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Visualizing Predictive Modeling Results

**CANE Spring Meeting
Massachusetts, March 20, 2007
Louis Mak FIAA
Watson Wyatt Worldwide**

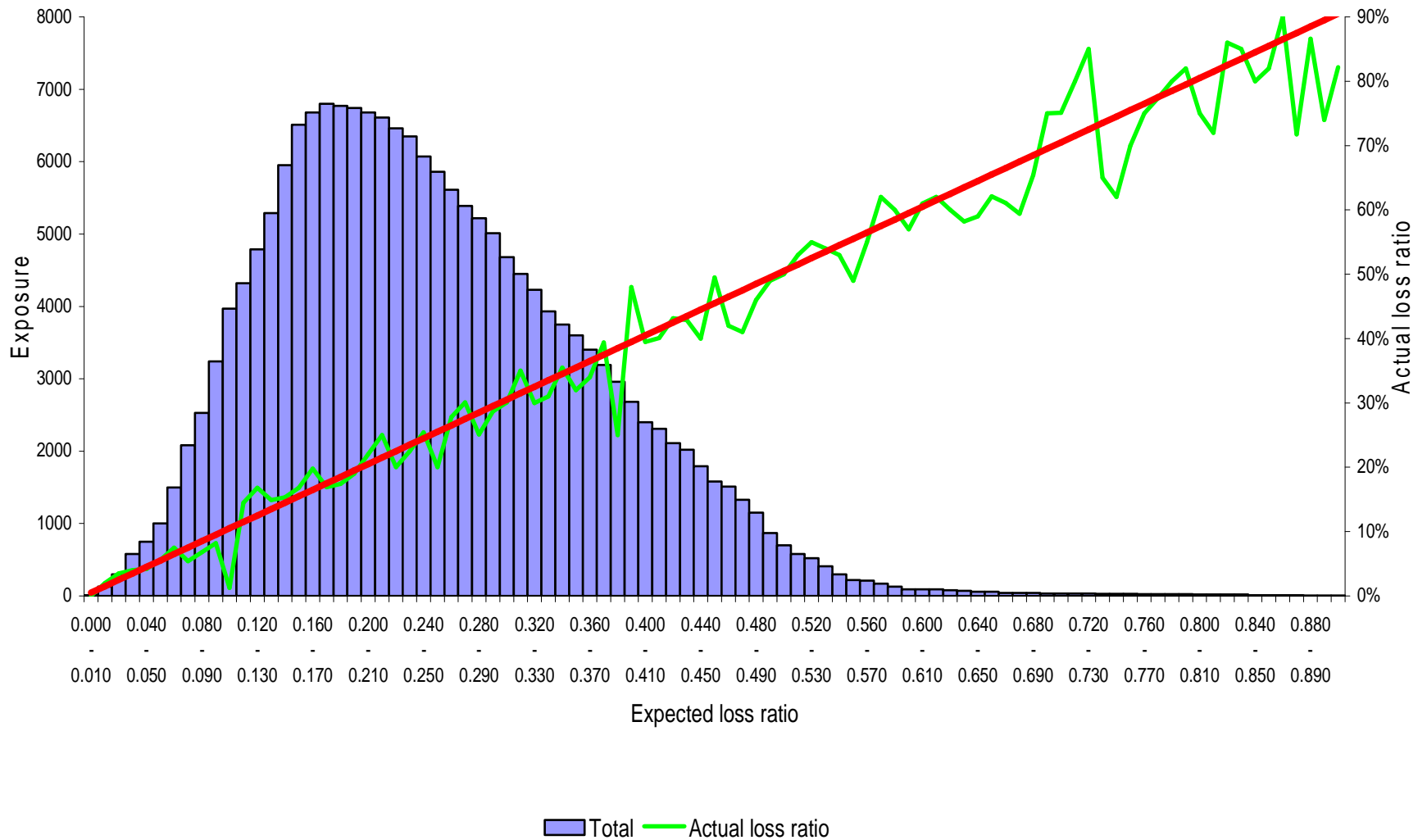


Communicating modeling results visually

- Stakeholder approach
 - focus on the value of the results
- Technical / actuarial approach
 - tell the story of the model development in a chronological fashion



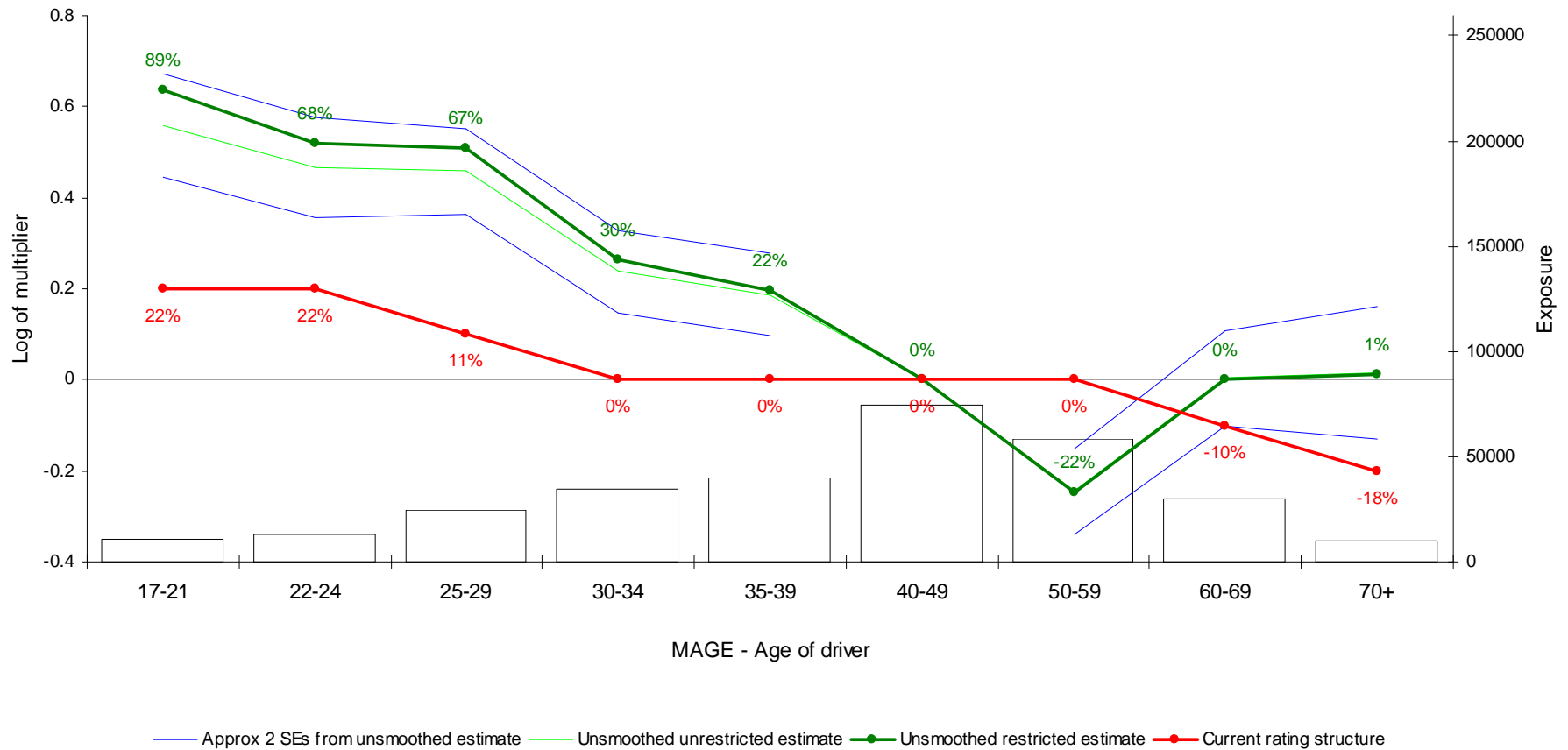
Loss ratio impact



Factor effect analysis

Demonstration job

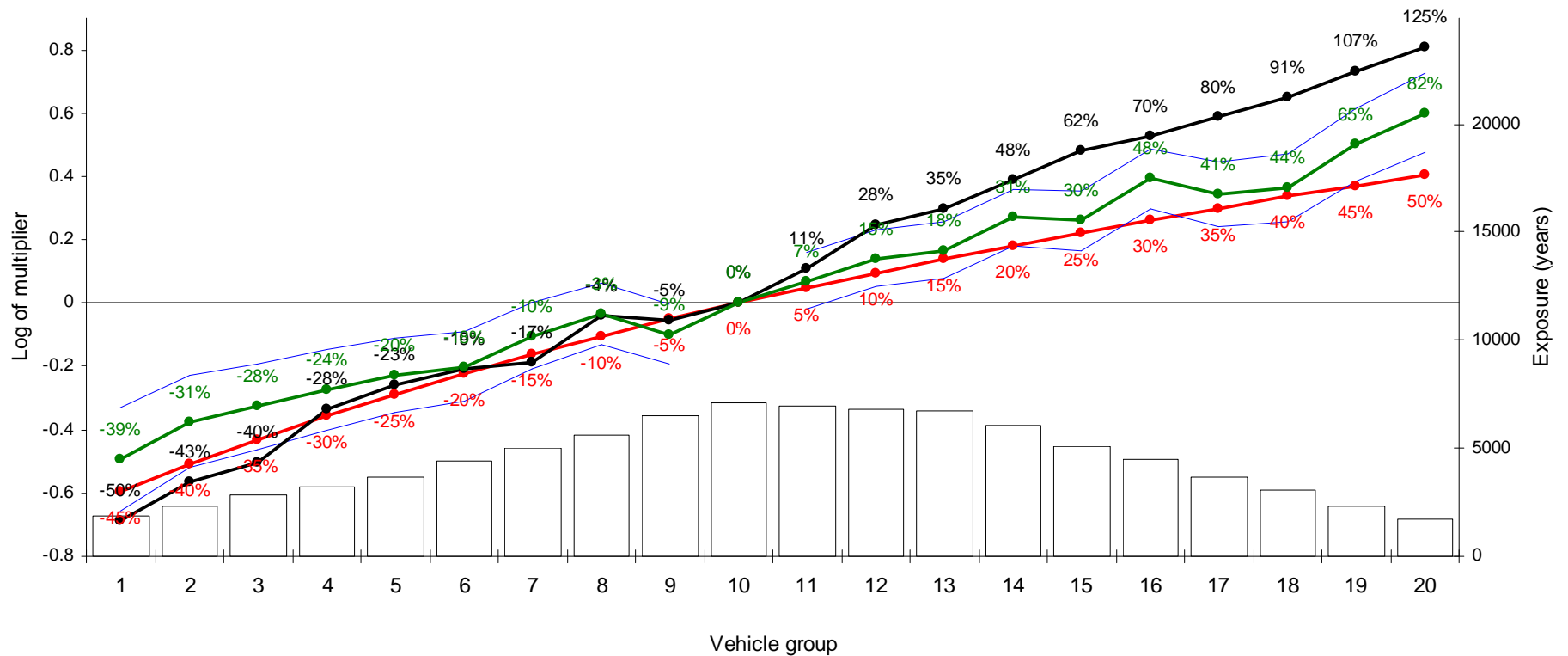
Run 10 Model 2 - Third party material, standard risk premium run - Unsmoothed standard risk premium model



Considering current rates and the competitive position

Example of competitor analysis

Third party cover

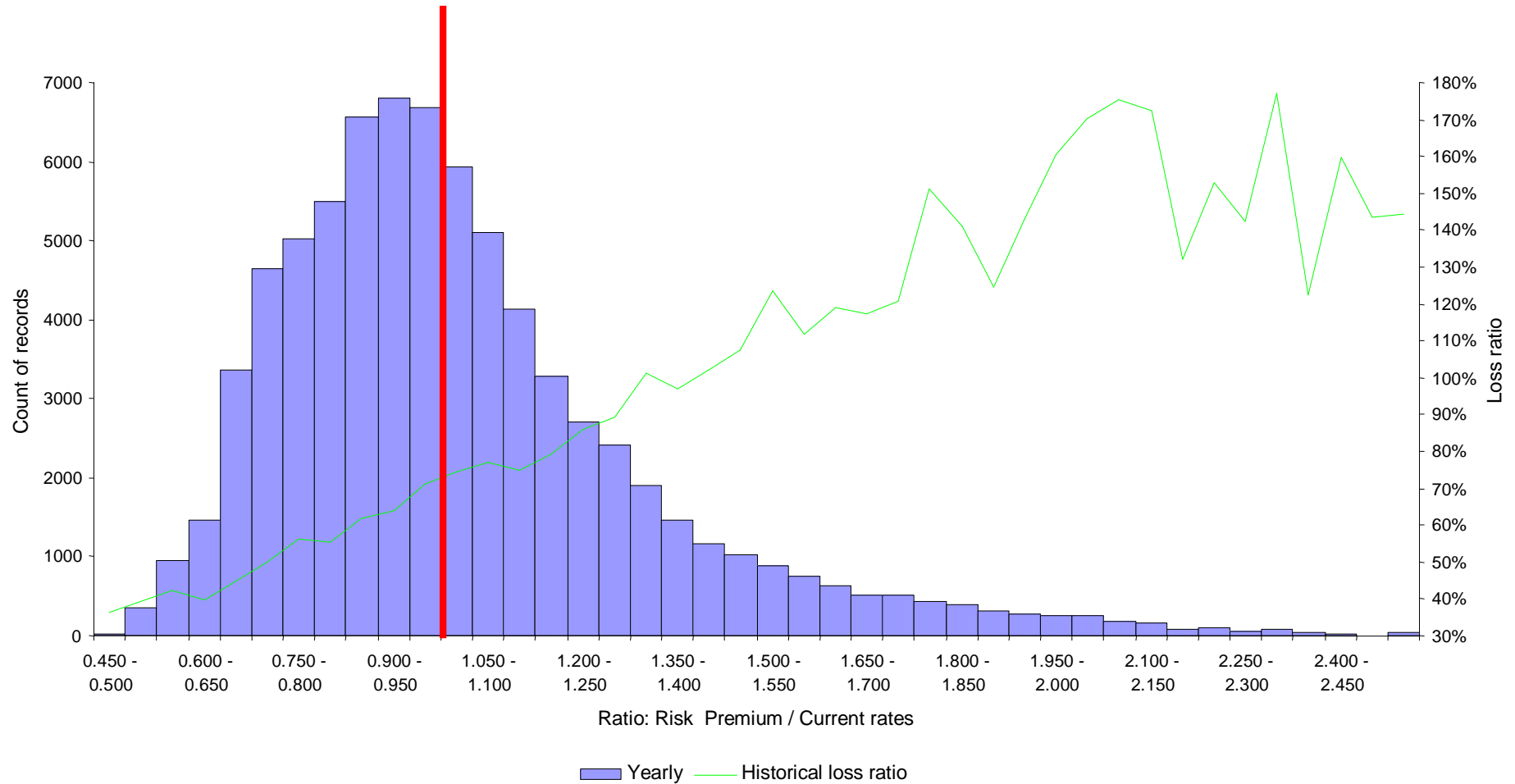


● Current rates
 — Approx 95% confidence interval
 ● Third cheapest market quote
 ● Smoothed estimate

