watsonwyatt.com

C-6: Communicating Predictive Modeling Results

CAS Predictive Modeling Seminar
San Diego, October 6-7, 2008

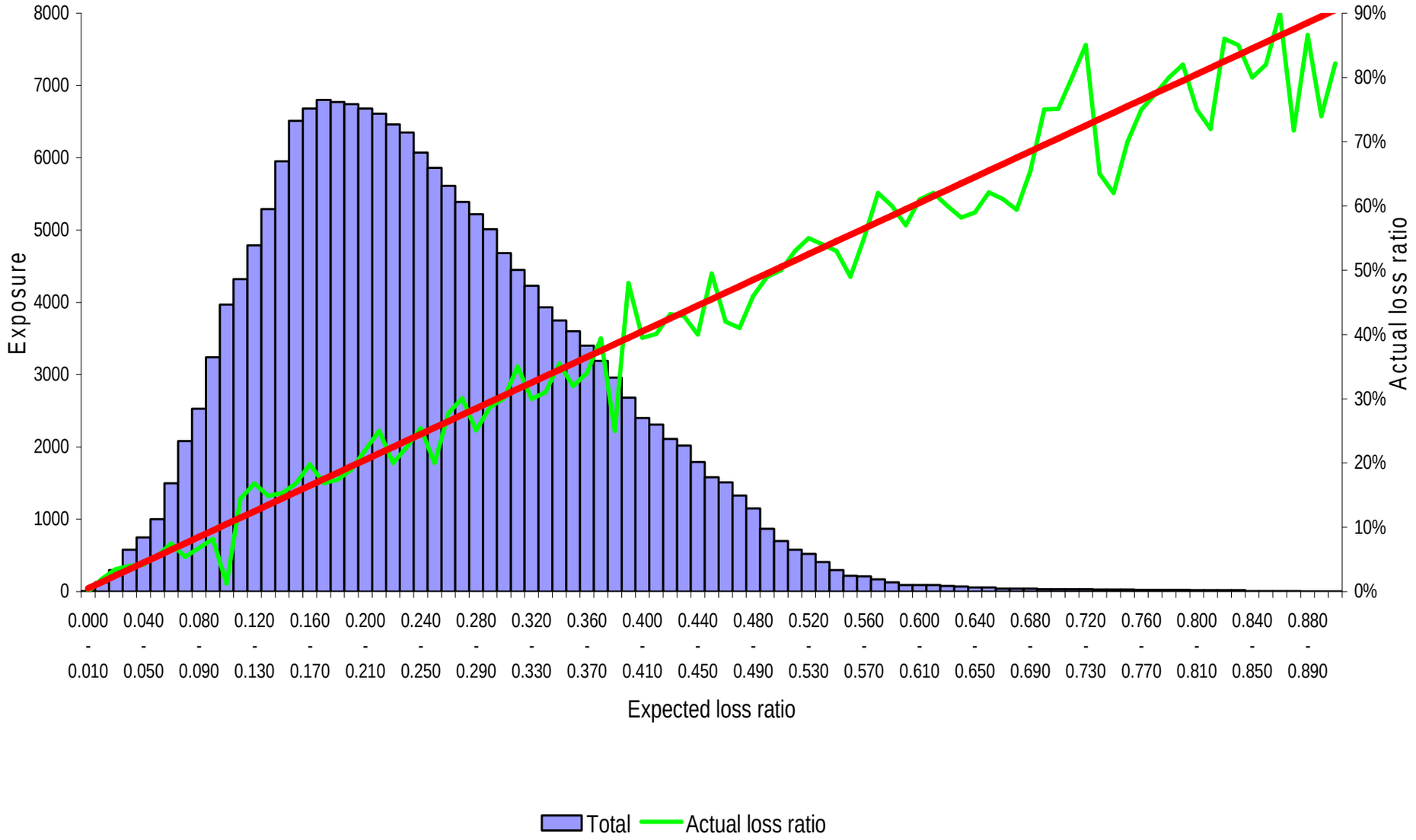
Louis Mak FCAS FIAA
Watson Wyatt Worldwide

