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Workers Compensation
Exposure Rating by Class

- Introduction
- The Standard Model
- Problems with the Hazard Group Approach
- Alternative Methodology
- ELF Refresher Course
- Illustration
- Comparison of Alternative and Standard Approaches
- Performance Testing

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Introduction

Introduction

- Exposure rating, a technique for pricing excess layers:
  1. Determine expected ground-up losses or loss ratio
  2. Allocate expected losses by layer
- Allocation of loss by layer
  - based on industry layer relationships
  - or in-house reinsurer curves
- For workers compensation, there is often a disconnect:
  - For ground-up expected losses - state and class level detail is used *(i.e. class rates)*
  - however, by layer, the industry typically uses sets of curves or tables that vary only by state and hazard group

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The Standard Model

The Standard Model

- "Excess ratio" denotes the ratio of expected excess losses to ground-up losses
- Excess ratios can be derived for each injury type *(fatal, permanent total…)*
  - *"partial excess ratios"* - weighted together give an overall excess ratio
- Standard approach adjusts for differences by state and hazard group:
  1. Size-of-loss distributions by injury-type are scaled using the prospective average cost per case for the state-hazard group combination being modeled.
  2. Weights applied to the partial excess ratios (in deriving an overall excess ratio) reflect state and hazard group differences.

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Problems with the Hazard Group Approach

Problems with the Hazard Group Approach

- Four-hazard group classification plan - *currently* used to price excess workers compensation - not sufficiently refined
  - Standard approach does not differentiate *within* hazard groups.
  - About 95% of workers compensation exposures are in Hazard Groups II and III
- Current Hazard Groups II and III are extremely heterogeneous
  - a class at the more severe end of Hazard Group III is much more hazardous than one at the other end
- Shortcomings prompted an alternative exposure rating methodology
- Anticipated refinements in NCCI methodology should dramatically improve pricing efficiency
  - More hazard groups
  - More homogeneity *within* hazard groups

Injury Type Frequencies

Across / Within Hazard Groups

Means

HG	Fatal:TT	PT:TT
1	0.21%	0.33%
2	0.28%	0.44%
3	0.69%	0.72%
4	1.83%	1.44%

95th Percentiles*

HG	Fatal:TT	PT:TT
1	0.86%	0.74%
2	0.97%	1.47%
3	2.82%	2.66%
4	4.79%	2.77%

**95th percentile of larger classes*

- Hazard Group means are very different.
- Significant variation exists within each Hazard Group

Most hazardous classes in Hazard Group I have as many Fatal and Permanent Total claims as the average Hazard Group III class code

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Alternative Methodology

Alternative Methodology
Our Approach

- Adjust weights by type of injury to reflect class differences in the composition of loss *within* Hazard Groups.
  - Changing the weights yields class-specific ELFs

Alternative Methodology
Relative Incidence Ratio

- Relative Incidence Ratio (for a given injury type) =
  ratio of expected ultimate claim counts for the injury type
  to the expected temporary total claim counts
  - V = Fatal : Temporary Total
  - W = Permanent Total: Temporary Total
  - X = Major Permanent Partial : Temporary Total
  - Y = Minor Permanent Partial : Temporary Total
  - M = Medical Only : Temporary Total

Alternative Methodology
Our Approach

1. Analyze the relative incidence of serious claims by type of injury at the Hazard Group level of detail
2. Use credibility method to adjust expectations for individual classes within each hazard group to reflect class deviations
   - to the extent these are credible

- Result: a vector of ***Relative Incidence Ratios*** for each class.
- A ***Vector of Class Relativities***
   - dividing corresponding entries of the class Relative Incidence Ratio Vector by the Hazard Group Relative Incidence Ratio Vector

Alternative Methodology
Assumed Structure for Relativities

$$V(HG, i, State) = V(HG) \times R(V,State) \times R(V, i)$$
$$W(HG, i, State) = W(HG) \times R(W,State) \times R(W,i)$$
$$X(HG, i, State) = X(HG) \times R(X,State) \times R(X,i)$$
$$Y(HG, i, State) = Y(HG) \times R(Y,State) \times R(Y,i)$$

Where i is the index for class

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Excess Loss Factor Refresher Course

