NCCI's New ELF Methodology

Presented by:

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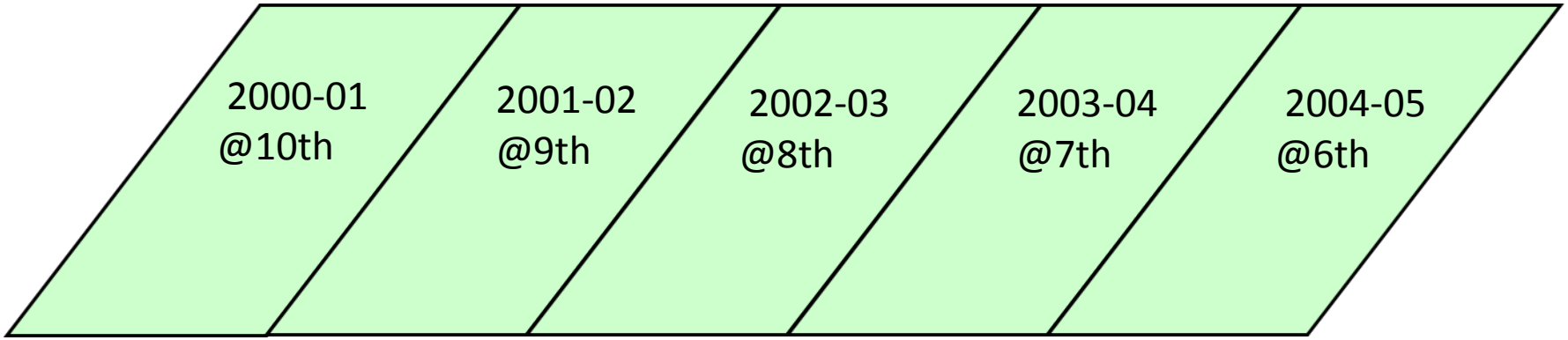
Overview

- 6 Key Components of the New Methodology
  - Advances in the Proposed ELF Methodology
  - Differences from Prior Approach
- Impact analysis for ELFs – For Countrywide (i.e., NCCI states) and Across States
- New Per Occurrence Model
- Catastrophe Considerations
- Summary of R-1408 Filed Excess Ratios
- Summary

Key Components in the New ELF Methodology

Organization and Maturity of the Data

Data Underlying the New CW ELF Curves:
Unit Statistical Plan Policy Periods* and Report Levels



- The data underlying the prior state ELF curves is from approximately 1995-1997. Maturity is:
  - @3rd – 5th reports for fatal and permanent total
  - @5th report only for permanent partial, temporary total, and medical-only
- Advantage: New CW curves use more mature data and much more volume than prior state curves

* New curves exclude Pre-reform data for Florida (prior to 10-1-03). Policy periods vary by state.

Organization of the Data: Comparison of Prior and New Claim Groupings

Prior ELFS – Curves by Injury Type
Fatal
Permanent Total (PT)
Permanent Partial (PP)
Temporary Total (TT)
Medical-Only

New ELFs- Curves by Claim Groups
Fatal
Permanent Total (PT)
Likely-to-Develop (PP & TT)*
Not-likely-to-Develop (PP & TT)
Medical-Only

- Advantages:
  - Incorporates injured part of body and open/closed claim status for grouping PPD and TTD
  - Reduces injury type crossover due to introduction of likely-to-develop and not likely-to-develop groups

* Consists of open claims @ 1st report and having injured parts of body including head, back, trunk, multiple body, etc.

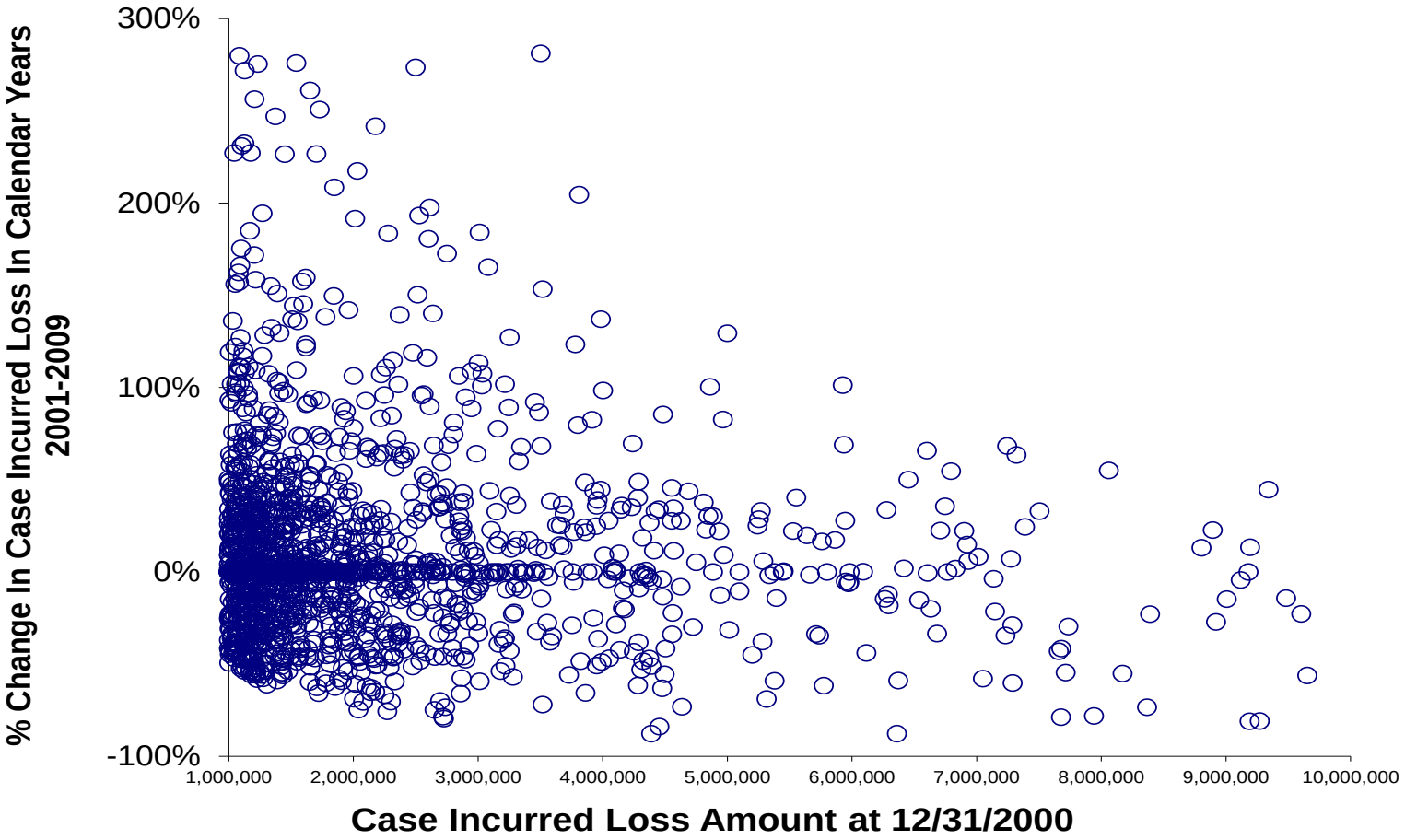
Loss Development and Dispersion Model: A Two-Step Approach

