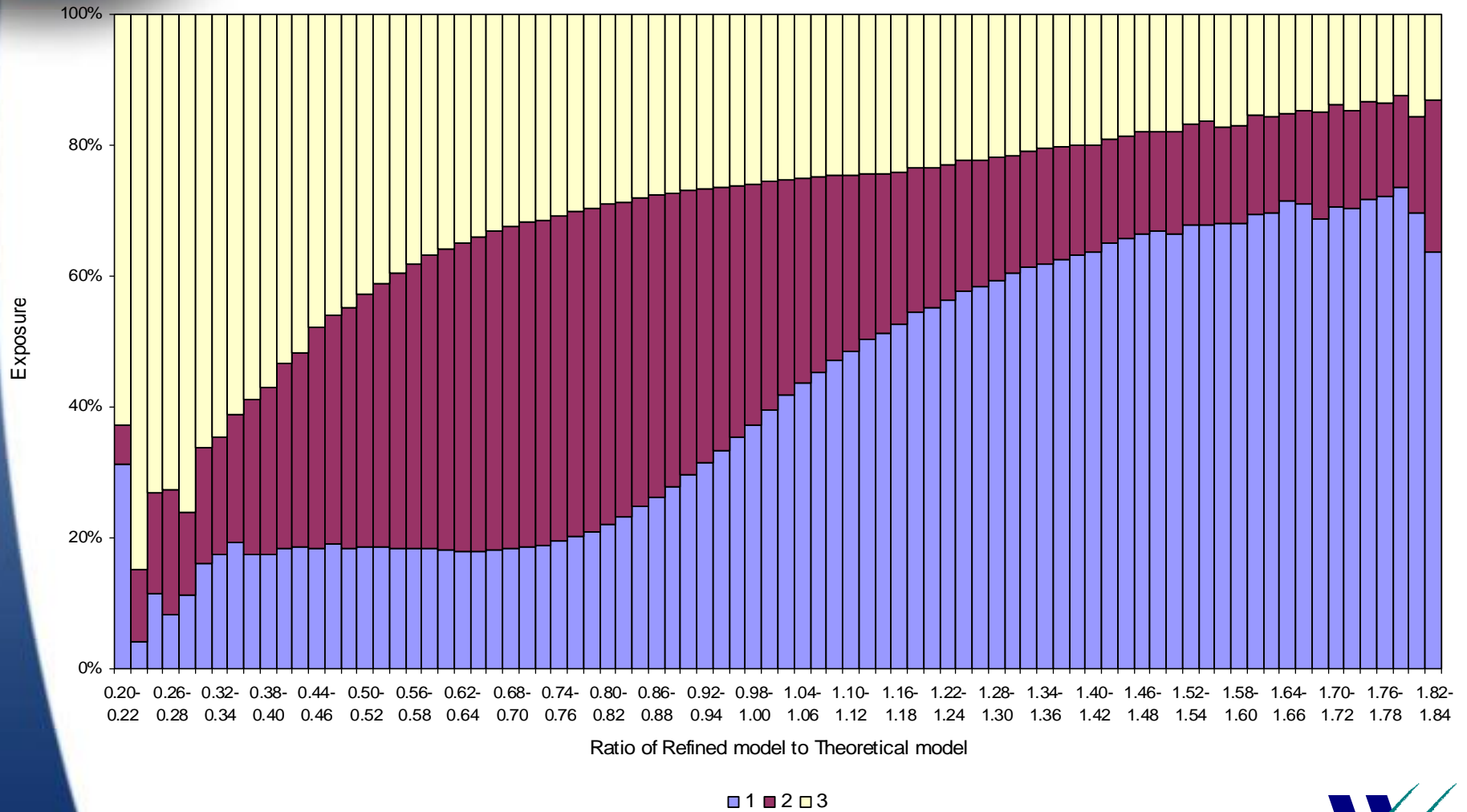- **Measuring the effect of commercial decisions**