P value = 0.0%
Rank 9/11

Impact analysis

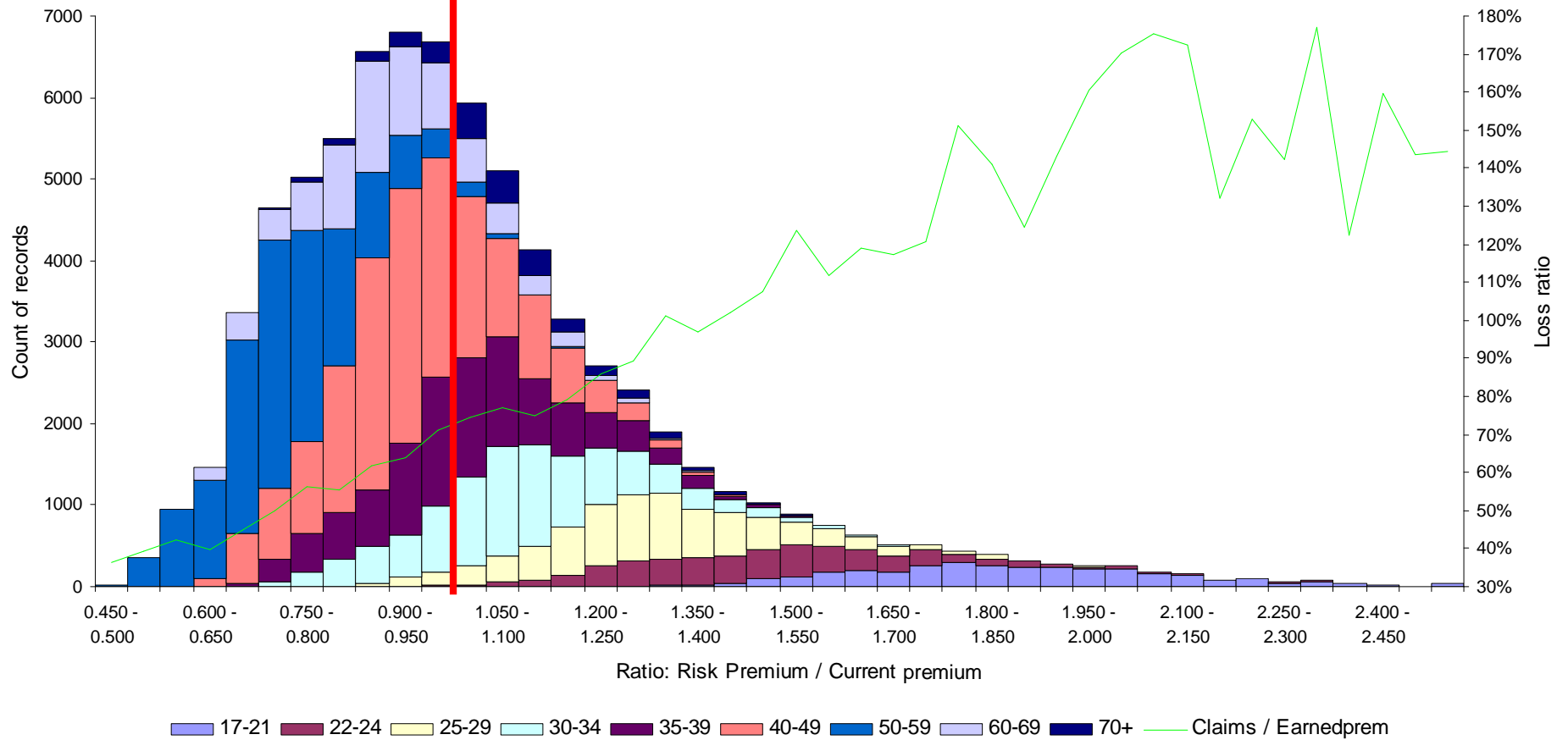
Example job



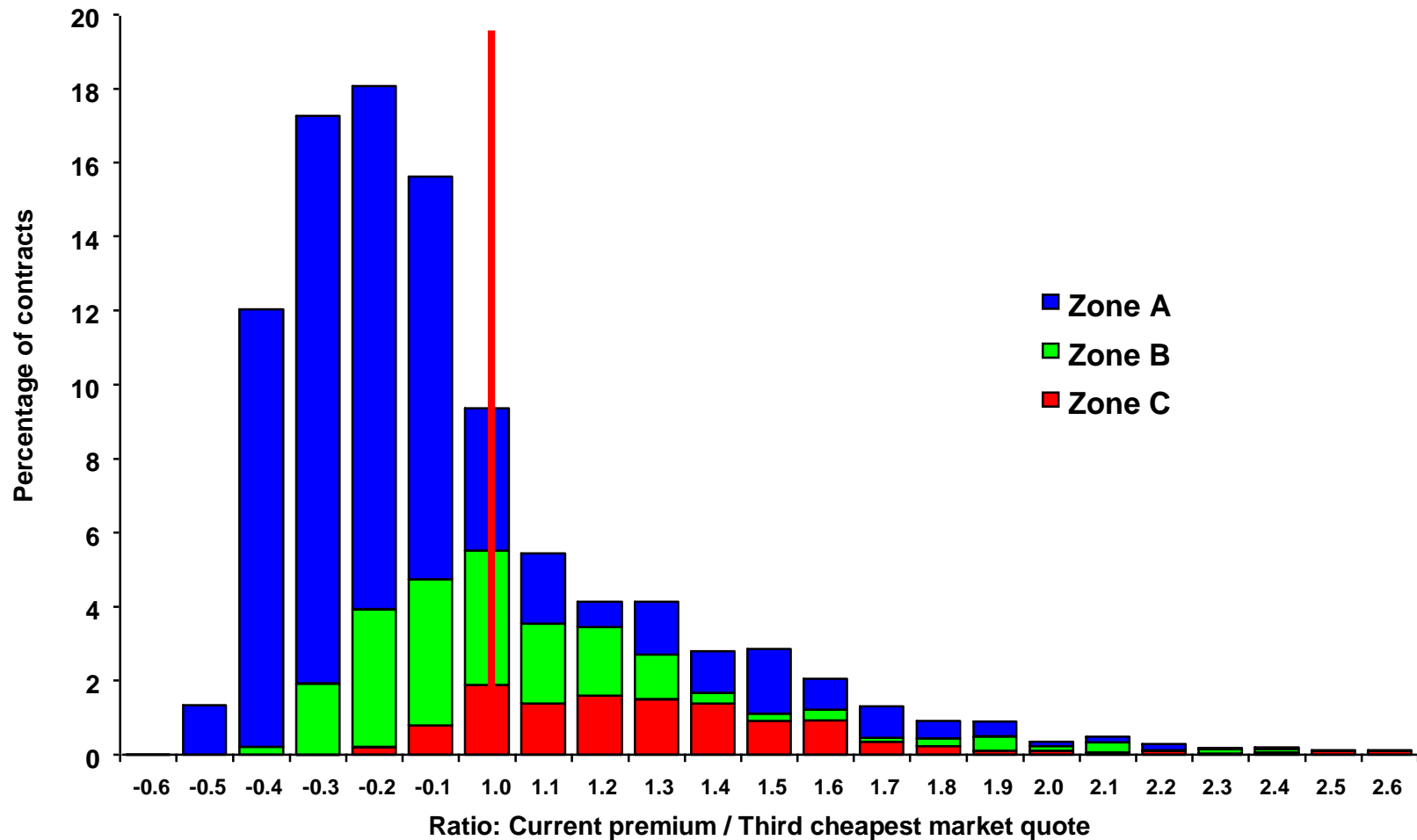
Impact analysis

Example job

Age of driver

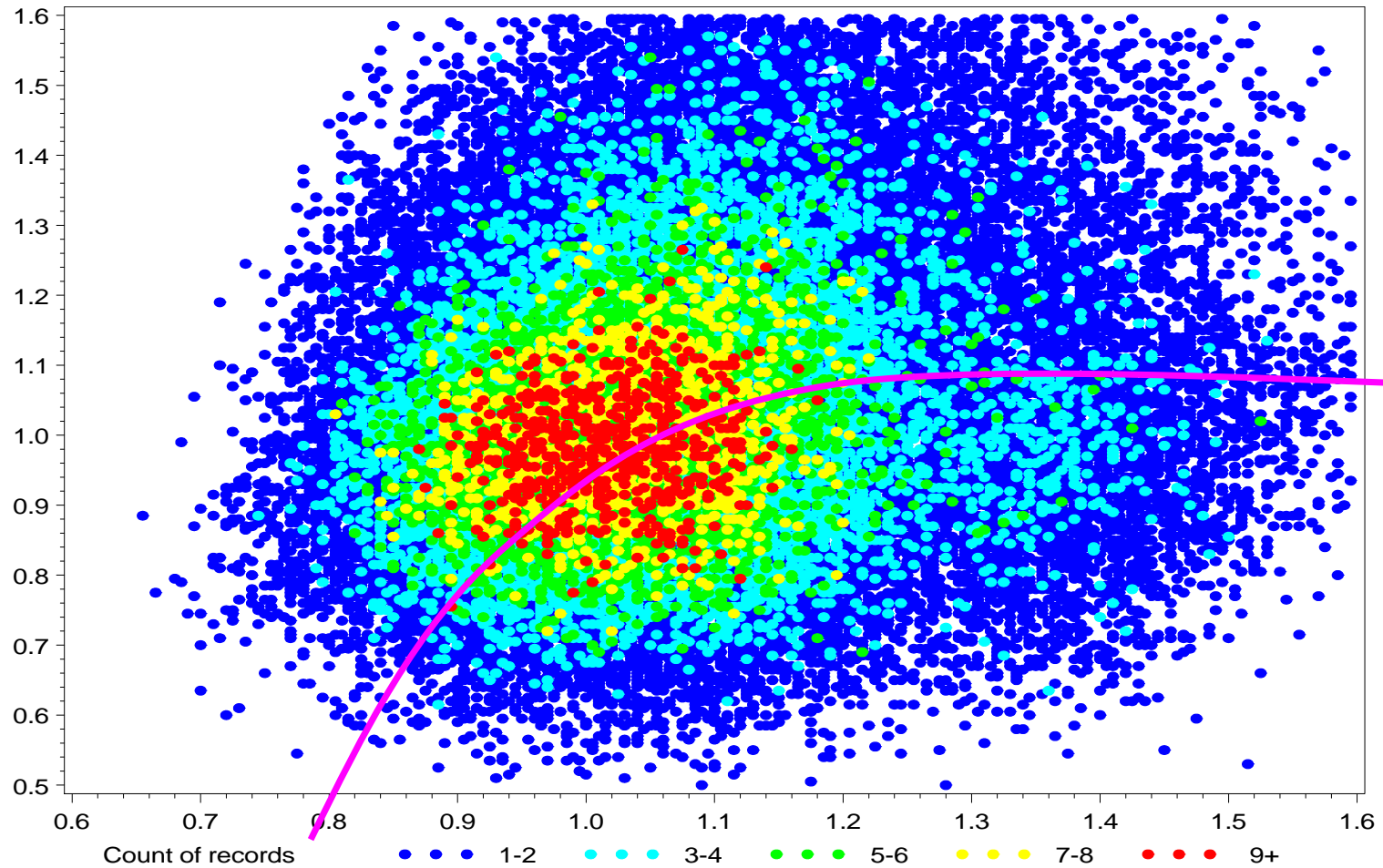


Comparison with competitors



Moving toward competitive / profitable (Before)

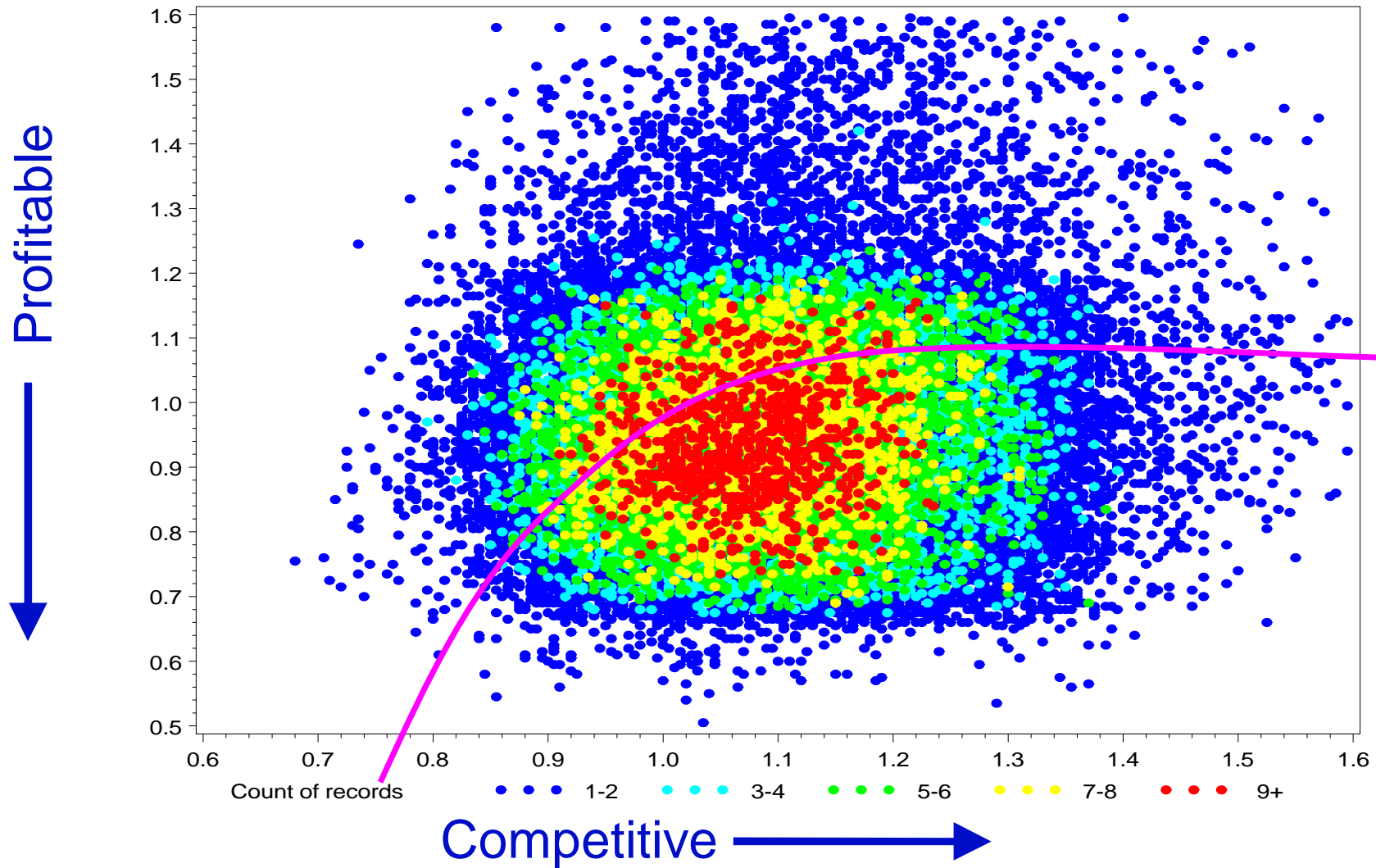
Profitable



Competitive



Moving toward competitive / profitable (After)



Communicating modeling results visually

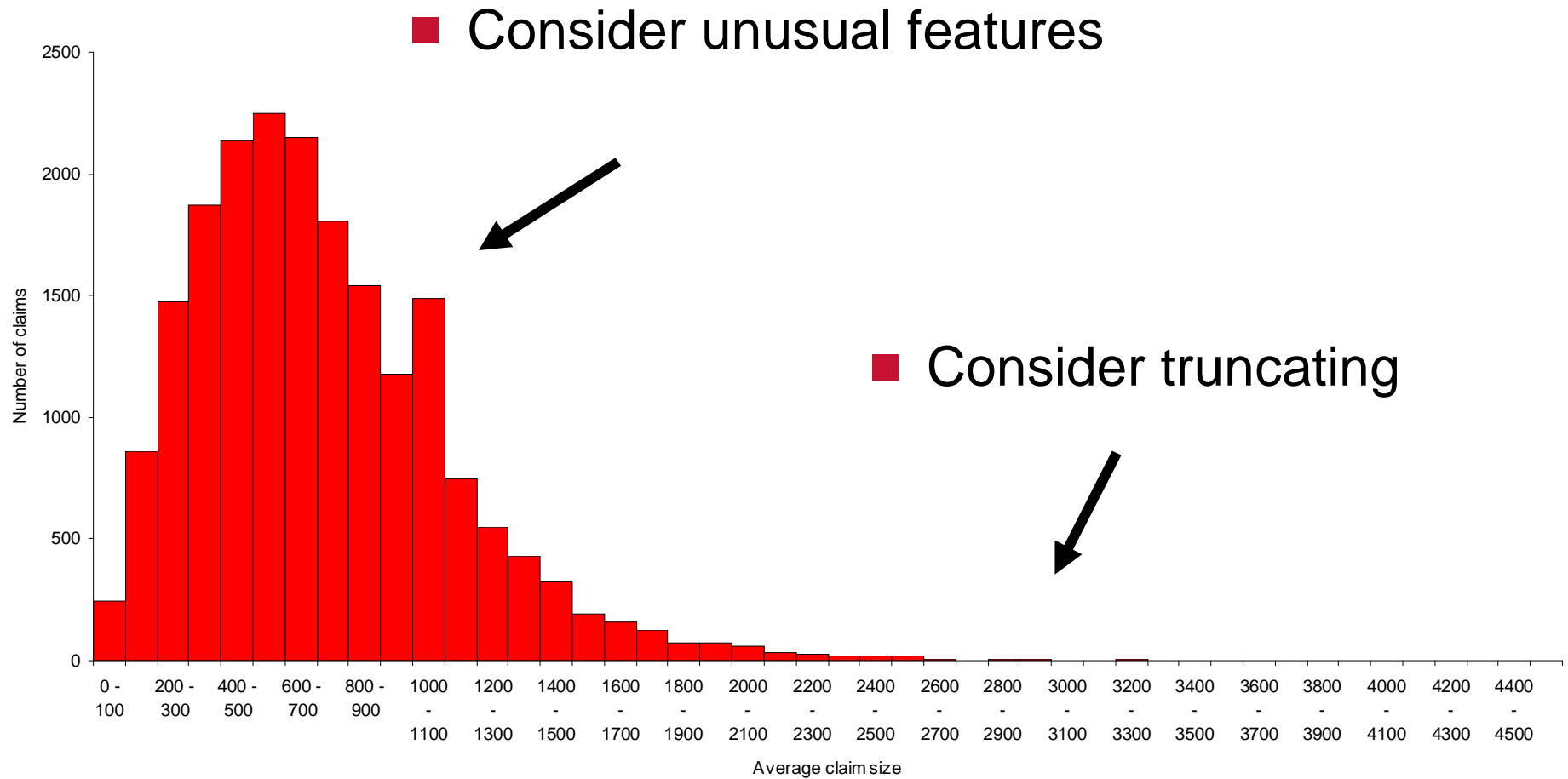
- Business approach
 - lead with the value of the results
- Technical / actuarial approach
 - tell the story of the model development in a chronological fashion



Technical stories

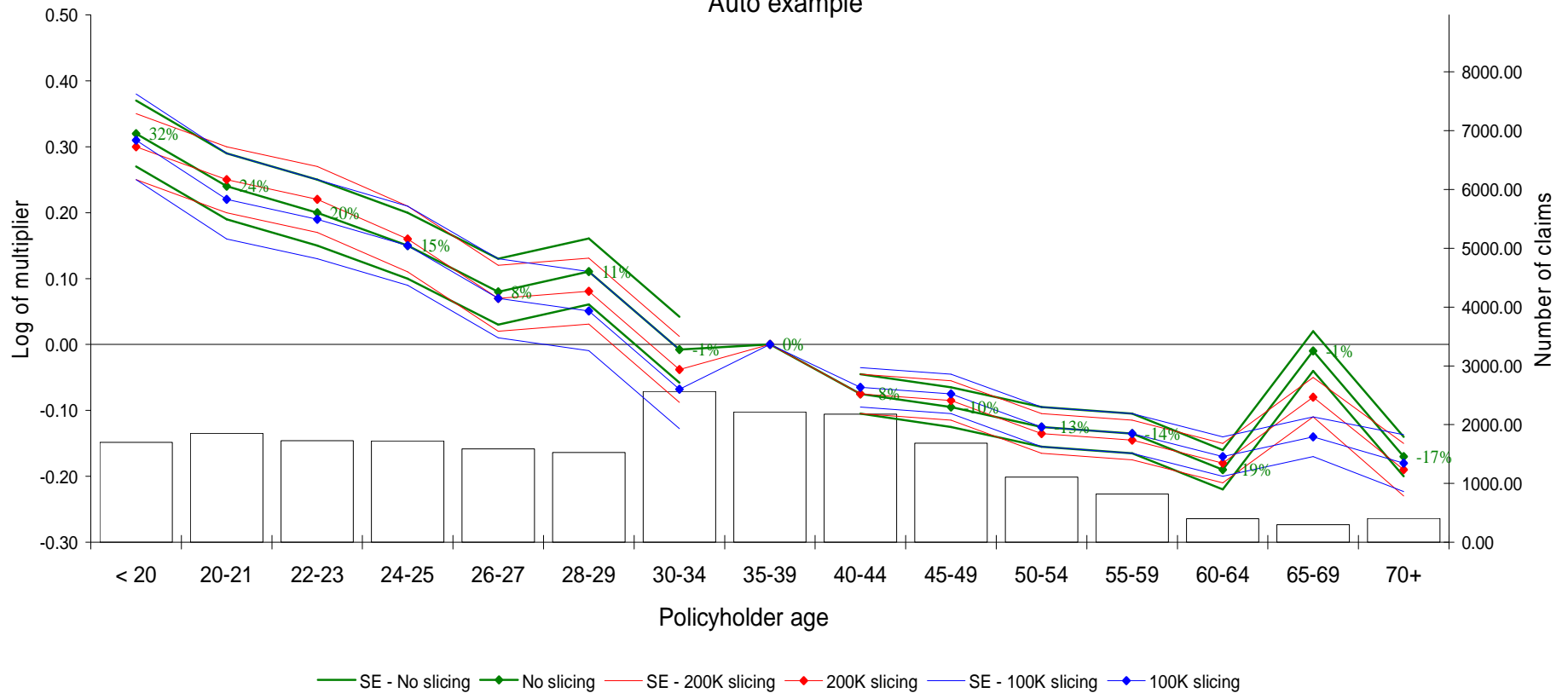
- Portfolio analysis
- Deviance tests vs graphical results
- Consistency with time
- Interactions (deciding which to test & detecting significance)
- Residual diagnostics
- Measuring the effect of commercial decisions
- Validating models
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Claim size distribution analysis