Loss Development and Dispersion Approach

- Dispersion models and loss development are applied within each claim group
- Loss development measures the change in reported loss amounts from one point in time to another
- Dispersion:
  - Is a probabilistic approach to individual claim loss development using a distribution of LDFs
  - Reflects the fact that claims do not all develop by the same uniform percentage
  - Necessary to capture uncertainty, such as the expected contribution to higher loss layers
- Both the prior and new methodologies:
  - Are based upon empirical data
  - Apply all loss development to open claims only
  - Balance the aggregate loss development to the appropriate factors used in loss cost filings
- For the new methodology, loss development varies by size of loss up to a 10th report

Case Incurred Loss Development by Size of Loss in 2001-2009

Accident Years 1984-1995*



Source data: Call 31 data in states where NCCI provides ratemaking services, excluding TX and WV.

*Evans, Jon, *WC Excess Loss Development*, NCCI, 2011.

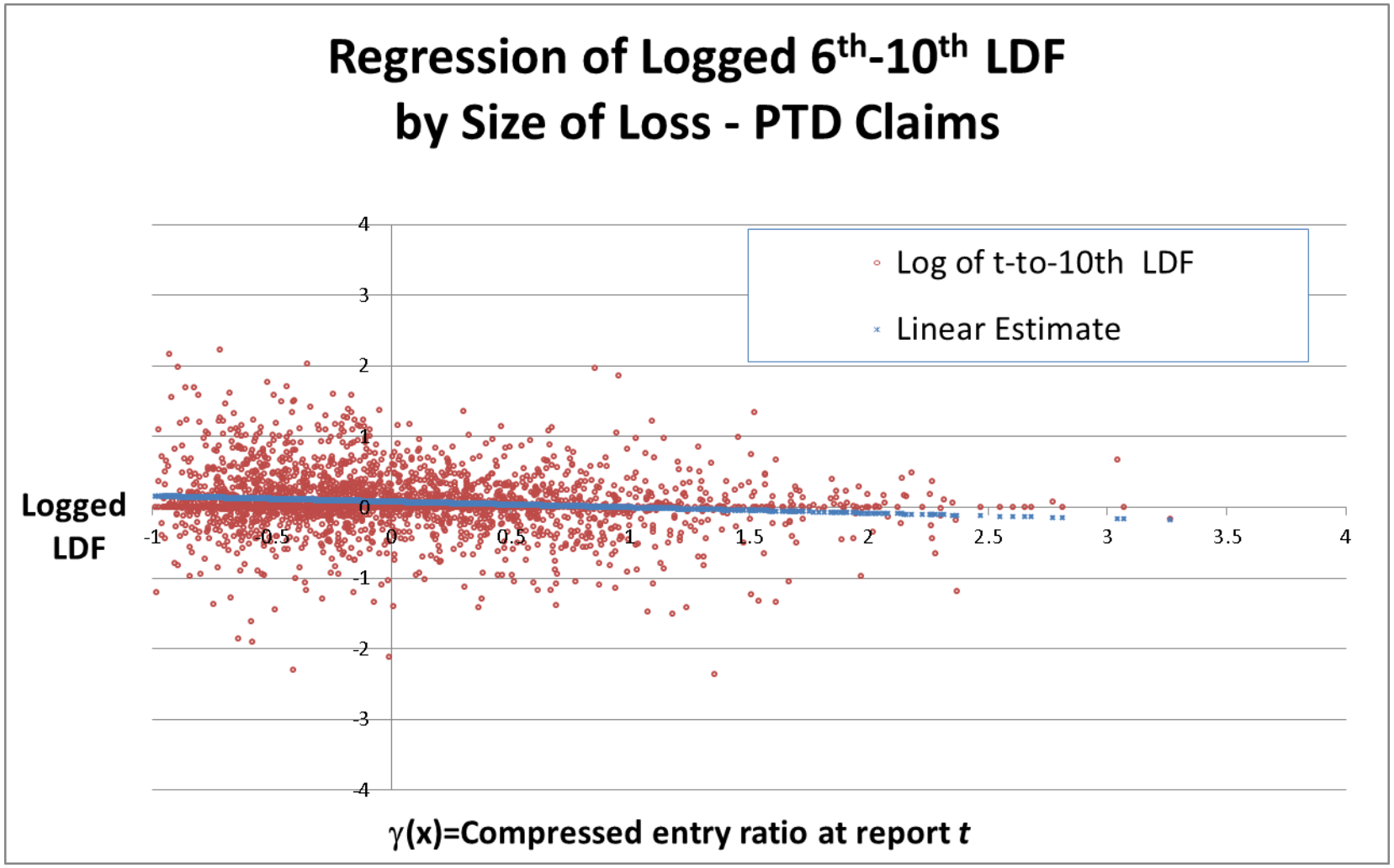
Loss Development and Dispersion:
Overview of the New Two-Step Approach