- Validating models

- Maps

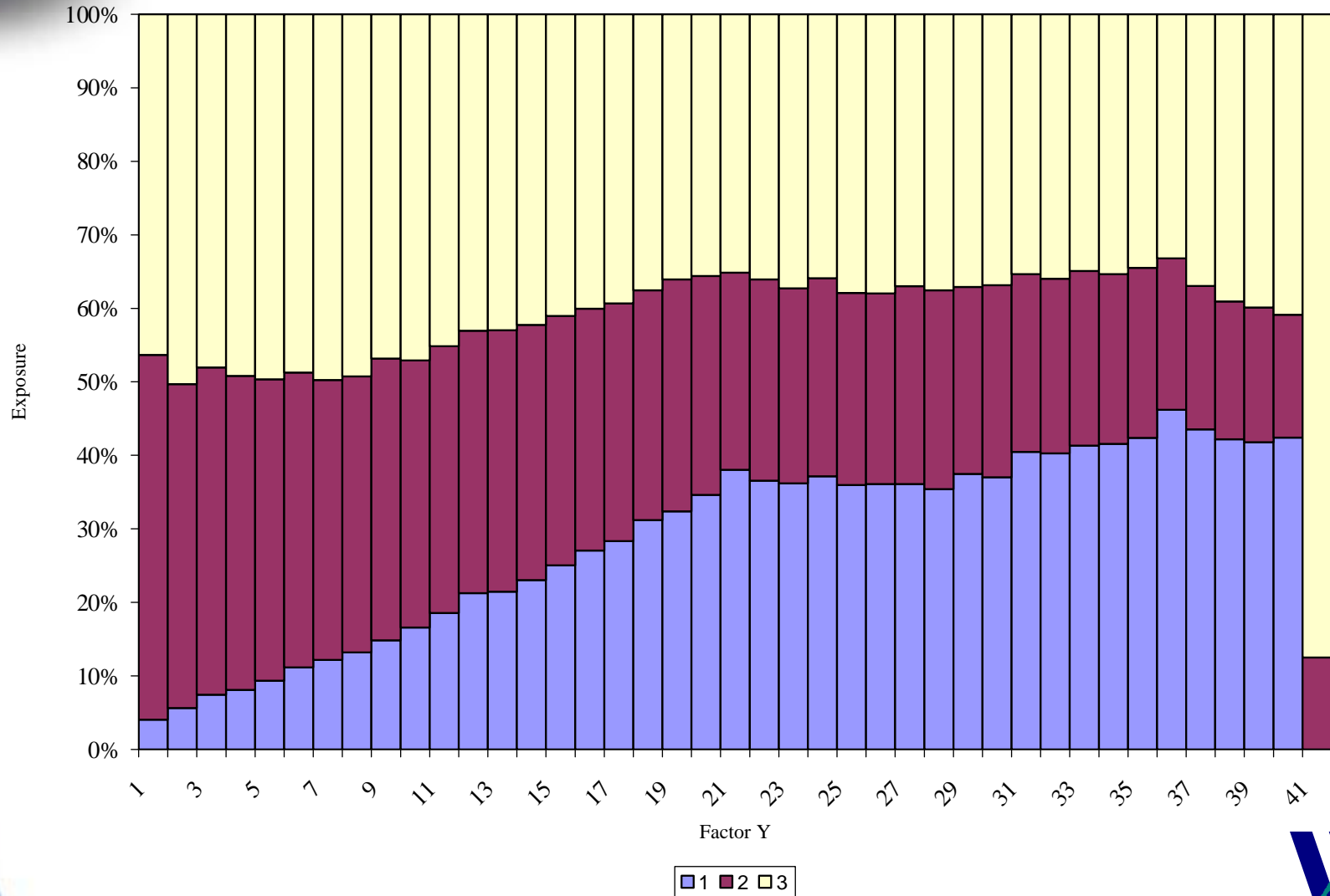# Investigating loss of accuracy