Large loss sensitivity testing

Third Party Liability - Severity
Auto example



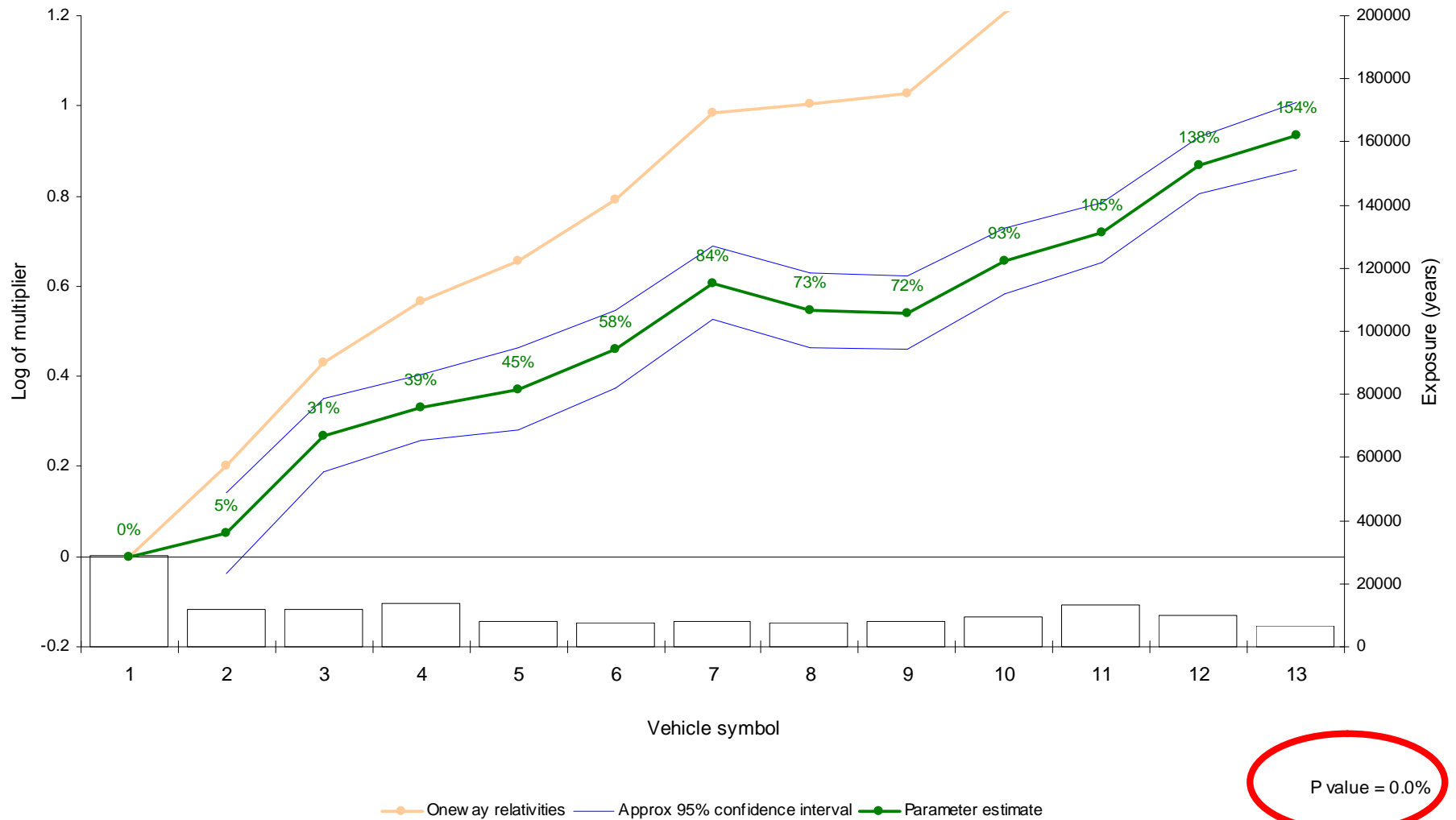
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Deviance tests

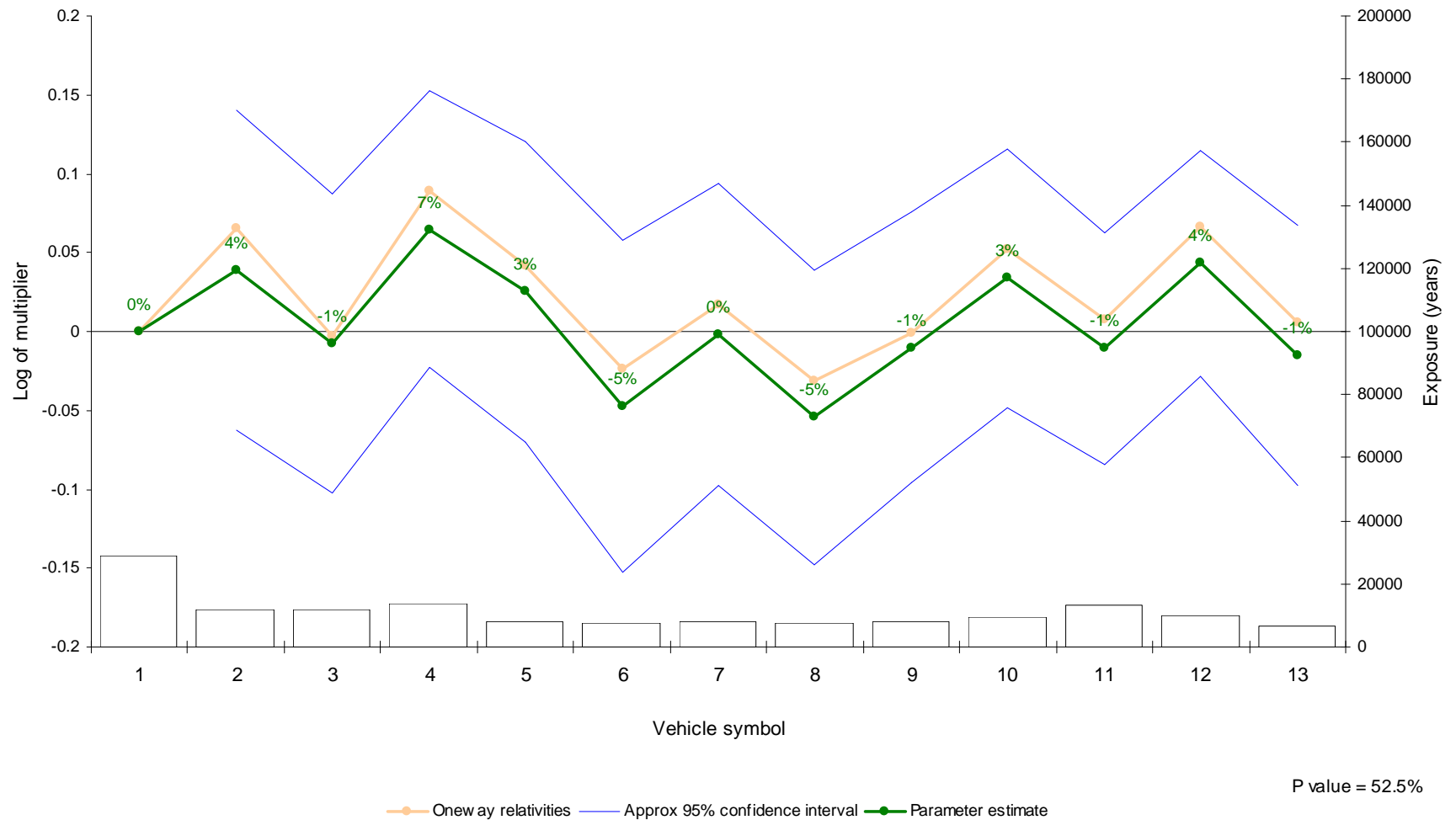
- Single figure measure of goodness of fit
- Try model with & without a factor
- Statistical tests show the theoretical significance given the extra parameters

GLM output (significant factor)

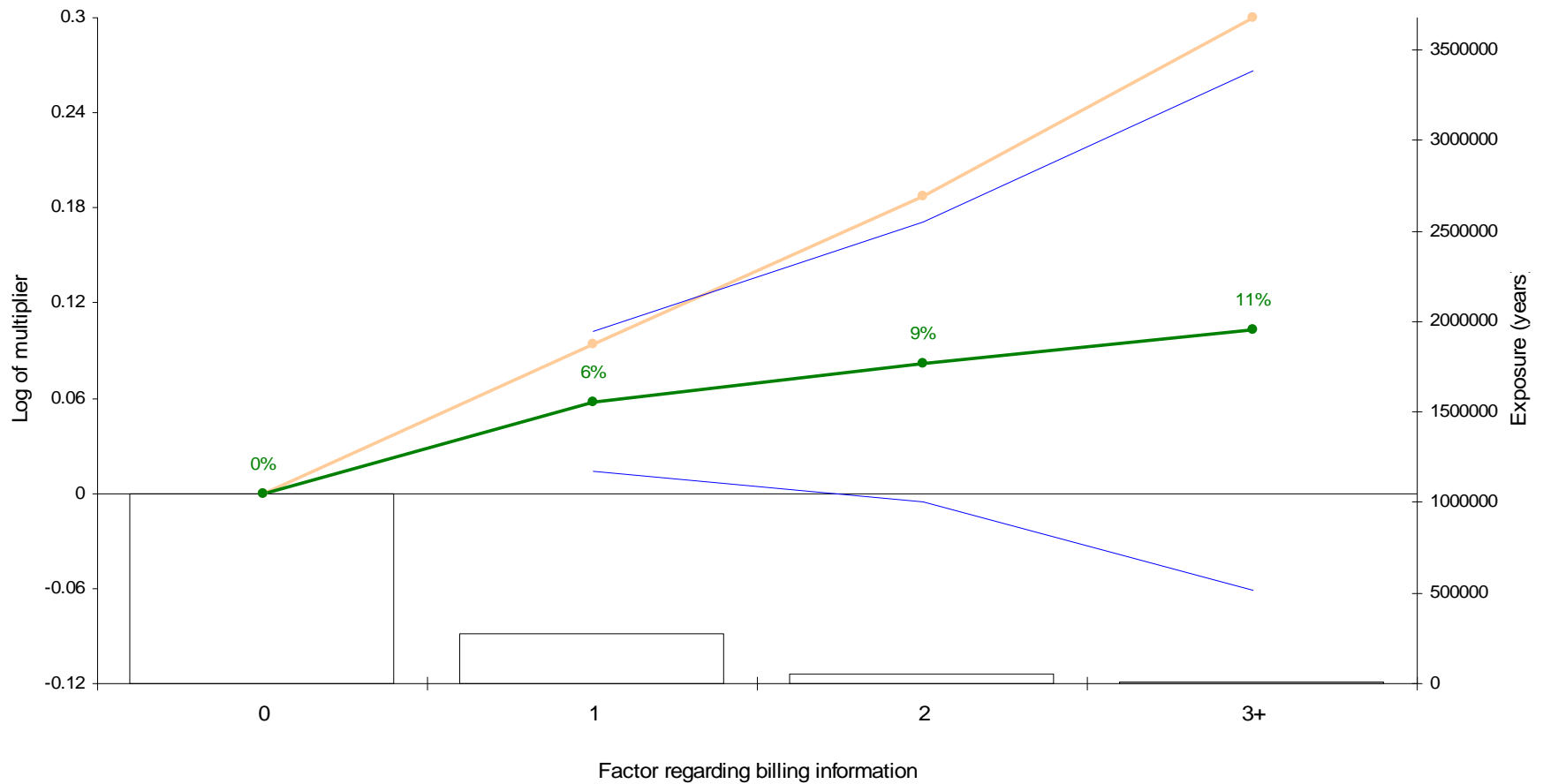


P value = 0.0%

GLM output (insignificant factor)



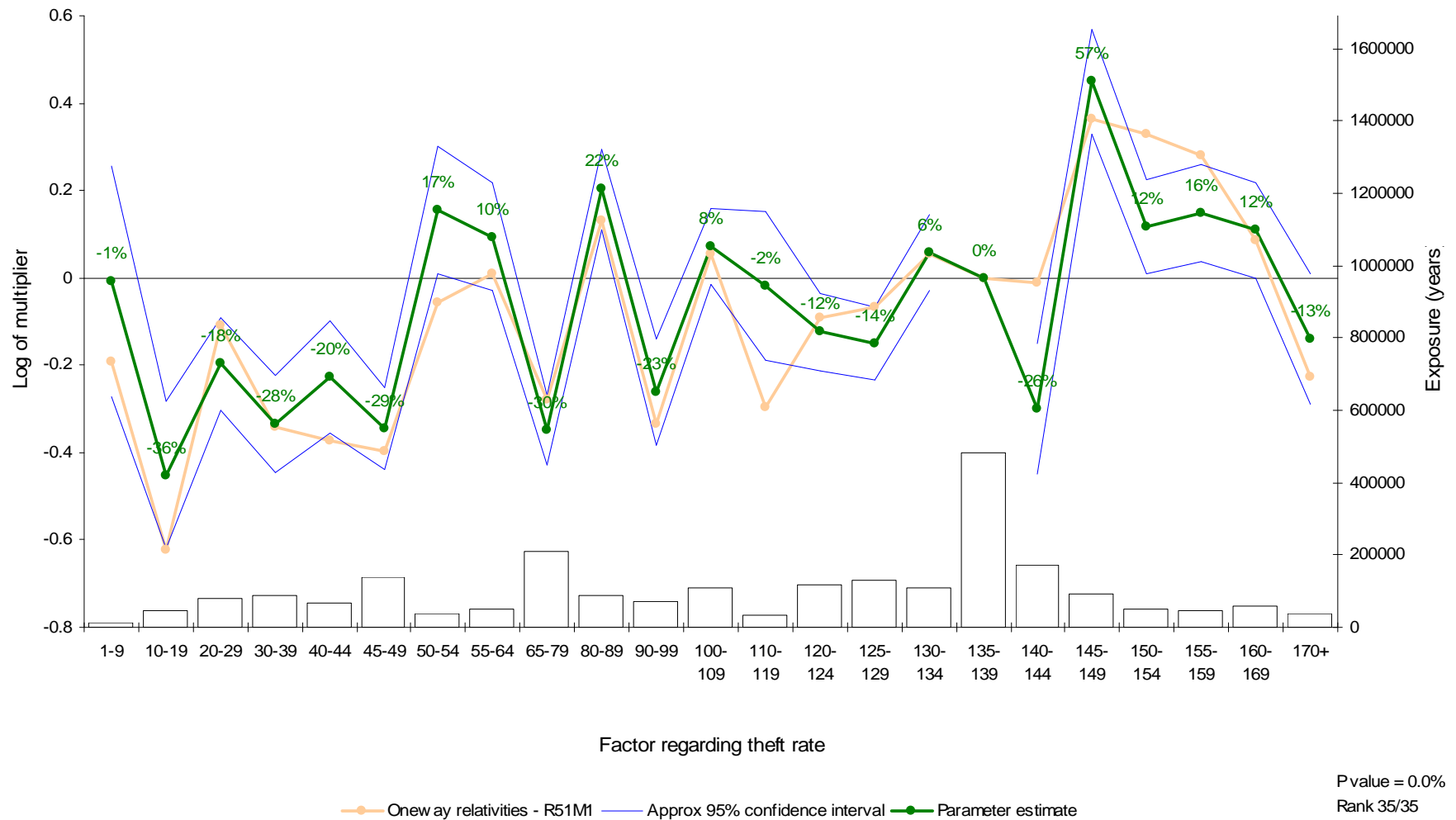
Deviance tests vs graphical results



—●— Onew ay relativities
 — Approx 95% confidence interval
 — Unsmoothed estimate
 —●— Smoothed estimate