Watson Wyatt Worldwide

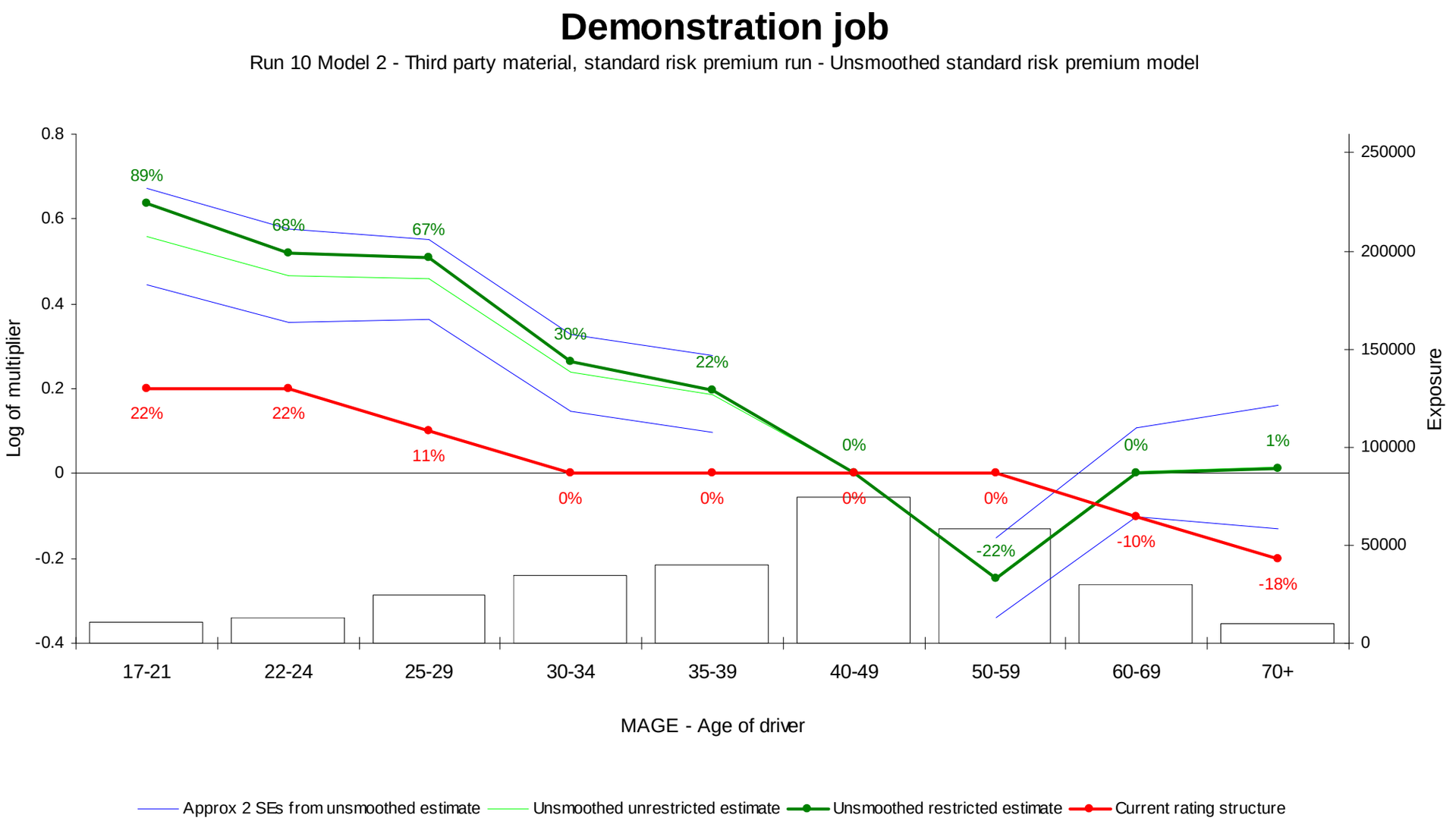
Communicating modeling results visually

- 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



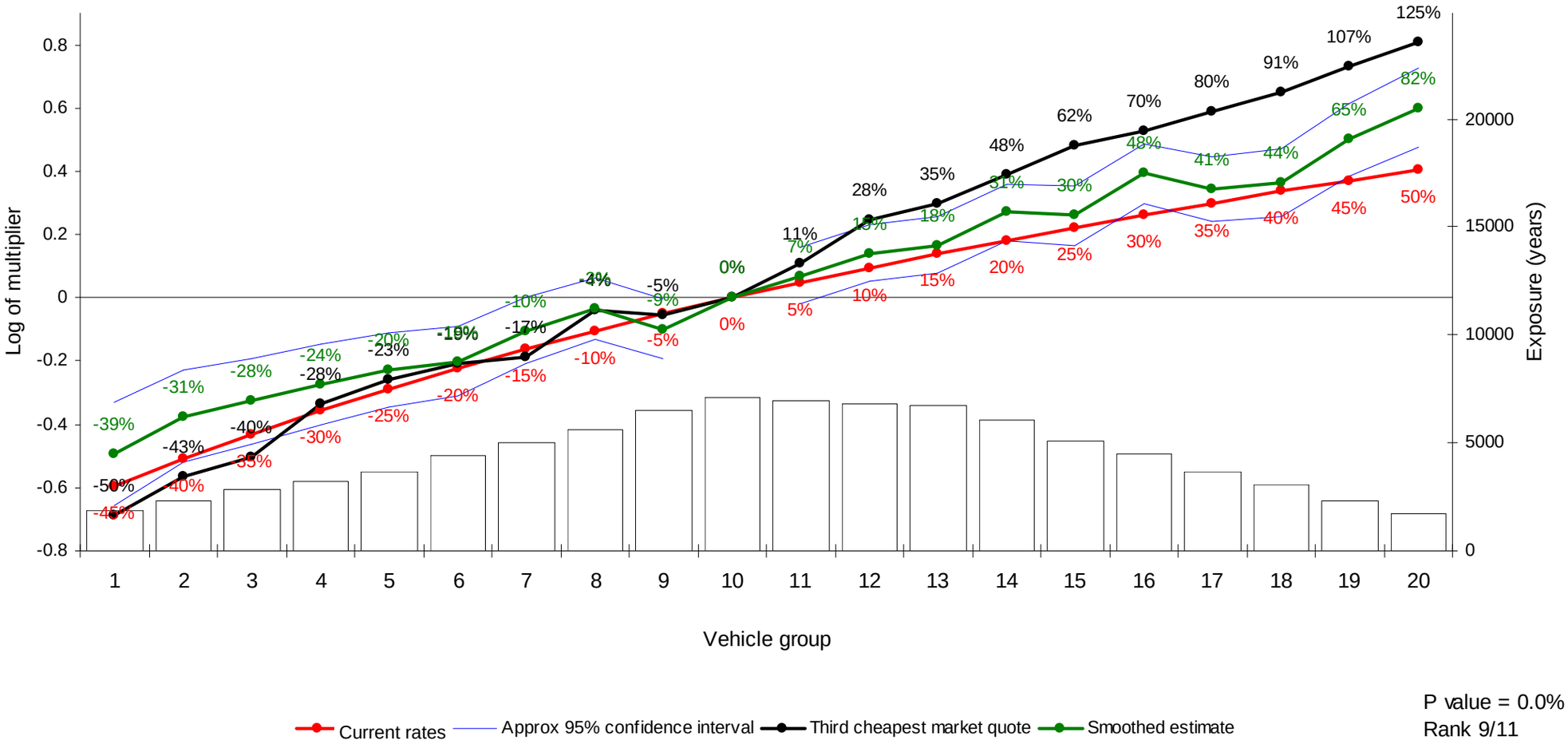
Factor effect analysis



Considering current rates and the competitive position

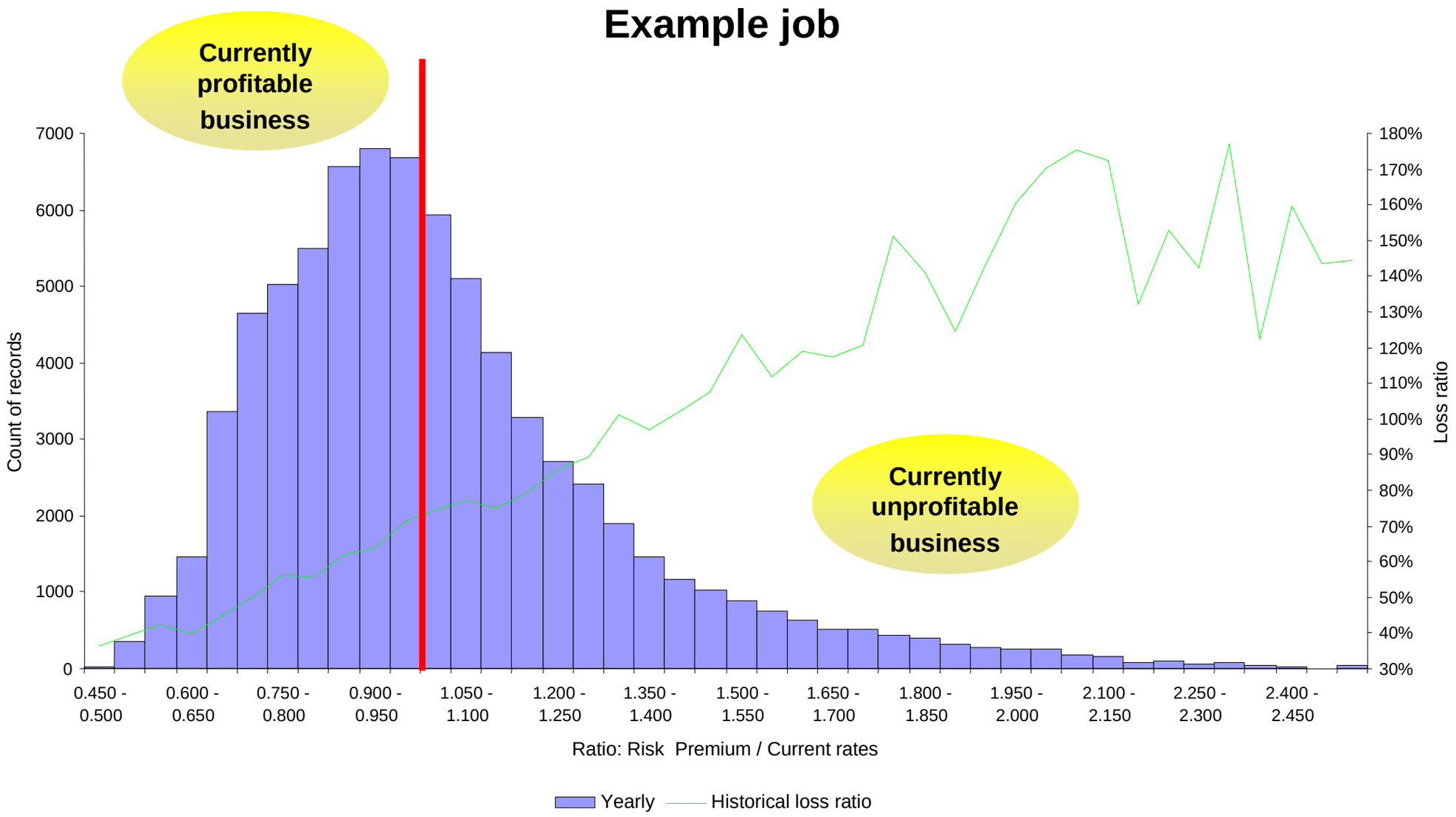
Example of competitor analysis

Third party cover

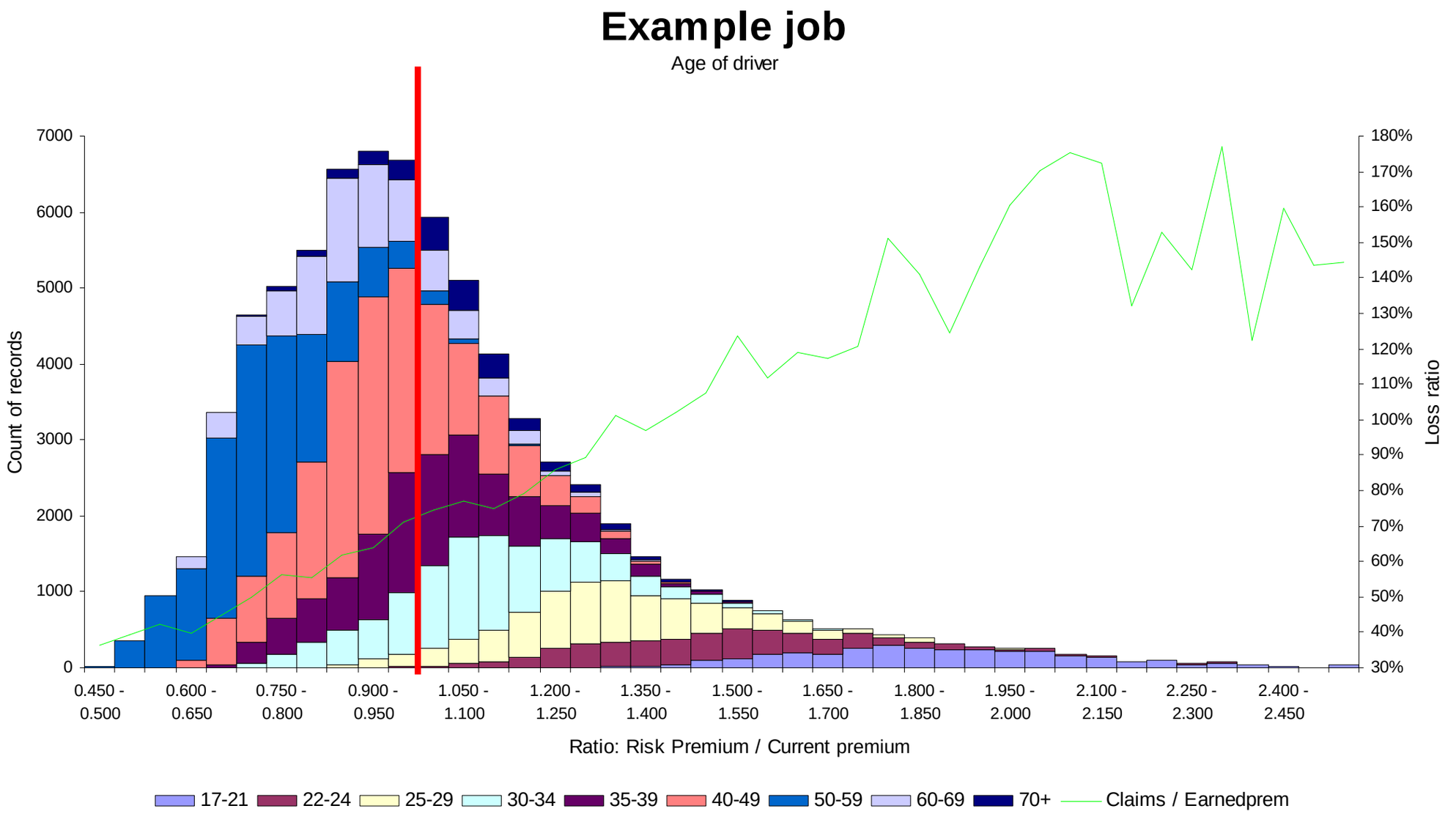


P value = 0.0%
Rank 9/11

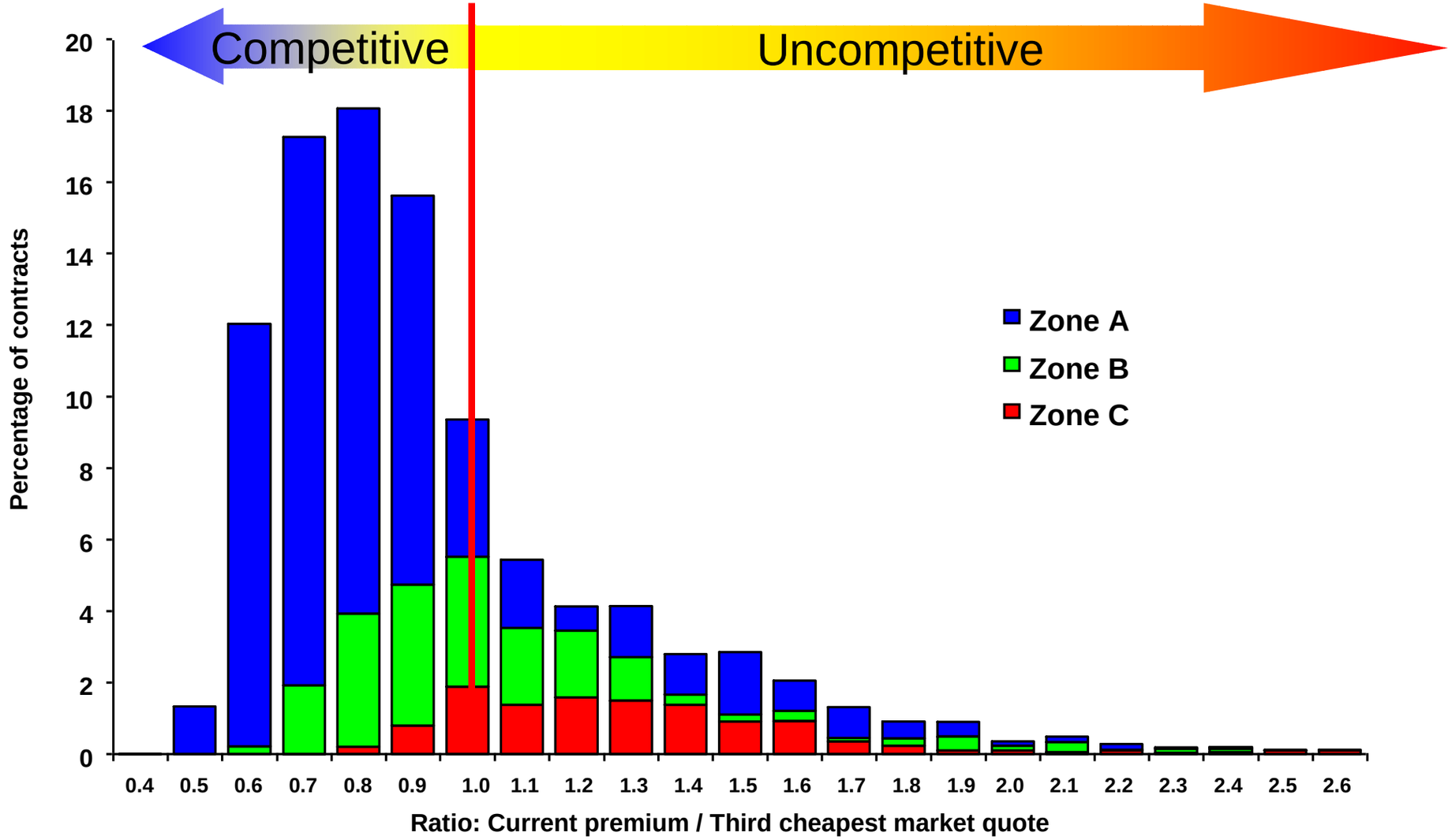
Impact analysis



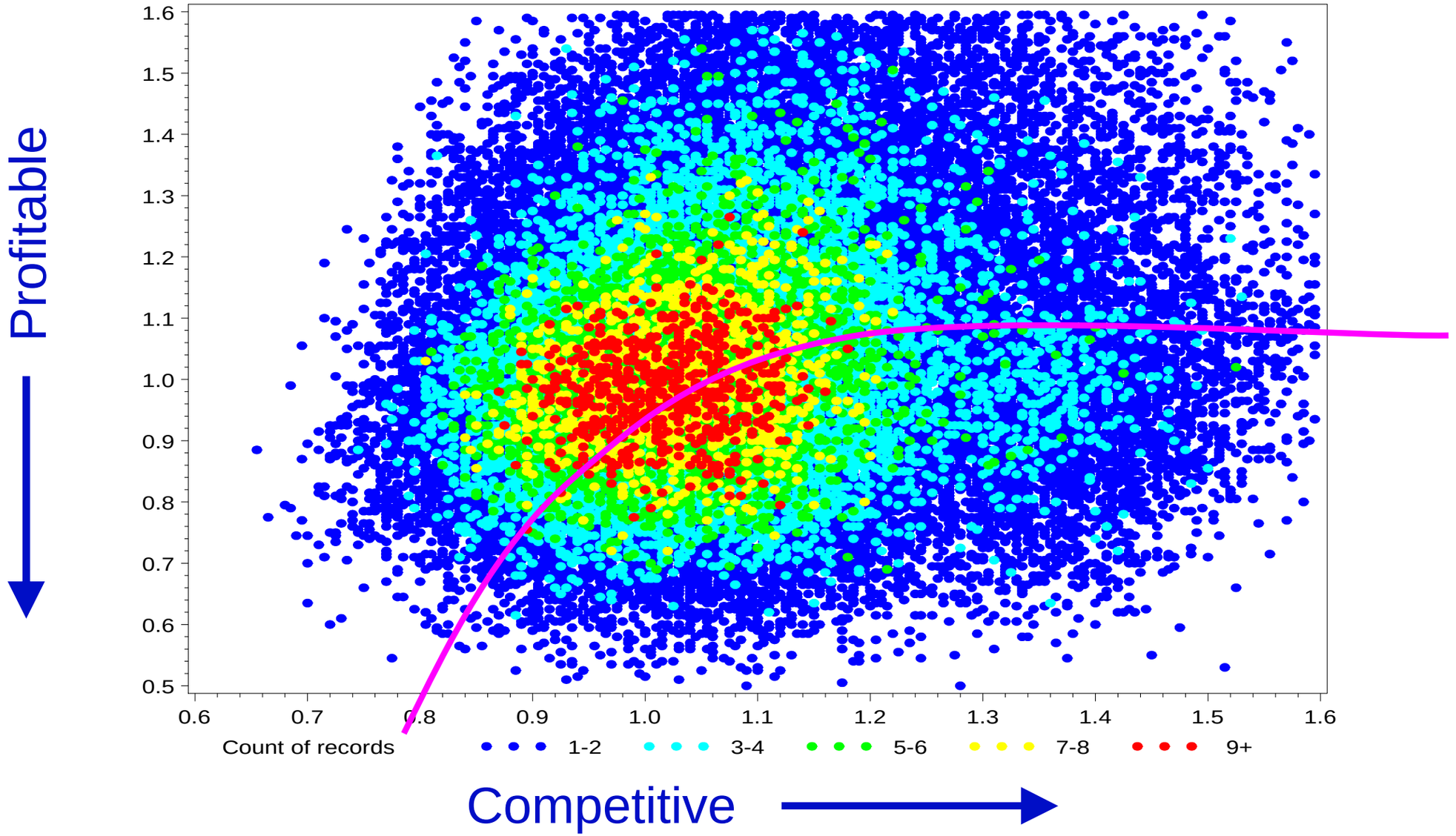
Impact analysis



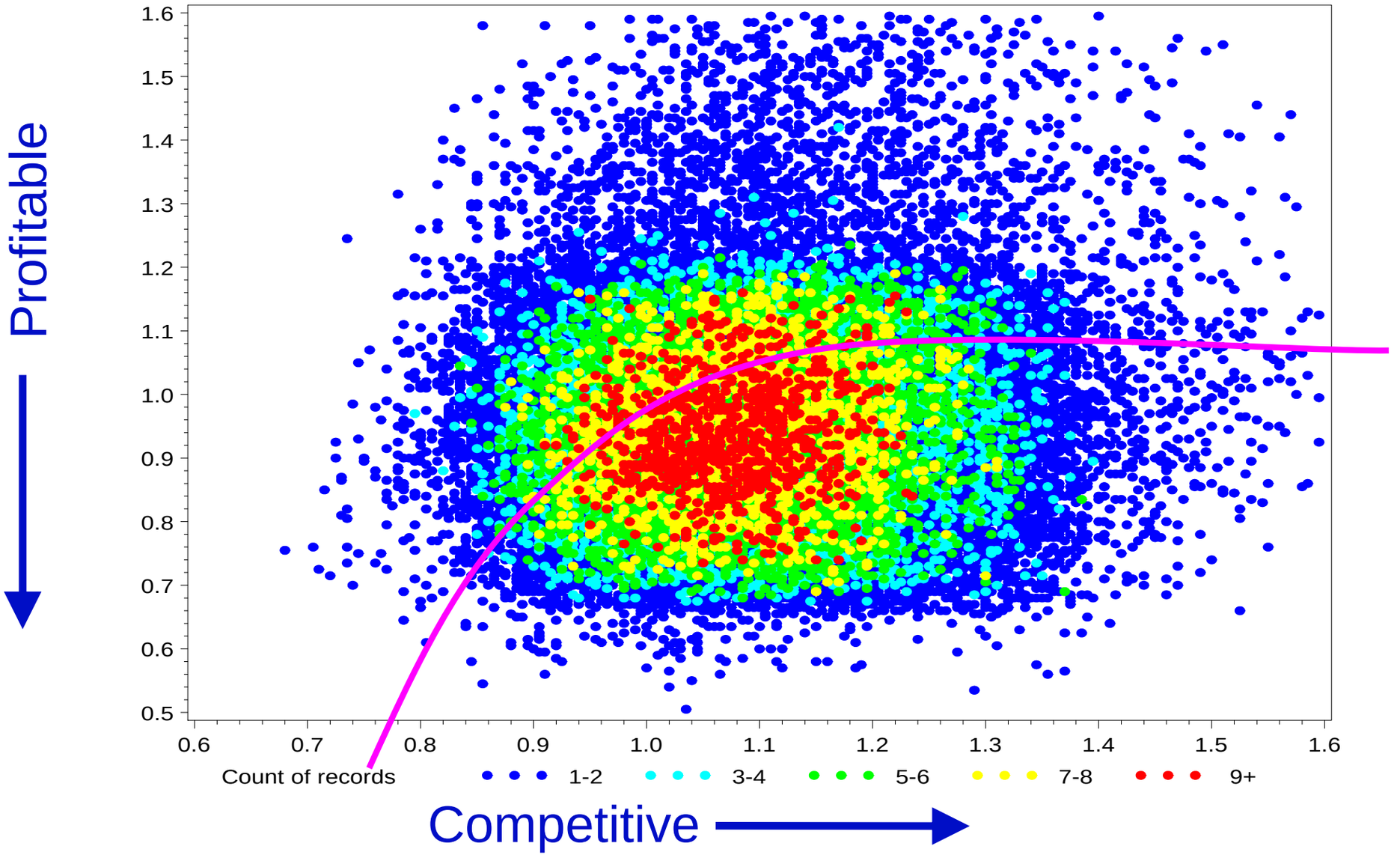
Comparison with competitors



Moving toward competitive / profitable (Before)



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

- Data Cleaning
- Portfolio analysis
- Deviance tests vs graphical results
- Consistency with time
- Interactions (deciding which to test & detecting significance)
- Residual diagnostics and leverage
- Testing the effectiveness of restrictions
- Validating models
- Maps
- Monitoring

Technical stories

- Data Cleaning
- Portfolio analysis
- Deviance tests vs graphical results
- Consistency with time
- Interactions (deciding which to test & detecting significance)
- Residual diagnostics and leverage
- Testing the effectiveness of restrictions
- Validating models
- Maps
- Monitoring

One way table

- Check data reasonable
- See obvious features
- Allows consideration of factor mapping

Level	Number of records	Exposure	Premium	Number of claims	Incurred claims	Claim frequency	Average cost per claim	Pure premium	Loss ratio
02	89	317	181,270	9	7,586	2.8%	843	24	4.2%
04	124	409	256,502	29	23,671	7.1%	816	58	9.2%
05	2,186	8,772	5,076,035	381	229,390	4.3%	602	26	4.5%
06	4	17	22,886	2	764	11.5%	382	44	3.3%
07	2,883	11,451	8,101,723	560	380,803	4.9%	680	33	4.7%
08	9,420	36,571	37,021,314	2,310	1,652,938	6.3%	716	45	4.5%
09	12,852	49,515	50,639,518	3,030	2,098,998	6.1%	693	42	4.1%
10	16,758	64,407	73,509,639	4,401	3,114,671	6.8%	708	48	4.2%
11	13,702	53,372	63,136,308	3,608	2,602,046	6.8%	721	49	4.1%
12	10,302	40,512	51,408,113	2,715	1,928,351	6.7%	710	48	3.8%
13	5,682	22,108	28,594,451	1,658	1,177,545	7.5%	710	53	4.1%
14	1,829	6,990	11,039,929	466	336,051	6.7%	721	48	3.0%
15	480	1,797	3,091,657	119	81,852	6.6%	688	46	2.6%
16	195	744	1,387,007	73	54,593	9.8%	748	73	3.9%
	76,506	**296,980**	**333,466,350**	**19,361**	**13,689,260**	**6.5%**	**707**	**46.09**	**4.1%**

Data Problem Identification / Cleaning

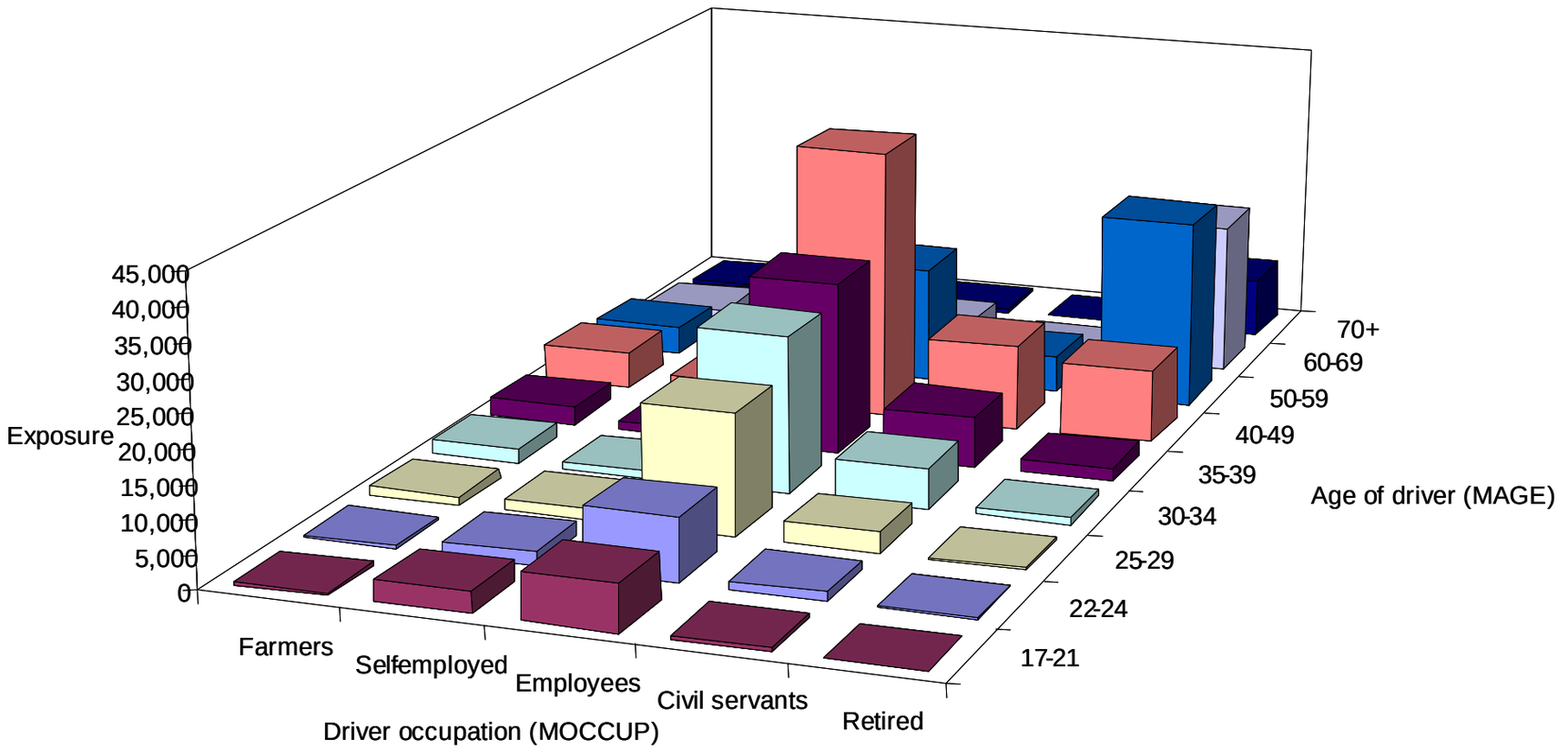
Data exception report
Record count = 150100

Variable	Missing (Claim fields)	Missing (Other)	Negative (Claim fields)	Negative (Other)	Zero	Numbers > 0 and Incurred = 0	Incurred ^= 0 and Numbers = 0	Exposure = 0 and Numbers > 0	-1 < Incurred < 1 and Numbers > 0
Numad	0		0		144541	0			
Numtppd	0		0		131884	21			
Numtpbi	0		0		143404	0			
Incad	0		0		144541		0		0
Inctppd	0		0		131905		0		33
Inctpbi	0		0		143404		0		71
Expy	0		22		57			0	
Expyad	0		7		73005			0	
Eprem	0		22		57				
Epremad	0		7		73005				

Pretium 20/02/2008 16:18

Two way analyses

- Hint where interactions may lie



Correlation

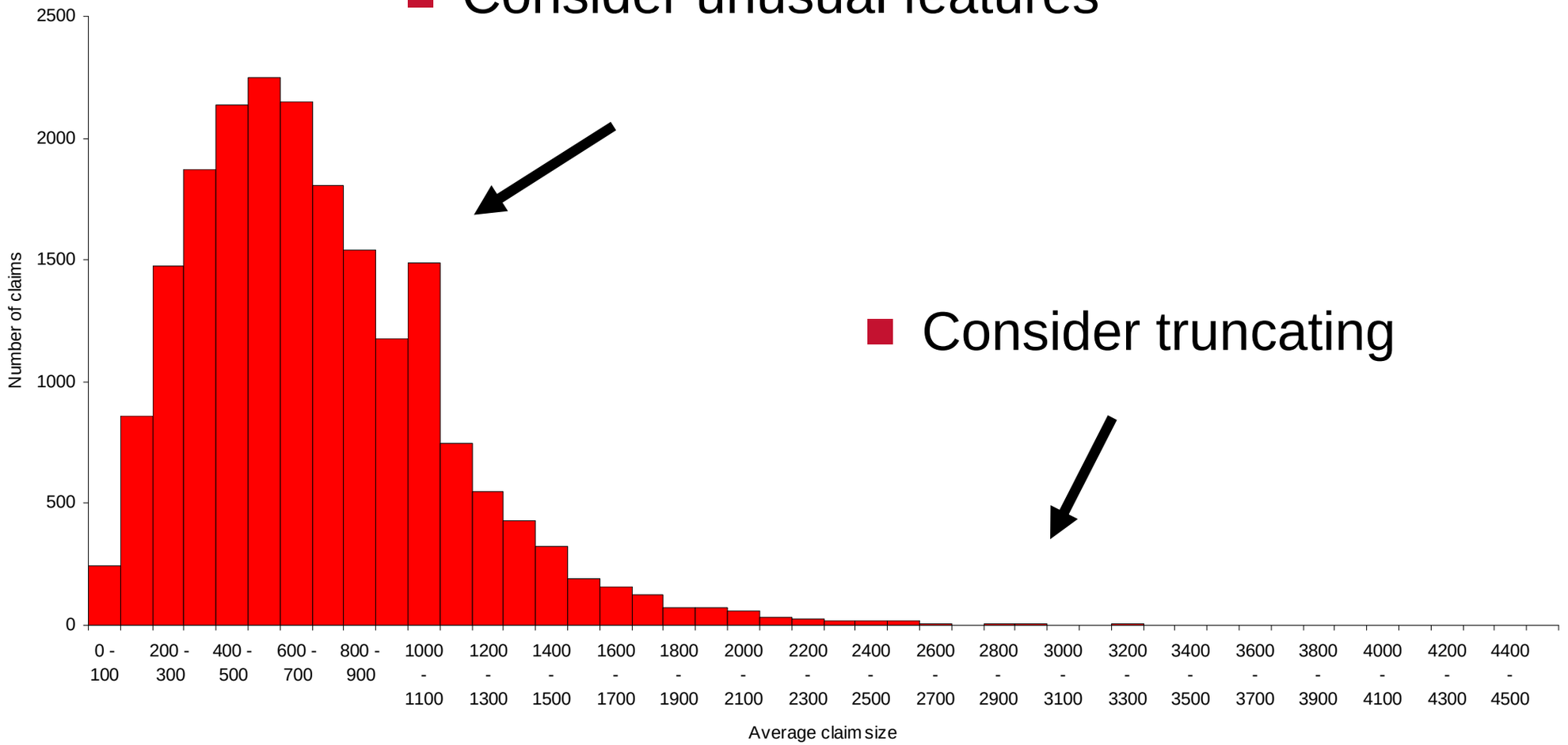
- Identified key correlations
- Not used directly, but helps with interpretation later

Cramer's V

	Age of driver	Area of garage	Calendar year	Class of vehicle	Type of fuel	Group of vehicle	Married driver	No claim discount	Driver occupn	Payment freq	No of secndry drivers	Sex of driver
Age of driver												
Area of garage	3%											
Calendar year	1%	1%										
Class of vehicle	6%	2%	1%									
Type of fuel	10%	4%	1%	**39%**								
Group of vehicle	6%	2%	1%	**51%**	**46%**							
Married driver	**32%**	3%	1%	3%	1%	4%						
No claim discount	**28%**	5%	2%	6%	6%	6%	**23%**					
Driver occupn	**35%**	7%	1%	5%	13%	6%	18%	**19%**				
Payment freq	**26%**	10%	1%	6%	5%	8%	12%	**30%**	**22%**			
No of secndry drivers	12%	3%	1%	6%	2%	7%	2%	8%	8%	2%		
Sex of driver	**22%**	4%	0%	16%	11%	**19%**	2%	6%	16%	3%	6%	
Age of vehicle	4%	2%	1%	10%	**27%**	16%	3%	4%	5%	5%	2%	4%