Investigating loss of accuracy
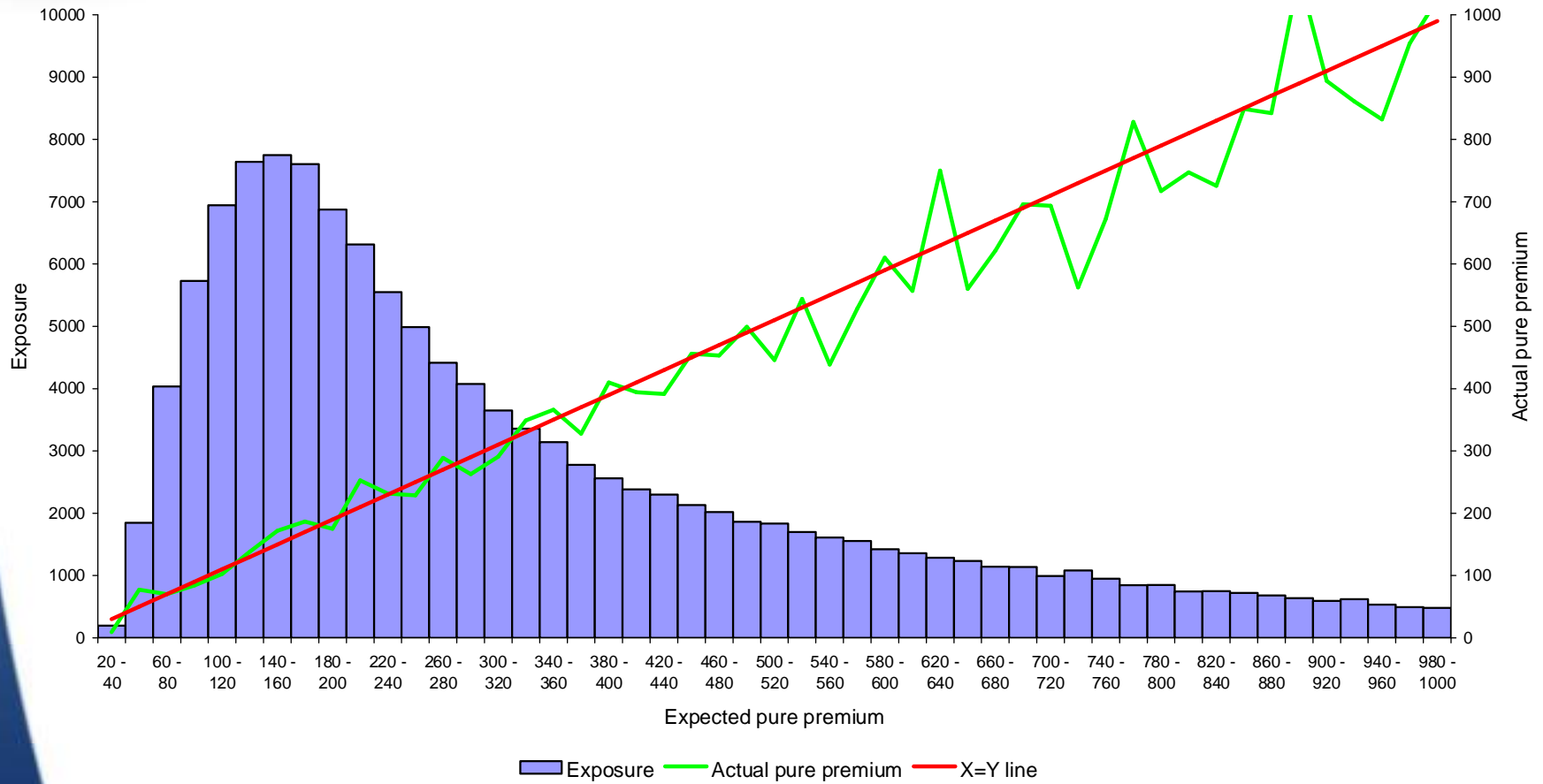
Investigating loss of accuracy