- The new ELF methodology introduces a new "Two-Step" approach
- The following are common for each of the steps:
  - The goal is to determine an expected excess loss for each open claim
  - LDFs by state, claim grouping, and report are rescaled to apply to open claims
  - We'll refer to it as "open only" LDF factors
  - LDFs for closed claims are 1.0
  - The "open only" LDF is replaced with a distribution of LDFs
  - Assumes the LDF distribution is lognormal

Overview of Two-Step Approach

- Step 1 (through 10th report) –The mean and variance of the LDF distribution varies by size of loss
  - Linear regression considers individual claim development from report *t* to report 10 and relates it to the open claim amount at report *t*
  - A linear regression model is determined:
    - For claims open at each of 4 reports *t*, for *t* = 6, 7, 8, 9
    - For each of the 5 claim groupings
    - 20 models in total
- NCCI applied development by size of loss only where WCSP data can be observed (i.e., 10th report and prior)
- For Step 2 (10th-to-ultimate) - The mean and variance of the LDF distribution does not vary by size of loss

Illustration: Step 1 (through 10th report)

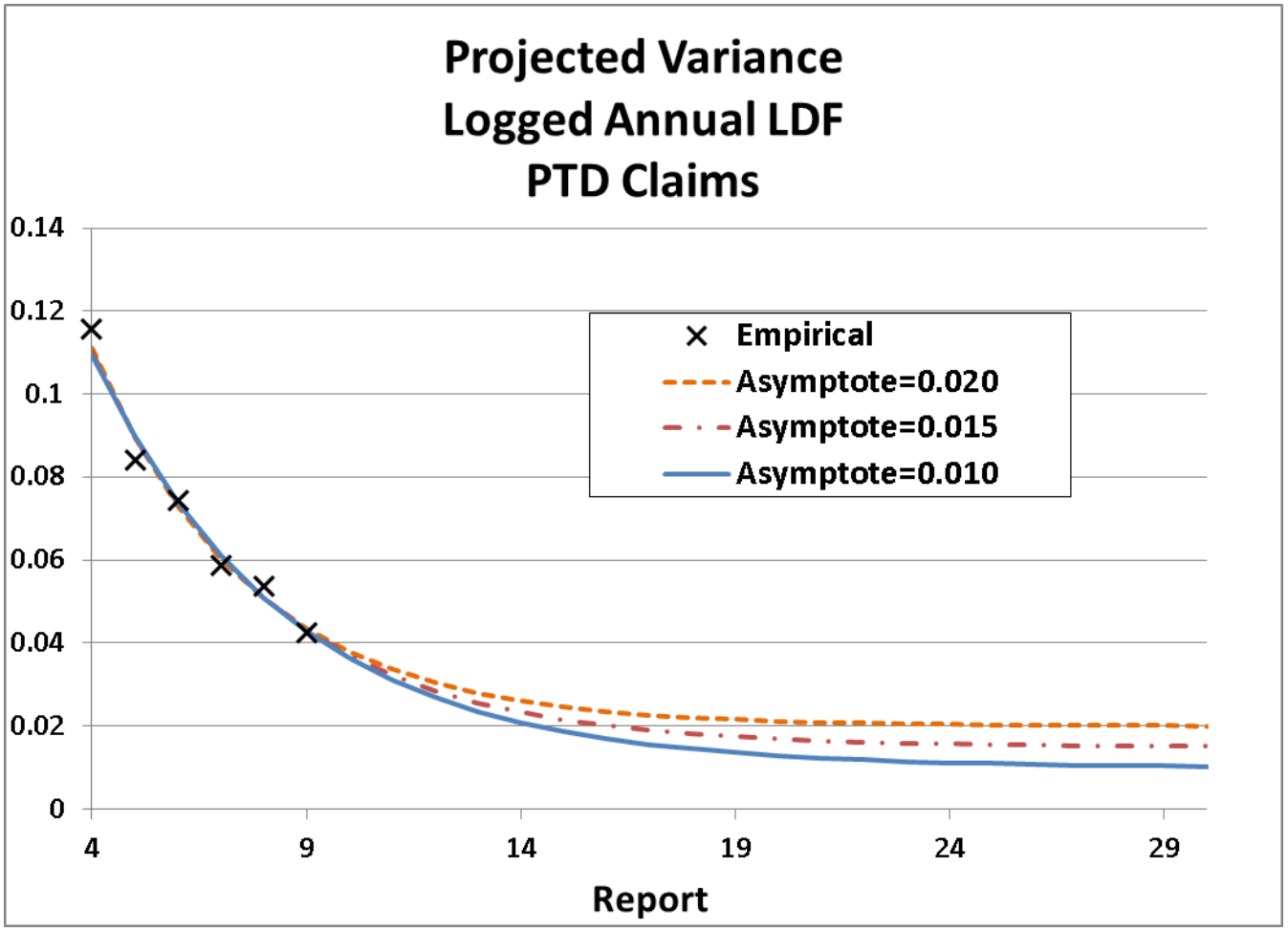


Source of Data: WCSP data from 6th-10th reports for 36 jurisdictions where NCCI provides ratemaking services. Model uses the "compressed" size of loss metric $\gamma(x) = \ln(x)$ for $x \geq 1$; $\gamma(x) = x-1$ for $x \leq 1$ as the only explanatory variable.