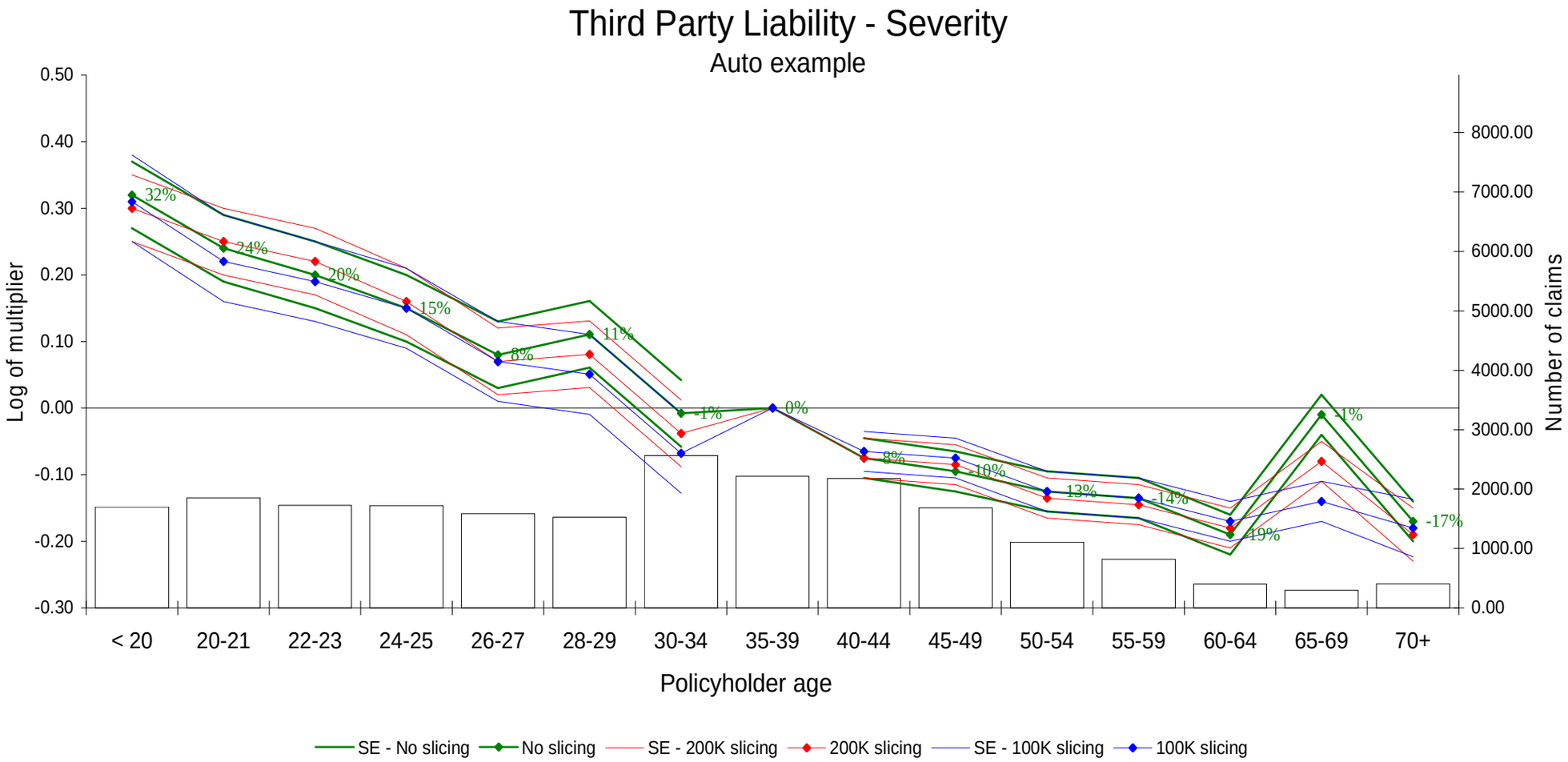
Claim size distribution analysis

- Consider unusual features



- Consider truncating

Large loss sensitivity testing



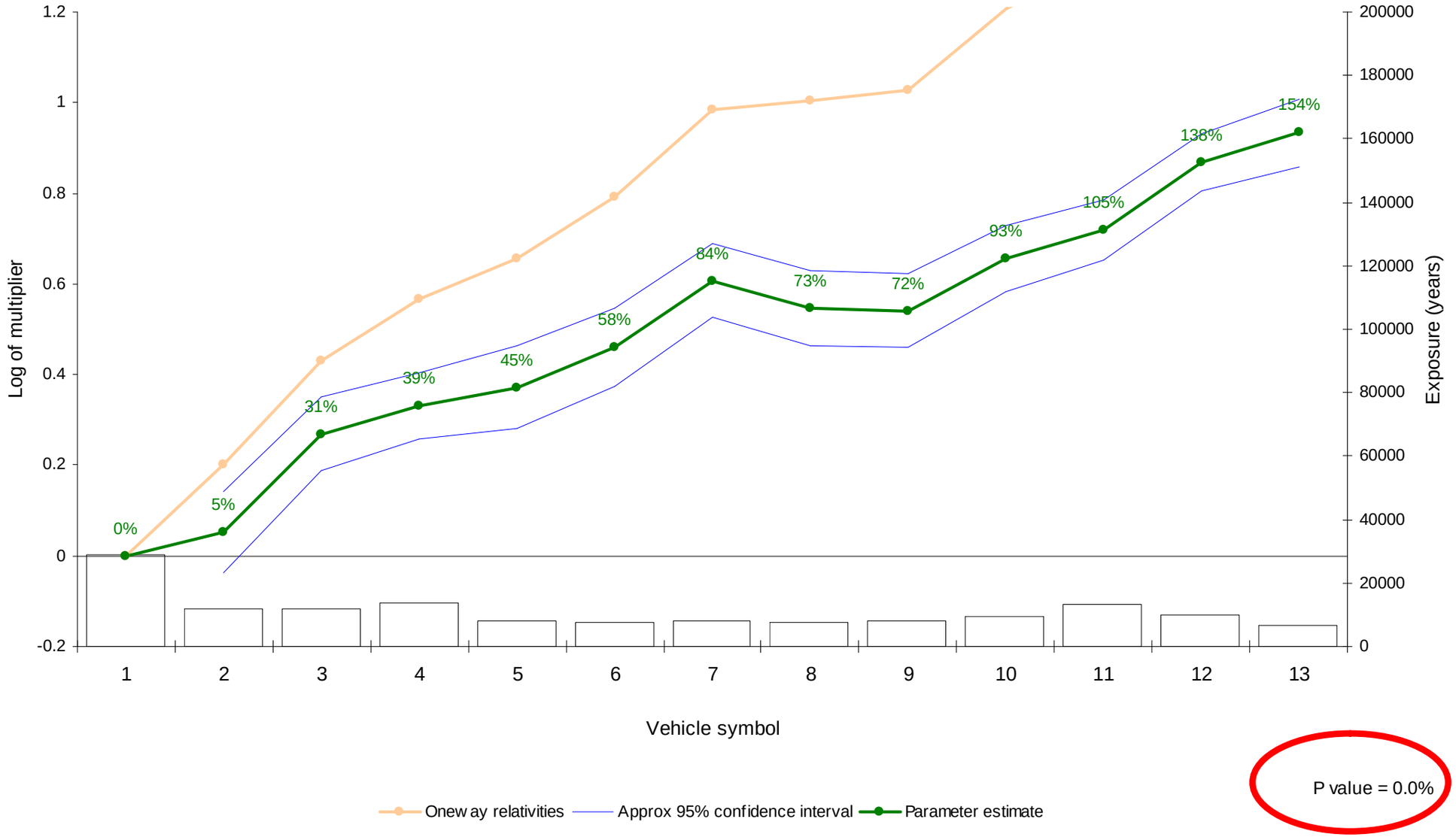
Technical stories

- Data Cleaning
- Portfolio analysis
- Deviance tests vs graphical results
- Consistency with time
- Interactions (deciding which to test & detecting significance)
- Residual diagnostics and leverage
- Testing the effectiveness of restrictions
- Validating models
- Maps
- Monitoring

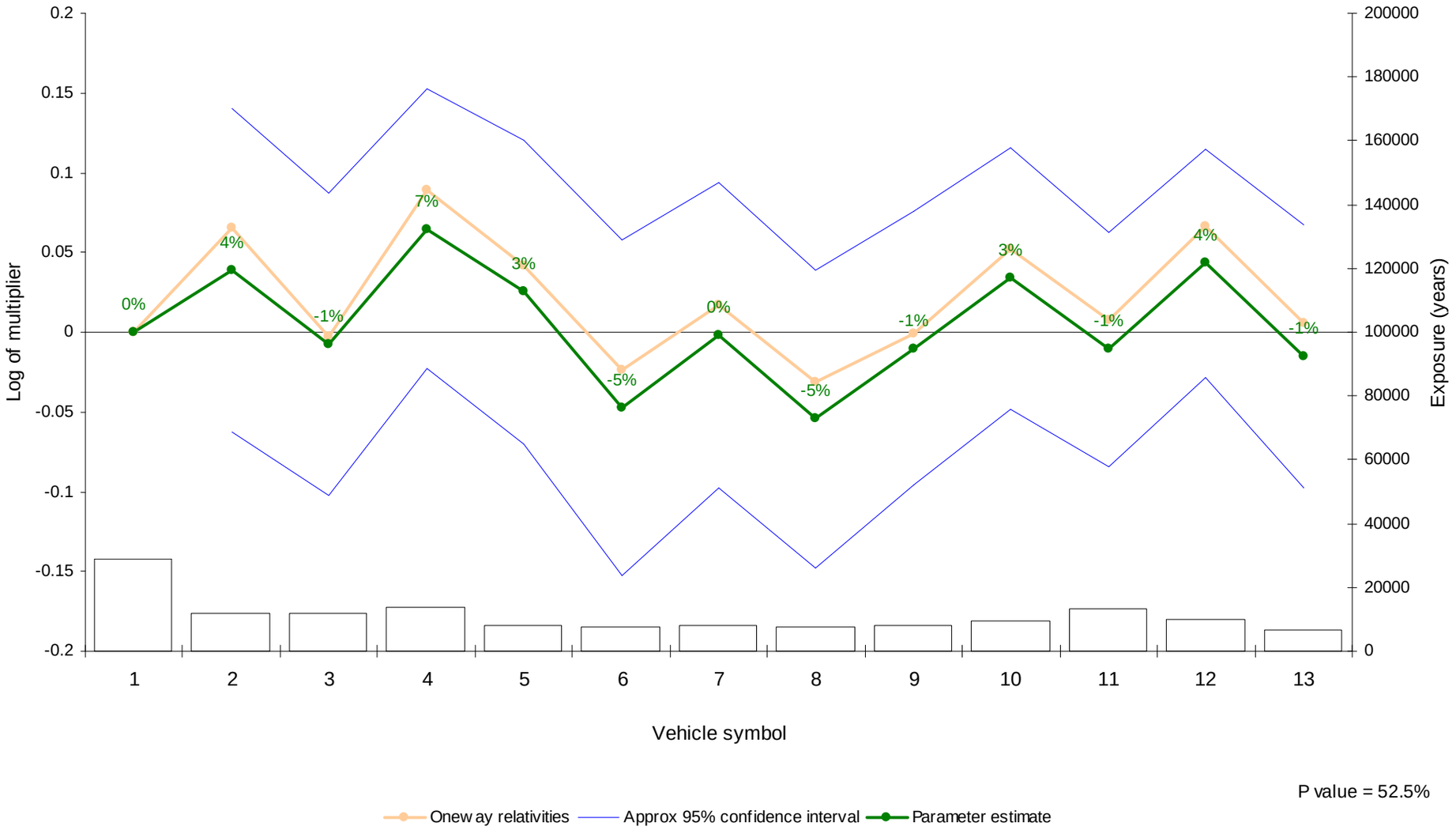
Deviance tests

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

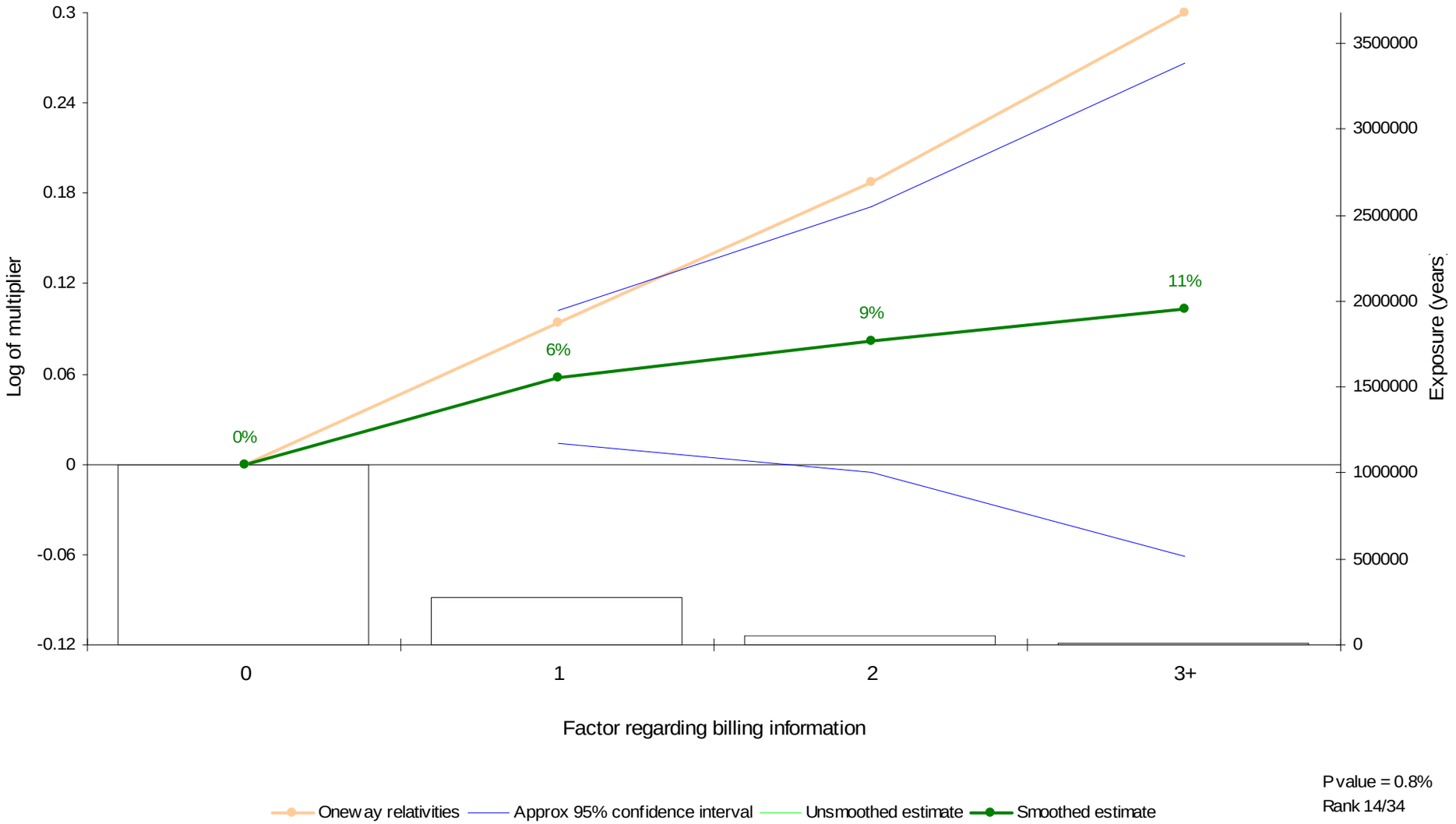
GLM output (significant factor)



GLM output (insignificant factor)