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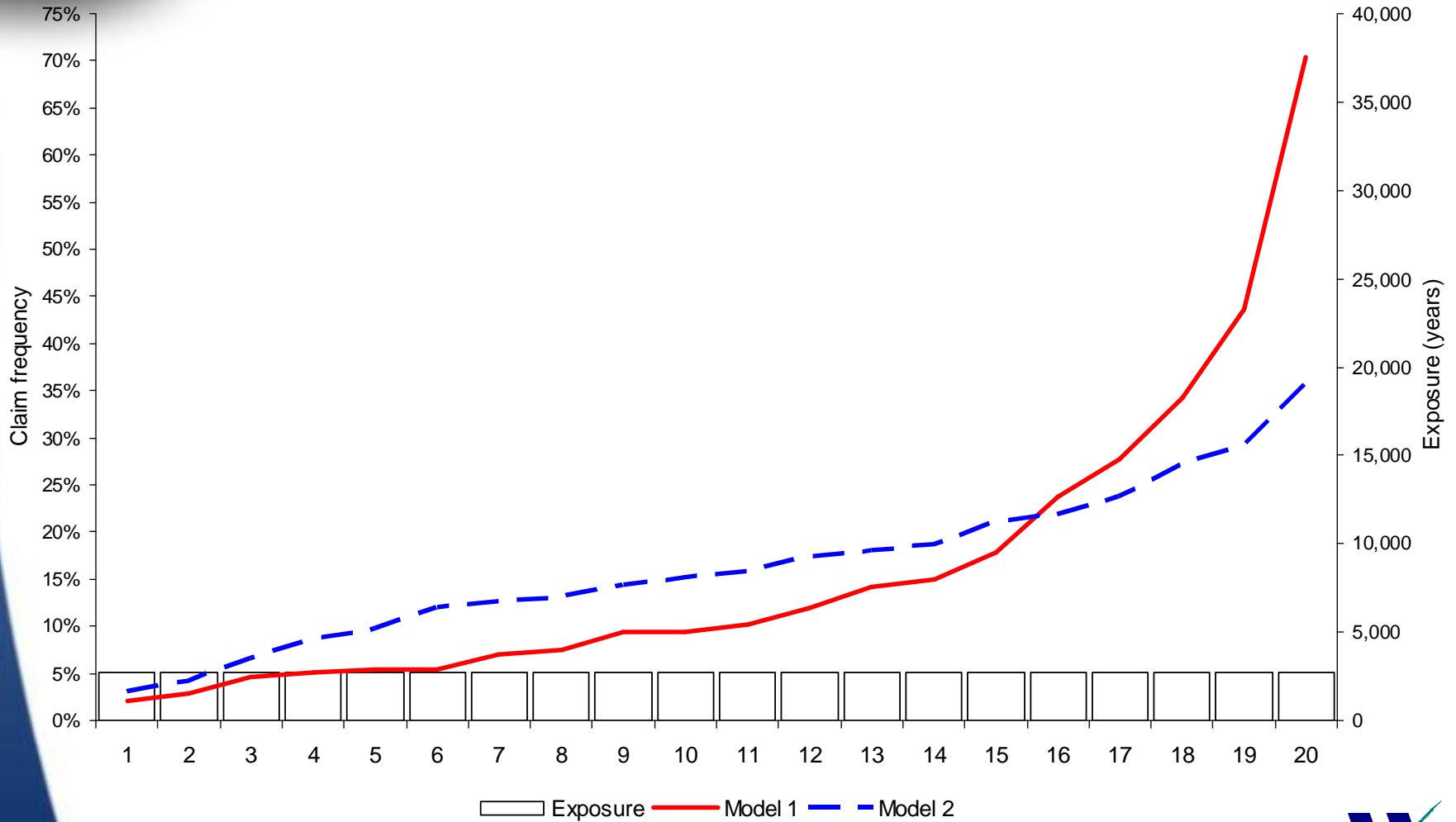- **Validating models**