Overview of Step 2 (10th - ultimate)

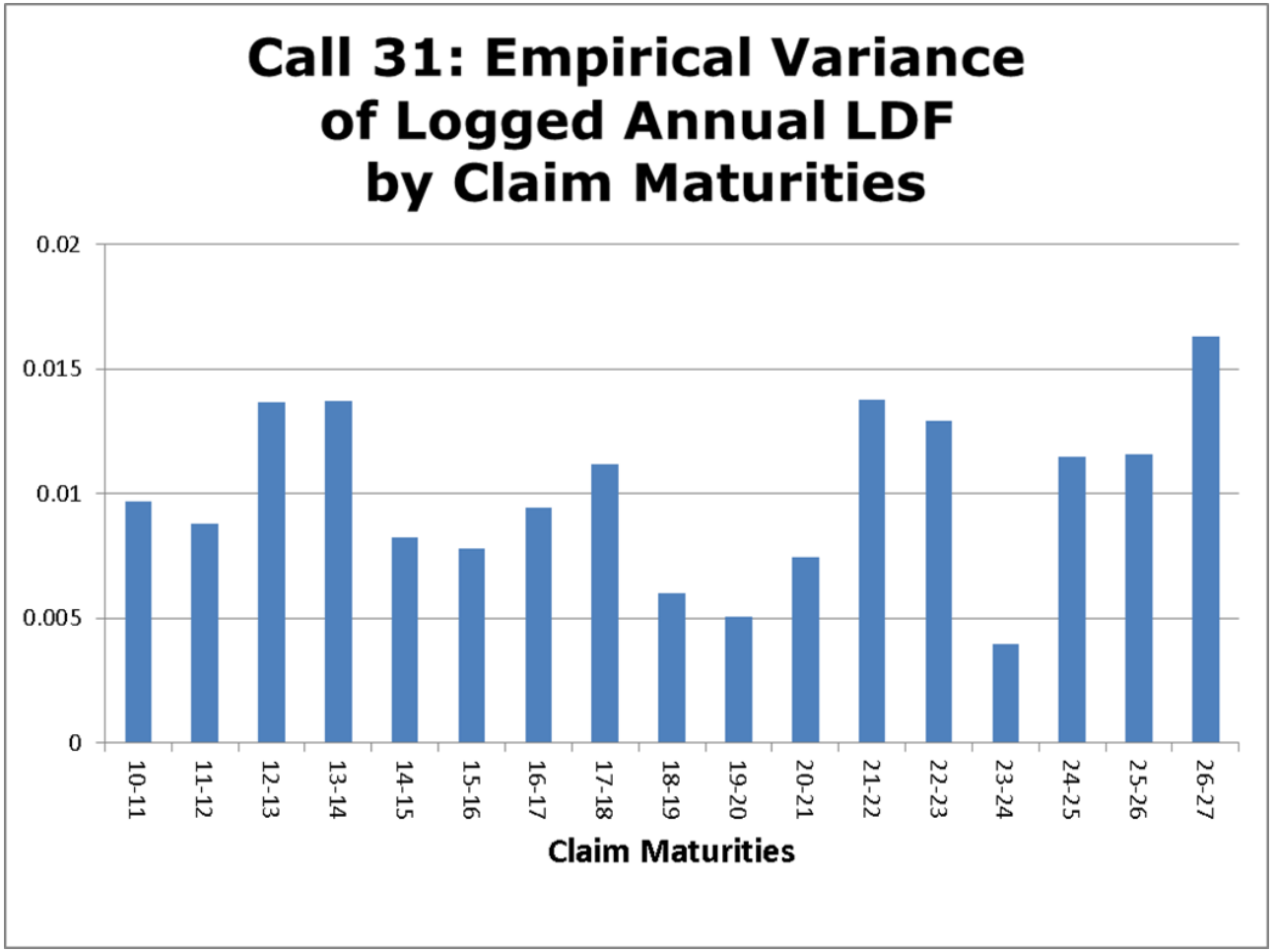
- Development and Dispersion does not vary by size of loss
- The following describes the Development and Dispersion routine for Step 2:
  - The variance of the LDF distribution considers observed variance of annual LDFs from reports t to t+1,for t = 4 to 9
  - Reflects a declining age-to-age LDF variance for longer duration claims
  - Duration to closure varies by claim group (closure rate is constant)
  - Large Loss Call 31 data is used to project asymptotic variance
- Aggregate expected loss dollars for open cases is balanced to the open-only LDF by state, report, and injury type

Step 2 (beyond 10th report)
Projecting the Variance of LDFs for PT Claims



Source of Data: WCSP data from 4th-10th reports for 36 jurisdictions where NCCI provides ratemaking services.

Step 2 (beyond 10th report)
Choice of Long-Term LDF Variance Estimate



Source of Data: Call 31 data from AYs 1984-2001 and valuation years 1998-2011.

Loss Development and Dispersion Summary

- The new loss development and dispersion approach provides several advantages over the current
- Having empirical data out to 10th report enhances:
  - Projections of loss development to closure
  - Categorization of claims into claim groupings
- Varies by size of loss*; the new methodology reflects this in the age-to-age LDFs from 6th through 10th reports

* Evans, Jon, *WC Excess Loss Development*, NCCI, 2011.