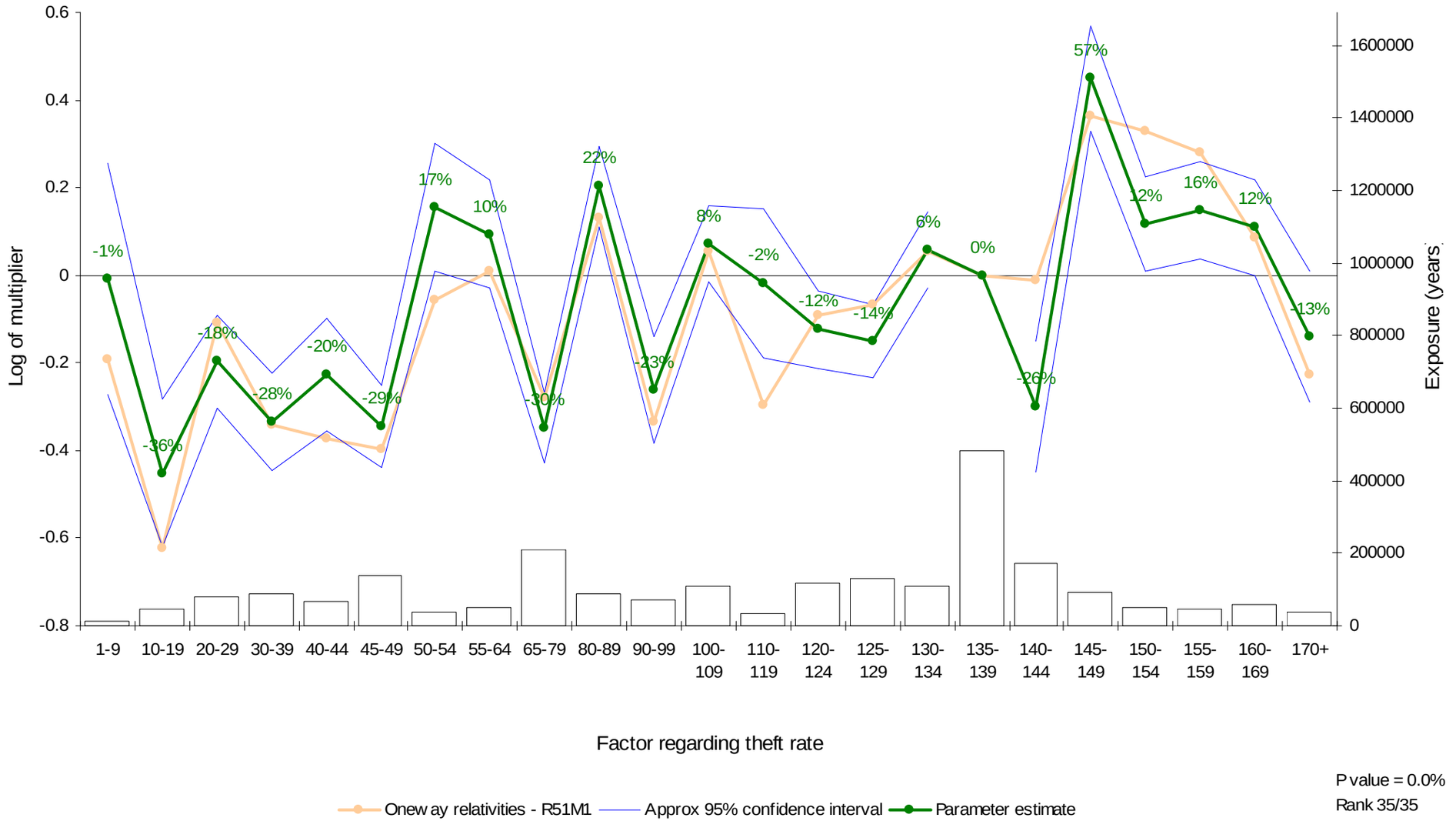


Deviance tests vs graphical results



P value = 0.8%
Rank 14/34

Deviance tests vs graphical results



P value = 0.0%
Rank 35/35

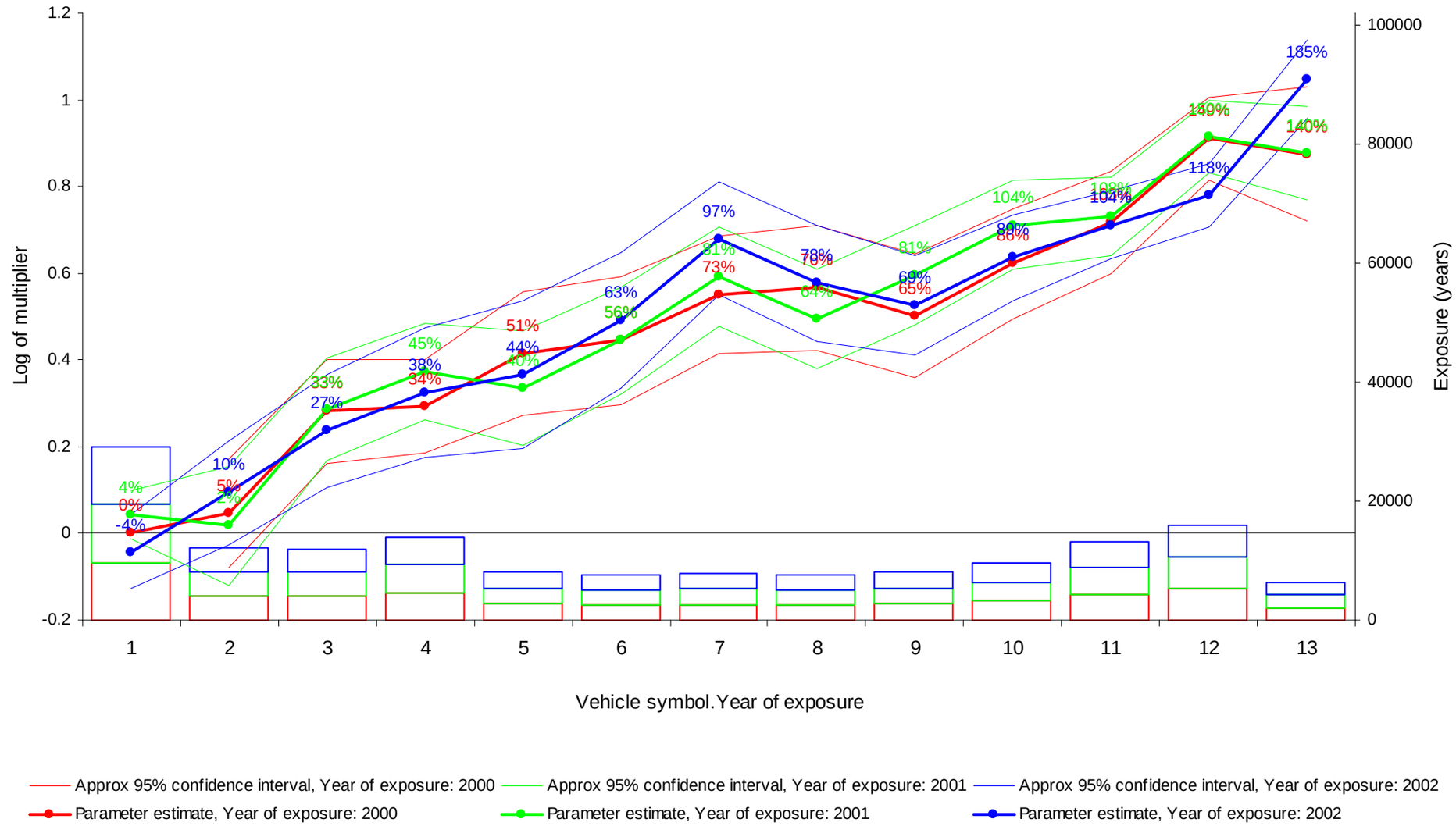
Deviance tests vs graphical results

- 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

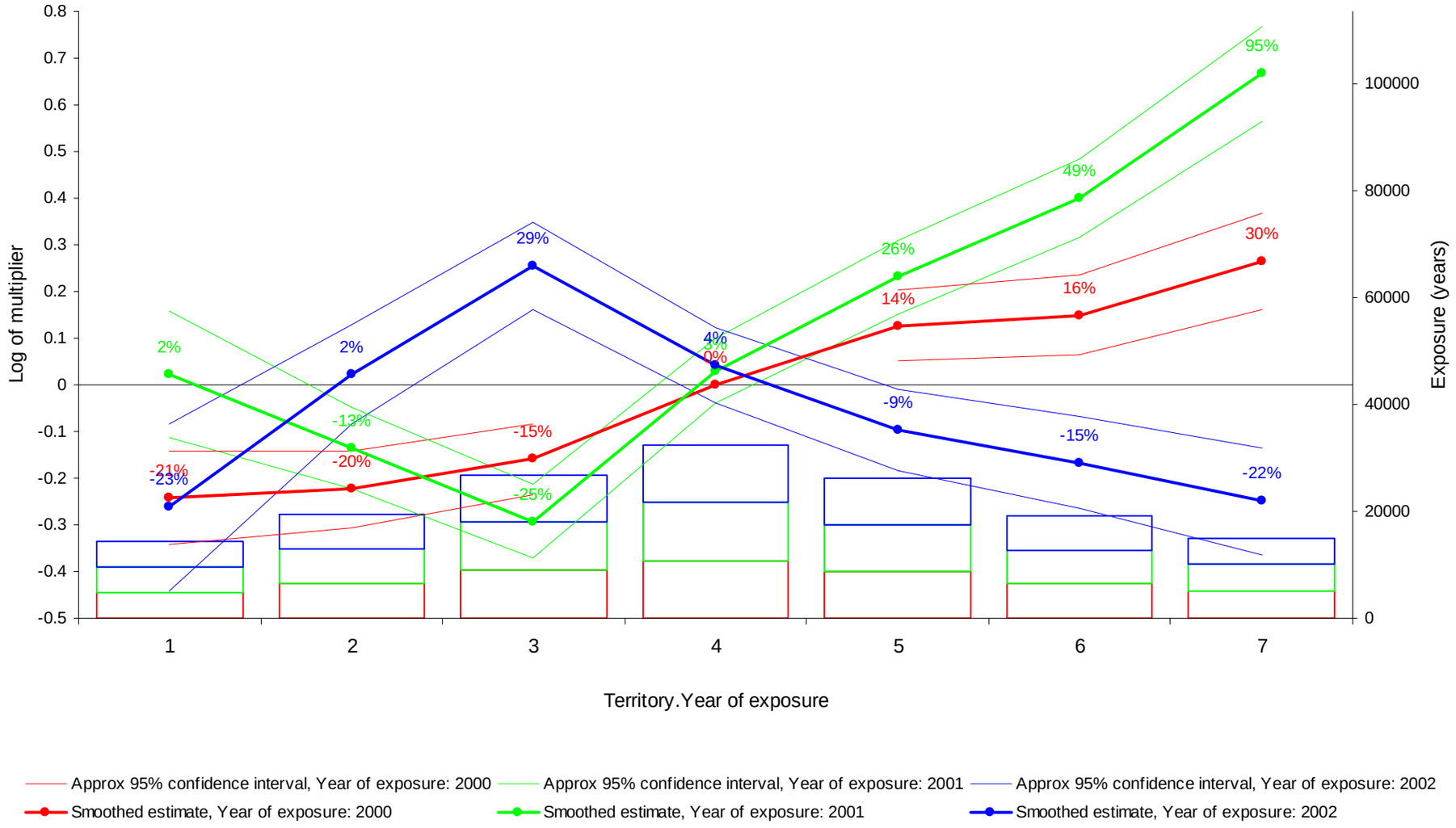
Technical stories

- Data Cleaning
- Portfolio analysis
- Deviance tests vs graphical results
- Consistency with time
- Interactions (deciding which to test & detecting significance)
- Residual diagnostics and leverage
- Testing the effectiveness of restrictions
- Validating models
- Maps
- Monitoring

Consistency over time



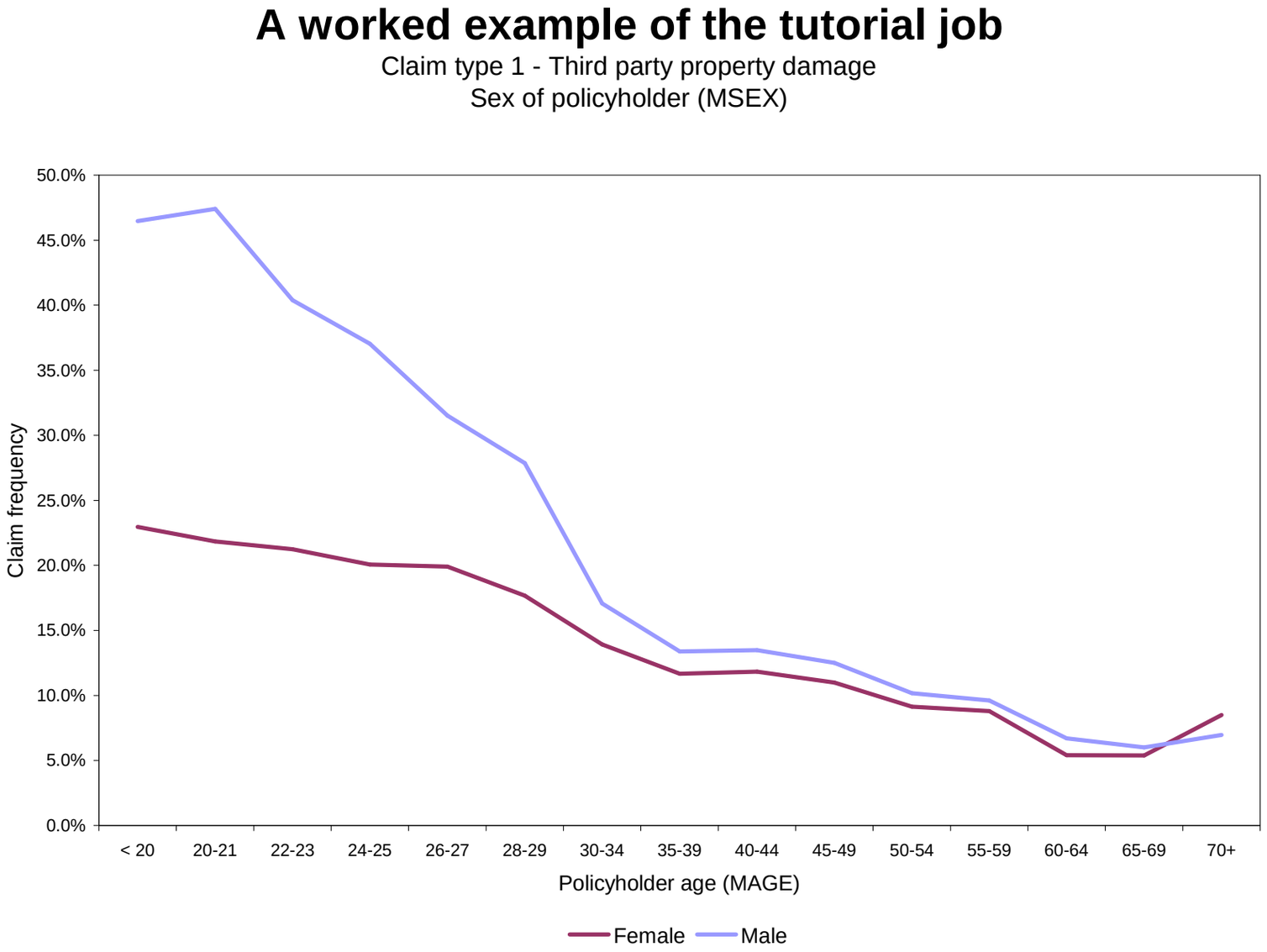
Consistency over time



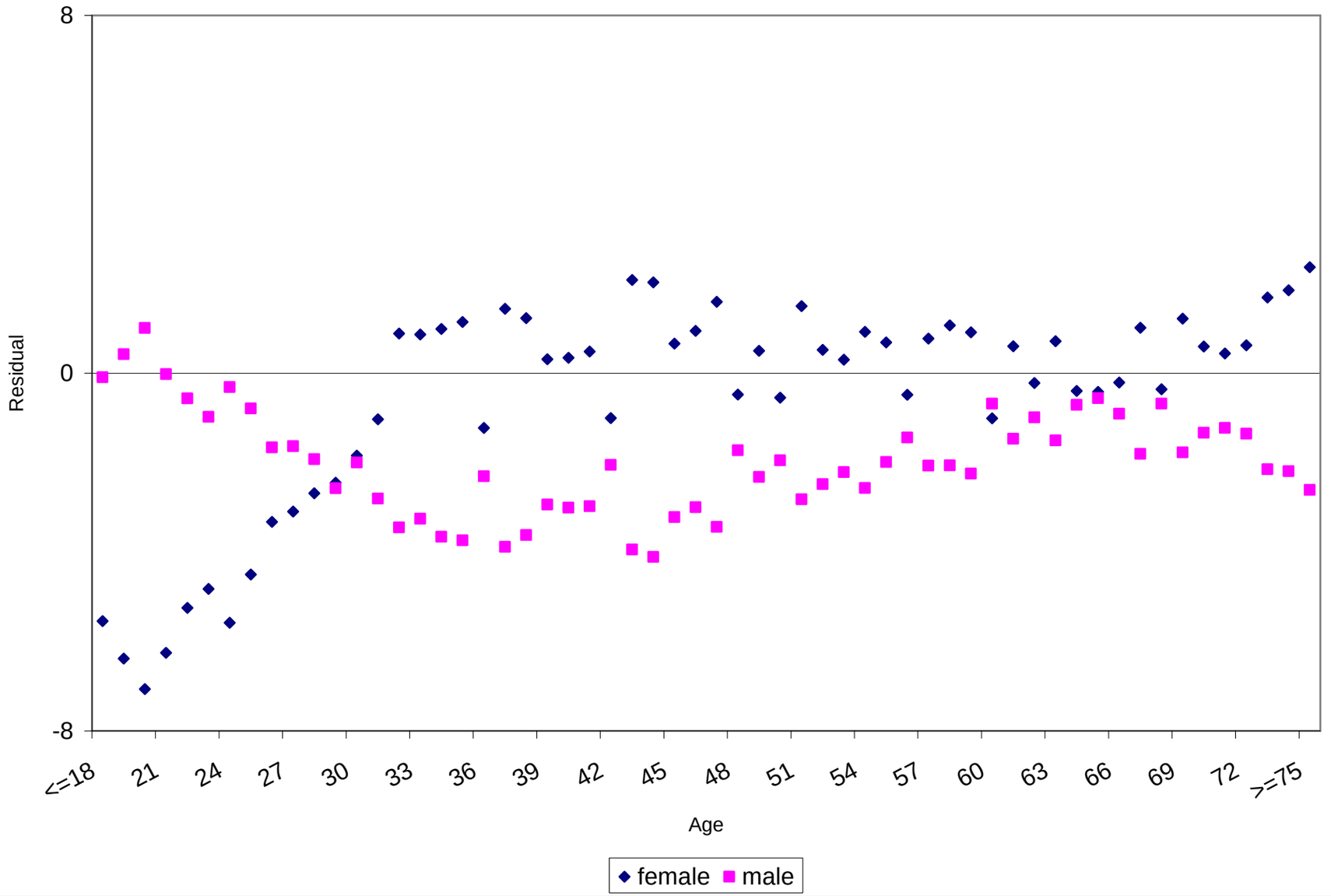
Technical stories

- Data Cleaning
- Portfolio analysis
- Deviance tests vs graphical results
- Consistency with time
- Interactions (deciding which to test & detecting significance)
- Residual diagnostics and leverage
- Testing the effectiveness of restrictions
- Validating models
- Maps
- Monitoring

Two way frequency



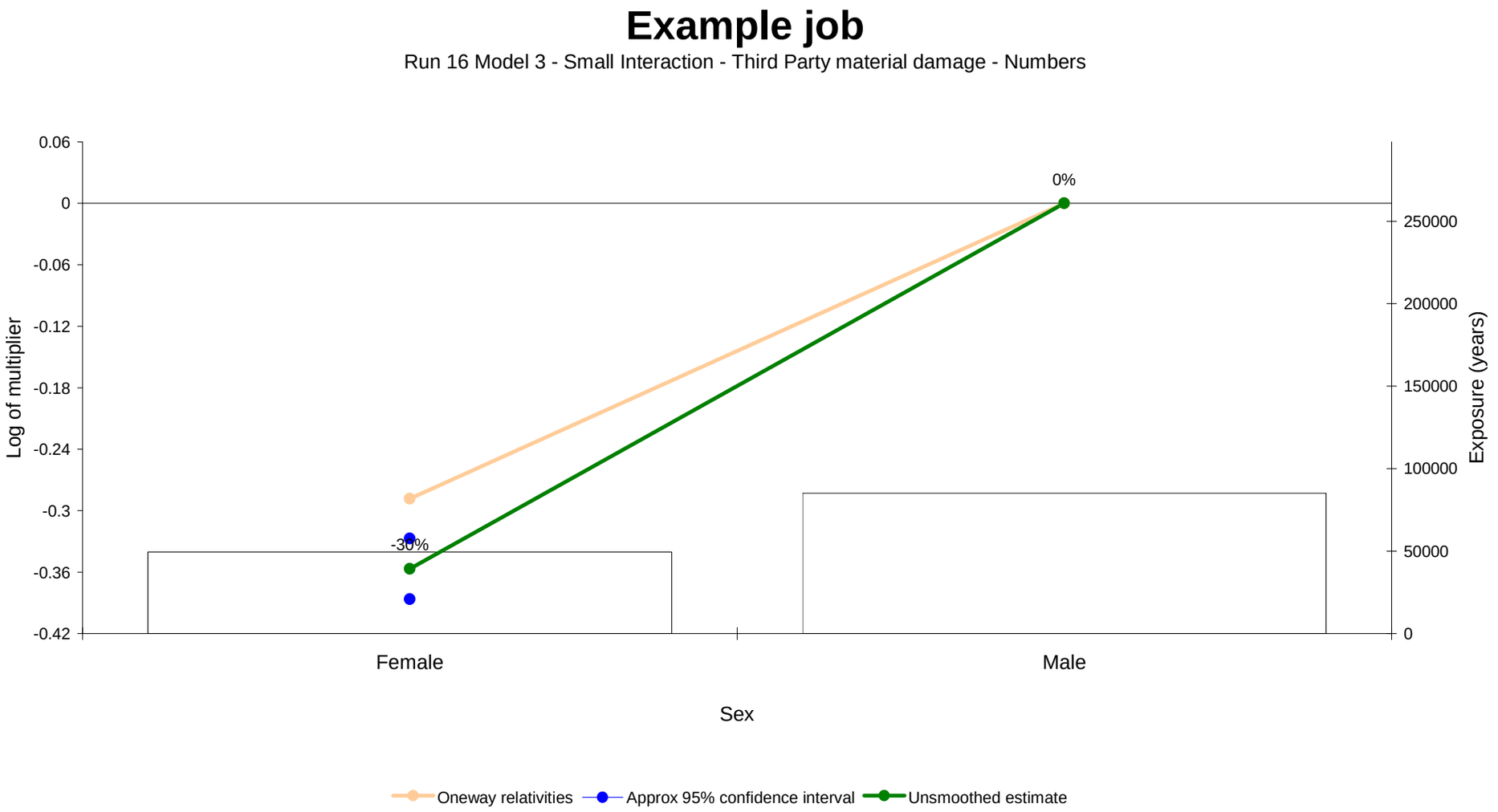
Two way of deviance residual (age and sex)



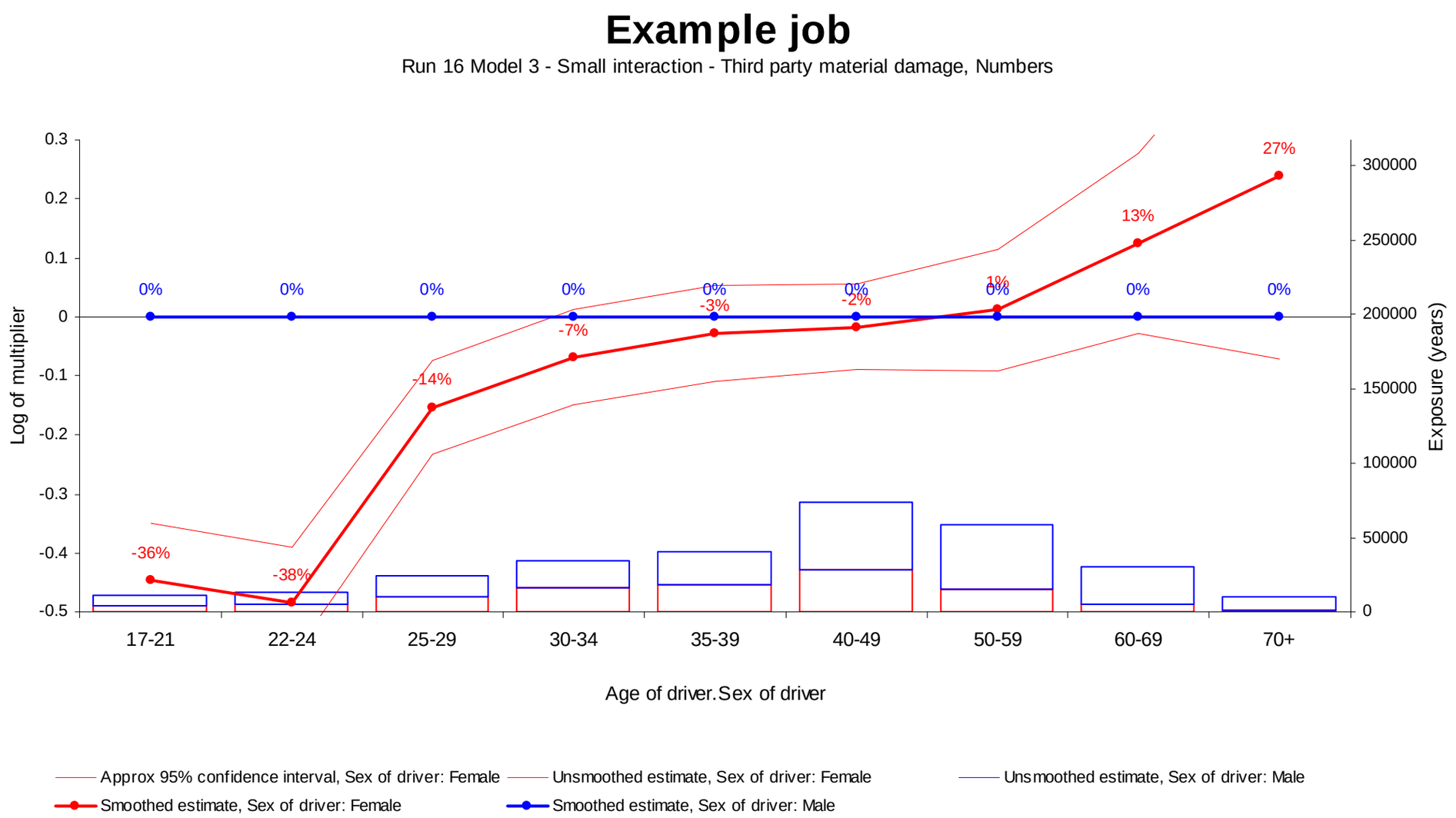
Age - sex interaction (full interaction)