- Maps

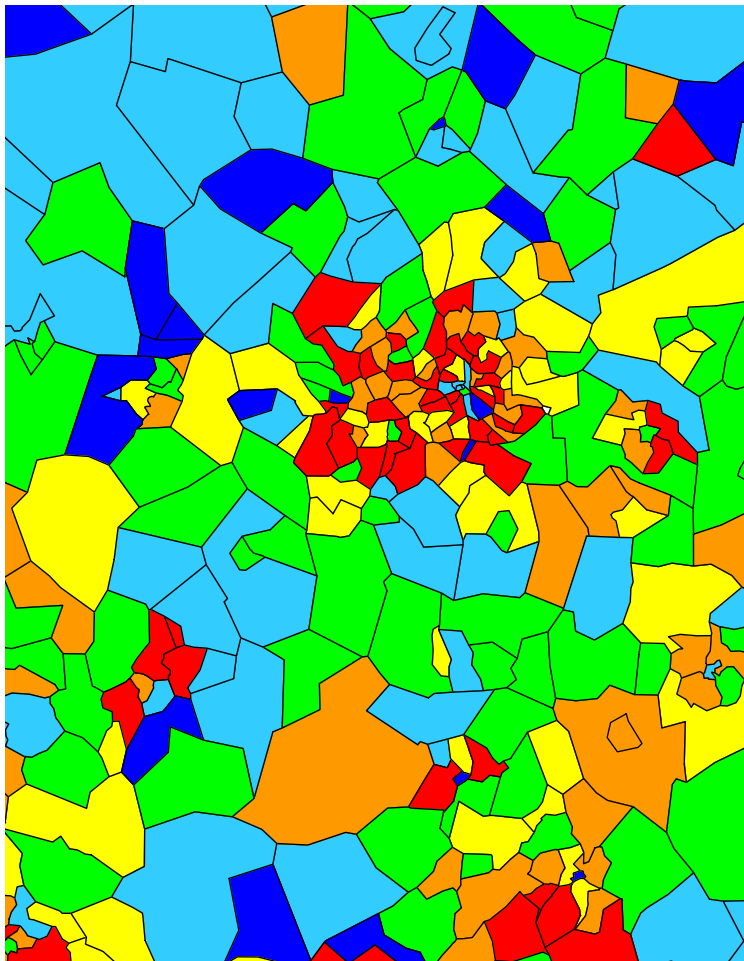# Model validation

Lift curves

Technical stories

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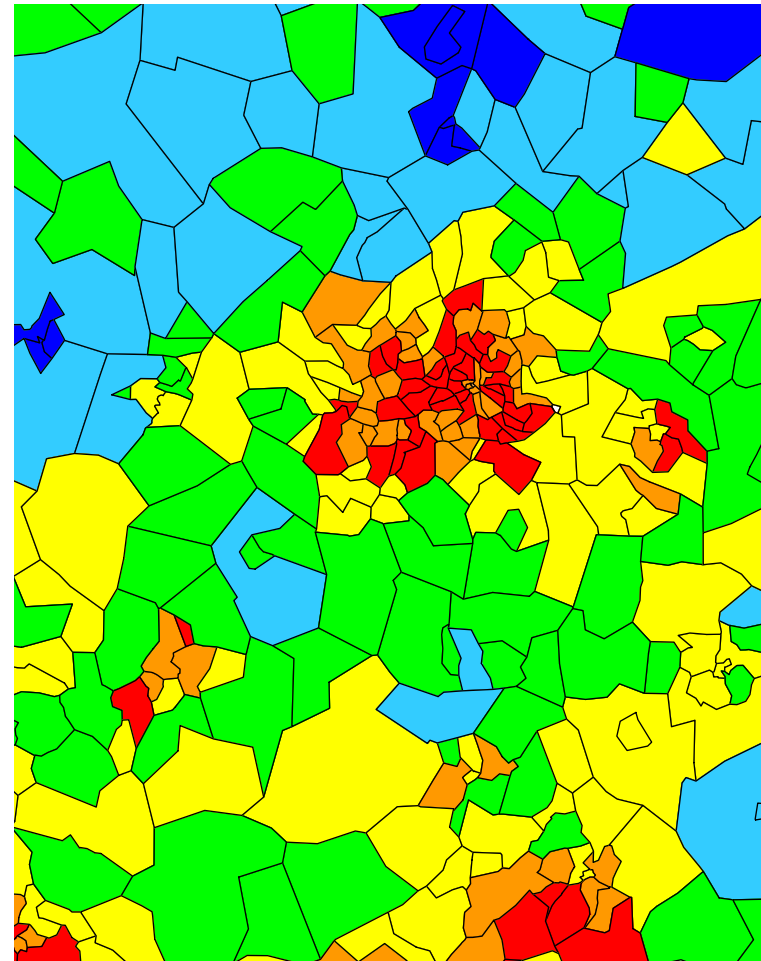- Validating models