P value = 0.8%
Rank 14/34

Deviance tests vs graphical results



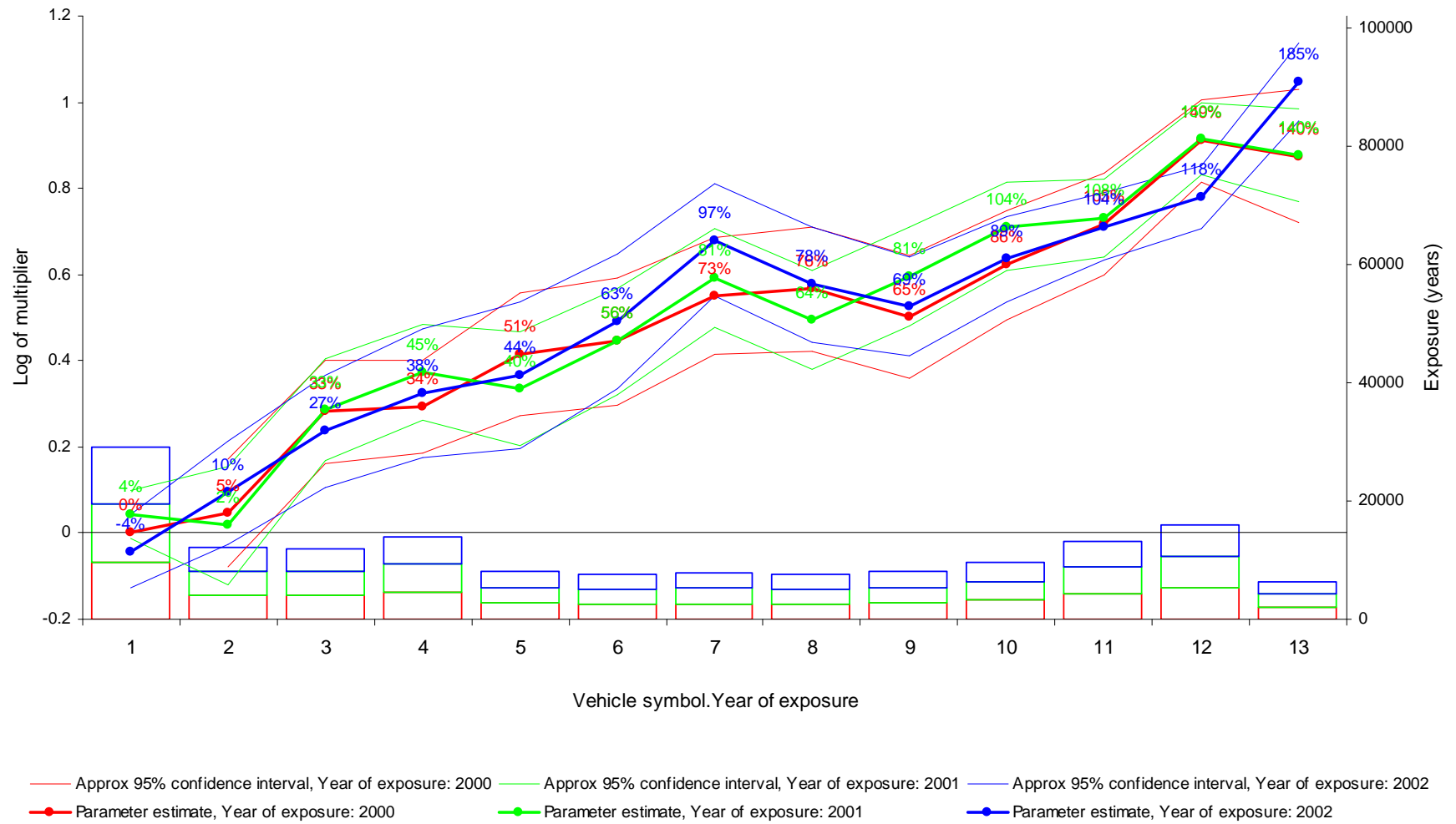
Deviance tests vs graphical results

- 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

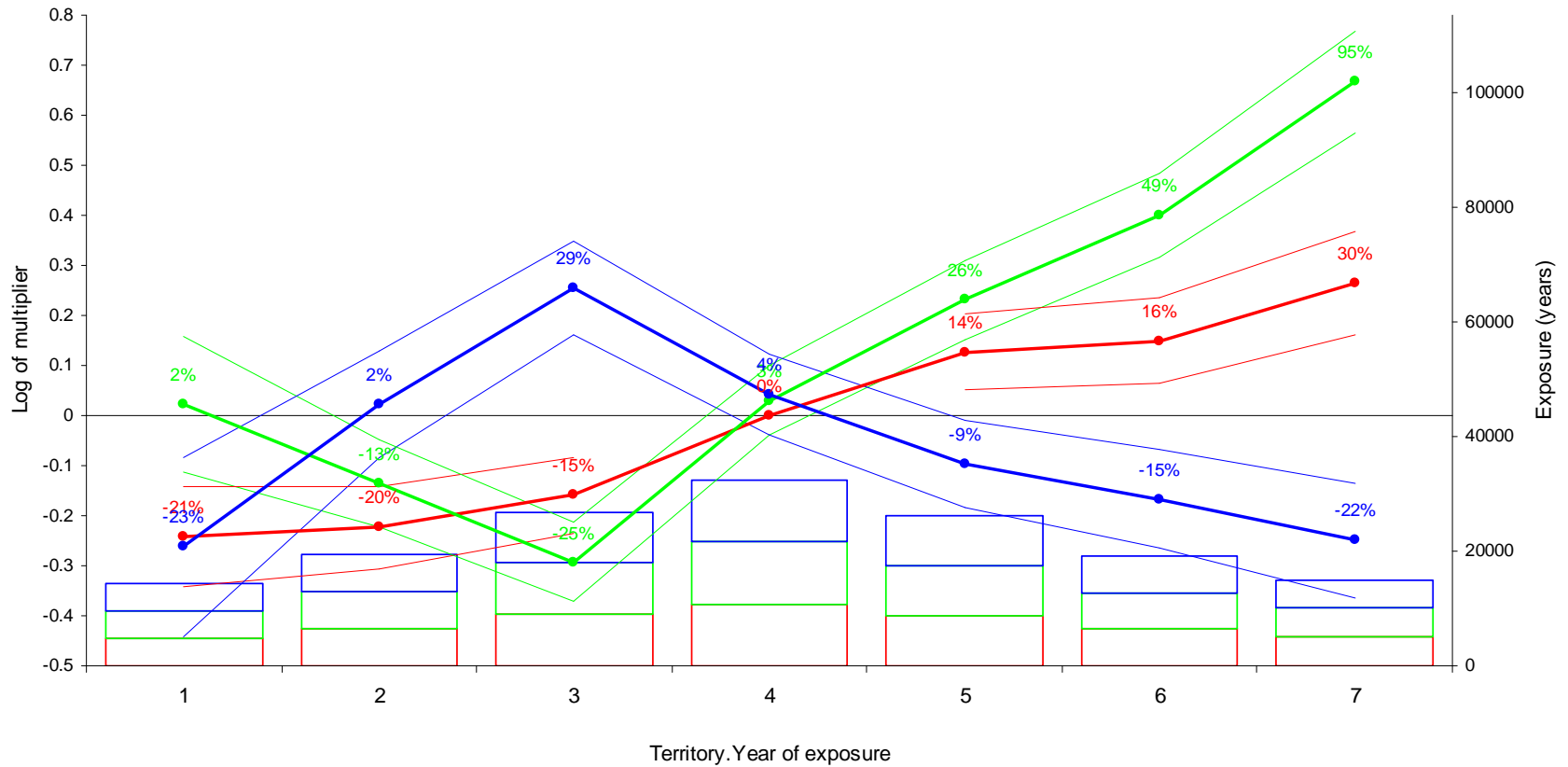
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Consistency over time

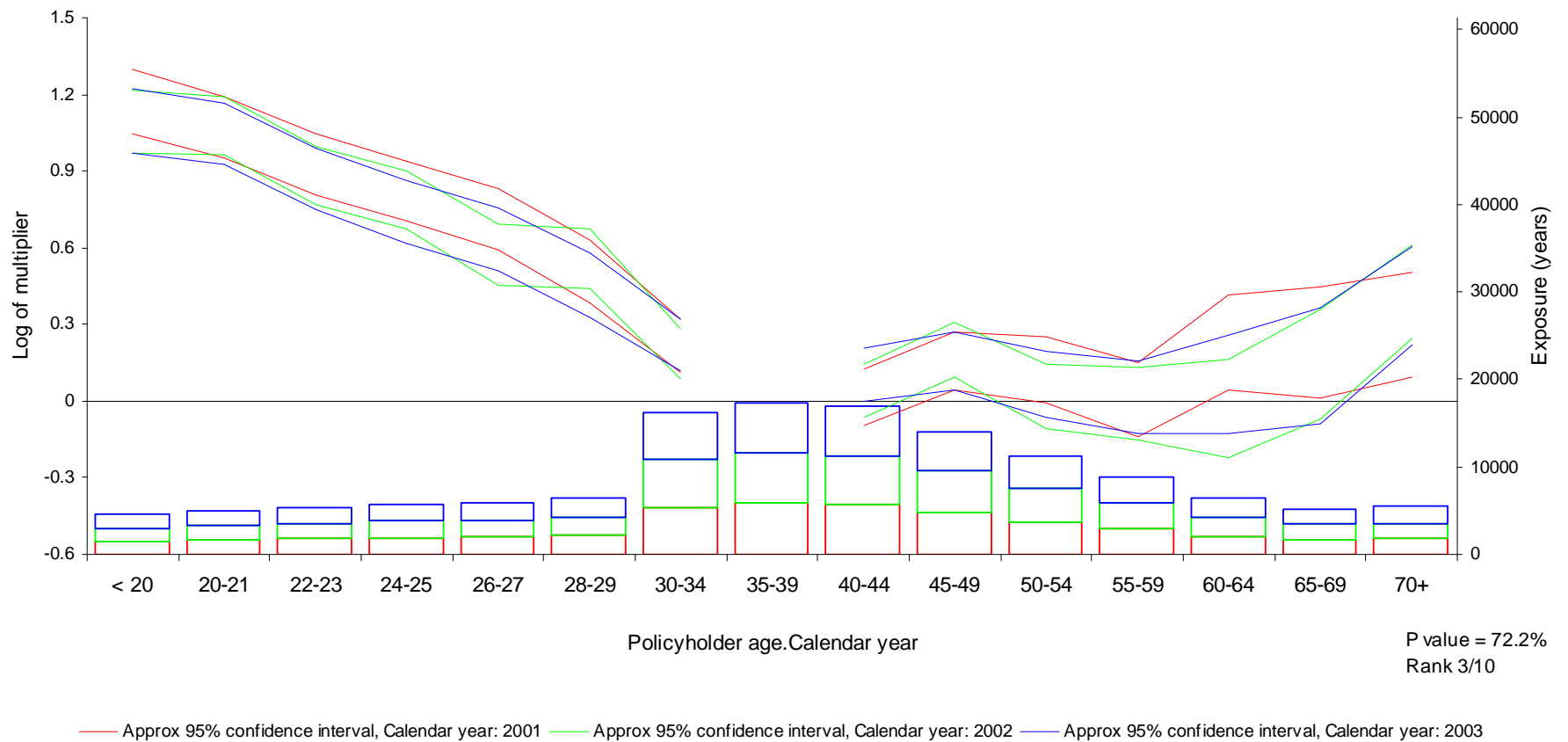


Consistency over time



— Approx 95% confidence interval, Year of exposure: 2000
 — Approx 95% confidence interval, Year of exposure: 2001
 — Approx 95% confidence interval, Year of exposure: 2002
● Smoothed estimate, Year of exposure: 2000
 ● Smoothed estimate, Year of exposure: 2001
 ● Smoothed estimate, Year of exposure: 2002

Consistency over time



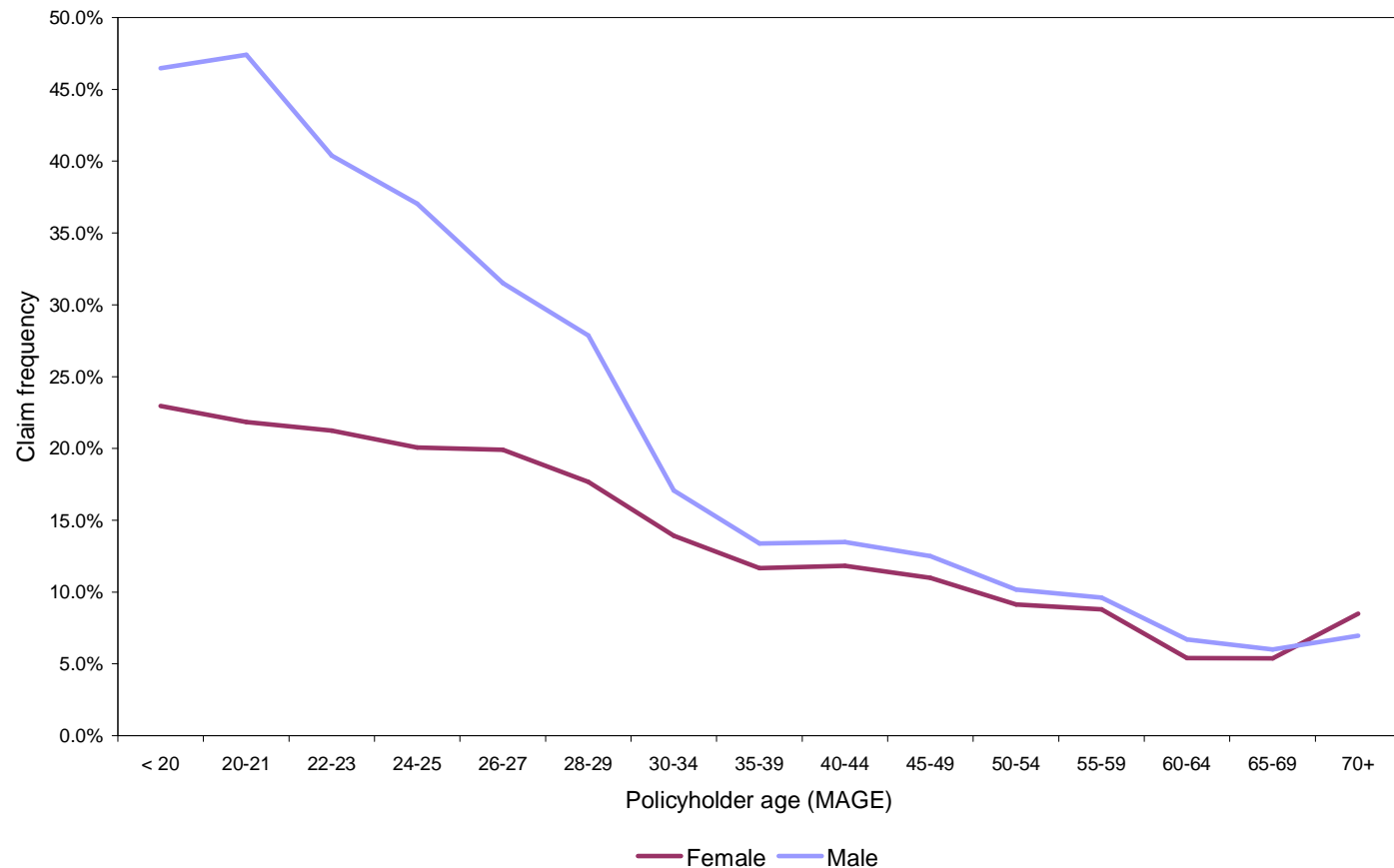
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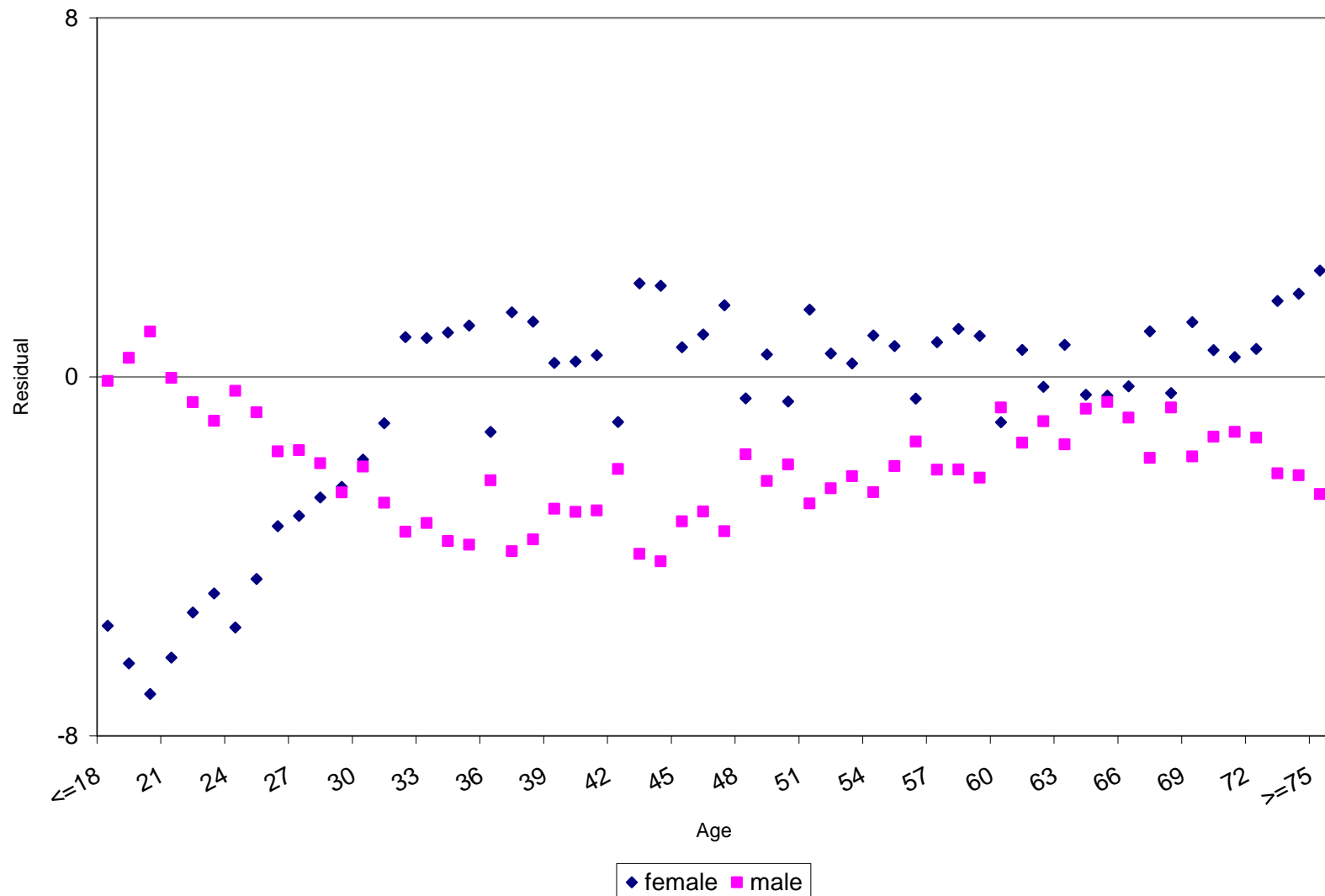
Two way frequency

A worked example of the tutorial job

Claim type 1 - Third party property damage
Sex of policyholder (MSEX)



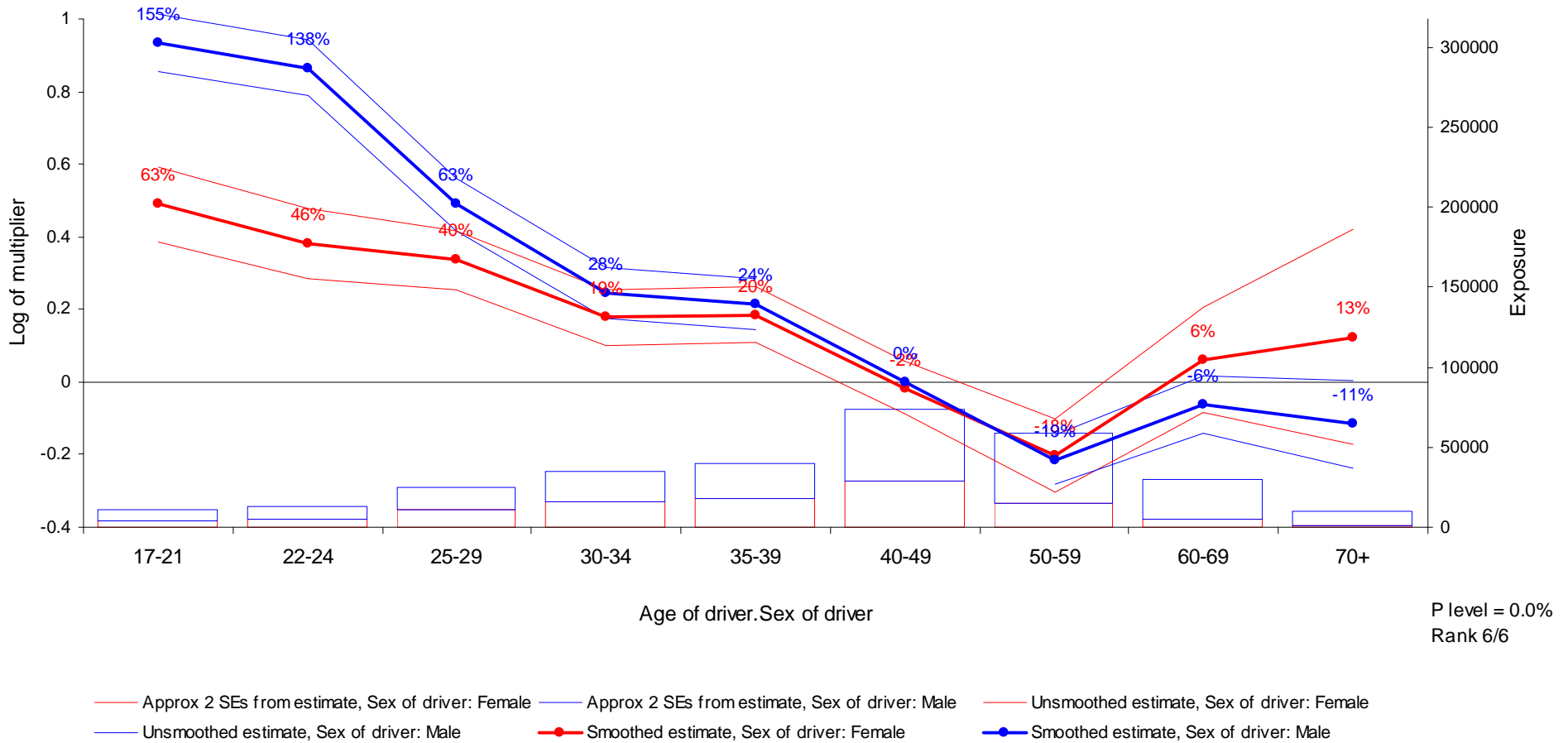
Two way of deviance residual (age and sex)