Form of Body of ELF Curves

Form of Body of ELF Curves

- The prior methodology uses empirical excess ratio tables by state and injury type
- New methodology curves will use a mixture of lognormal excess ratio functions for each claim group
- The advantages of the new methodology are:
  - Countrywide curves less anomalous to outliers
  - Spreadsheet friendly representation in a closed functional form
  - Parameters can be modified to reflect a change in shape by state
  - Provides very good fits
- Staff compared results of lognormal mixture to other familiar families of curves

Form of Body of ELF Curves

- Each claim group (examples below) is fit by a 2-lognormal mixture. Selected forms are shown in bold
- The table illustrates a very good fit by Lognormal mixtures

Claim Grouping	Distributional Form	Number of Components	Number of Points Fit	Sum of Squared Differences
Likely PPTT	Lognormal	1	4,500	0.3
	Gamma	1	4,500	36.5
	Weibull	1	4,500	4.6
	Lognormal Mix	**2**	**4,500**	**0.0008**
	Lognormal Mix	4	4,500	0.0008
PTD	Lognormal	1	4,199	4.8
	Gamma	1	4,199	50.7
	Weibull	1	4,199	6.4
	Lognormal Mix	**2**	**4,199**	**0.007**
	Lognormal Mix	4	4,199	0.007

Form of Tail of ELF Curves

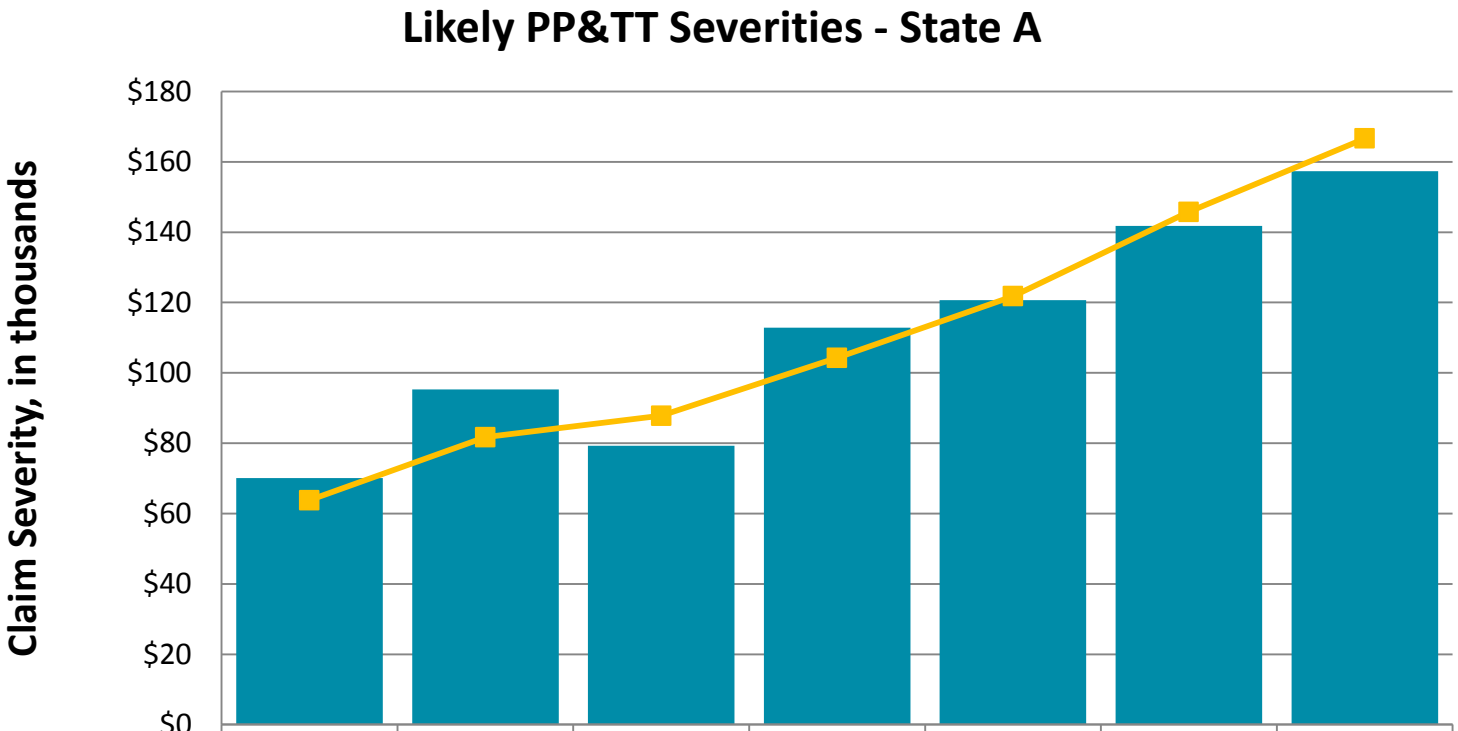
- The prior methodology uses mixed exponential tail by state and injury type
- In the new methodology, claims from all states (normalized to entry ratios) are pooled in fitting both the body and tail of a countrywide curve
- A Generalized Pareto (GPD) tail will be spliced upon each CW curve by claim group (right-hand tail)
- Extreme Value Theory shows GPD is the correct form for asymptotic behavior

Multi-Level Models to Determine Average Cost per Claim and Loss Weights

New Multilevel Models

- Two multilevel statistical models are used to separately estimate
  - Severities
  - Claim counts
- Observed values by state, hazard group and claim group are input into each model for 36 states
- The models produce fitted severities and fitted claim counts
- The fitted severities and fitted claim counts are then combined to produce loss weights (by state, hazard group, and claim group)
- The models are used to develop weights and severities for these claim groups:
  - Fatal
  - Likely-to-develop PP and TT
  - Not-Likely-to-develop PP and TT
- For Permanent Total, we apply a special procedure (illustrated in a later section)