Excess Loss Factor Refresher Course

State X
Hazard Group

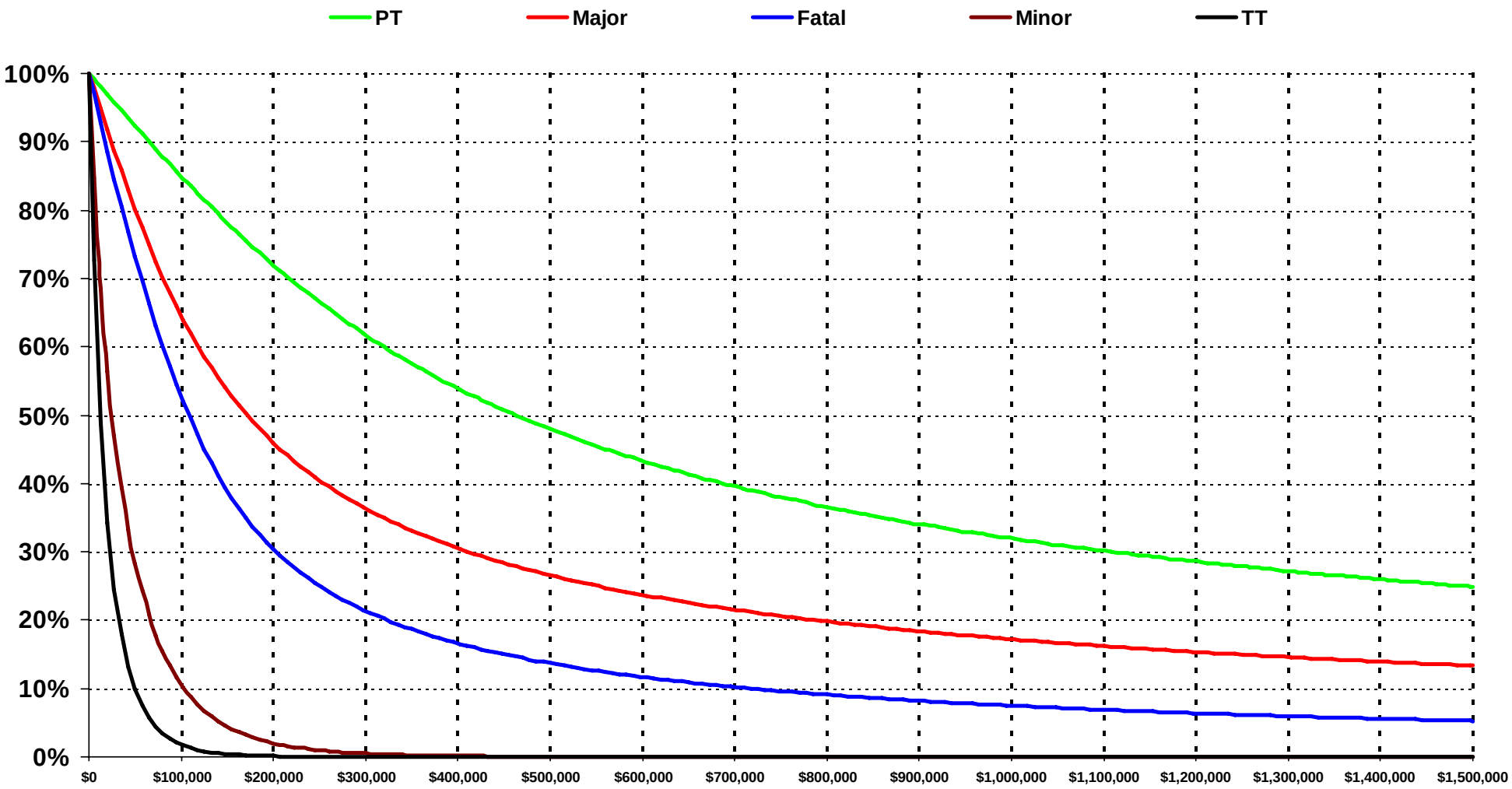
Retention	I	II	III	IV
250,000	12.5%	14.3%	24.8%	34.1%
500,000	8.1%	9.2%	16.5%	22.8%
1,000,000	5.2%	6.0%	10.7%	14.8%

Note:

- *ELF and Excess Ratio are used interchangeably (warning).*
- *ELF represents the portion of ground-up loss in excess of a given retention.*
- *ELFs vary by state and hazard group.*
- *ELFs below are for illustration only.*
- *Non-standard use of six injury types.*

Excess Loss Factor Refresher Course

An ELF is a Weighted Average of the ELFs by Injury Type



Non-standard ELFs for Illustration only.