Age - sex interaction

Example job

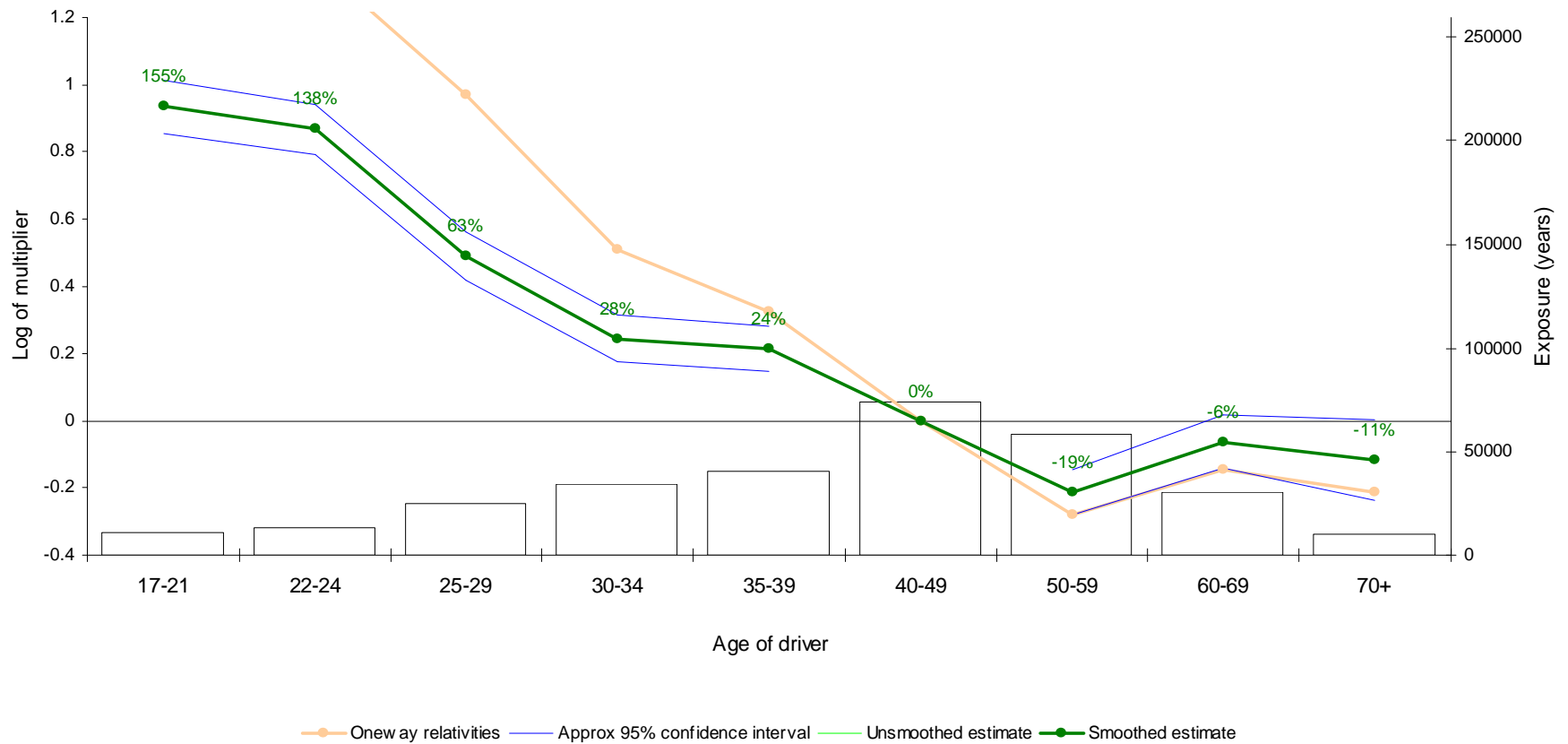
Run 5 Model 3 - Small interaction - Third party material damage, Numbers



Marginal interaction: Age effect

Example job

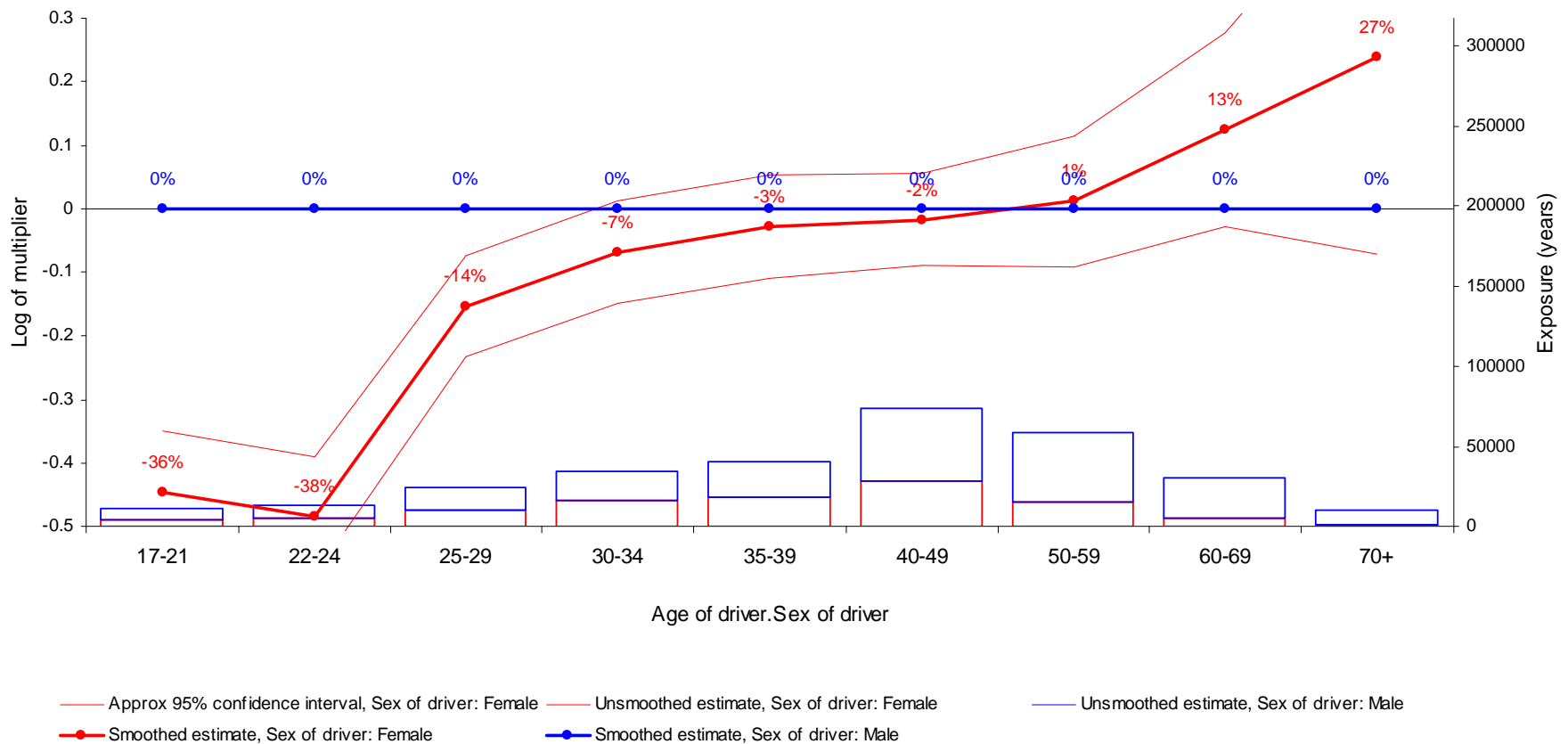
Run 16 Model 3 - Small interaction - Third party material damage, Numbers



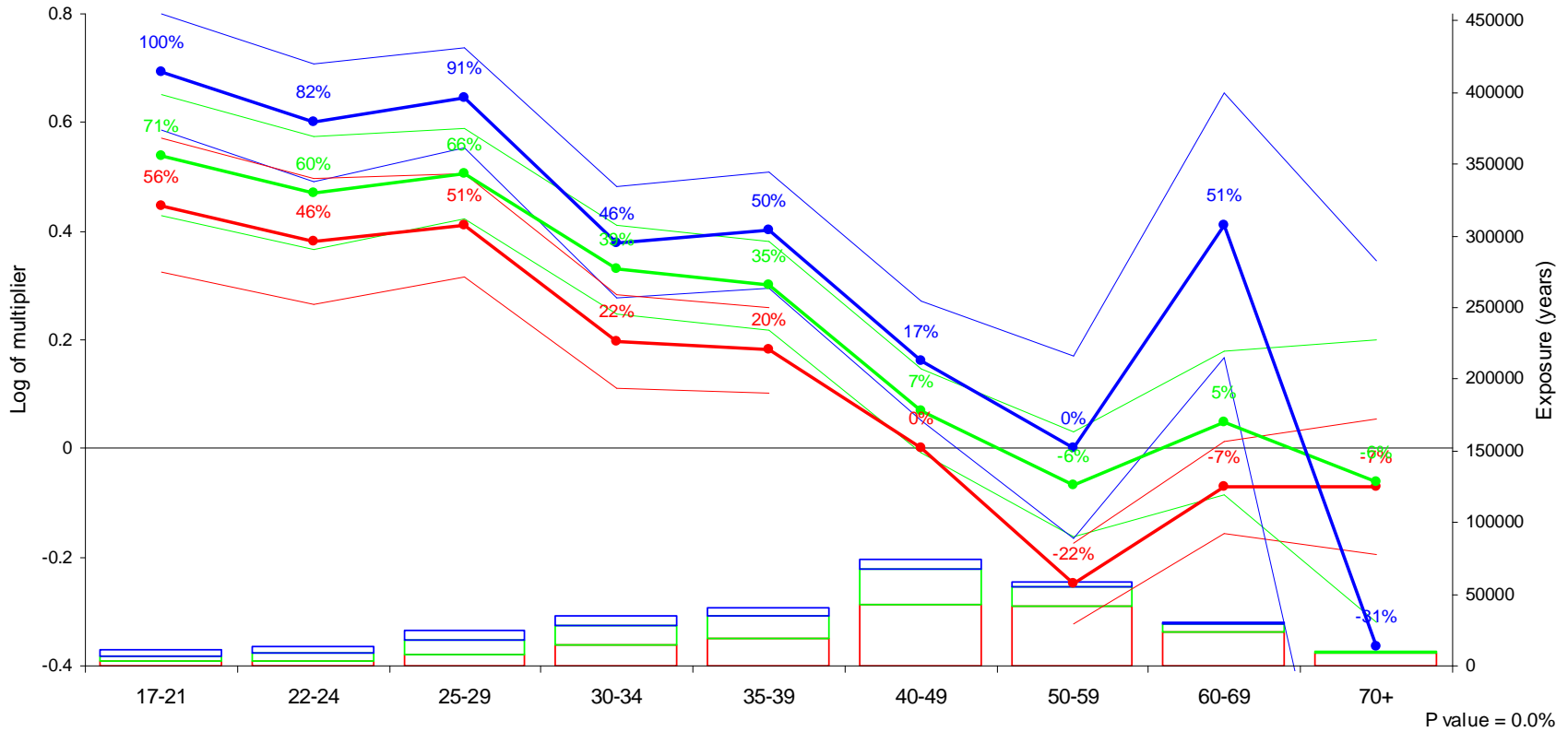
Marginal interaction: Age.Sex (ie additional female multipliers)

Example job

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

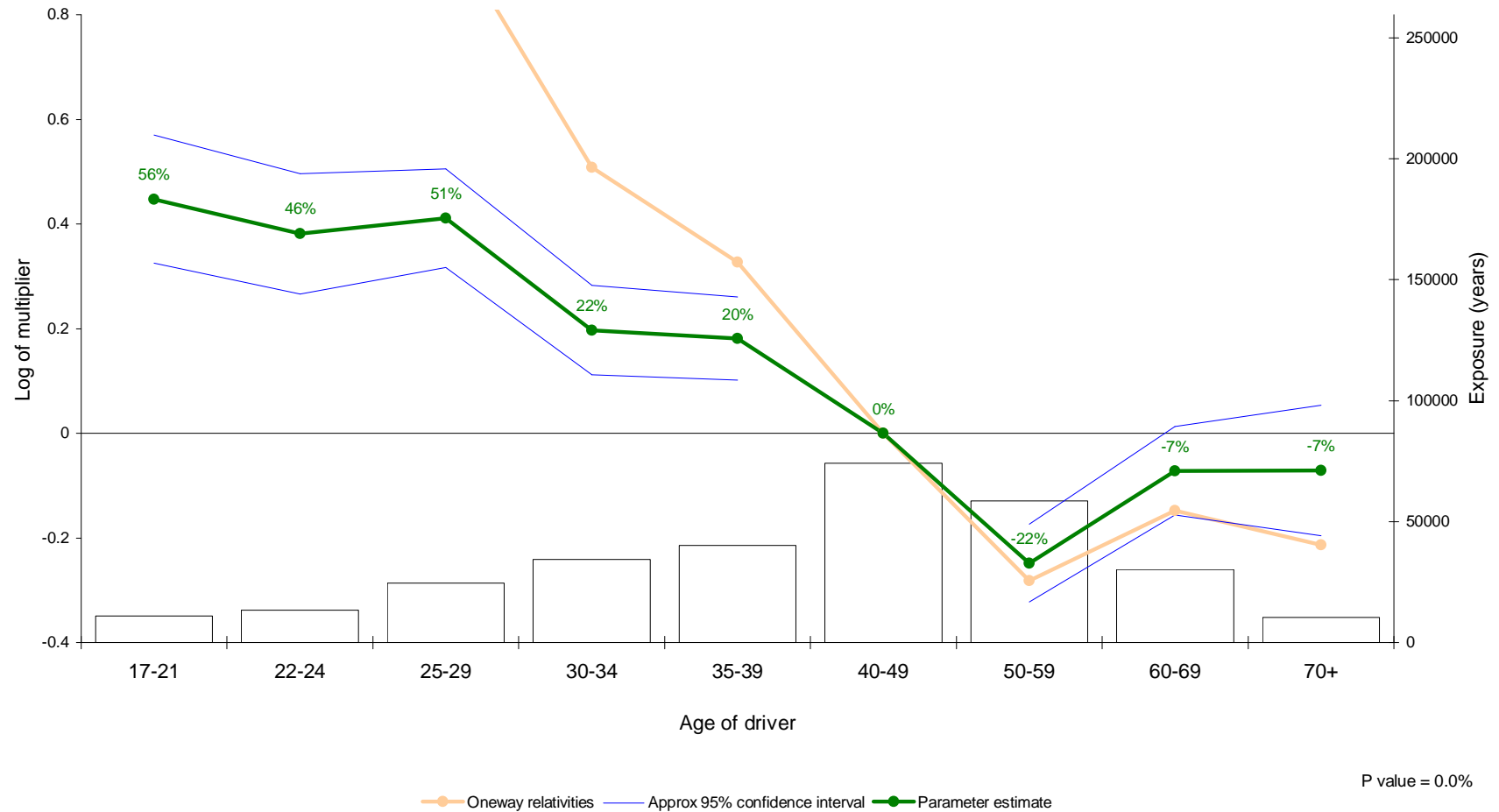


An example of no interaction

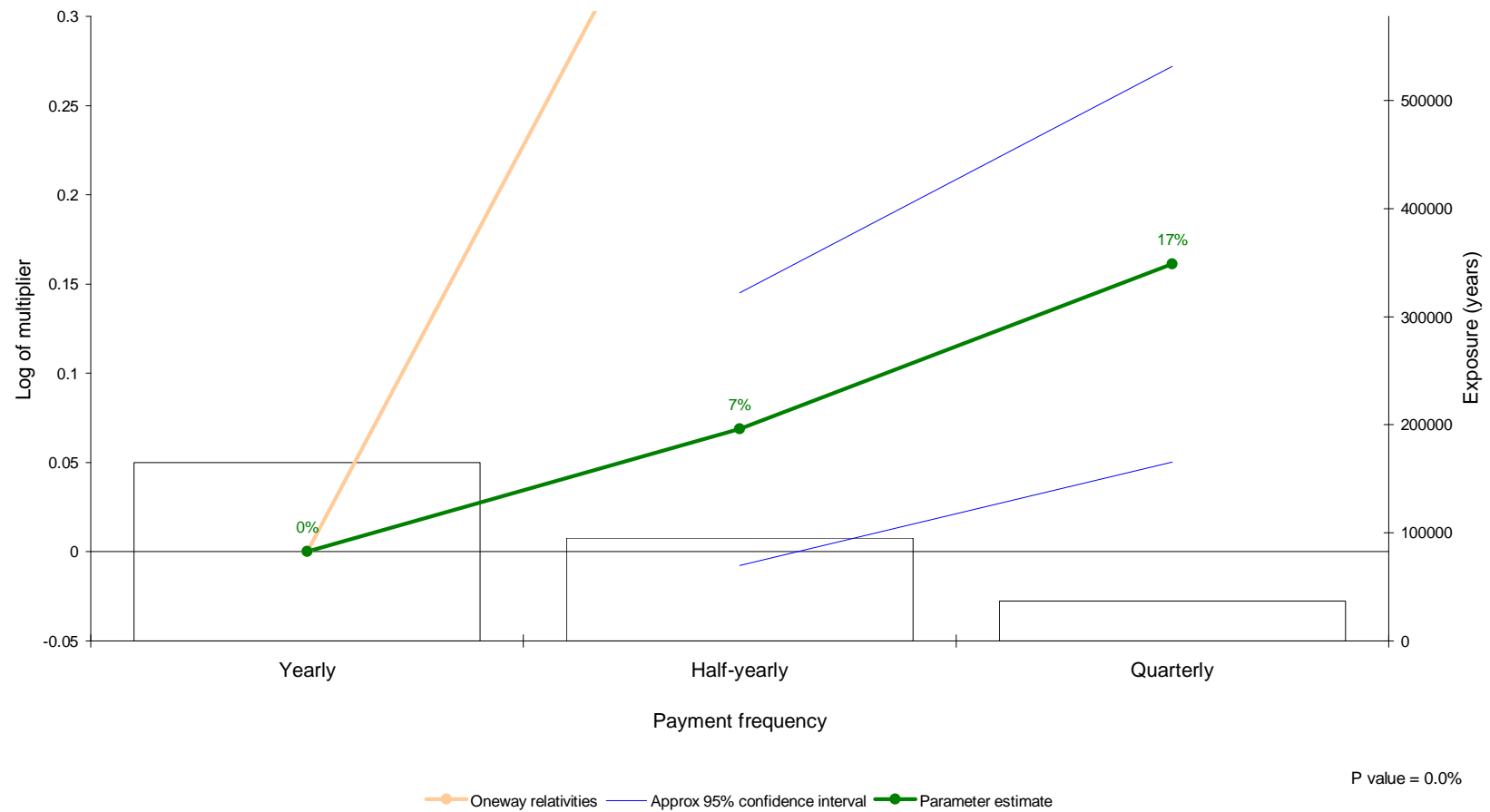


— Approx 95% confidence interval, Payment frequency: Yearly
 — Approx 95% confidence interval, Payment frequency: Half-yearly
 — Approx 95% confidence interval, Payment frequency: Quarterly
● Parameter estimate, Payment frequency: Yearly
 ● Parameter estimate, Payment frequency: Half-yearly
 ● Parameter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