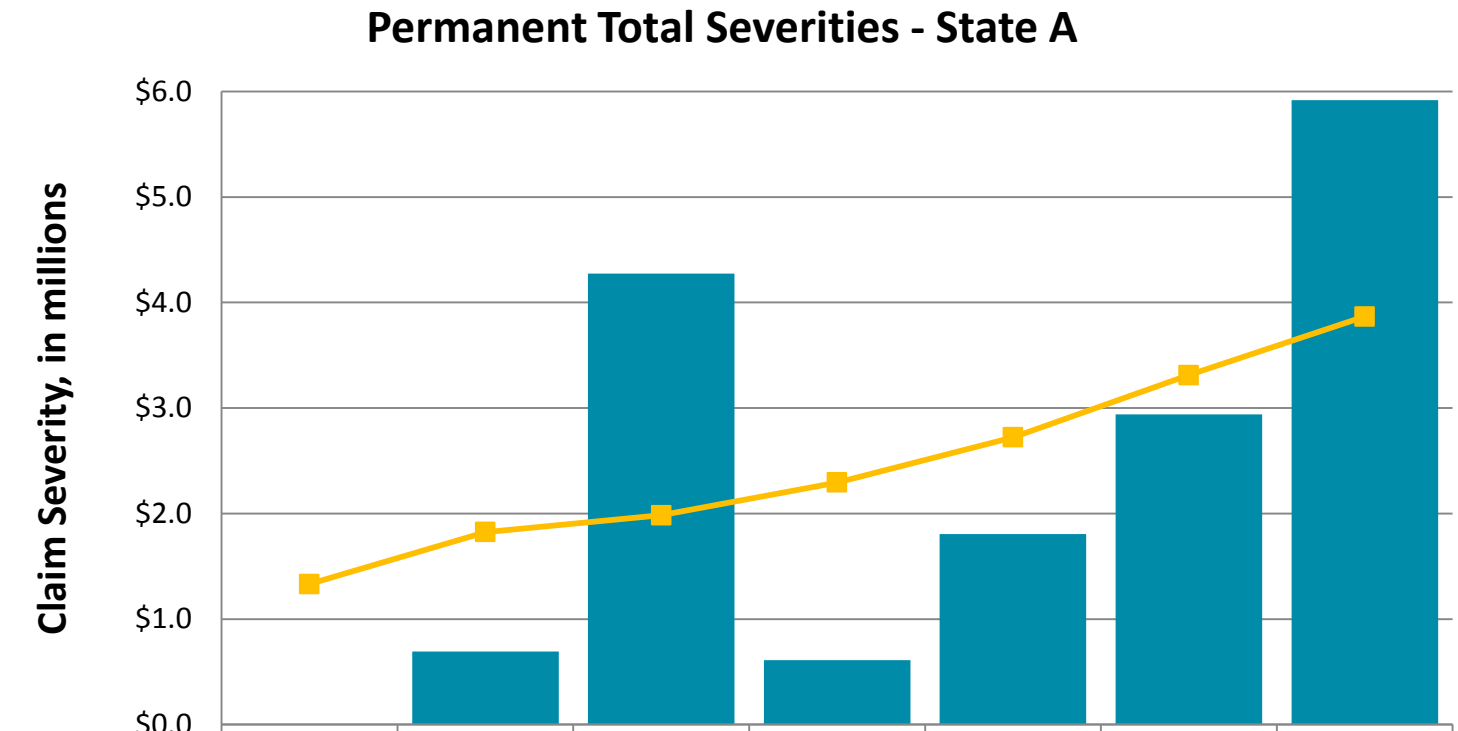
Illustration of Multilevel Model on Severities Small State A



	A	B	C	D	E	F	G
Observed	70,112	95,287	79,302	112,827	120,663	141,750	157,304
Fitted	63,764	81,702	87,823	104,264	121,778	145,736	166,655
Claim Counts	152	468	1,002	442	760	741	213

Severities for claim groups other than PT are based on WCSP data from the 5 recent policy periods. Observed severities are developed to ultimate, on-leveled, and trended to 2014 while claim counts are developed to ultimate.

Illustration of Multilevel Model on Severities Small State A



	A	B	C	D	E	F	G
Observed	0	691,242	4,274,211	610,125	1,804,474	2,939,829	5,917,490
Fitted	1,331,796	1,824,246	1,984,020	2,293,832	2,722,321	3,311,466	3,866,450
Claim Counts	0	8	9	2	19	16	8

Permanent total severities are based on WCSP data from policy periods 2000-2005. Severities and claim counts are developed to ultimate.

Advantages to Using Multi-Level Models for Generating Loss Weights and Severities

- Based upon pooled data from 36 states, each model generates smoothed results even when minimal claims are present
- Adds stability for annual updates of loss weights and severities by state and claim group
- New method will impose improved structure on hazard group relativities
- Minimizes the possibility of excess ratio reversals across hazard groups