- Maps

Example spatial smoothing results

Unsmoothed residuals

Smoothed residuals

Comparing indicated results with existing rates and the market
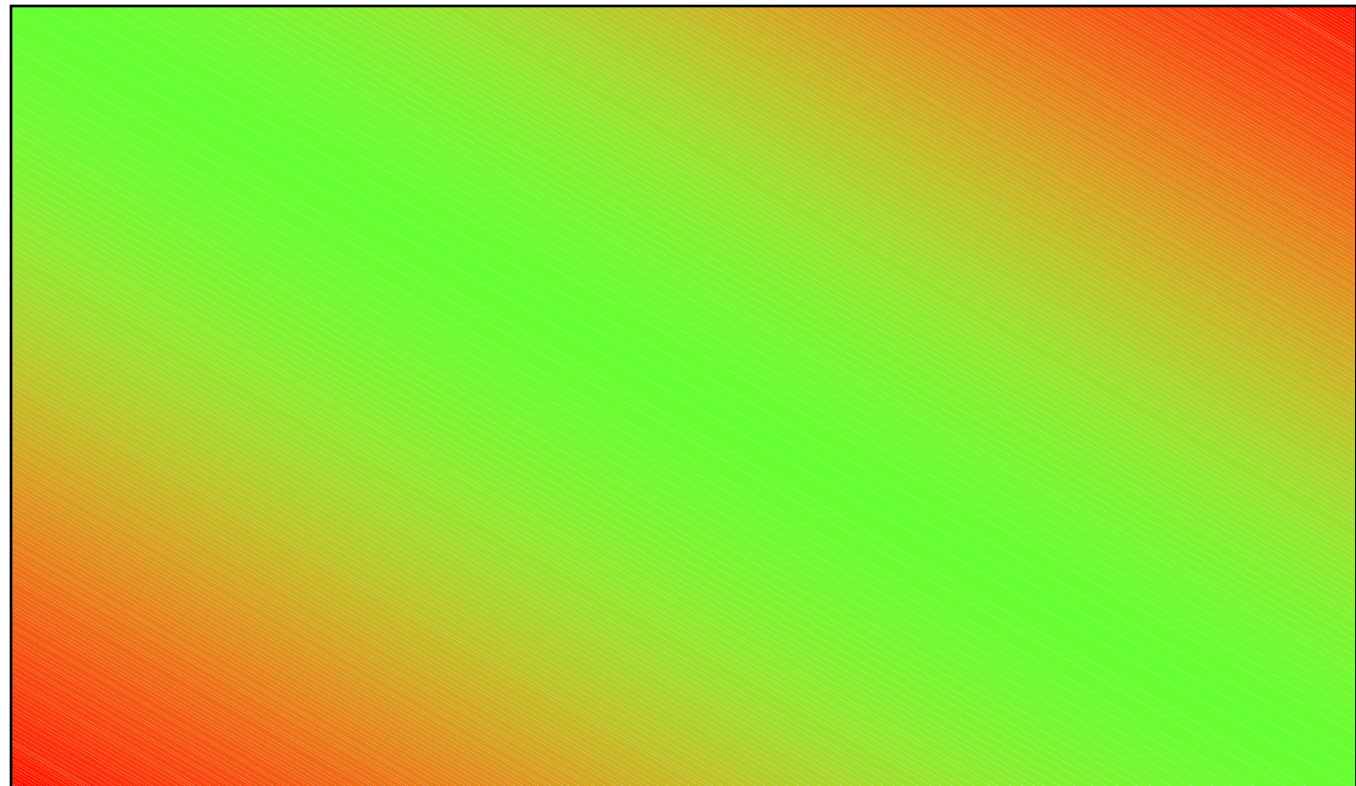
Our premium vs market