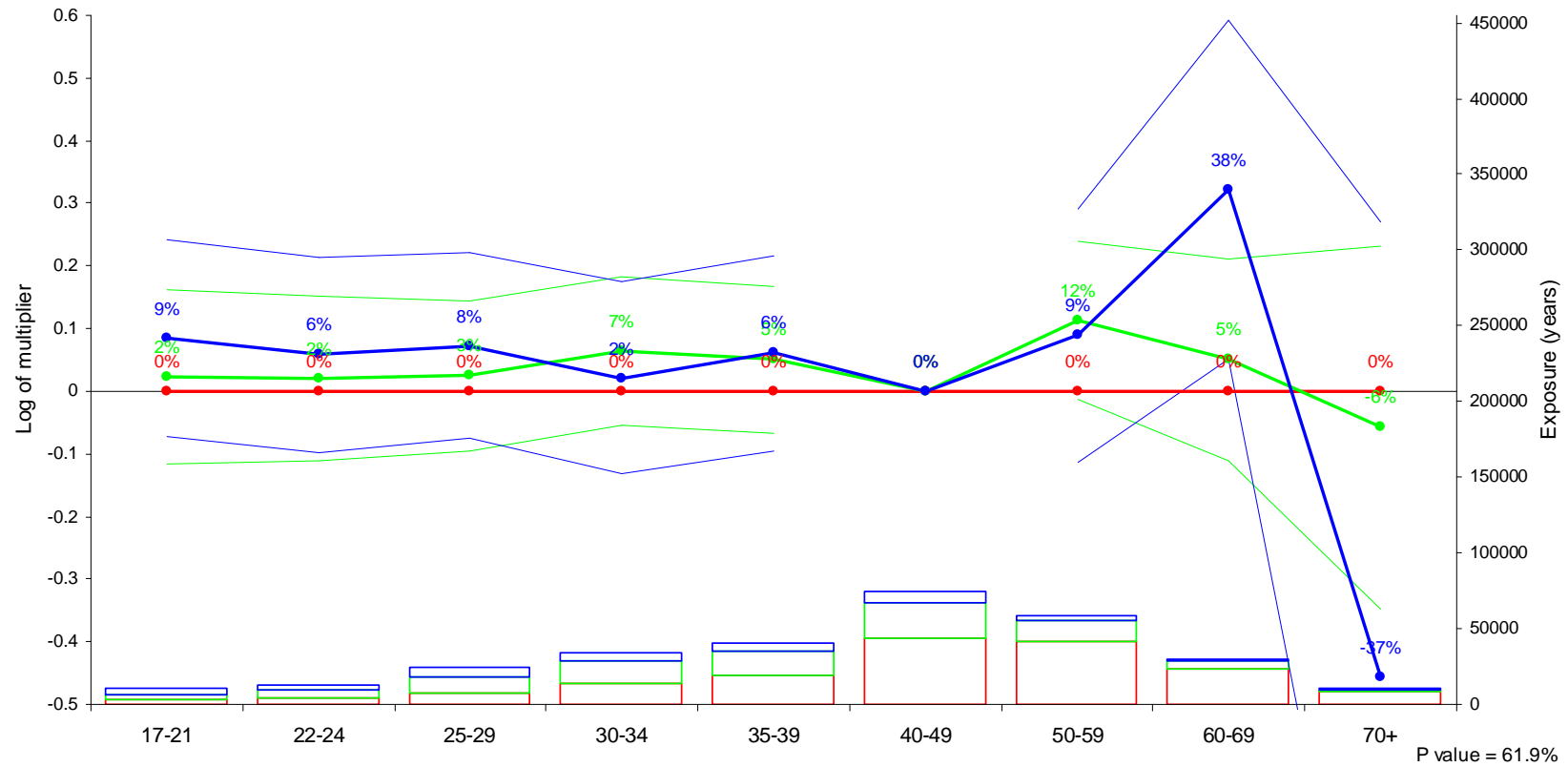
An example of no interaction



An example of no interaction



An example of no interaction



Marginal interaction of Age of driver and Payment frequency

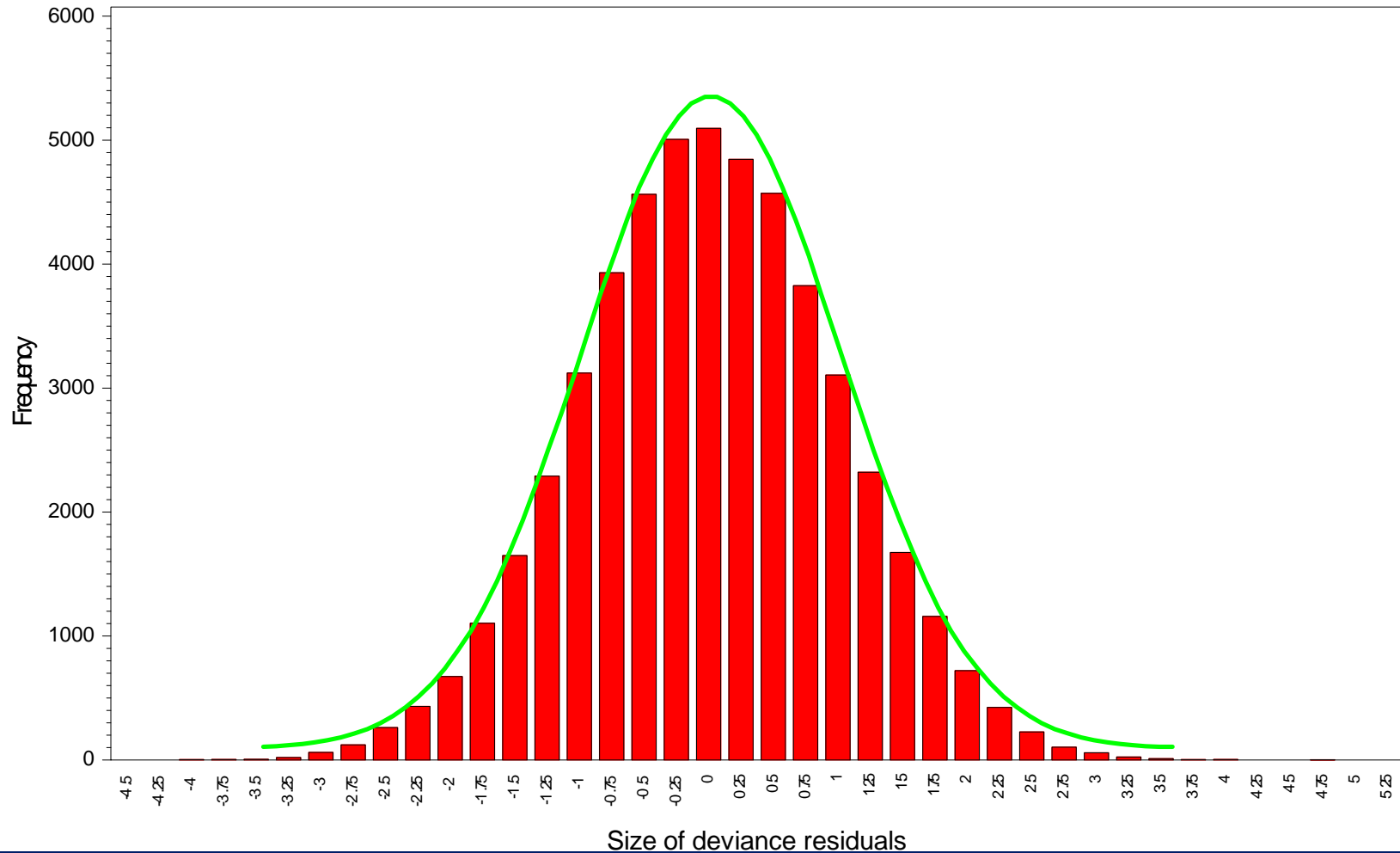
—●— Approx 95% confidence interval, Payment frequency: Half-yearly
 —●— Approx 95% confidence interval, Payment frequency: Quarterly
 —●— Parameter estimate, Payment frequency: Yearly
—●— Parameter estimate, Payment frequency: Half-yearly
 —●— Parameter estimate, Payment frequency: Quarterly

Technical stories

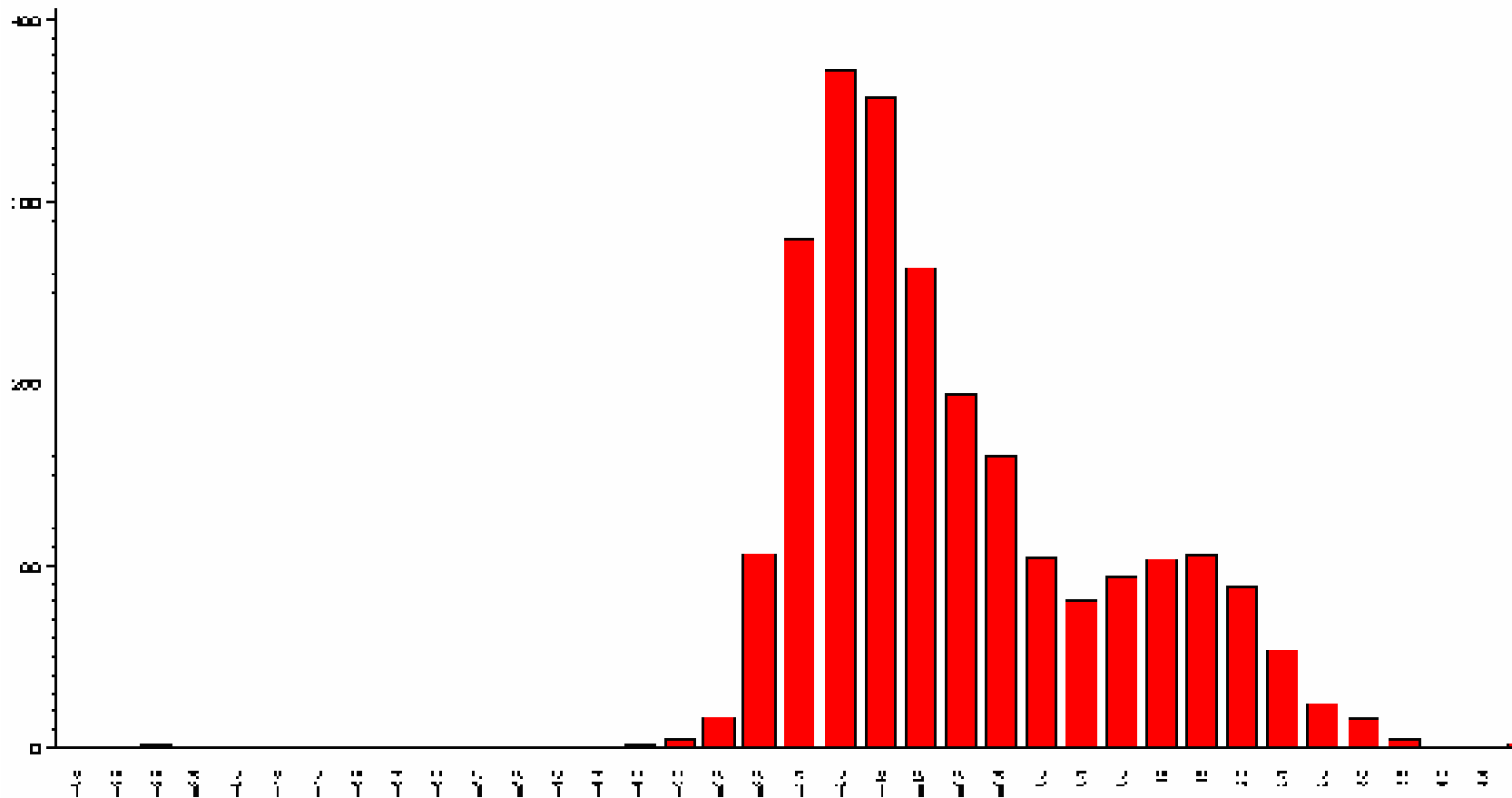
- Portfolio analysis
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- **Residual diagnostics**
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Residuals

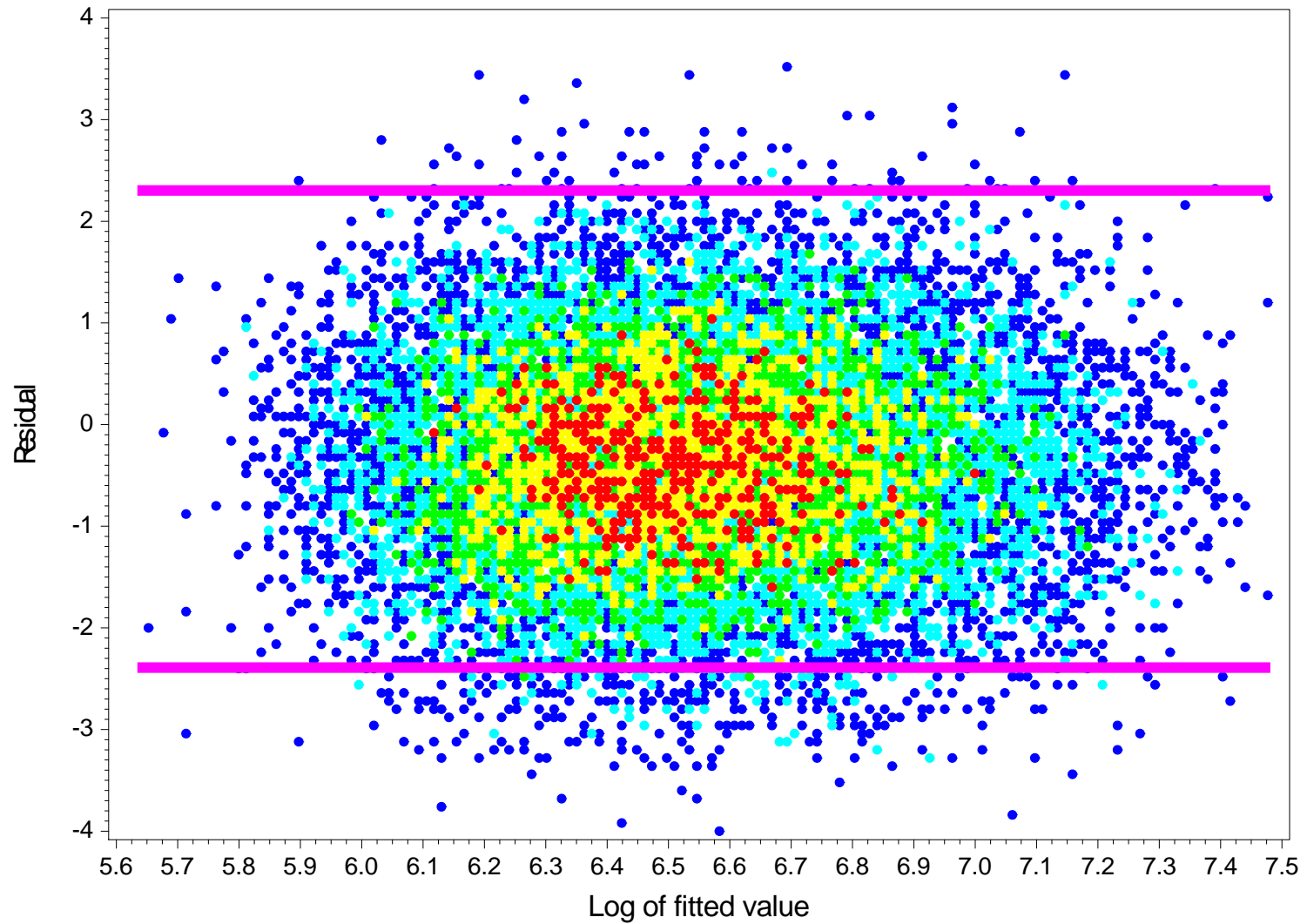
Histogram of Deviance Residuals
Run 12 (Final models with analysis) Model 8 (AD amounts)



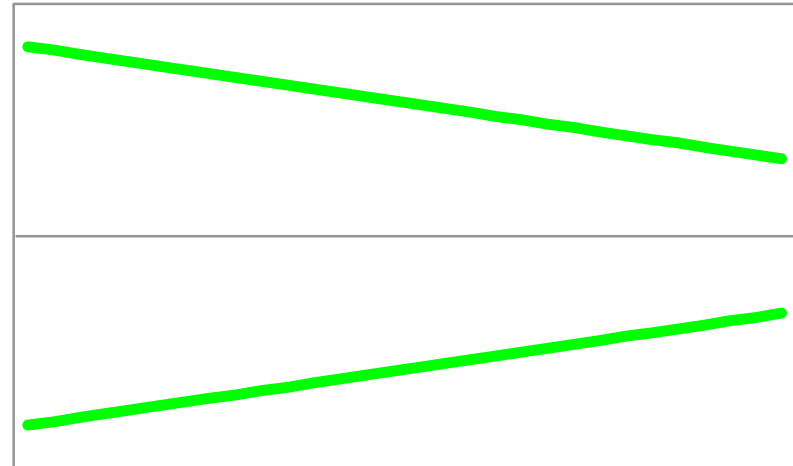
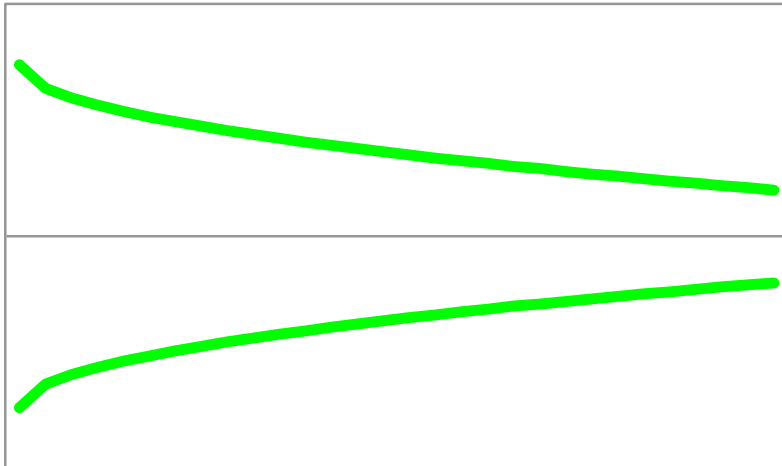
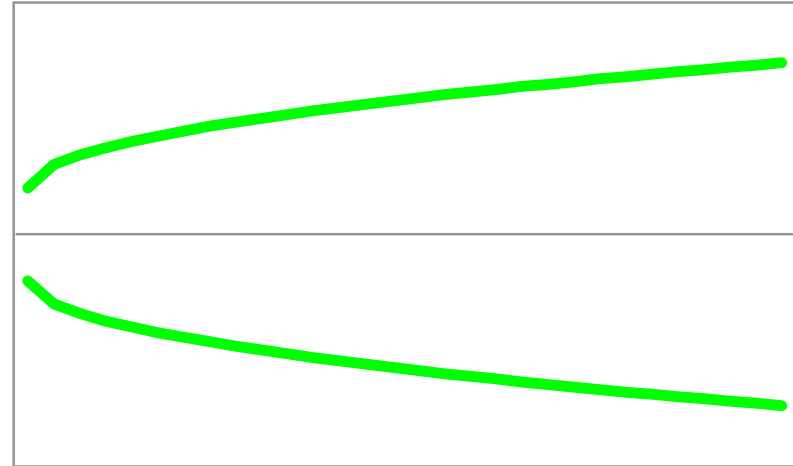
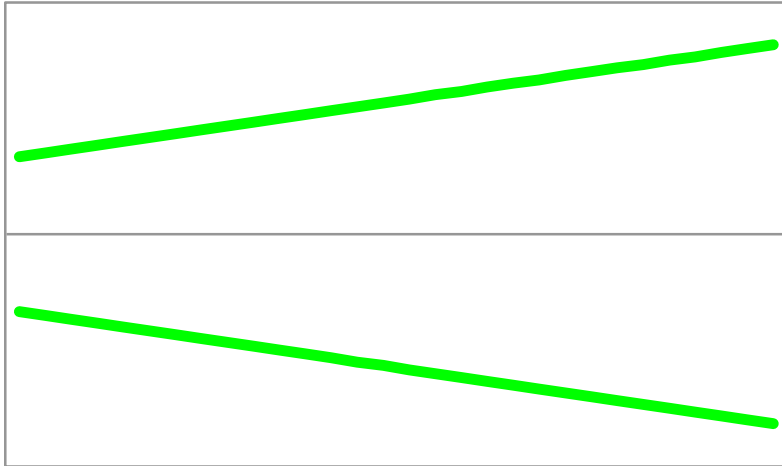
Residuals – example of bimodality