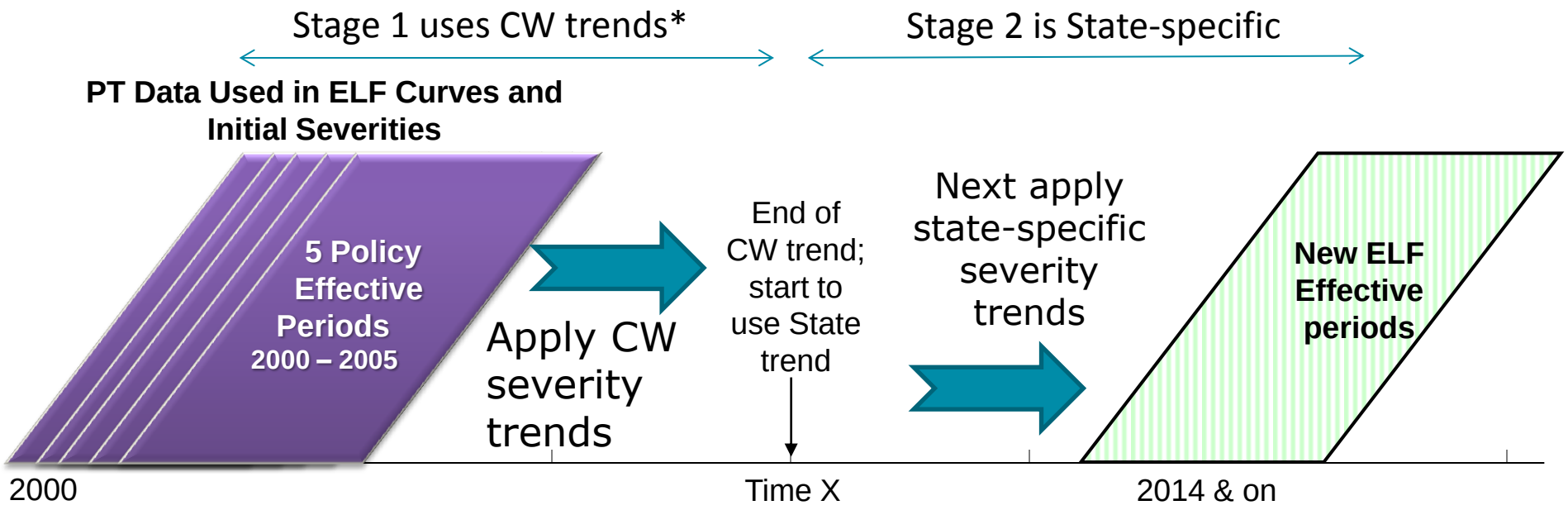
Treatment of Permanent Total Claims

Treatment of Permanent Total Claims

- PT claims are characterized by:
  - A high variation in individual claim amounts
  - A low volume, particularly in small states
- This can cause resulting ELF values to fluctuate from year to year in the prior methodology
- To reduce potential fluctuations for the PT claim group in the new methodology, two amounts are determined and held constant:
  - An initial PT severity by state and hazard group
  - The PT share of lost-time claims by state and hazard group
- This treatment stabilizes ELFs from one year to the next:
  - It reduces volatility due to reported data
  - Is responsive to changes in state average claim cost trends

Trending Permanent Total Claims for Annual Updates: Two Stages

- Advantages: Stabilizes ELFs by state for annual updates; adds consistent treatment of PT claims



Time X represents the midpoint of the 5 years of data used in annual updates. Loss dollars are also on-leveled to the future effective period.

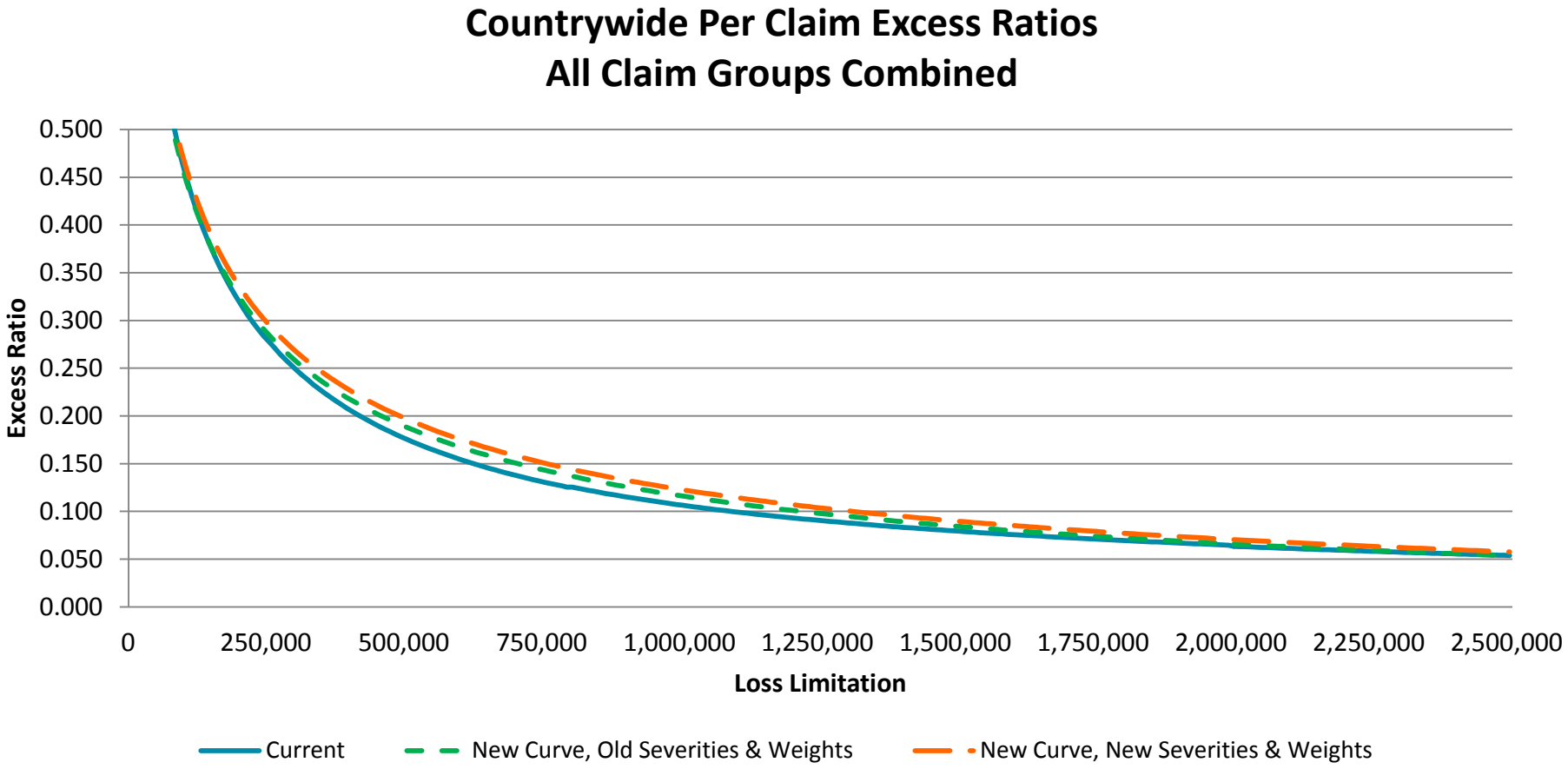
*NCCI tested alternatives of using state severity throughout the entire period. The selected approach proved to have the best balance between stability and responsiveness to state-specific data.