Below market   Above market

Theoretically desired change in premium

Increase

Decrease

Comparing indicated results with existing rates and the market

Our premium vs market

Below market   Above market

Theoretically desired change in premium

Increase

Decrease

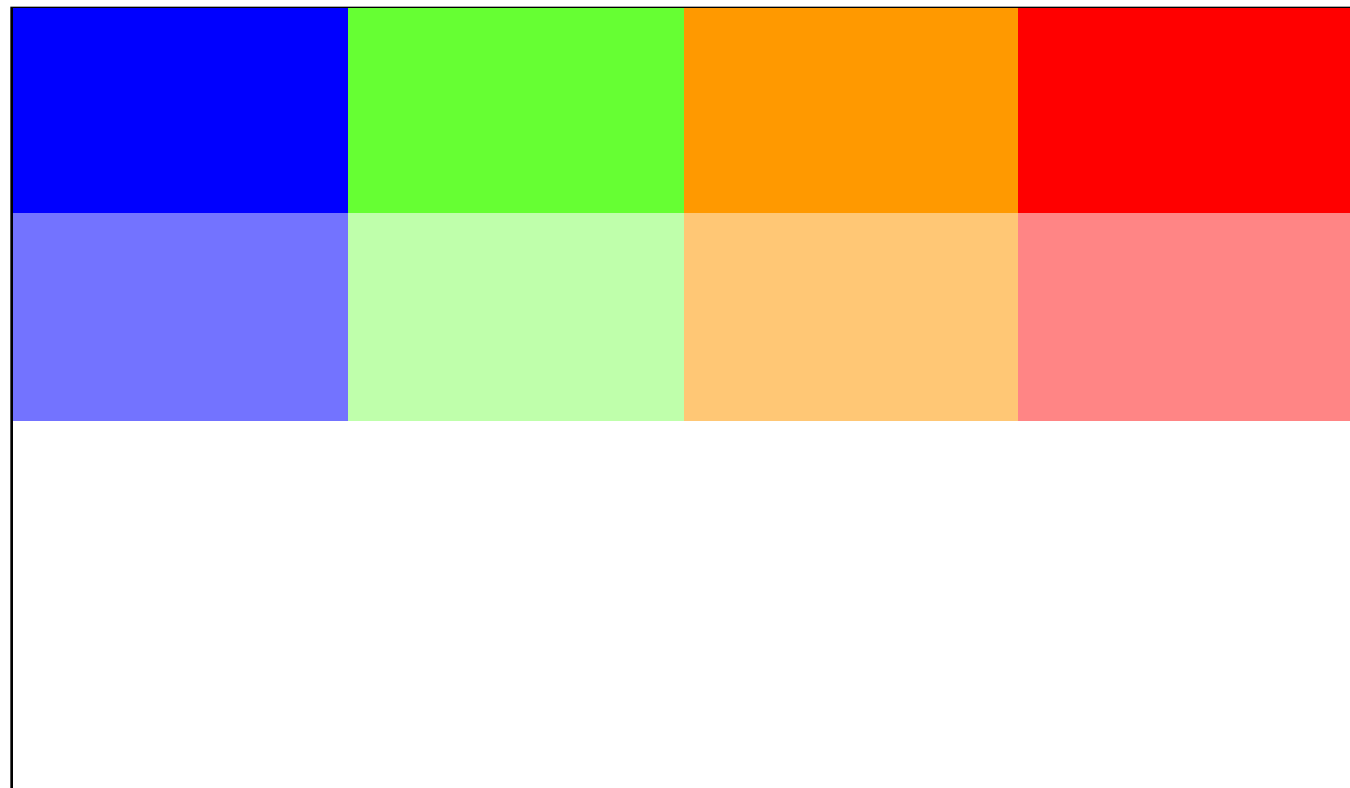# Comparing indicated results with existing rates and the market