Marginal interaction: Age effect

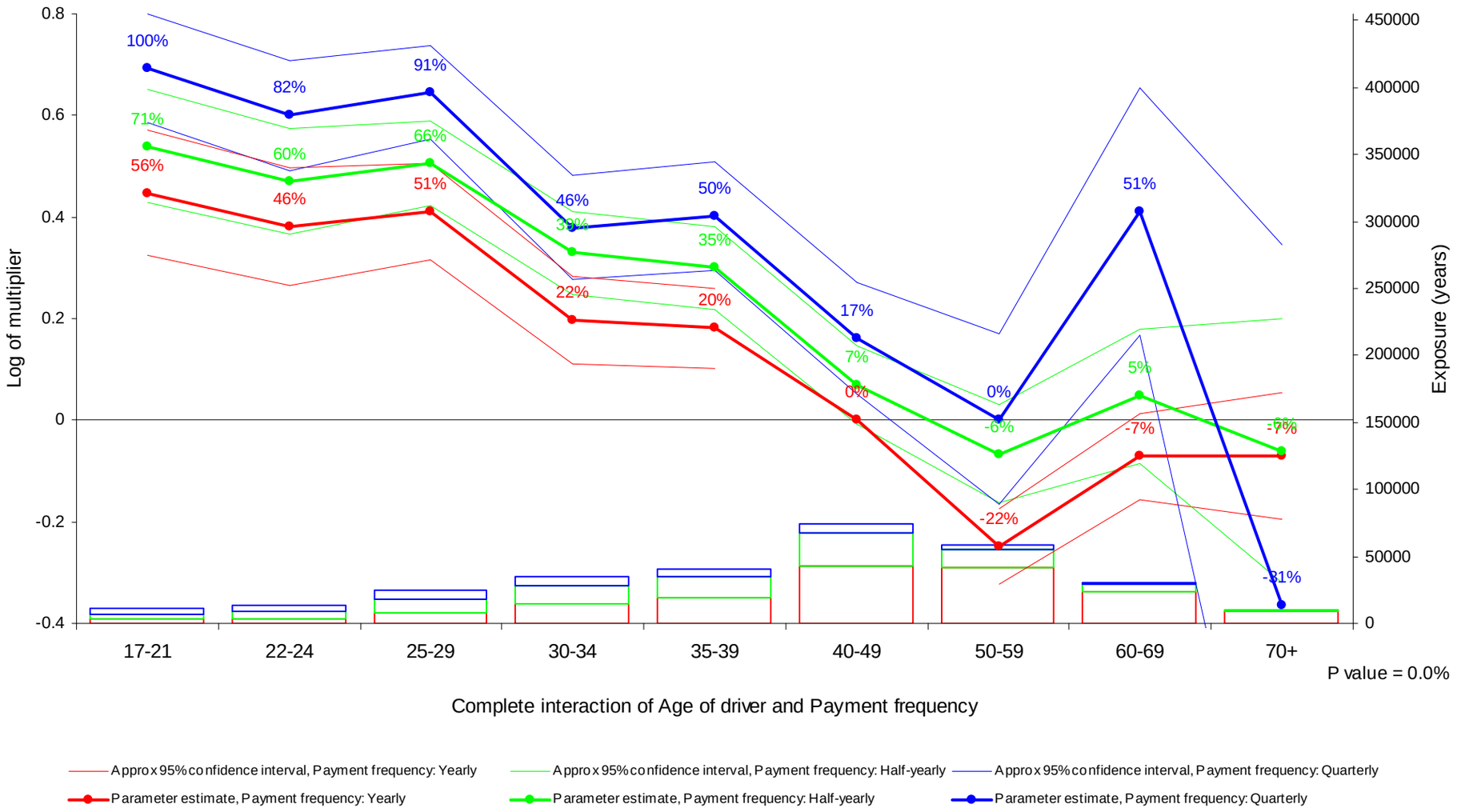
Marginal interaction: Sex effect



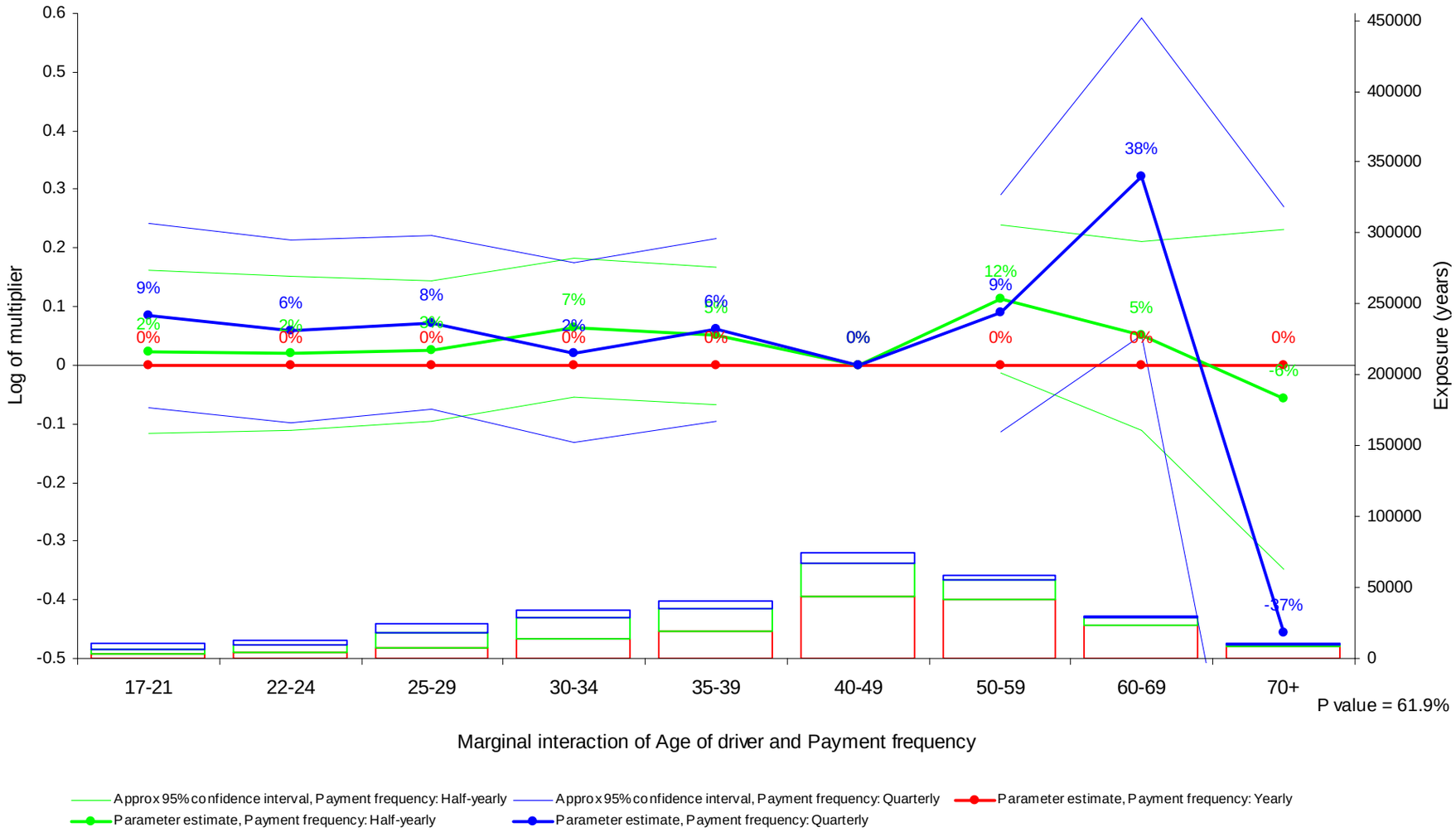
Marginal interaction: Age.Sex (ie additional female multipliers)



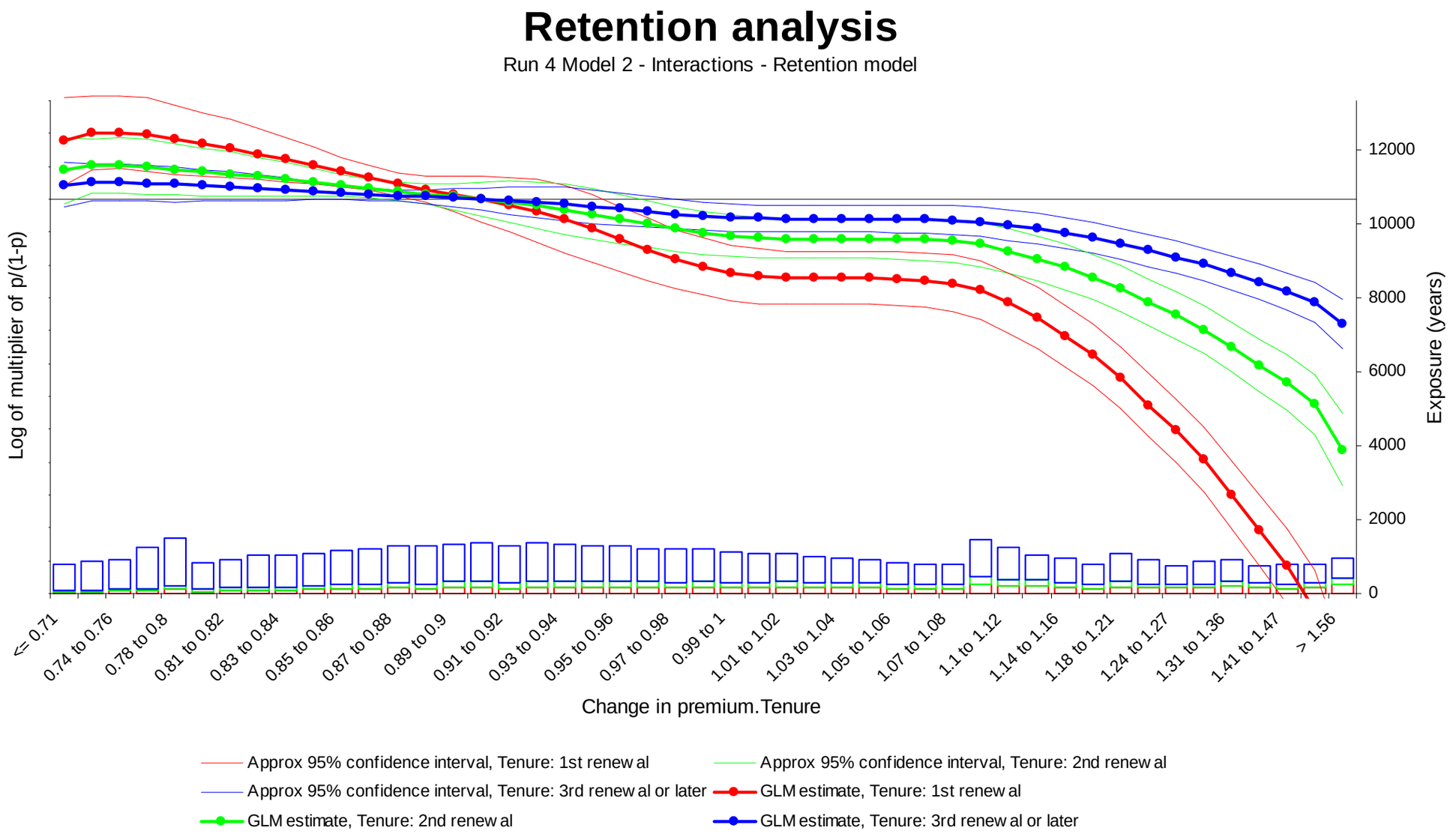
An example of no interaction (full interaction)



An example of no interaction (marginal)



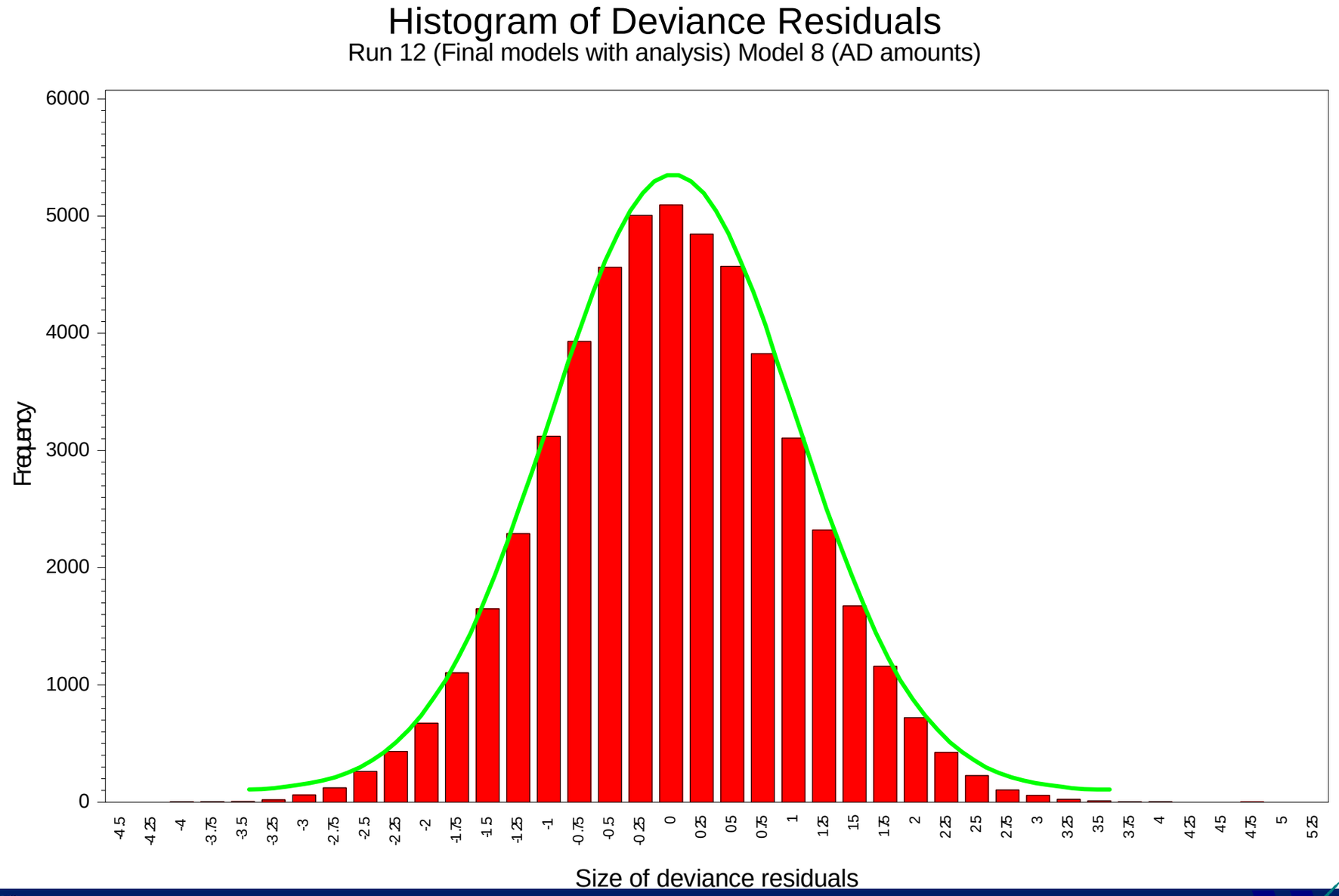
Example interaction - elasticity curve



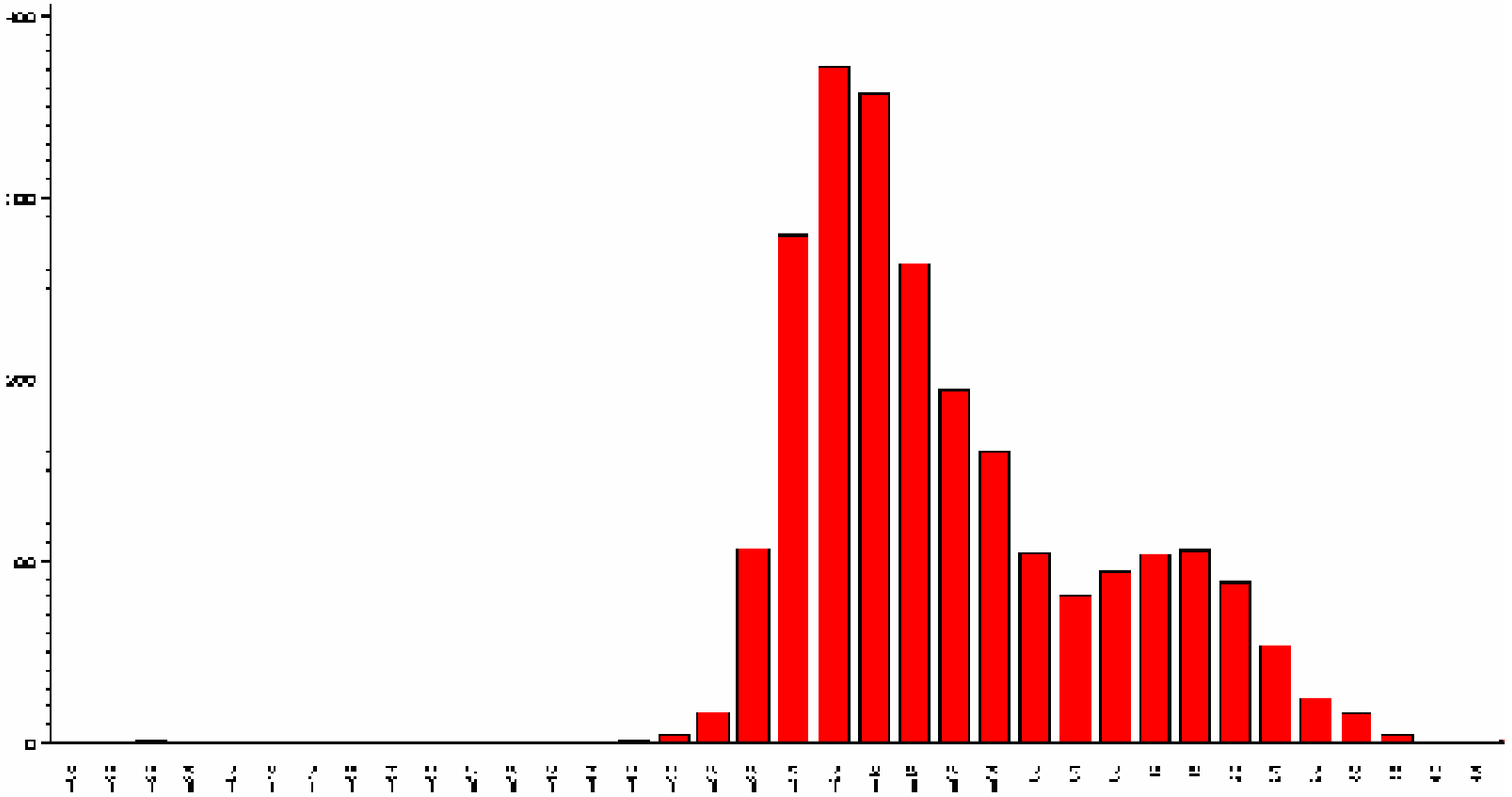
Technical stories

- Data Cleaning
- Portfolio analysis
- Deviance tests vs graphical results
- Consistency with time
- Interactions (deciding which to test & detecting significance)
- Residual diagnostics and leverage
- Testing the effectiveness of restrictions
- Validating models
- Maps
- Monitoring