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Excess Loss Factor Refresher Course

An ELF is a Weighted Average of the ELFs by Injury Type

Illustration: Calculation of HG 3 ELF at $500,000

	Fatal	PT	Major	Minor	TT	Medical	Total
ELF by Injury Type	13.7%	47.9%	26.6%	0.0%	0.0%	0.0%	
Injury Weights	3.4%	10.9%	40.7%	20.3%	19.3%	5.4%	
ELF x Weights	0.5%	5.2%	10.8%	0.0%	0.0%	0.0%	16.5%

State X

	Hazard Group			
Retention	**I**	**II**	**III**	**IV**
250,000	12.5%	14.3%	24.8%	34.1%
500,000	8.1%	9.2%	16.5%	22.8%
1,000,000	5.2%	6.0%	10.7%	14.8%

Non-standard ELFs for Illustration only.

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Illustration

Illustration

From Relative Incidence Ratio to Excess Loss Factor

- Knowing relative claim counts by injury type enables us to calculate composition of ground-up loss by injury type ("injury weights")
  - uniquely for each class.
- Final excess loss factor for a class is a weighted average of the excess loss factors by injury type.
  - Procedure generates class-specific weights by injury type
  - Apply weights to ELFs by injury type to produce class-specific excess loss factors
- Credibility weighting procedure
  - Gives each class credit for its experience
    - to the degree that experience is indicative of its underlying exposure
  - Method based on CAS Paper written by Gary Venter

Illustration: Injury Weights and Mean *Severity Vary by State and Hazard Group*

State X Injury Weights

HG	Fatal	PT	Major	Minor	TT	Medical	Total
1	0.7%	5.3%	26.7%	33.6%	24.6%	9.1%	100.0%
2	1.8%	5.0%	31.4%	28.2%	23.9%	9.8%	100.0%
3	3.3%	10.6%	40.9%	20.4%	19.4%	5.5%	100.0%
4	6.4%	12.9%	53.9%	12.1%	11.8%	2.7%	100.0%

State X Average Severity

HG	Fatal	PT	Major	Minor	TT	Medical
1	68,961	341,098	196,424	20,605	9,854	478
2	128,790	341,098	196,424	20,605	9,854	478
3	167,364	644,744	239,036	24,358	11,770	526
4	211,921	697,752	263,418	28,200	14,086	573

Note: non-standard injury breakdown (for Illustration only)

Illustration: Adjusting the Relative Frequency *by Injury Type to Reflect Class Differences*

Hazard Group III

Injury Type	Mean Severity	Relative Frequency	%Loss
Fatal	$167,364	0.012	3.30%
PT	$644,744	0.010	10.60%
Major PP	$239,036	0.104	40.87%
Minor PP	$24,358	0.510	20.42%
TT	$11,770	1.000	19.35%
Medical Only	$526	6.302	5.45%
Average Severity	$7,662		100.00%

Injury Type	Expected Frequency	Expected Loss
Fatal	1.97	$330,199
PT	1.64	$1,060,033
Major PP	17.10	$4,087,229
Minor PP	83.85	$2,042,415
TT	164.41	$1,935,124
Medical Only	1,036.12	$545,000
Total	1,305.10	$10,000,000

- Illustrates expected distribution of loss to a policy that is in Hazard Group III
- Assumes 1,305.10 claims for loss of $10,000,000 ground up with an average claim equal to $7,662 ($10,000,000/1,305.10)

Illustration: Adjusting the Relative Frequency *by Injury Type to Reflect Class Differences*

Hazard Group III

Class 7229

Injury Type	Mean Severity	HG Rel. Freq.	Class Relativity	Class Rel. Frequency	% Loss
Fatal	$167,364	0.0120	1.185	0.014	3.68%
PT	$644,744	0.0100	1.191	0.012	11.87%
Major PP	$239,036	0.1040	1.352	0.141	51.93%
Minor PP	$24,358	0.5100	0.634	0.323	12.17%
TT	$11,770	1.0000	1.000	1.000	18.19%
Medical Only	$526	6.3020	0.423	2.666	2.17%
Average Severity		$7,662		$15,573	100.00%

- Evaluating at the class code level
  - expected distribution of losses by injury type changes
- Class Relative Frequency = HG Relative Frequency x Class Relativity
- Alternative methodology reveals class to be significantly more hazardous than average of HG III
  - Higher expected frequency of serious injuries
  - Average cost per claim ***jumps 103%*** (from $7,662 to $15,573)