Residuals



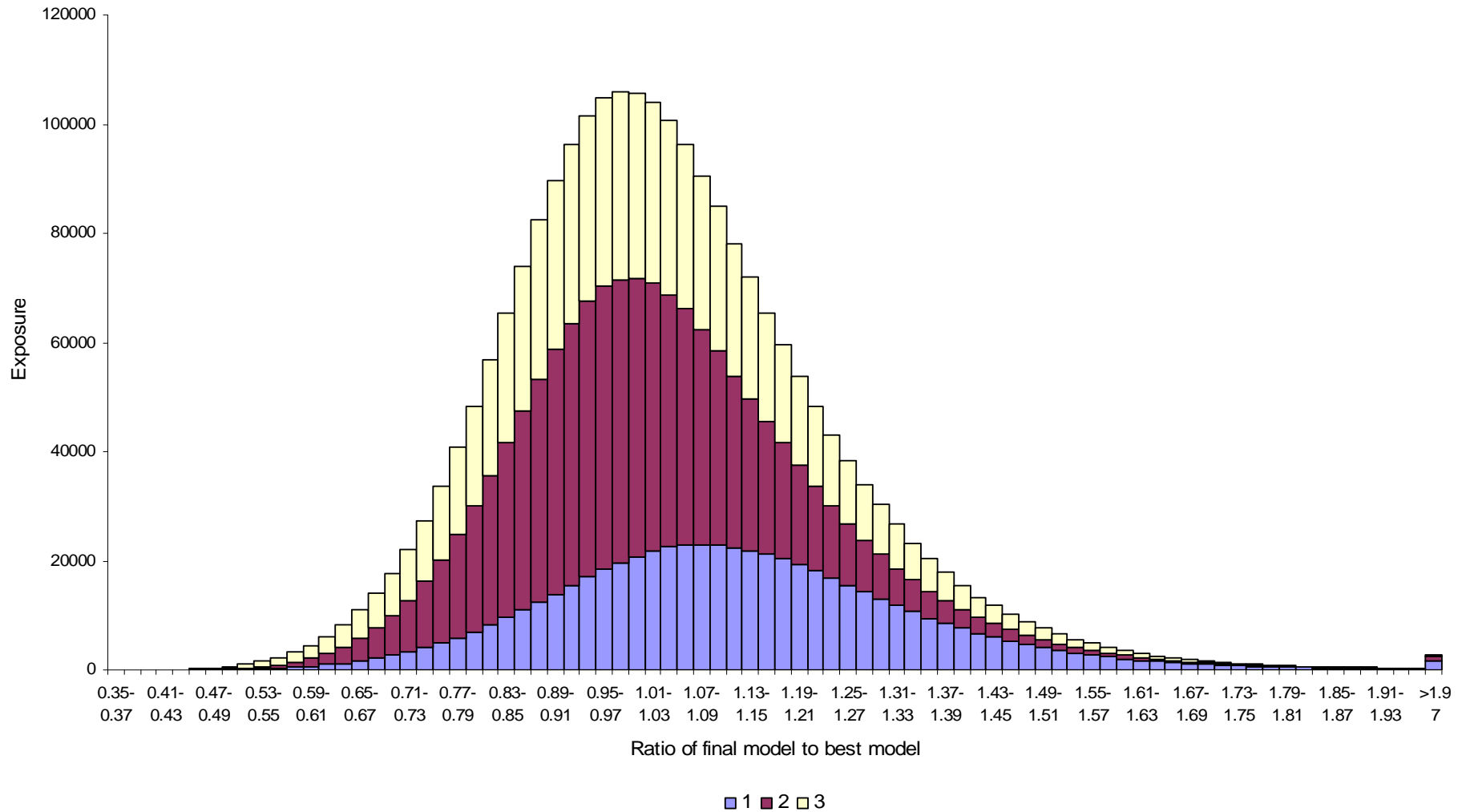
Residuals



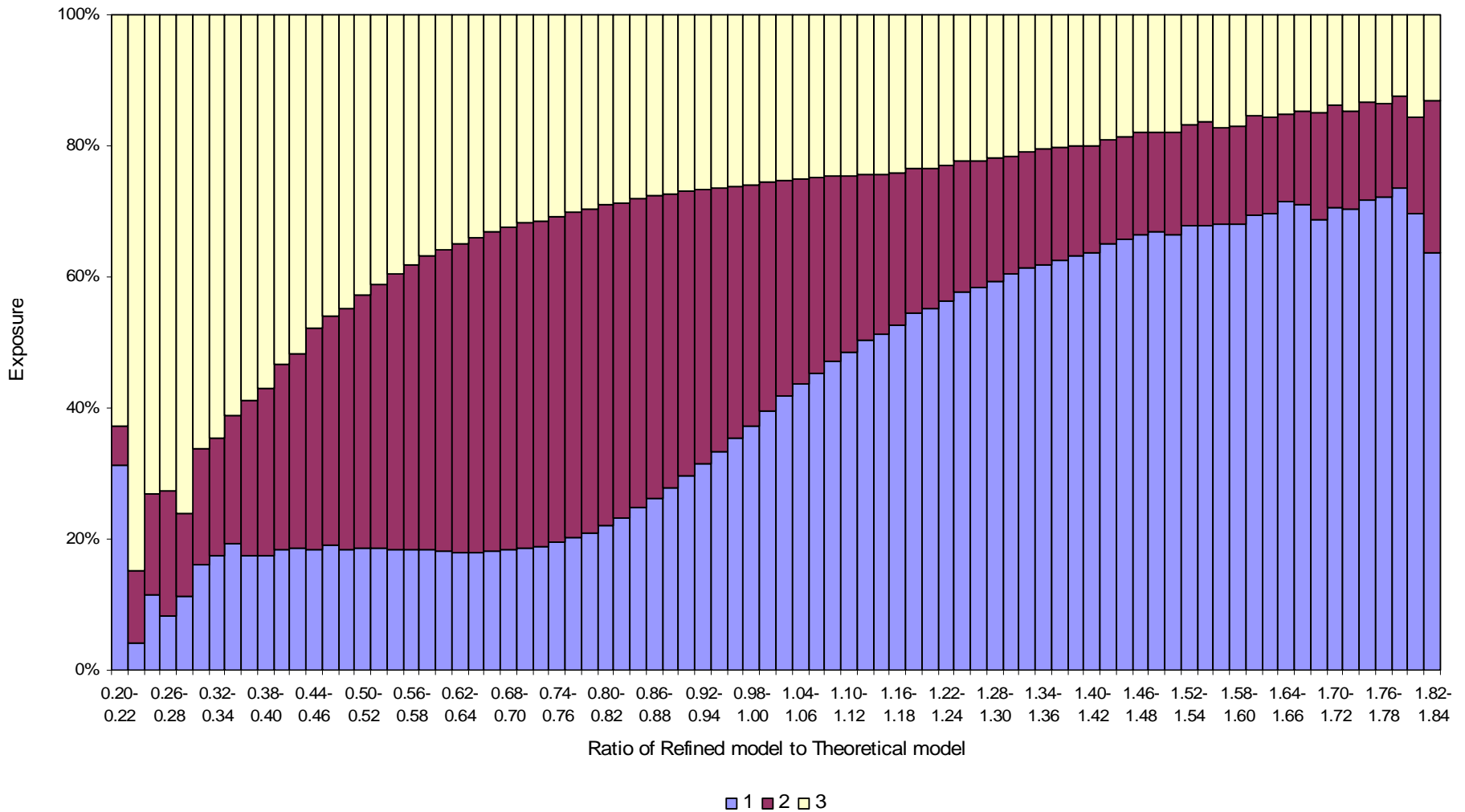
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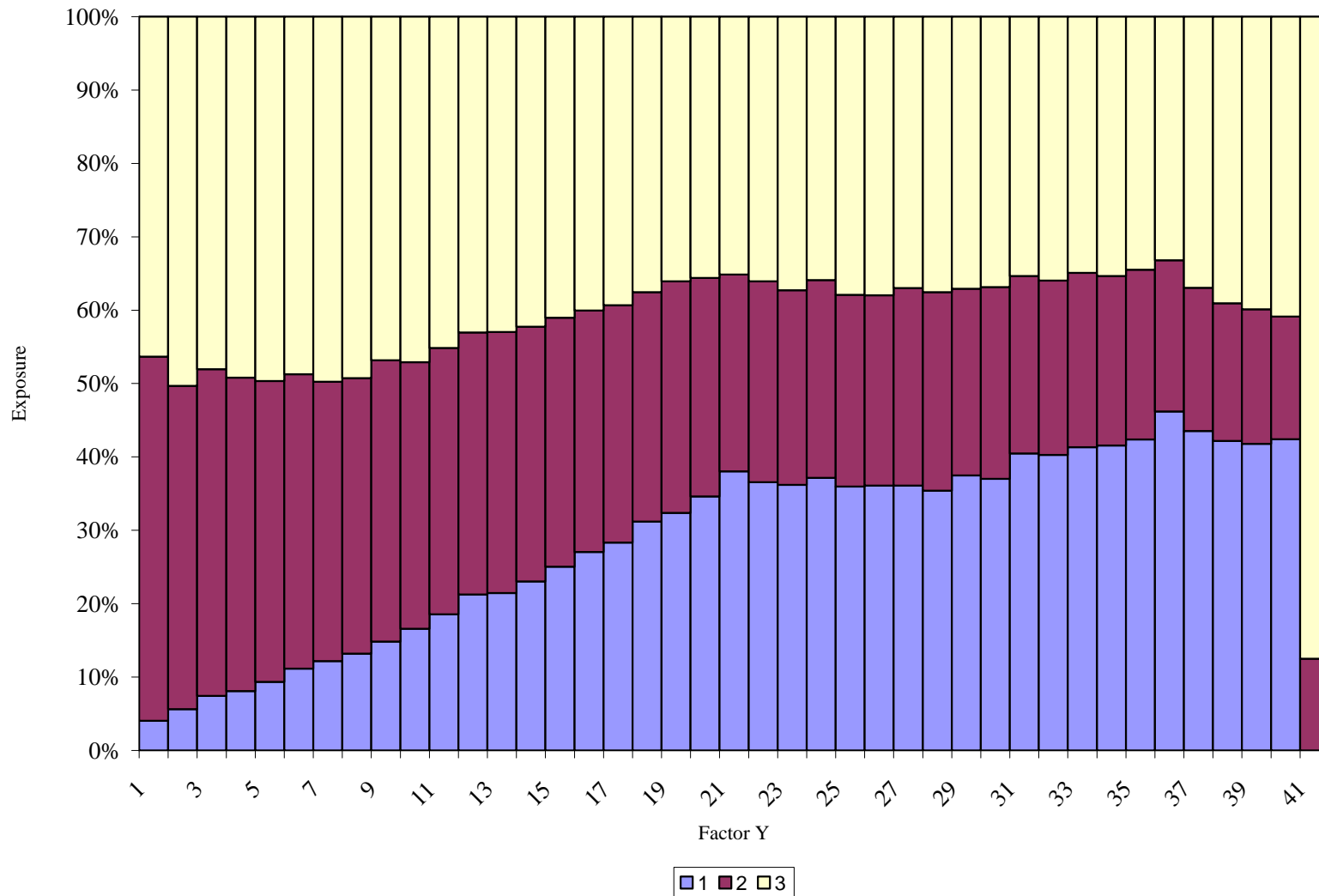
Investigating loss of accuracy



Investigating loss of accuracy



Investigating loss of accuracy



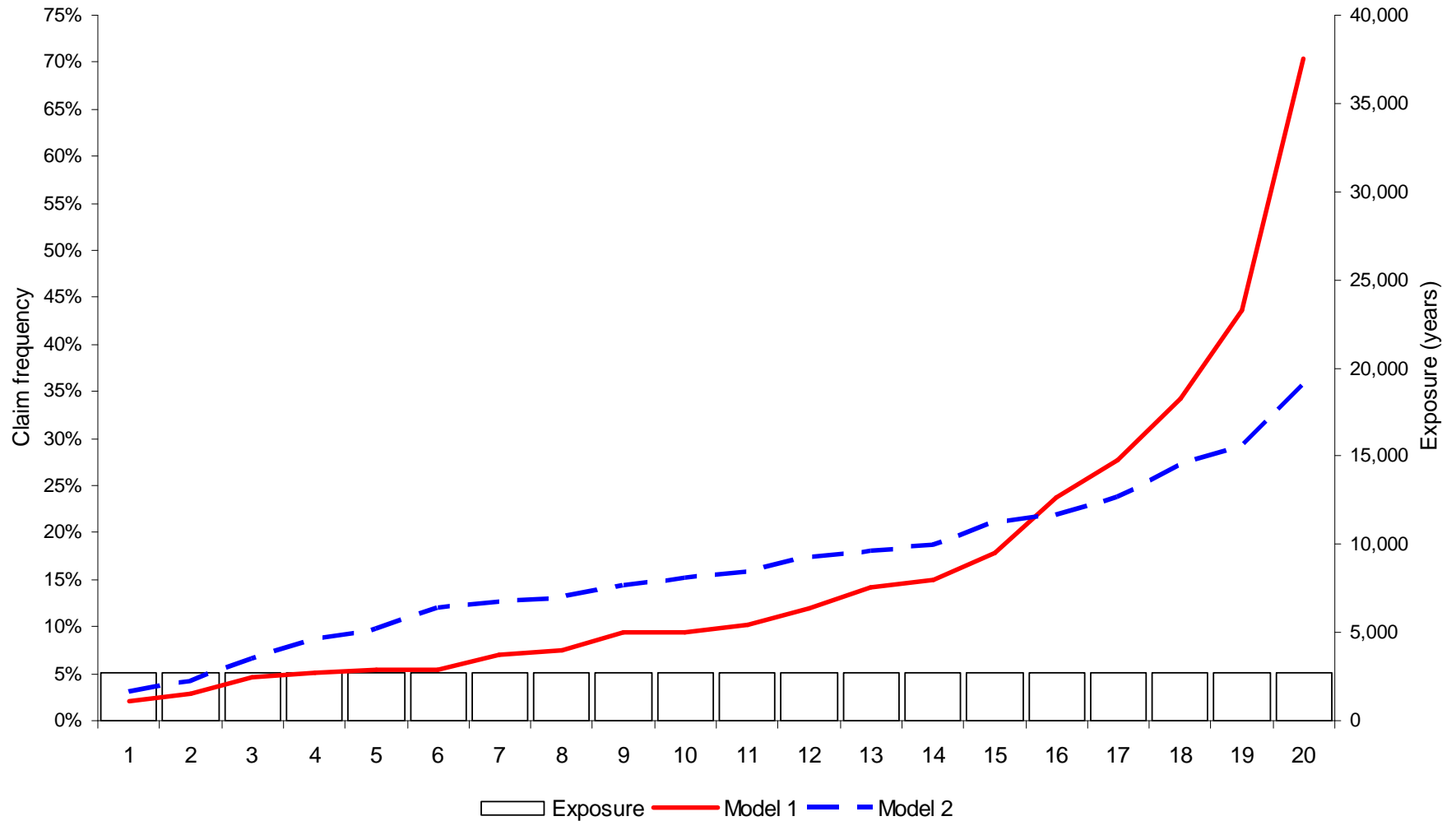
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Model validation



Lift curves

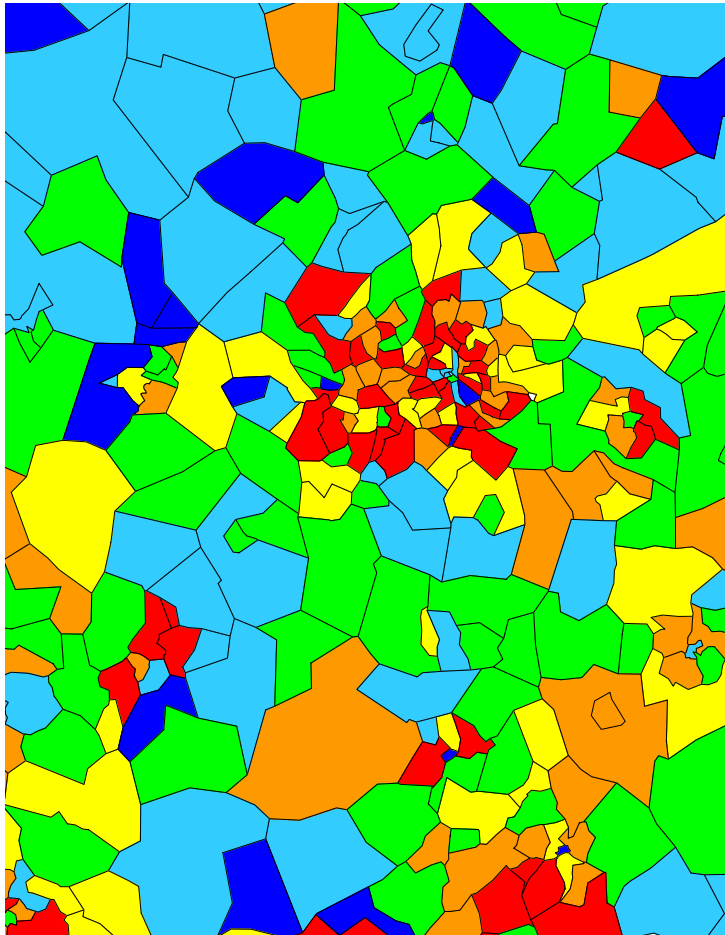


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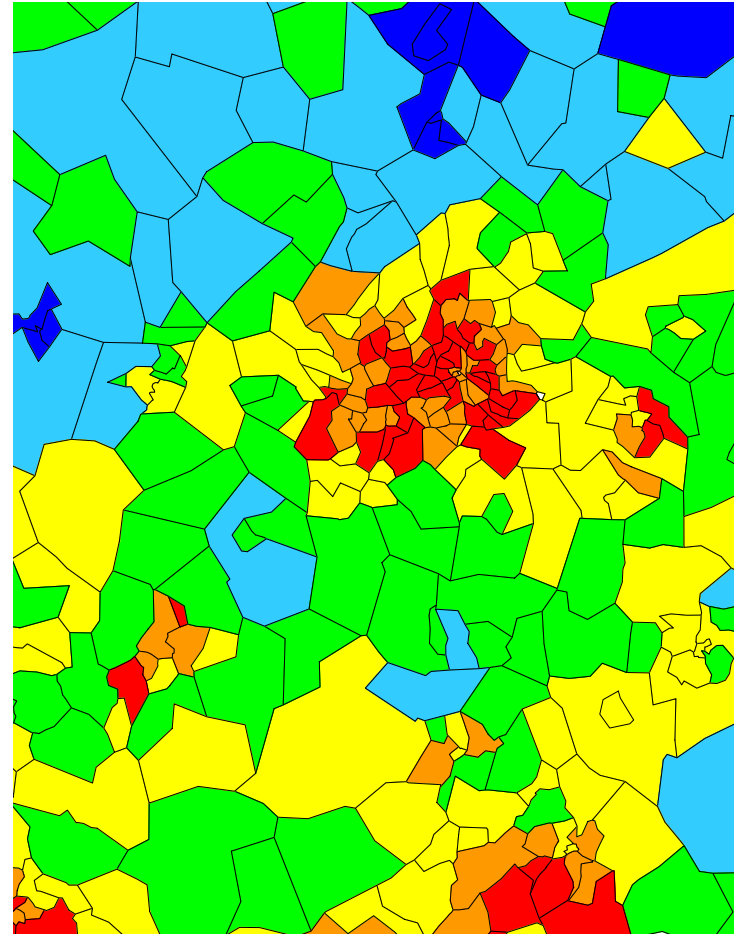
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Example spatial smoothing results