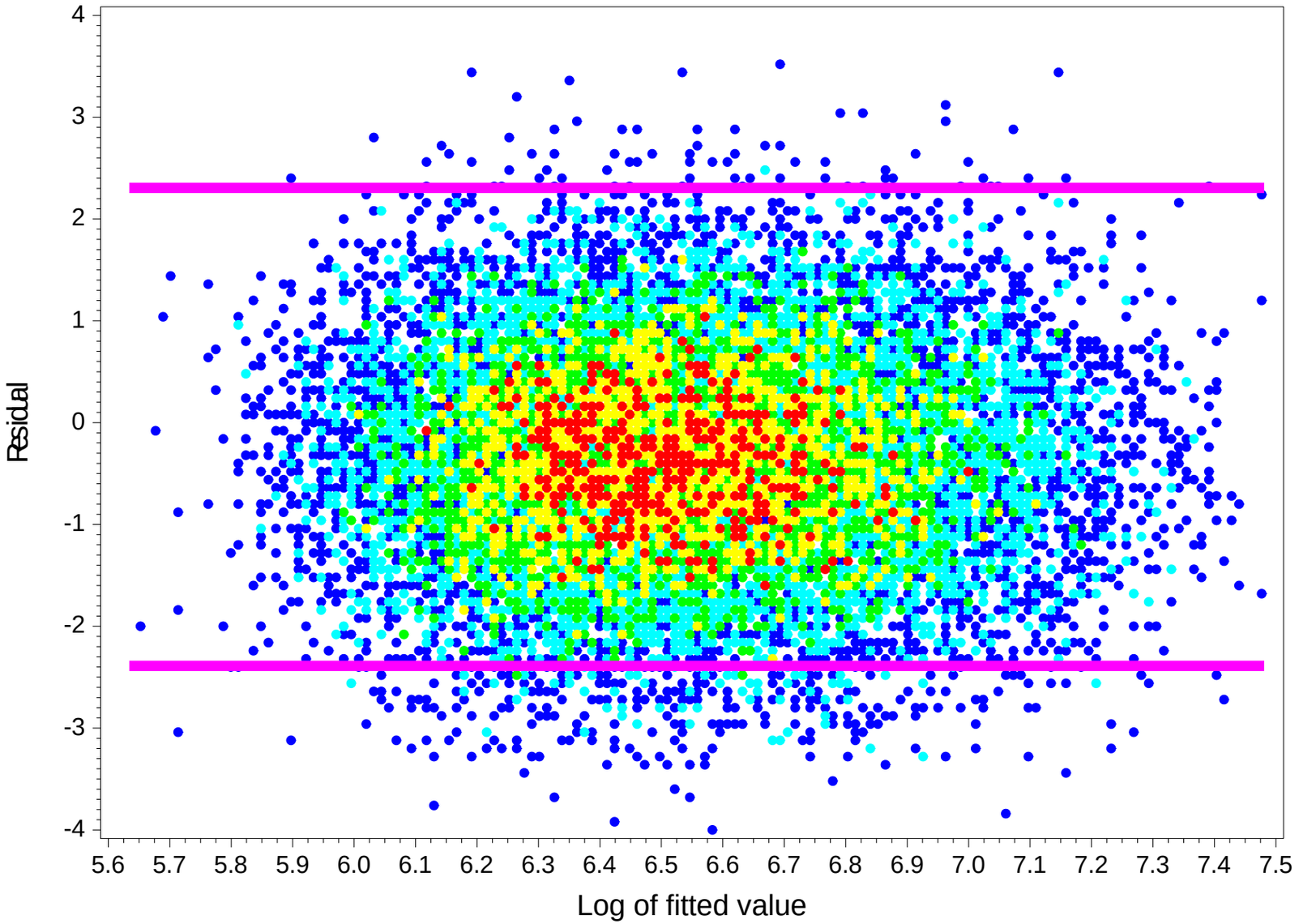
Residuals



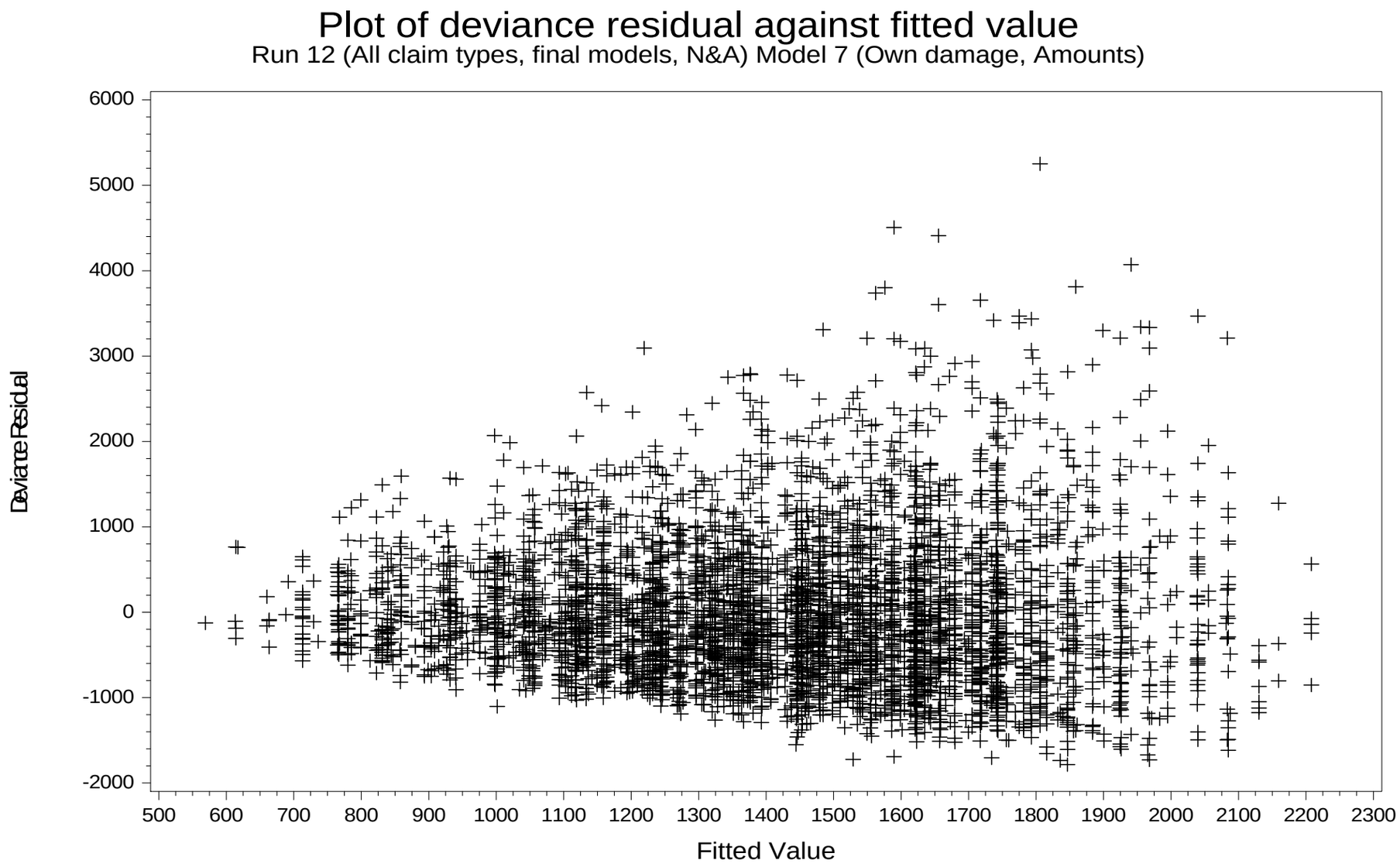
Residuals – example of bimodality



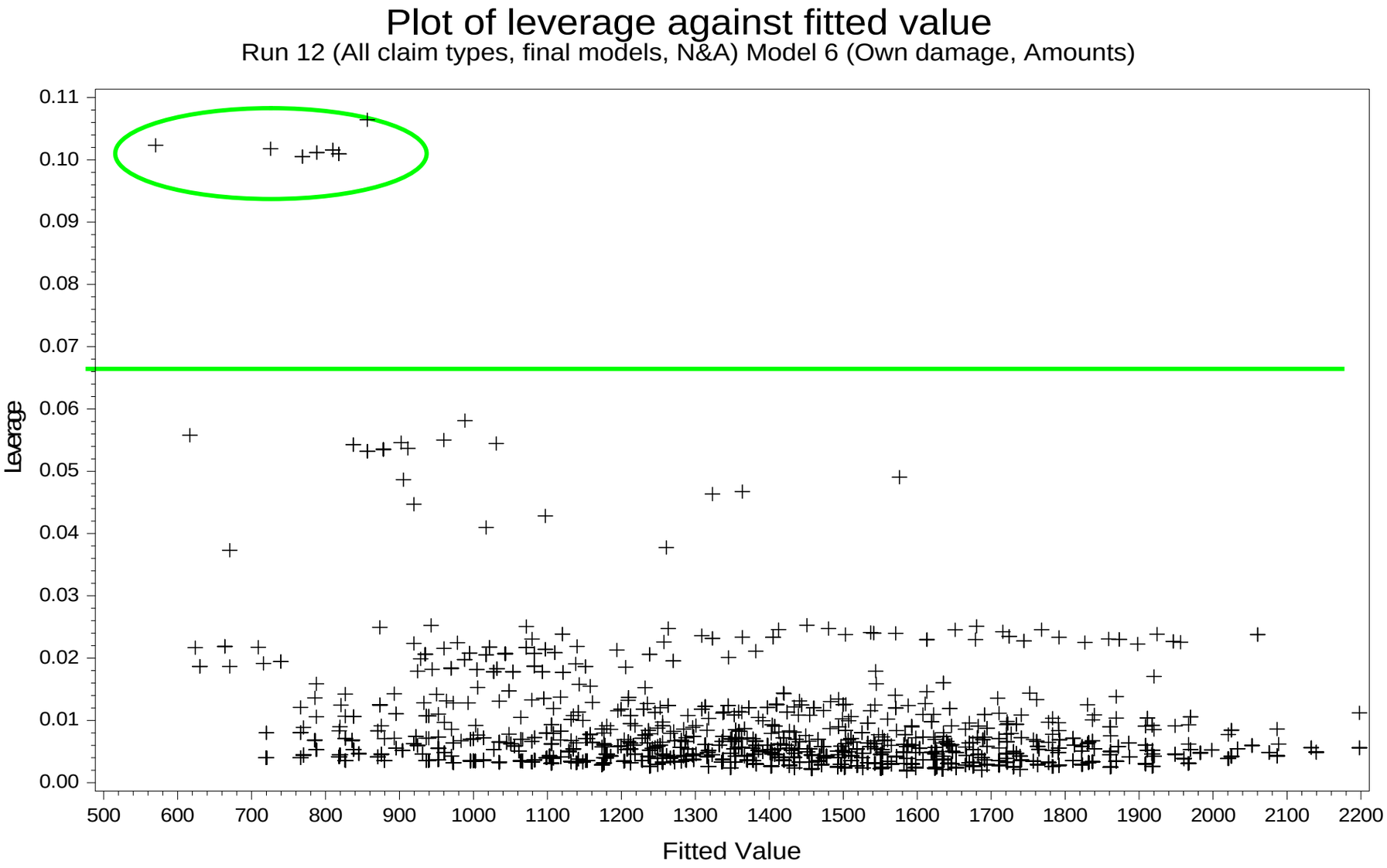
Residuals



Gamma data, Normal error

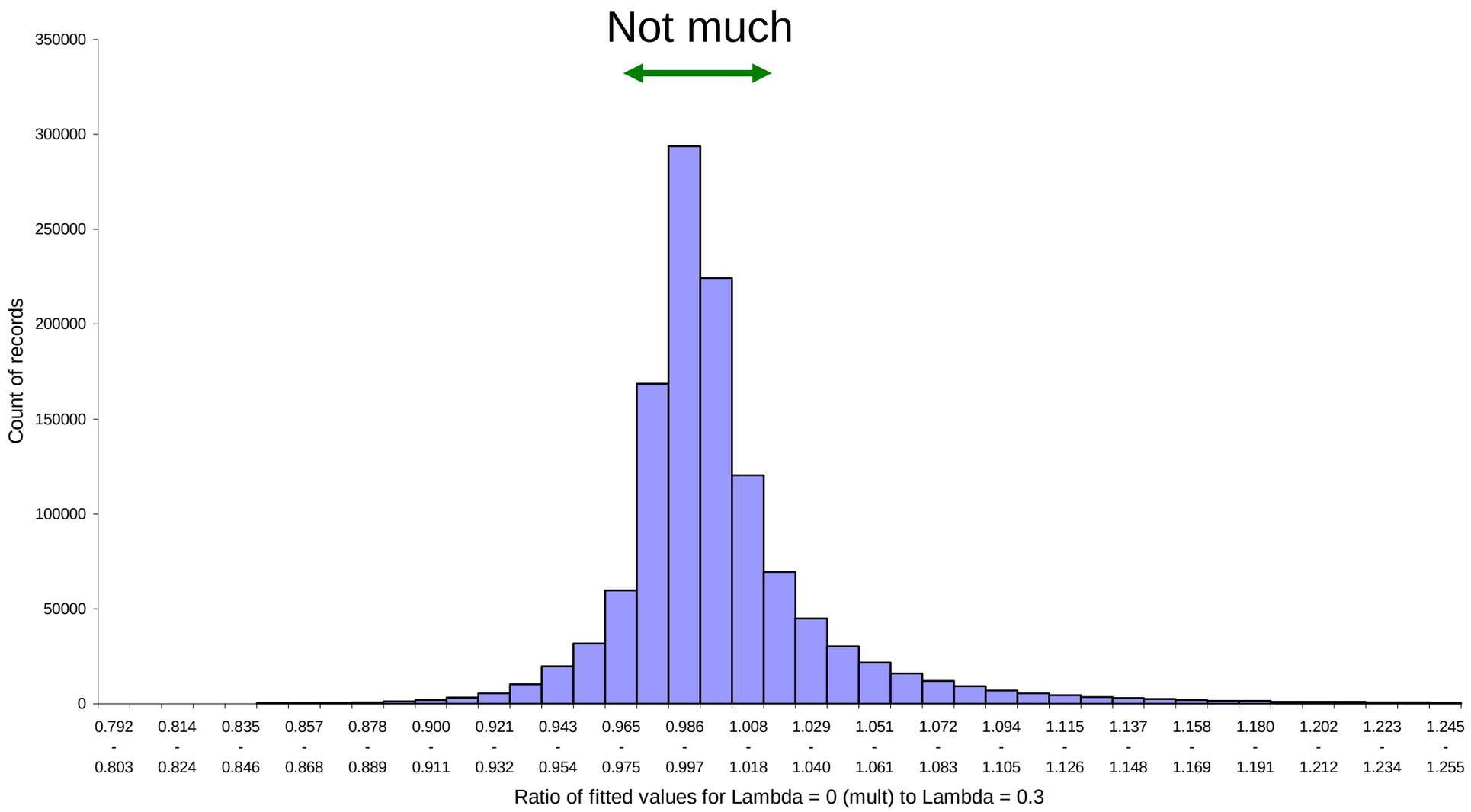


Leverage



Box-Cox link function investigation

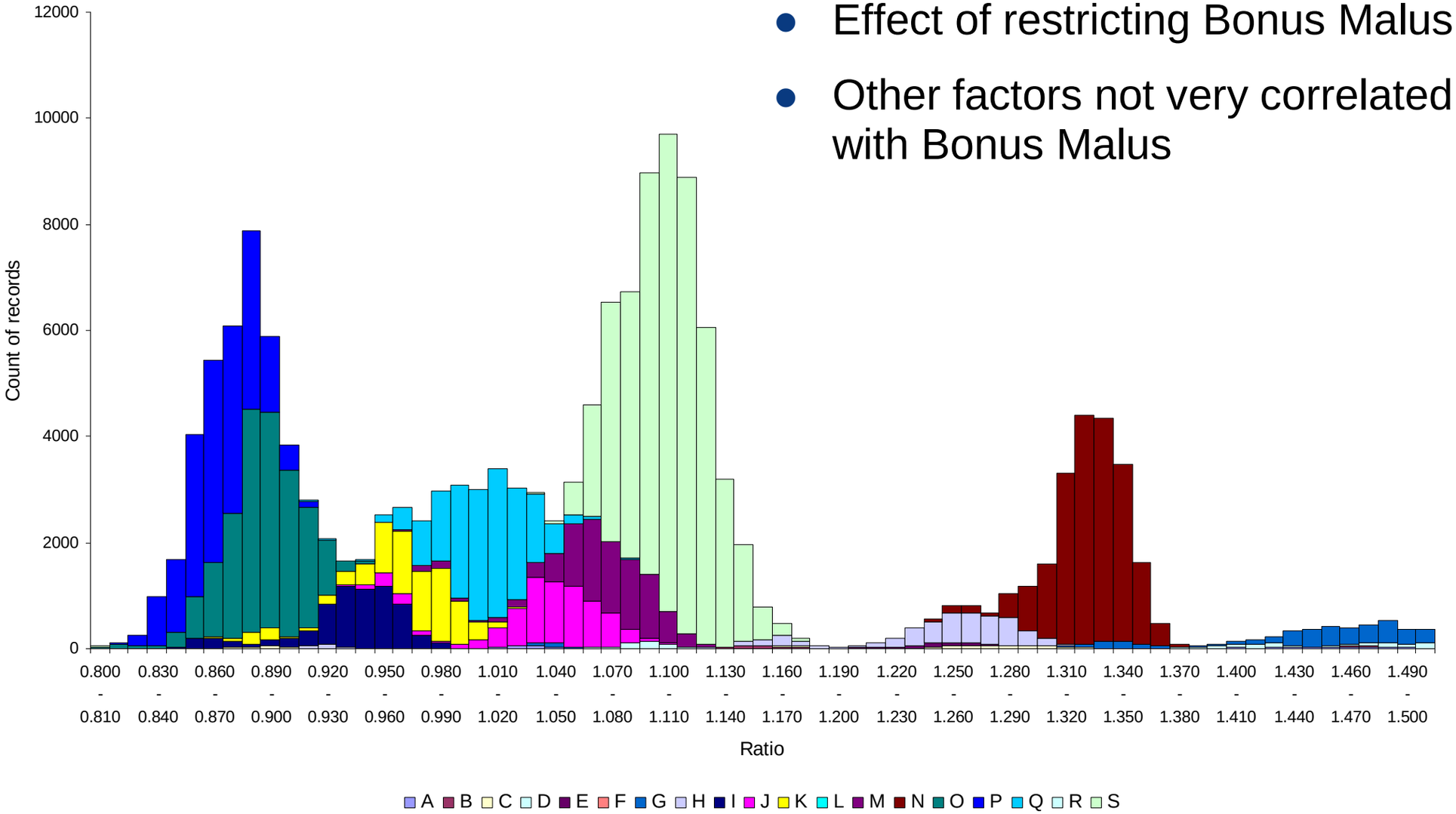
Comparing fitted values of different link functions



Technical stories

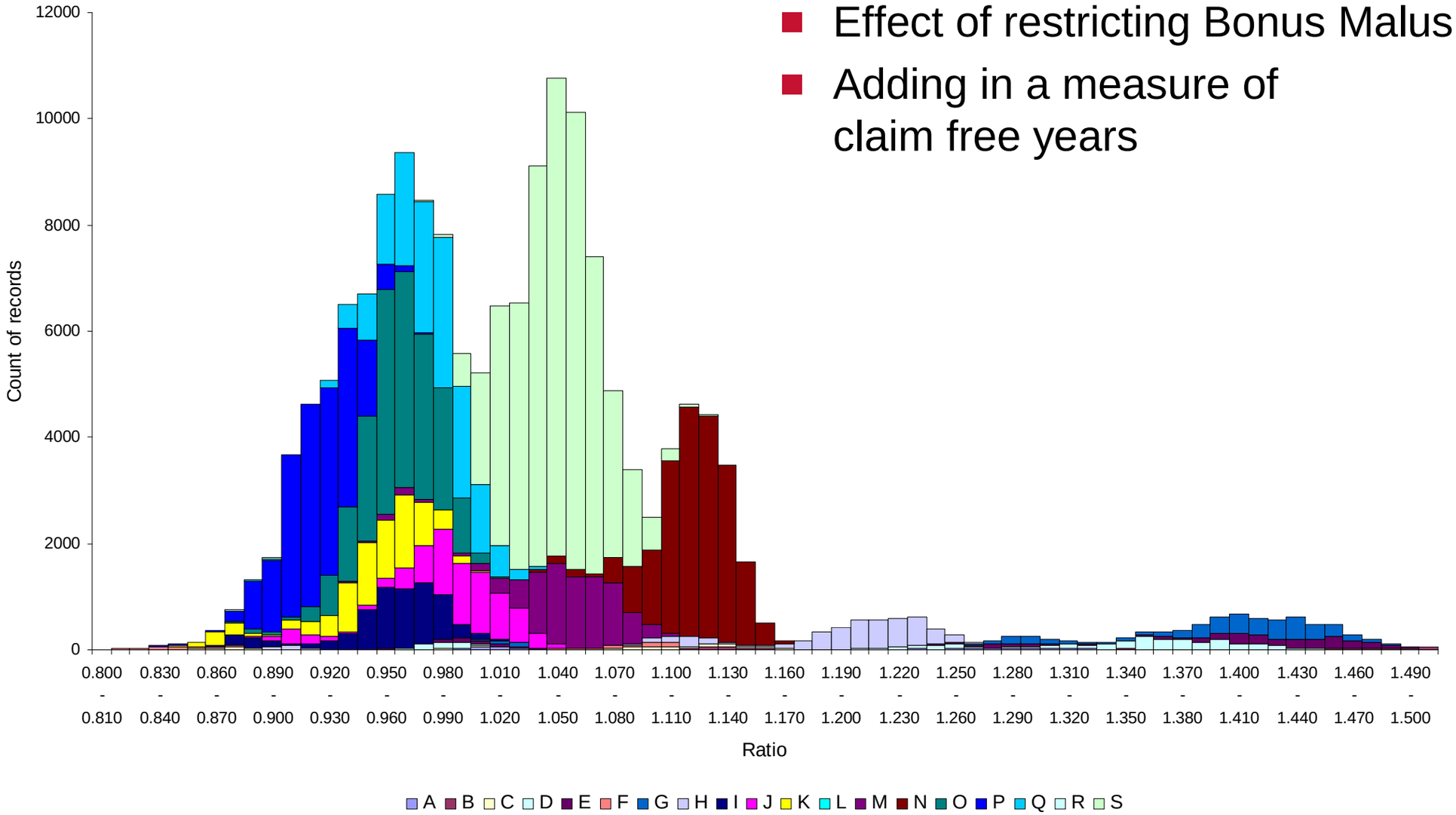
- Data Cleaning
- Portfolio analysis
- Deviance tests vs graphical results
- Consistency with time
- Interactions (deciding which to test & detecting significance)
- Residual diagnostics, leverage
- Testing the effectiveness of restrictions
- Validating models
- Maps
- Monitoring

Testing the effectiveness of restrictions



- Effect of restricting Bonus Malus
- Other factors not very correlated with Bonus Malus