Illustration: Impact of Change In Composition *of Loss on ELF at $500,000*

	State X, Hazard Group III			State X, Hazard Group III - Class 7229		
Injury Type	**Expected Losses**	**ELF**	**Expected Excess**	**Expected Losses**	**ELF**	**Expected Excess**
Fatal	330,199	13.7%	45,182	367,740	13.7%	50,319
PT	1,060,033	47.9%	508,088	1,186,530	47.9%	568,719
Major PP	4,087,229	26.6%	1,085,704	5,193,415	26.6%	1,379,544
Minor PP	2,042,415	0.0%	822	1,216,972	0.0%	490
TT	1,935,124	0.0%	5	1,818,679	0.0%	5
Med. Only	545,000	0.0%	-	216,663	0.0%	-
Total /Average	10,000,000	16.4%	1,639,802	10,000,000	20.0%	1,999,078

22% differential

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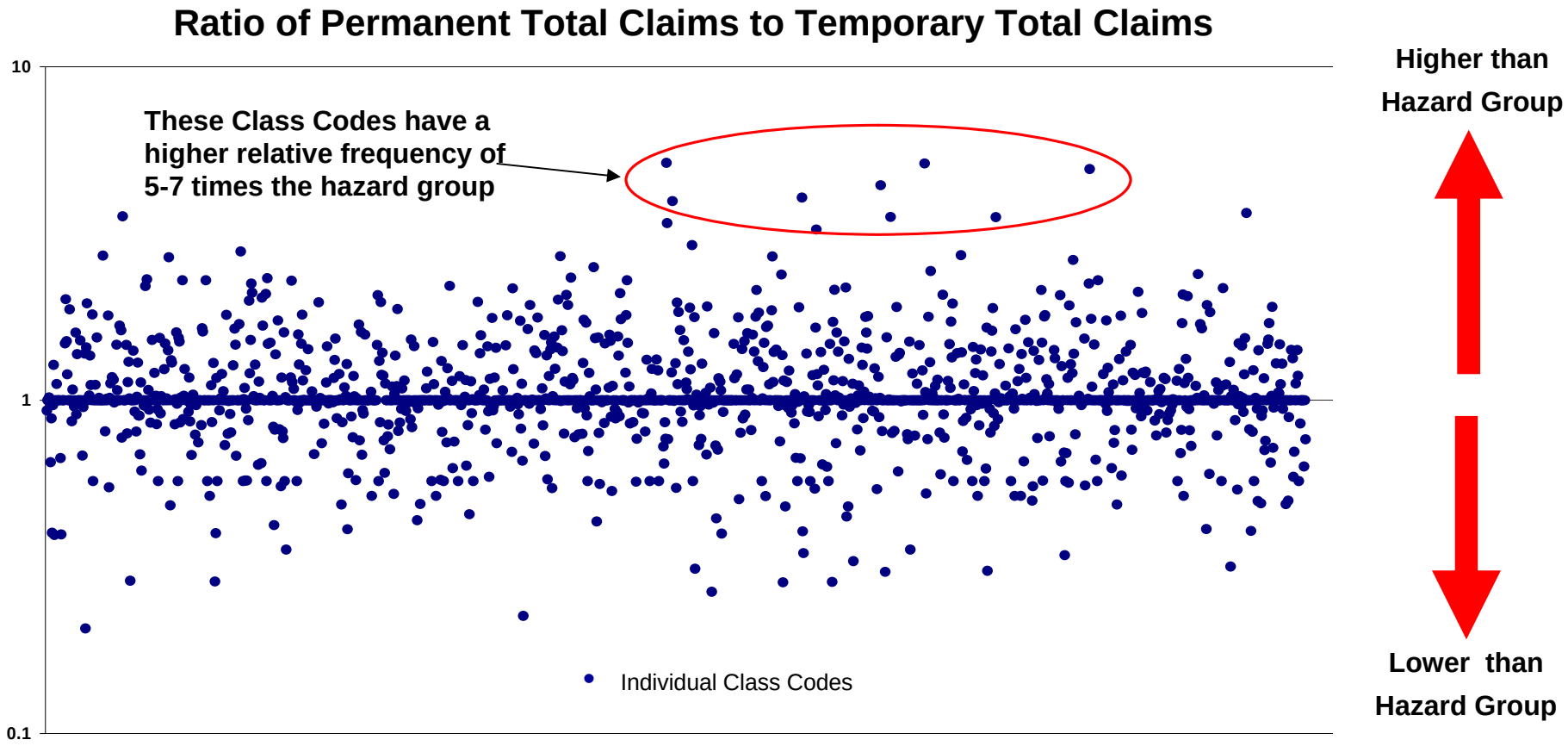
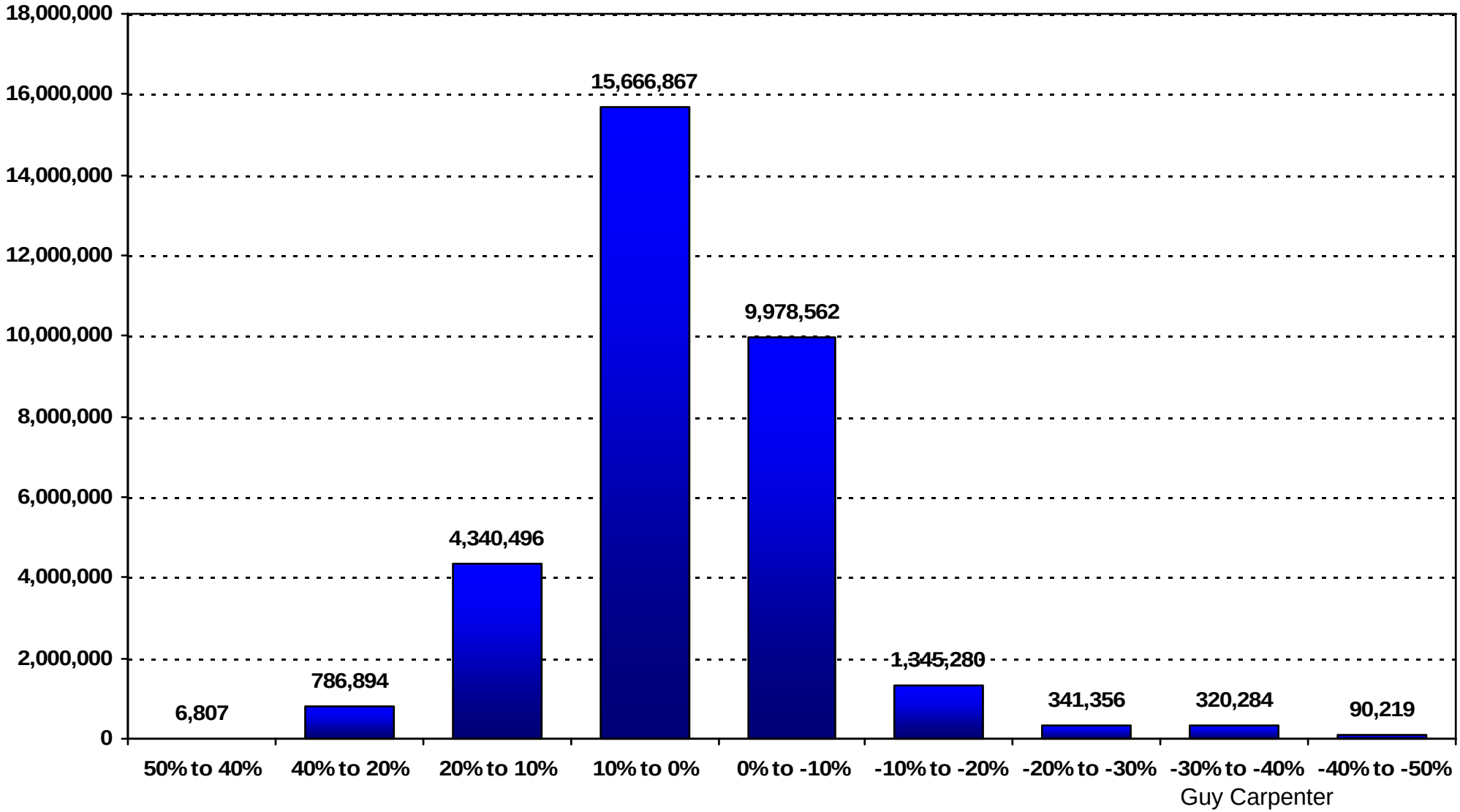
Comparison of Alternative and Industry Standard Approaches