Unsmoothed residuals



Smoothed residuals



Comparing indicated results with existing rates and the market

Theoretically desired change in premium

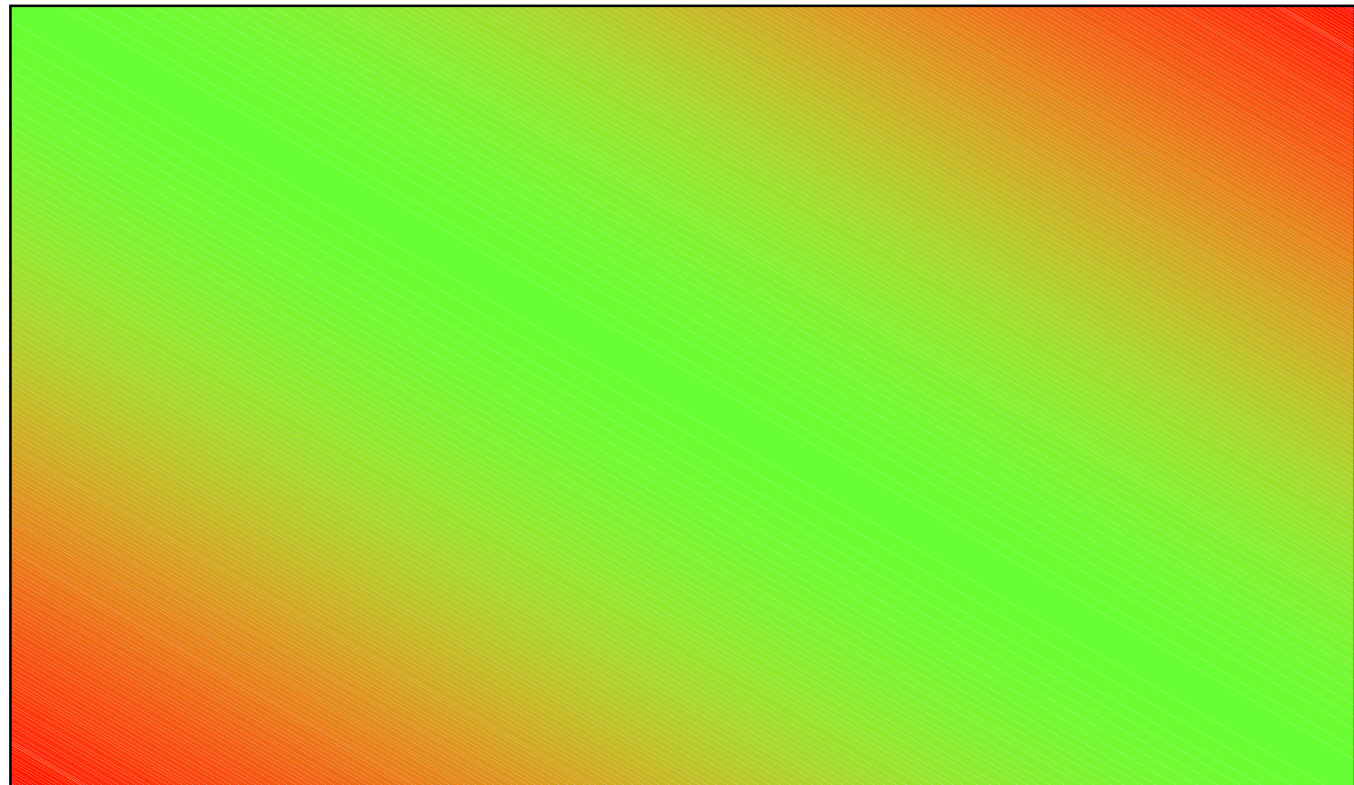
Increase

Decrease

Our premium vs market

Below market

Above market



Comparing indicated results with existing rates and the market

Theoretically desired change in premium

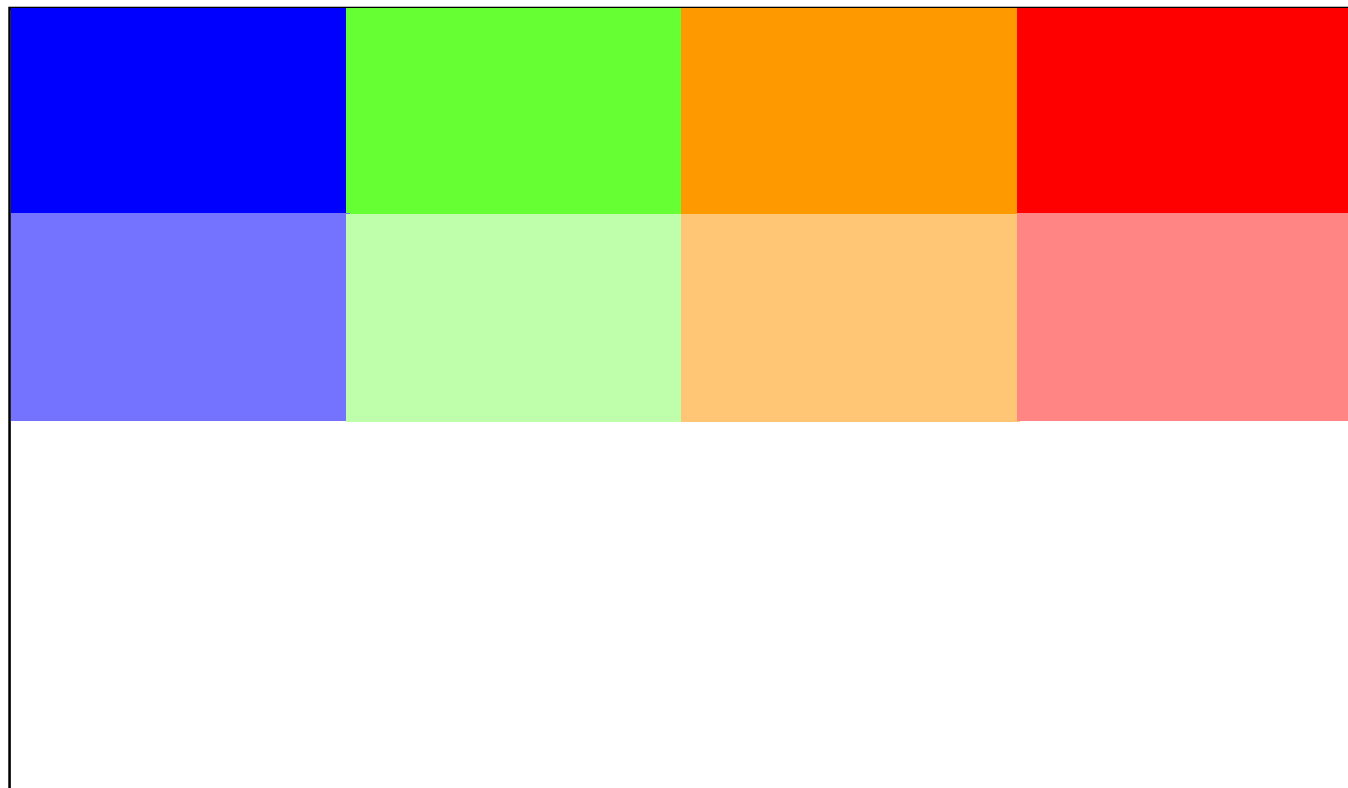
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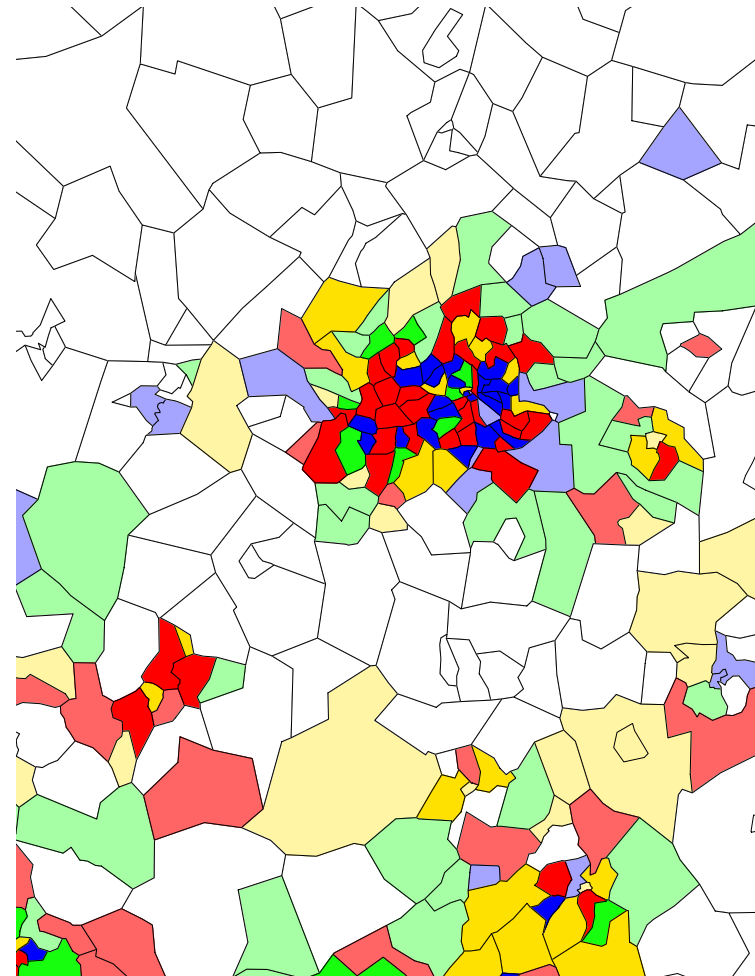
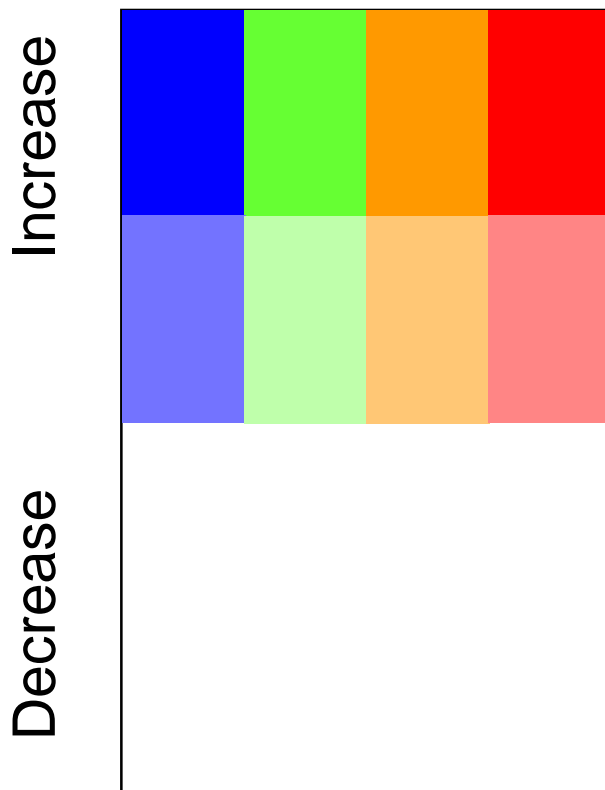


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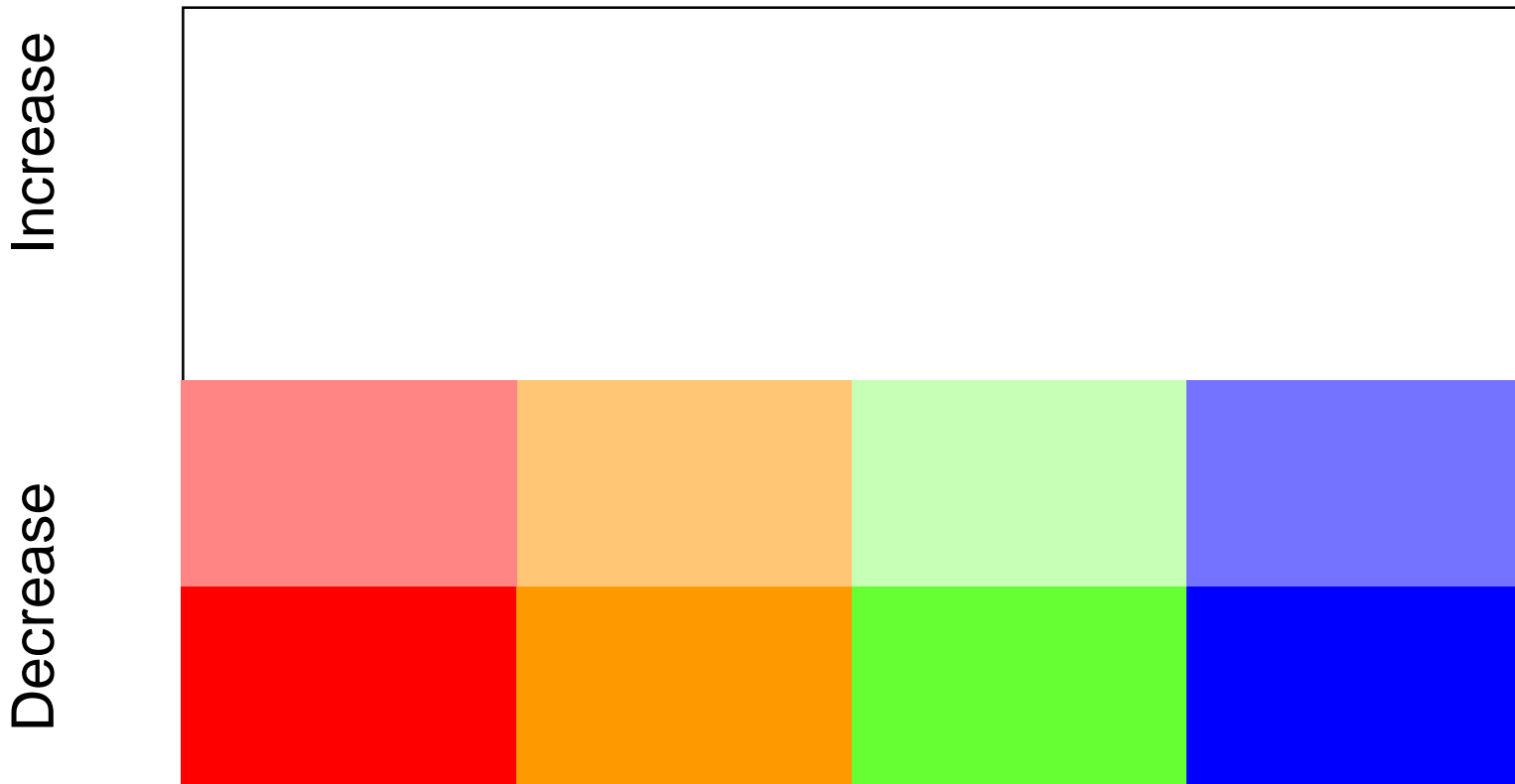
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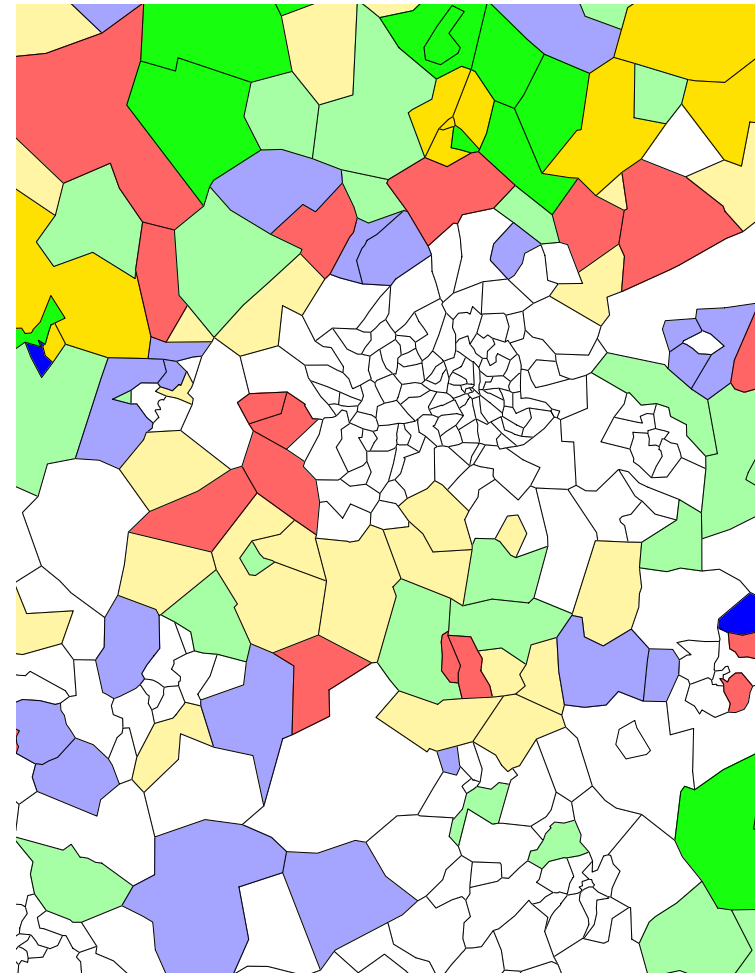
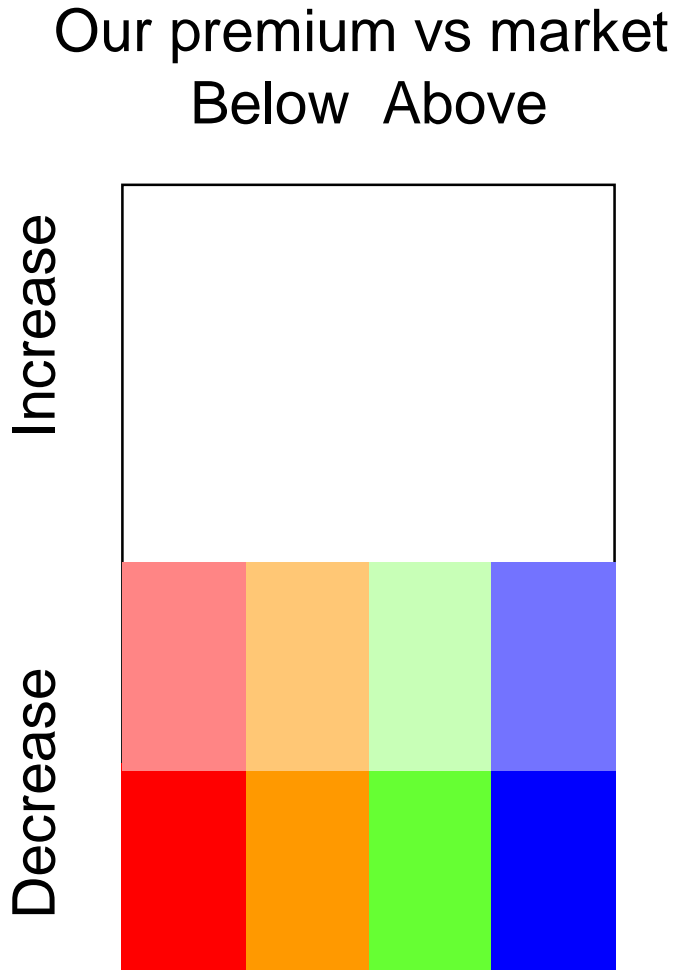
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