Testing the effectiveness of restrictions

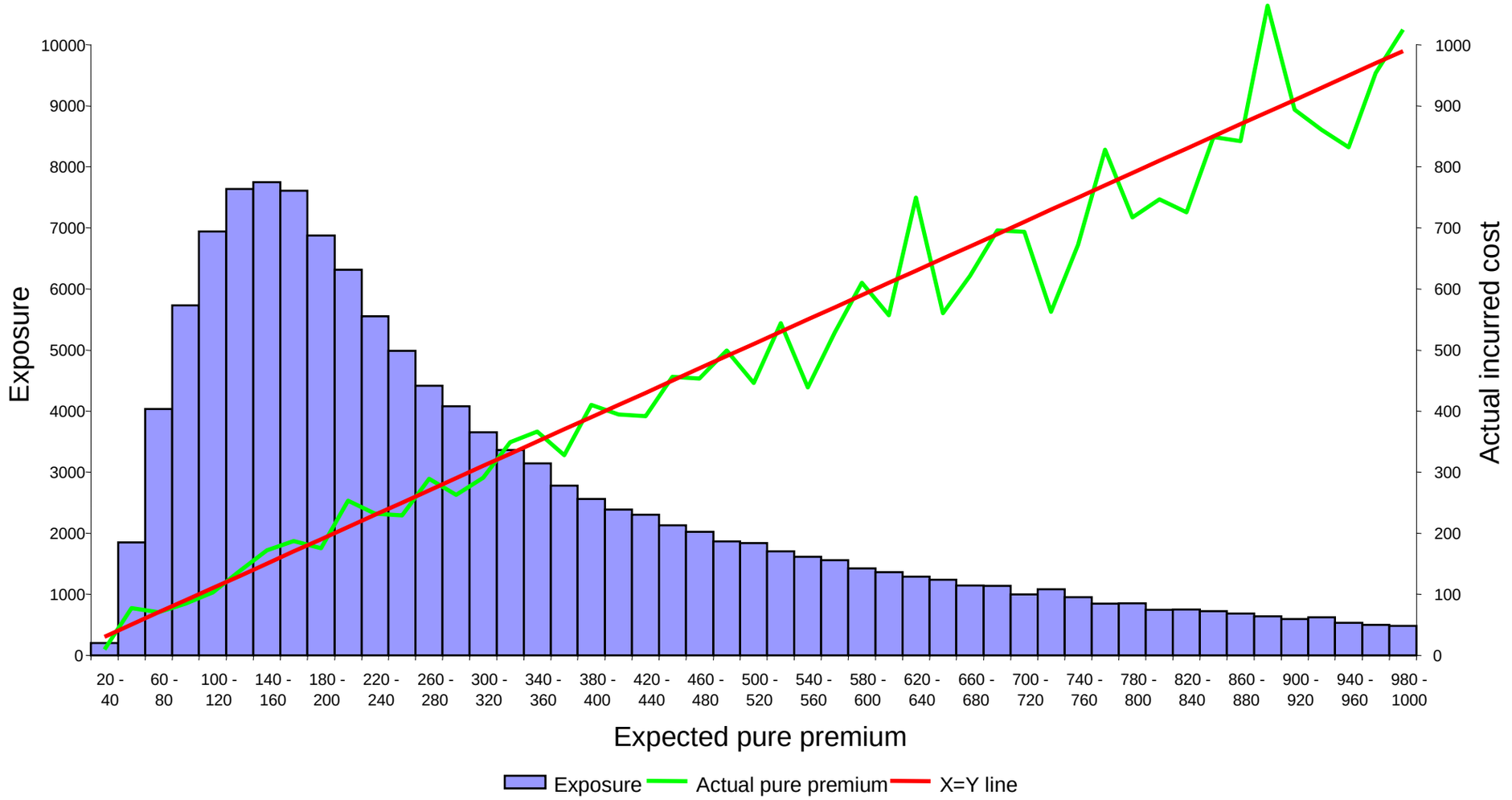


- Effect of restricting Bonus Malus
- Adding in a measure of claim free years

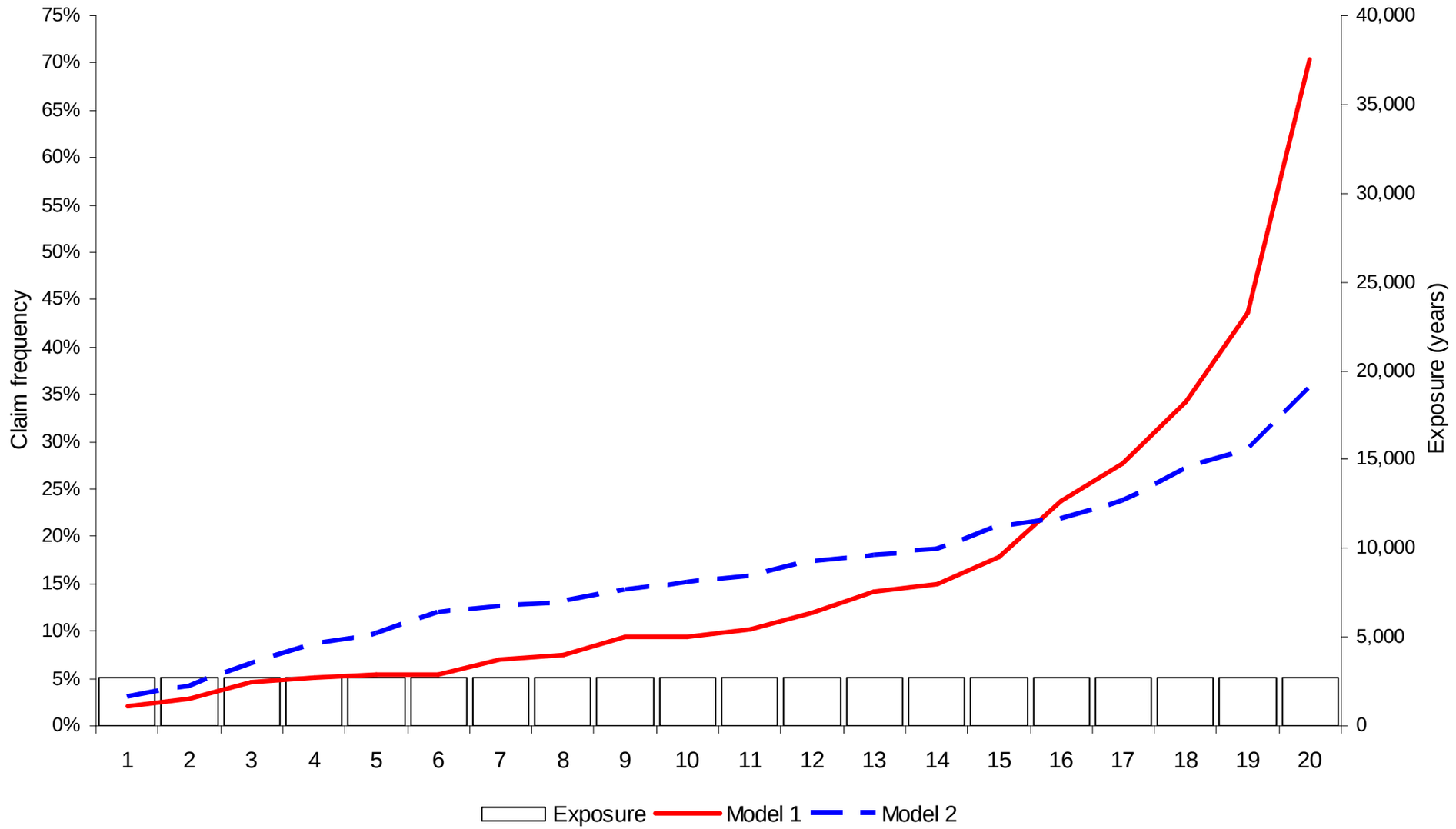
Technical stories

- Portfolio analysis
- Deviance tests vs graphical results
- Consistency with time
- Interactions (deciding which to test & detecting significance)
- Residual diagnostics and leverage
- Testing the effectiveness of restrictions
- Validating models
- Maps
- Monitoring

Model validation



Lift curves

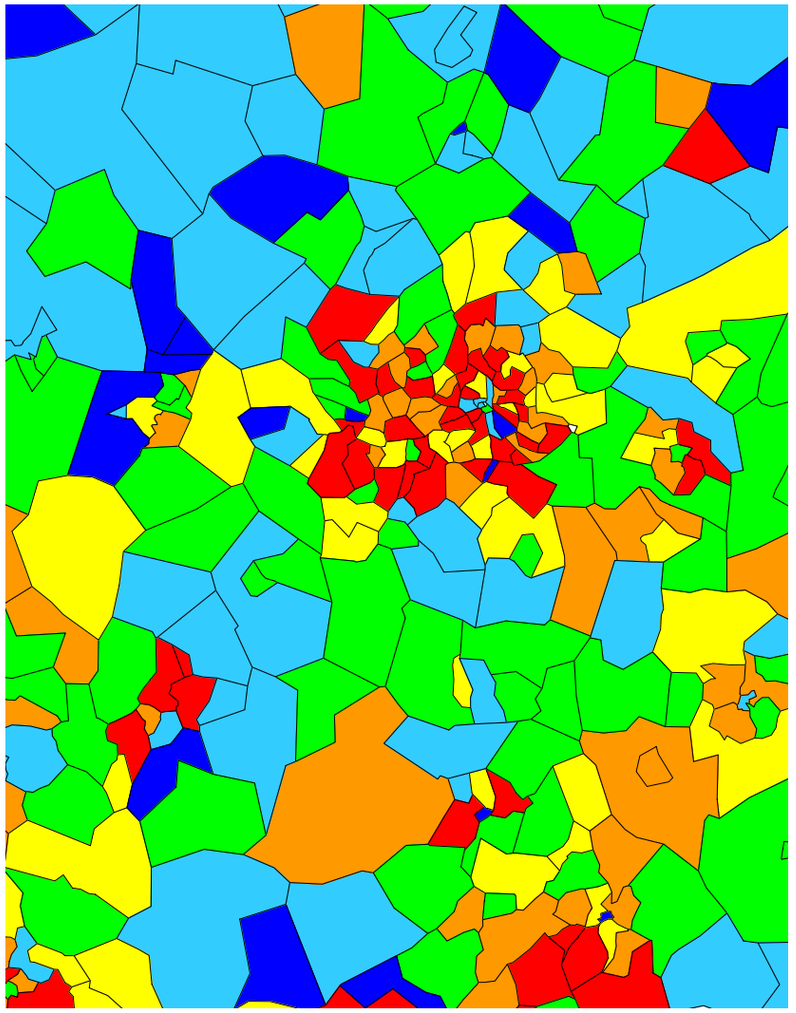


Technical stories

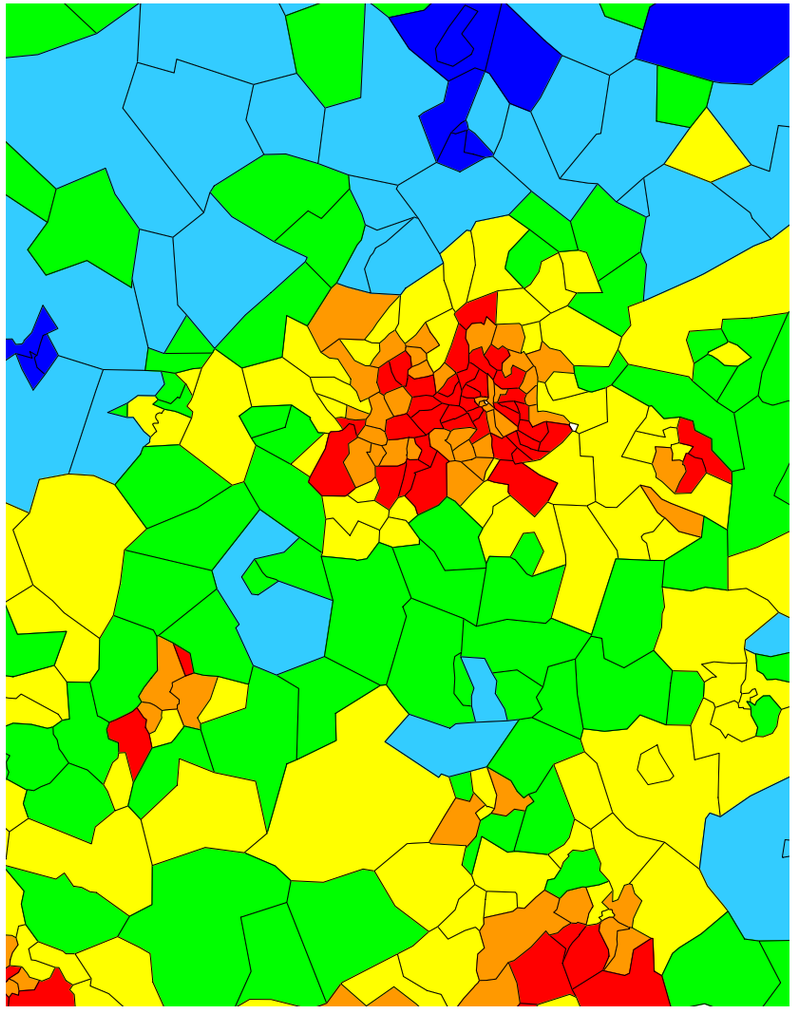
- Data Cleaning
- Portfolio analysis
- Deviance tests vs graphical results
- Consistency with time
- Interactions (deciding which to test & detecting significance)
- Residual diagnostics and leverage
- Testing the effectiveness of restrictions
- Validating models
- Maps
- Monitoring