Plotting the Class Codes
Relative Frequency by Class Code

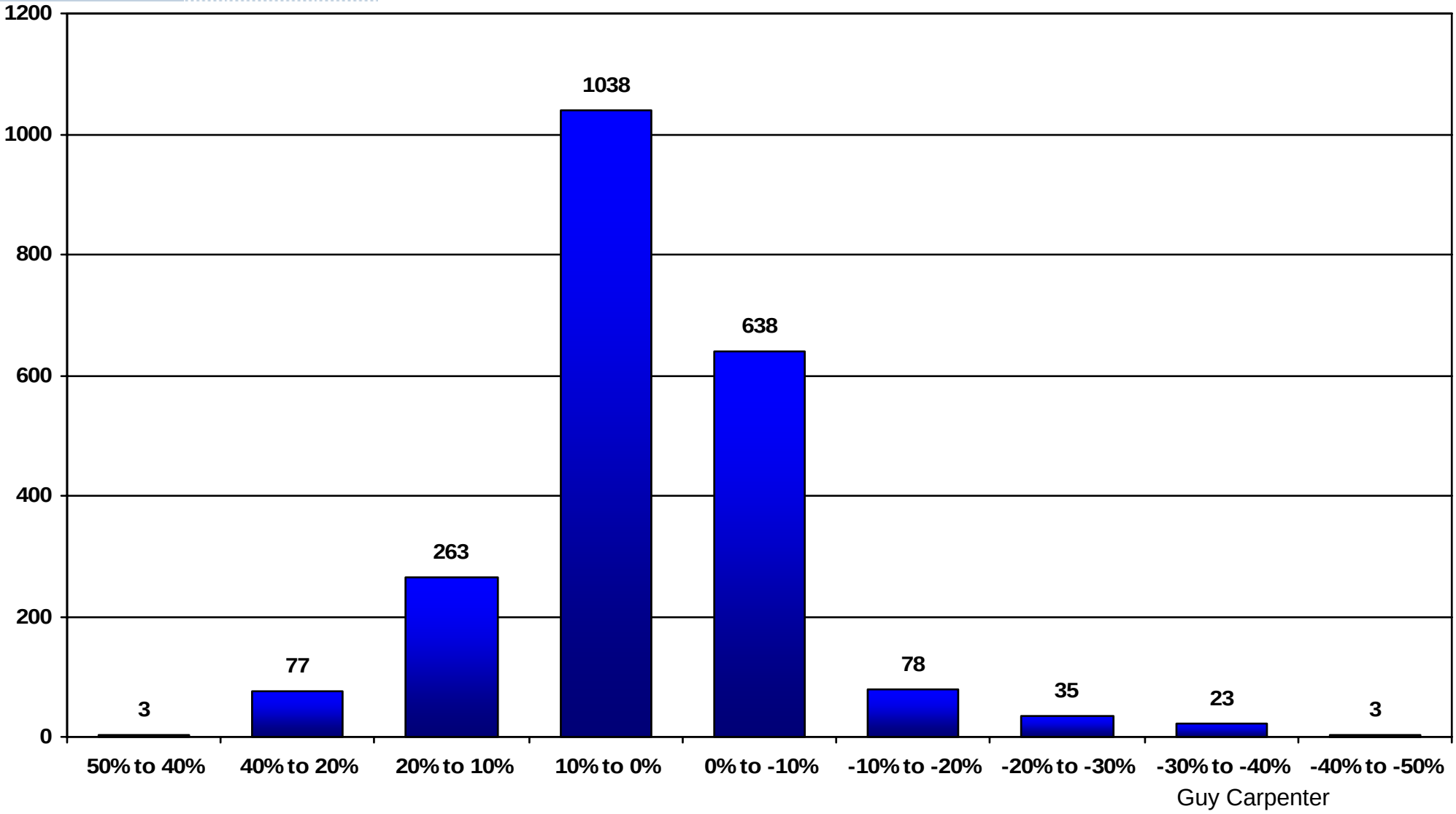


A point plotted near "1" represents a class code that has historically had an "average" number of observed Permanent Total claims, compared to the Hazard Group average. A point significantly above or below has had a disproportionate number of PT claims, compared to the class's HG average.