Our premium vs market

Below market   Above market

Theoretically desired change in premium

Increase

Decrease

Comparing indicated results with existing rates and the market

Our premium vs market

Our premium vs market

Below   Above
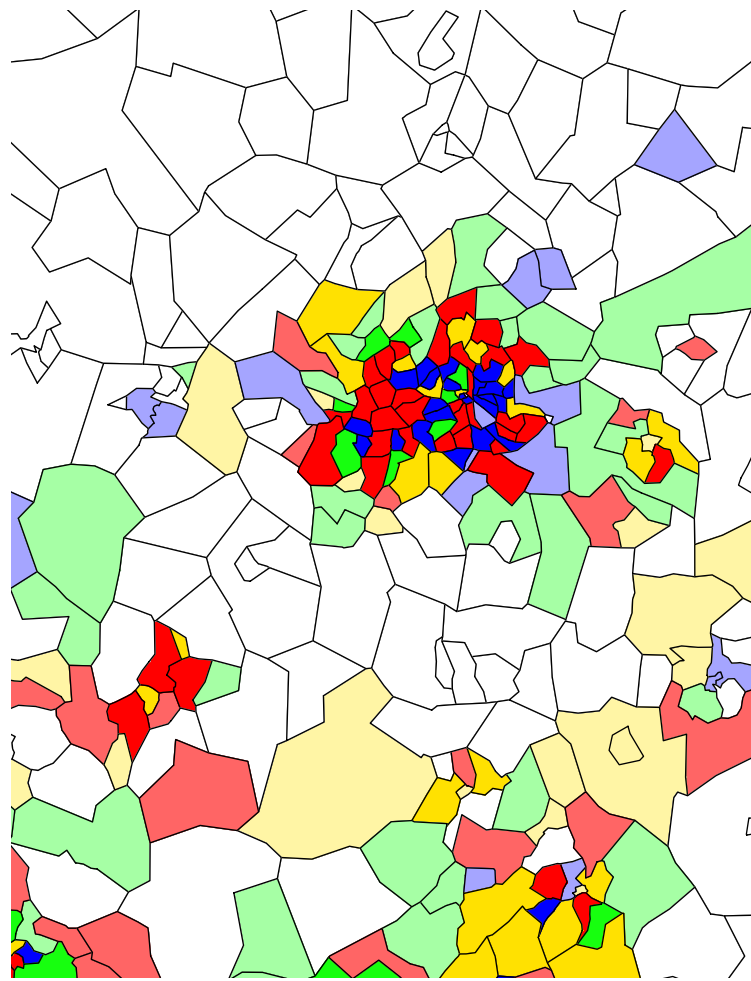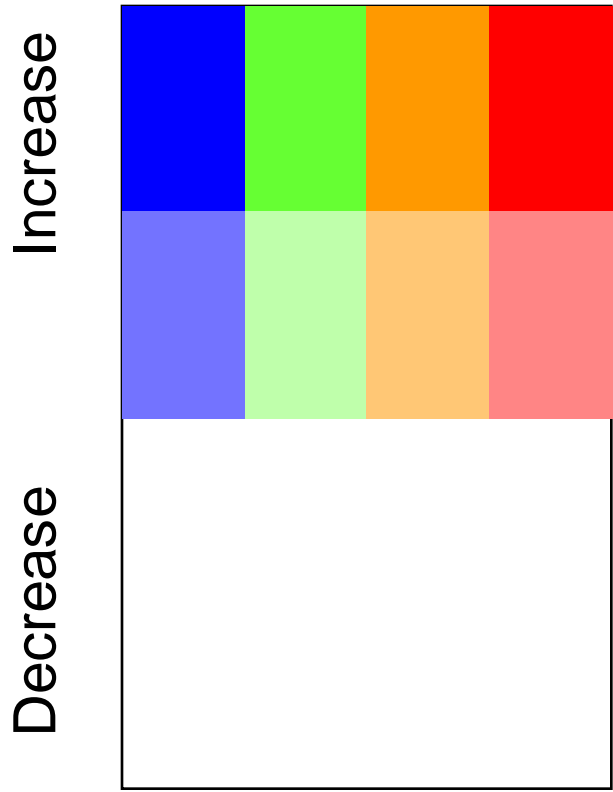
Theoretically desired change in premium

Increase

Decrease

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  - focus on the value of the results

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