Example spatial smoothing results

Unsmoothed residuals



Smoothed residuals



Comparing indicated results with existing rates and the market

Theoretically desired change in premium

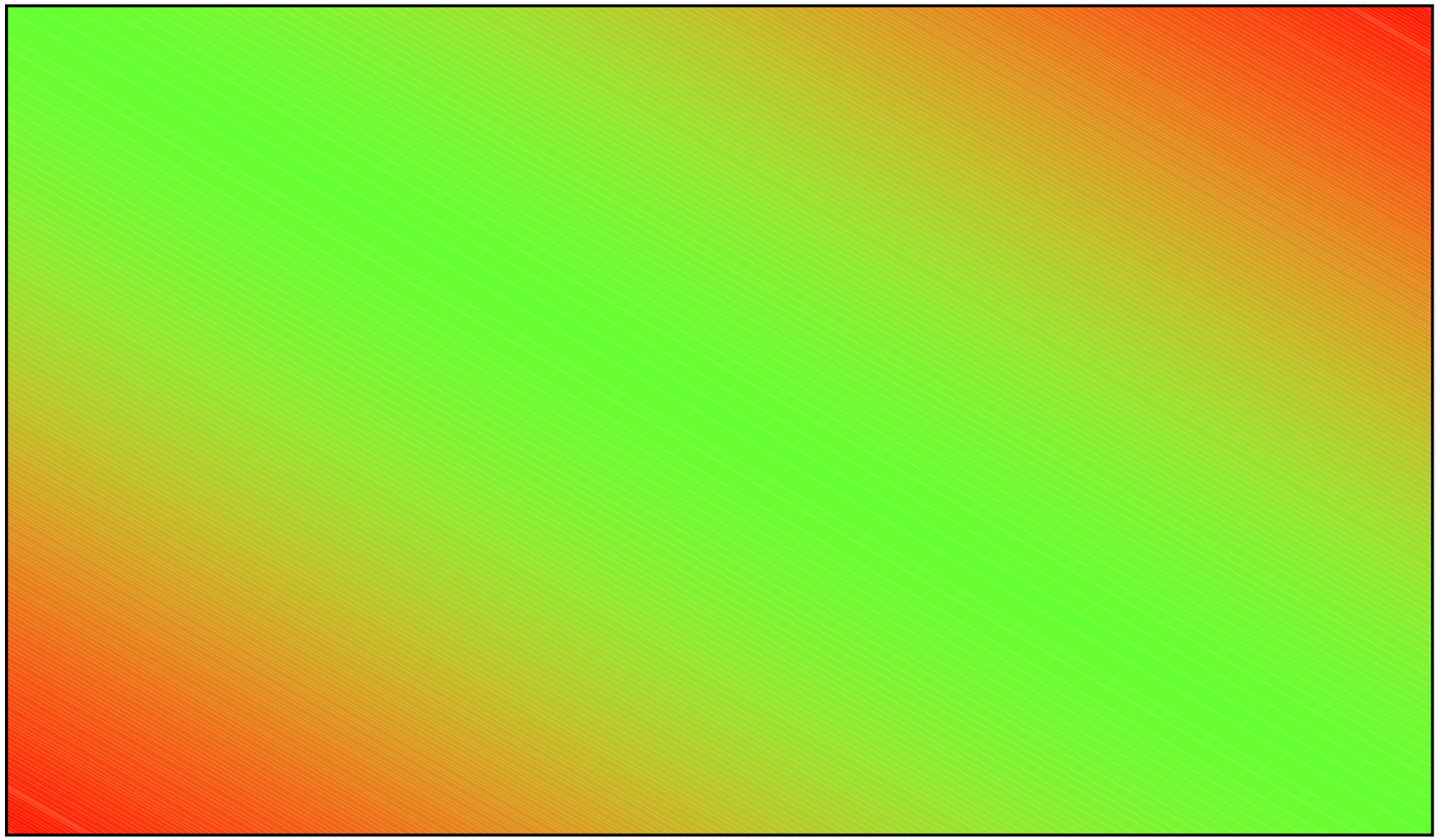
Increase

Decrease

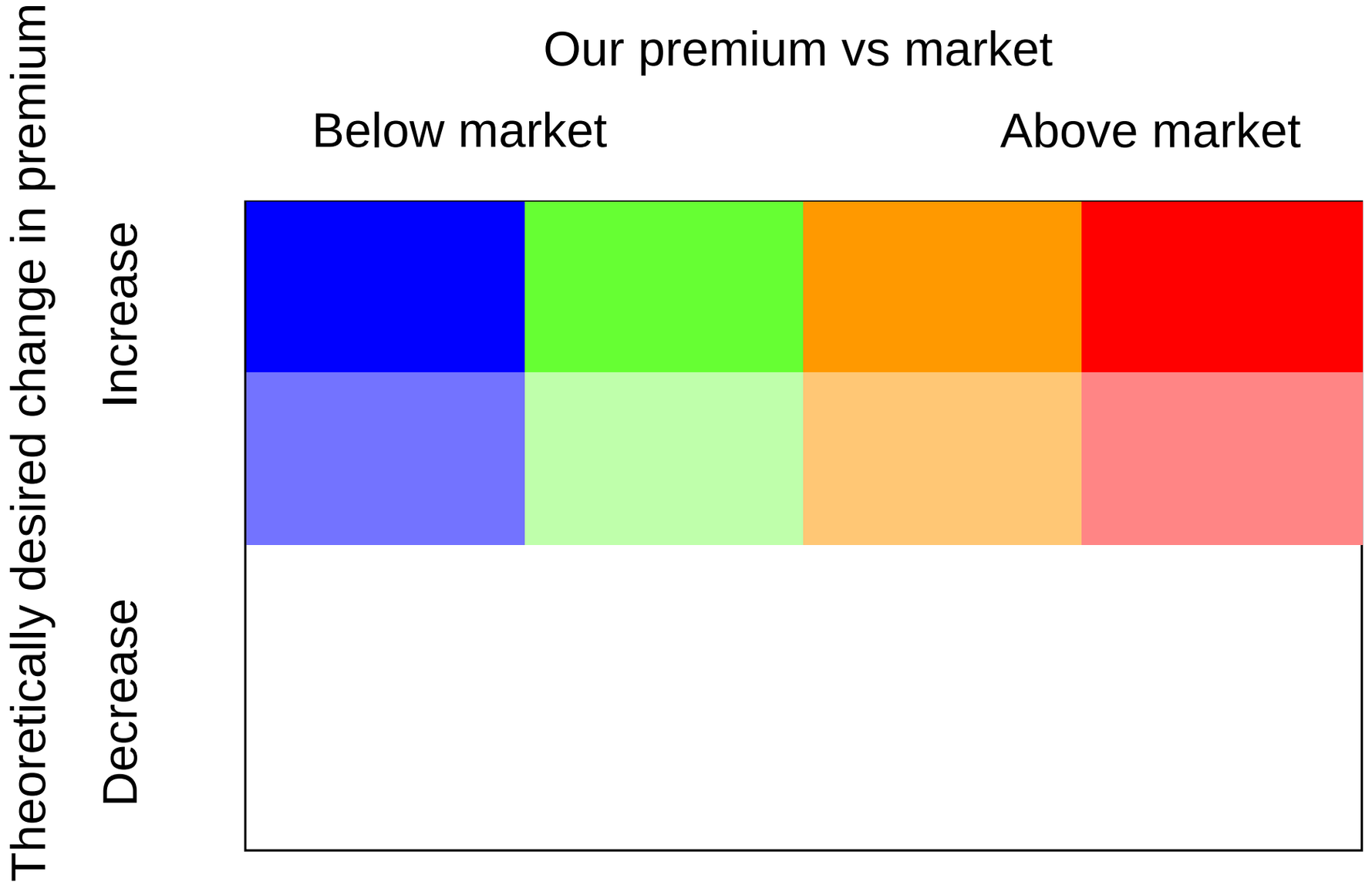
Our premium vs market

Below market

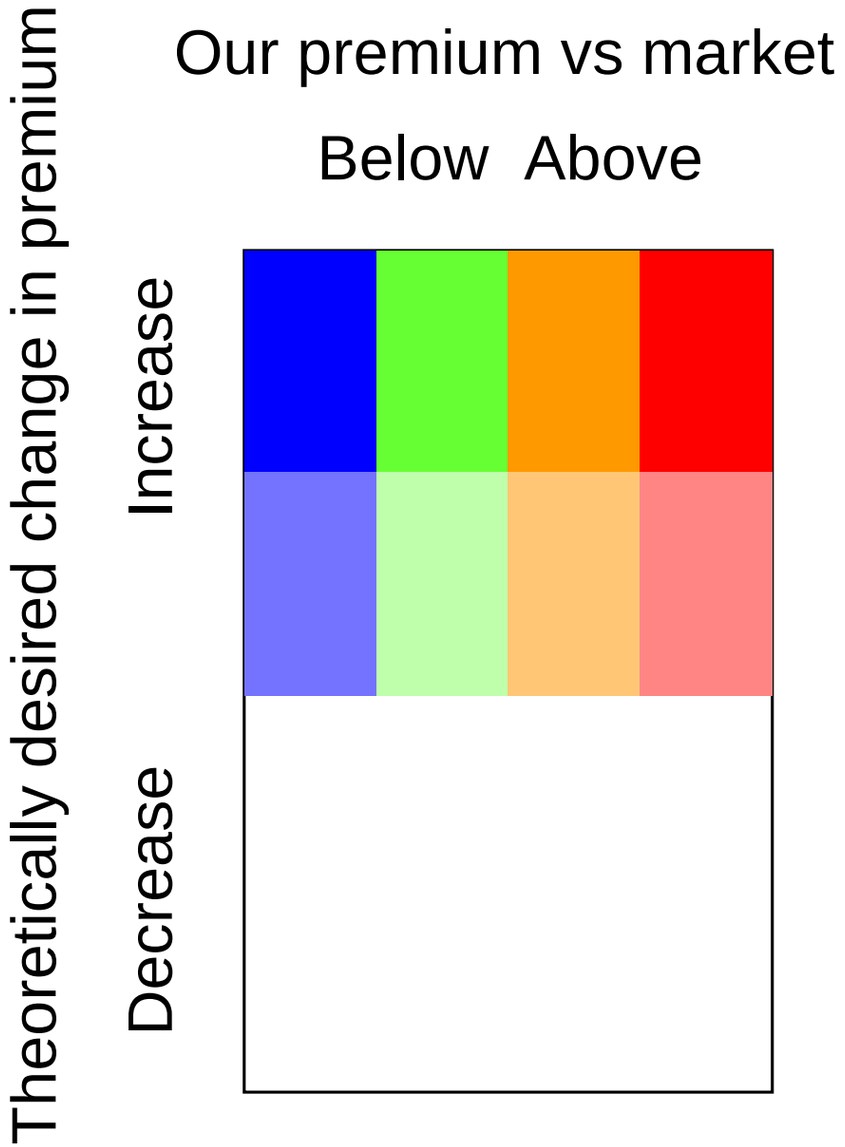
Above market

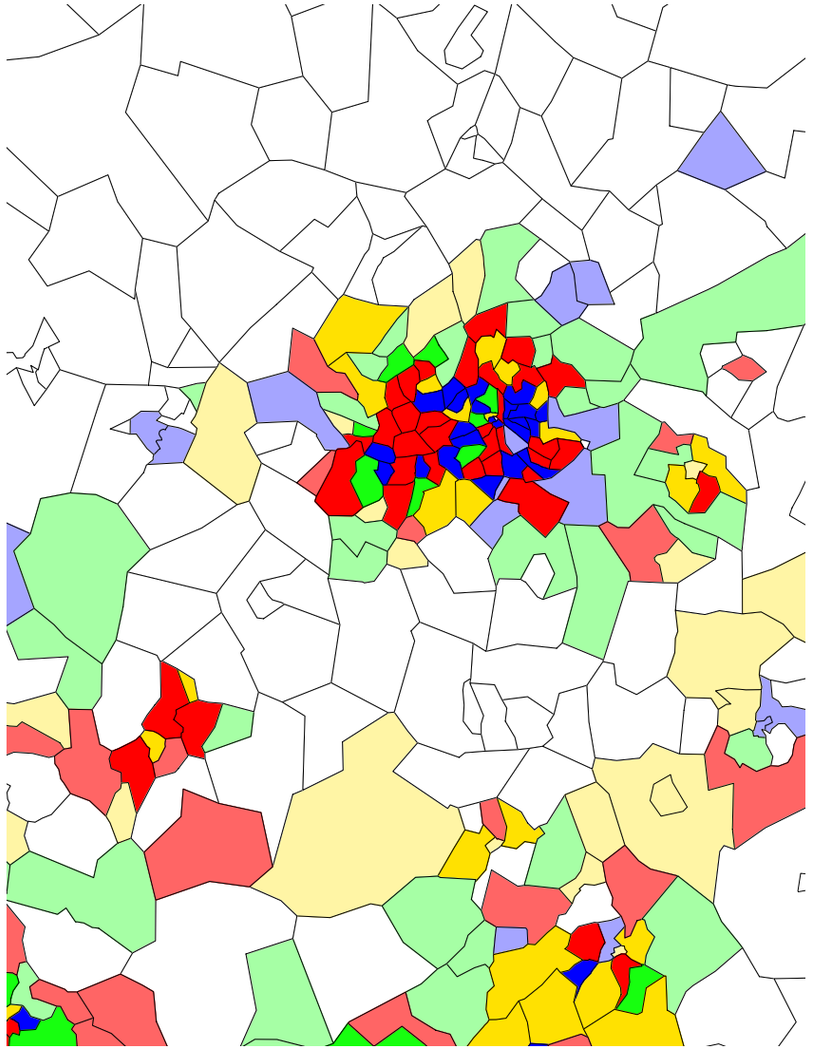


Comparing indicated results with existing rates and the market

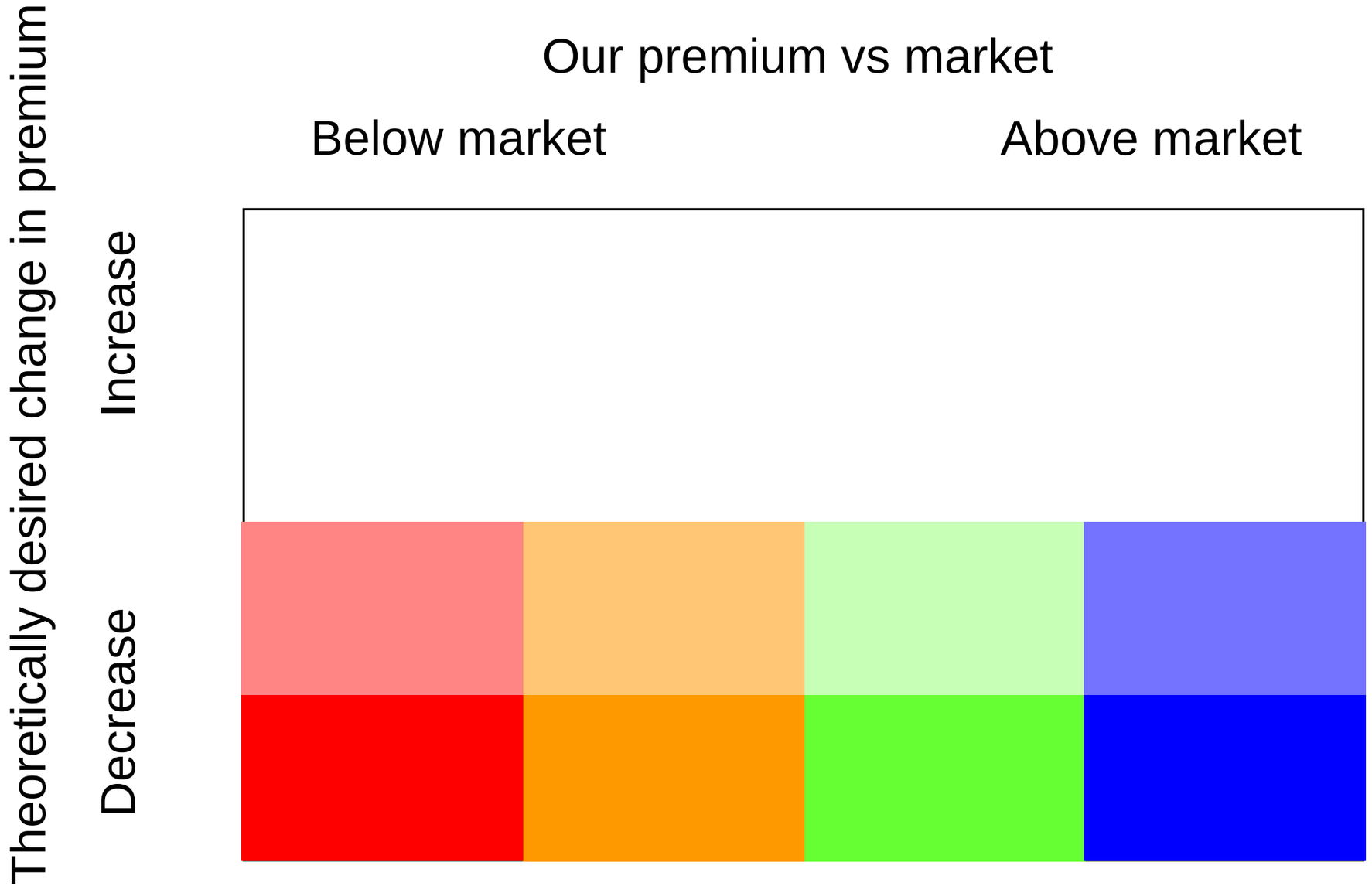


Comparing indicated results with existing rates and the market

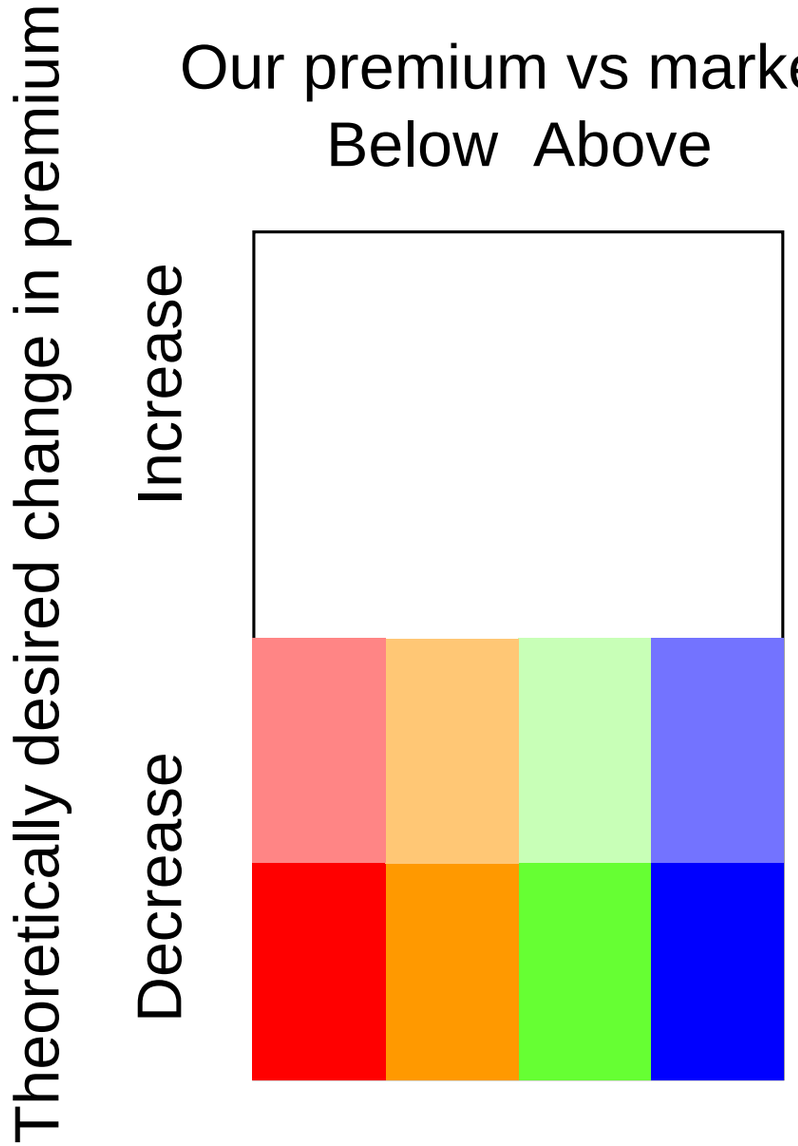


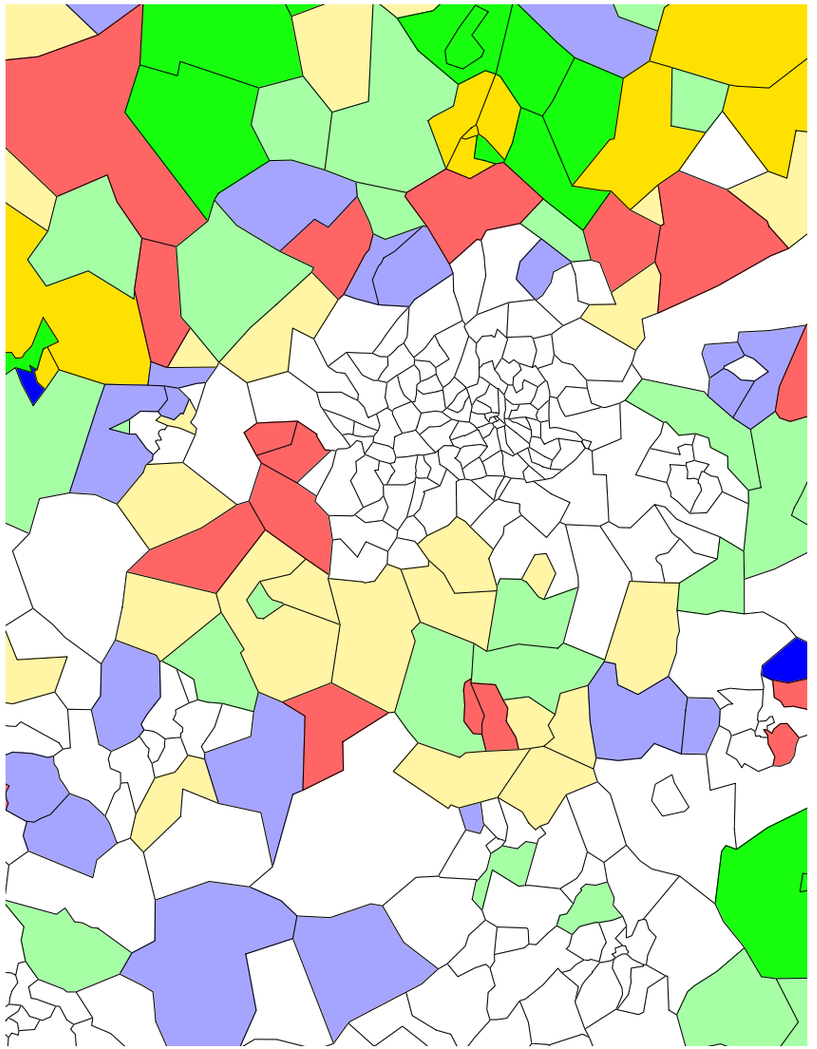


Comparing indicated results with existing rates and the market



Comparing indicated results with existing rates and the market





Technical stories

- Data Cleaning
- Portfolio analysis
- Deviance tests vs graphical results
- Consistency with time
- Interactions (deciding which to test & detecting significance)
- Residual diagnostics and leverage
- Testing the effectiveness of restrictions
- Validating models
- Maps
- Monitoring

Monitoring (one-way comparison)

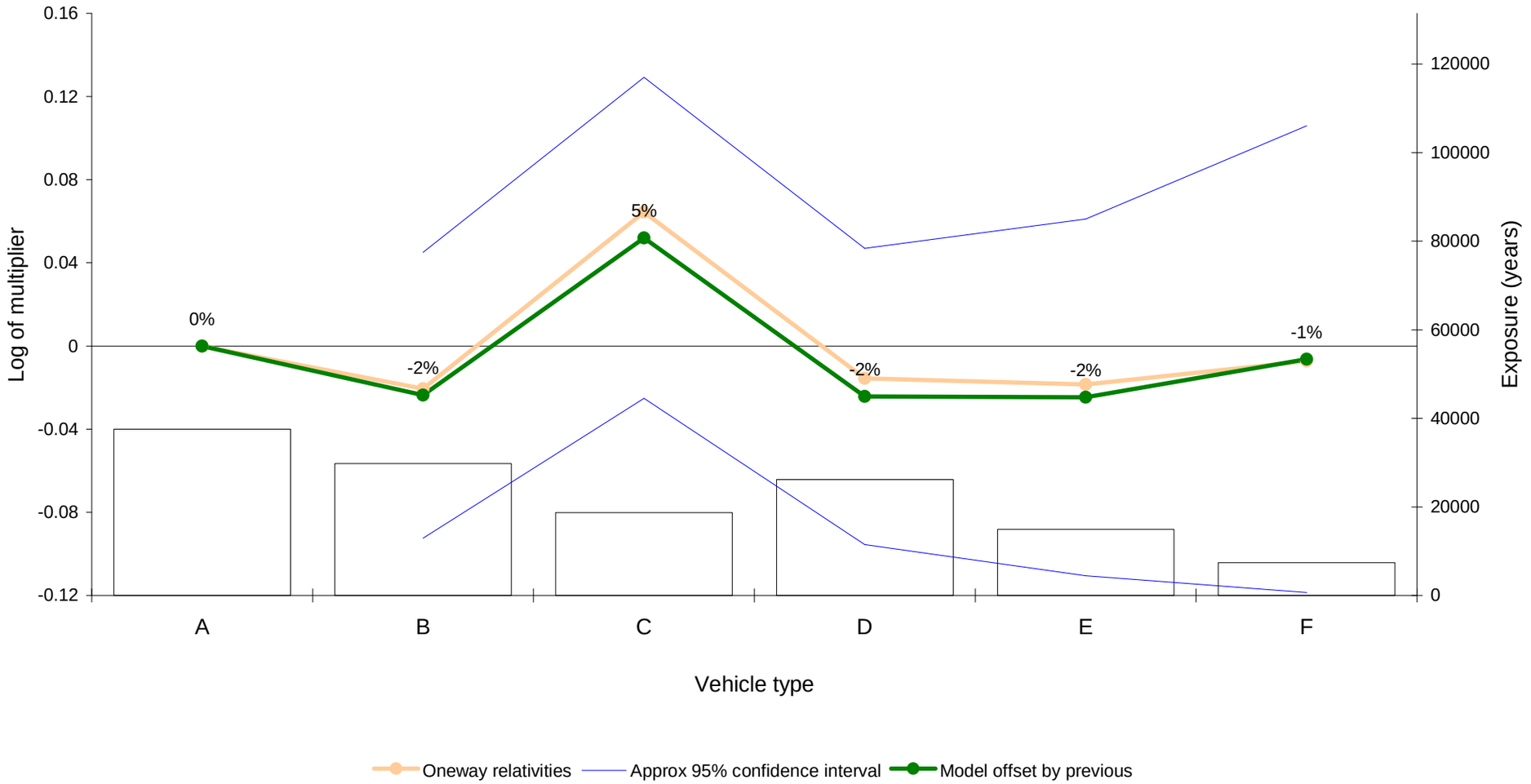
Benchmark renewal cohort - 6 months after implementation

Age	E(Volume)	Volume	% Difference	E(Freq)	Actual Freq	% Difference	E(Sev)	Actual Sev	% Difference	E(PP)	Actual PP	% Difference
16-20	11,500	11,845	3.0%	12.5%	13.1%	5.0%	3,200	3,213	0.4%	400	422	5.4%
21-24	46,910	45,972	-2.0%	8.9%	8.4%	-6.0%	3,034	3,094	2.0%	270	259	-4.1%
25-29	46,002	47,382	3.0%	6.0%	6.2%	3.0%	3,000	2,982	-0.6%	180	184	2.4%
30-39	55,517	53,296	-4.0%	5.1%	4.8%	-6.0%	2,941	2,990	1.7%	150	143	-4.4%
40-49	51,170	52,193	2.0%	4.8%	4.7%	-3.0%	2,708	2,778	2.6%	130	129	-0.5%
50-59	62,500	61,875	-1.0%	4.6%	4.6%	-1.0%	2,717	2,772	2.0%	125	126	1.0%
60-69	50,940	50,940	0.0%	4.8%	4.8%	0.0%	2,583	2,661	3.0%	124	128	3.0%
70+	44,602	43,709	-2.0%	5.4%	5.3%	-2.0%	3,333	3,278	-1.7%	180	173	-3.6%
	369,140	367,212	-0.5%	5.8%	5.7%	-1.8%	2,896	2,931	1.2%	170	169	-0.7%

Maintenance

Testing differences over previous analysis

Run 1 Model 2 Bodily Injury



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

watsonwyatt.com

C-6: Communicating Predictive Modeling Results

CAS Predictive Modeling Seminar
San Diego, October 6-7, 2008

Louis Mak FCAS FIAA
Watson Wyatt Worldwide

Watson Wyatt Worldwide