Results – Portfolio X
Layer $400,000 xs $100,000
Deviation from Hazard Group by Loss Cost



Results – Portfolio X
Layer $400,000 xs $100,000
Deviation from Hazard Group ELF by Number of Class Codes



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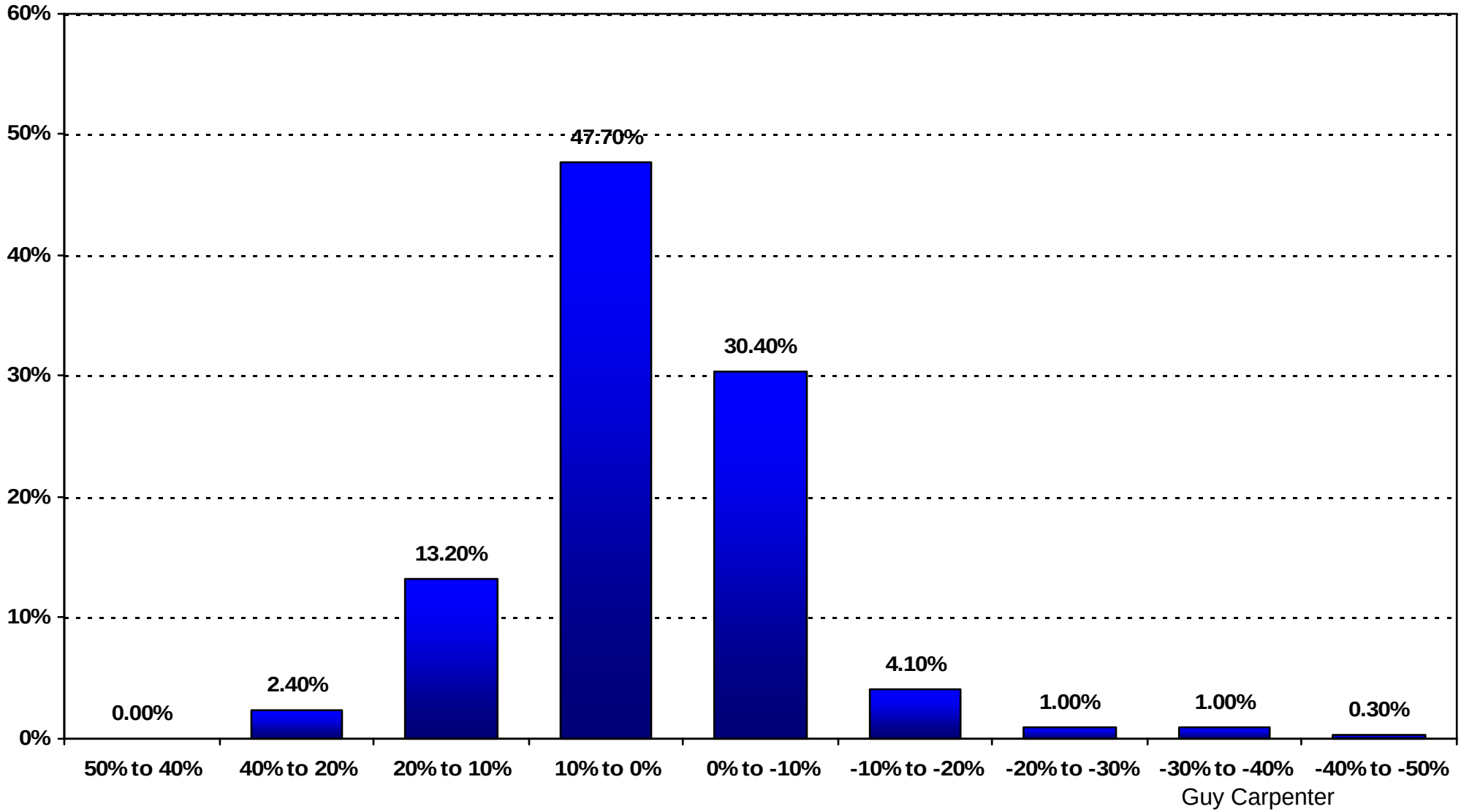
Results – Portfolio X
Layer $400,000 xs $100,000
Deviation from Hazard Group by Percentage of Loss



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Performance Testing

Quintiles Test

Performance Testing:
How Much Improvement Will This Procedure Yield?

- Split the data into historical and prospective periods.
- Estimate model parameters using only historical period data.
  - How well does the model predict outcome for prospective period?
- Specifically, we calculate class relativities using four years and attempt to predict results for fifth year.

Performance Testing:
How Much Improvement Will this Procedure Yield?

- Illustrate the procedure using Permanent Total relativities for classes in Hazard Group III
  - The procedure for the other injury types is the same
- Calculate the expected PT claim count for each class using only Hazard Group information
  - Without class-specific relativities, the expected number of PT claims in Hazard Group III is calculated as .0072 times the number of Temporary Total Claims *(the actual prospective period count)*

Performance Testing:
How Much Improvement Will this Procedure Yield?

- Classes within Hazard Group III are aggregated into 5 equal groups according to the value of their 4-year credibility weighted class
  - Lowest 20% of values belong to the risks in the 1st Quintile
    - the next 20% to the second - and so on
  - Extent to which the 4-year class relativities are predictive of the 5th year will be reflected in the pattern of the ratios of actual 5th year experience to expected 5th year experience (based on the Hazard Group PT : TT ratio)
  - **1st Quintile** (made up of what are presumably the best classes within the Hzd Gp)
    - will have a ratio of actual to expected significantly better than 1.00
  - **5th Quintile** (consisting of the more hazardous classes within the Hzd Gp)
    - will produce a ratio of actual to expected much higher than 1.00

Performance Testing: PT Quintiles Test
Hazard Group III

(1)		(2)	(3)	(4)	(5)	(6)
Quintile		**Before**	**Squared Deviation From Mean**	**After**	**Squared Deviation From Mean**	**Test Statistic (5) / (3)**
1		0.5983	0.1614	1.0392	0.0015	0.0095
2		0.8541	0.0213	1.0838	0.0070	0.3295
3	(about 2.5x)	0.8442	0.0243	0.9883	0.0001	0.0056
4		1.1341	0.0180	1.0847	0.0072	0.3992
5		1.5378	0.2893	0.9118	0.0078	0.0269
Mean / Total		1.0000	0.5143	1.0000	0.0236	0.0460

Actual to Expected *Permanent Total* Claim Counts Before & After Class Adjustment

- The ratios of actual to expected in column (2) increase across the Quintiles
- The sum of Squared Deviations in column (3) is 0.5143
  - ➔ there is significant variability of PT frequency within Hazard Group 3
- **Classes in 5th Quintile are almost 2.5x more likely to experience a PT claim than in the 1st**

Performance Testing: PT Quintiles Test
Hazard Group III

Actual to Expected *Permanent Total* Claim Counts Before & After Class Adjustment

(1)	(2)	(3)	(4)	(5)	(6)
Quintile	Before	Squared Deviation From Mean	After	Squared Deviation From Mean	Test Statistic (5) / (3)
1	0.5983	0.1614	1.0392	0.0015	0.0095
2	0.8541	0.0213	1.0838	0.0070	0.3295
3	0.8442	0.0243	0.9883	0.0001	0.0056
4	1.1341	0.0180	1.0847	0.0072	0.3992
5	1.5378	0.2893	0.9118	0.0078	0.0269
Mean / Total	1.0000	0.5143	1.0000	0.0236	0.0460

- **Application of class relativities against Yr. 5 data yields ratios of actual to modified expected in column (4).**
- **To the extent that our class relativities perform, the "After" ratios in column (4) will be flatter; producing a lower sum of the squared deviations (in this case .0236).**

➔ **The use of class relativities dramatically improves rating accuracy.**

Performance Testing: Fatal Claims Quintiles Test Hazard Group 3

Actual to Expected *Fatal Total* Claim Counts Before & After Class Adjustment

(1)		(2)	(3)	(4)	(5)	(6)
Quintile		Before	Squared Deviation From Mean	After	Squared Deviation From Mean	Test Statistic (5) / (3)
1		0.4455	0.3074	0.8150	0.0324	0.1114
2		0.6807	0.1019	0.9288	0.0051	0.0497
3	(about 4x)	0.7633	0.0560	0.8180	0.0331	0.5912
4		1.2190	0.0479	1.0323	0.0010	0.0217
5		1.8480	0.7191	1.1727	0.0298	0.0415
Mean / Total		1.0000	1.2323	1.0000	0.1014	0.0838

- **Difference of Fatalities within Hzd Gp III is significant as can be seen with the 5th Quintile (1.848) over 4x as more likely to sustain a fatality as the 1st Quintile (.4455)**
- **Alternative procedure reduces variability as can be seen by flattening of error ratios in column (5) relative to column (3).**

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