Impact Analysis: Comparisons of Countrywide Excess Ratio Curves

Impact Analysis Review

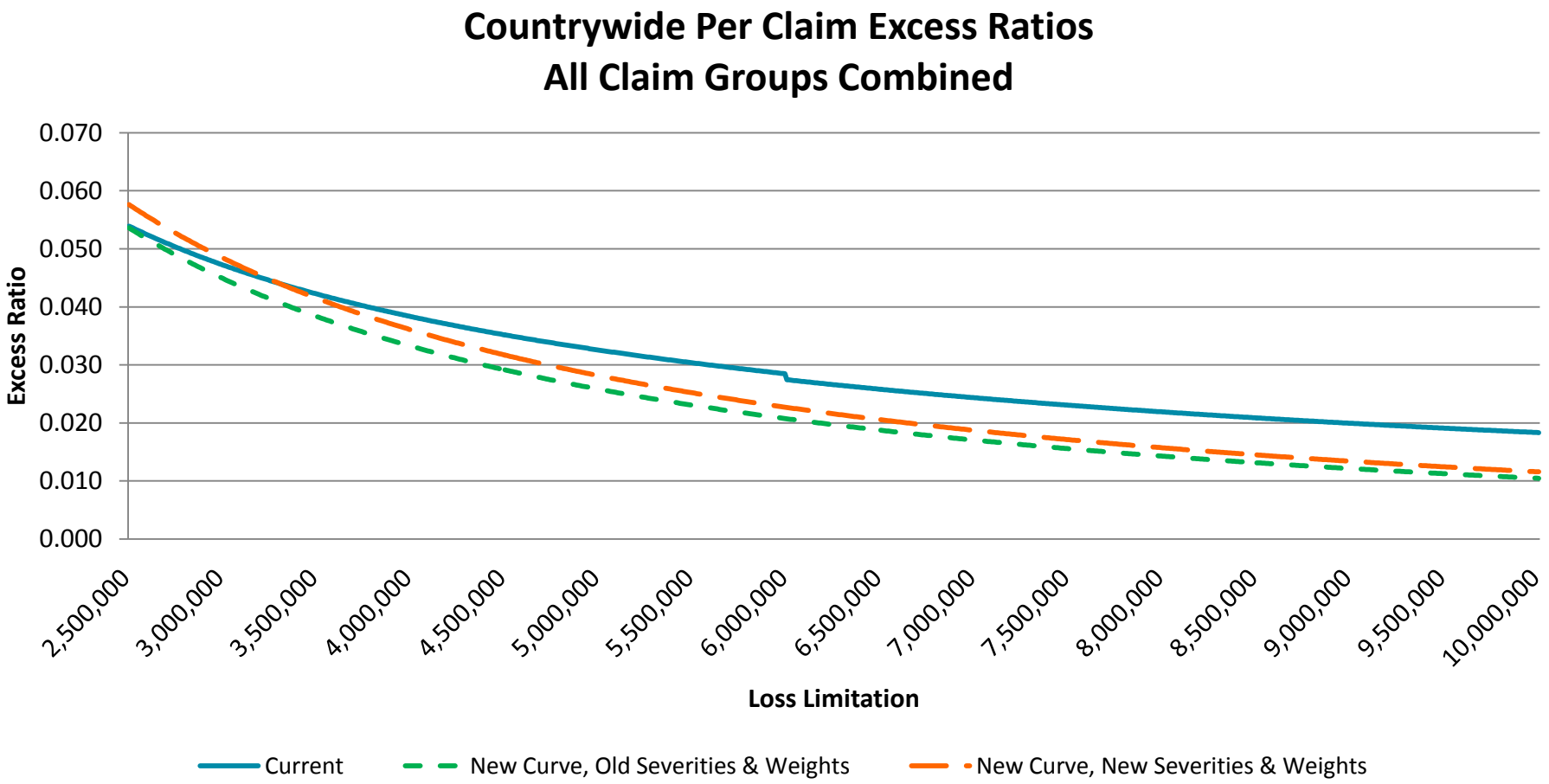
- Staff applied the new methodology to data and time periods underlying the prior approved ELF filing season (i.e., current-to-new comparisons)
- The "Current" excess ratios are those underlying filings effective 10/1/2013 – 7/1/2014
- Based upon results from this review, excess ratio curves were finalized for every state
- Staff later refreshed the severity and claim count models using the latest 5 years of unit data for the national ELF filing

Countrywide Excess Ratio Curve Comparisons
Limits Below $2.5M



The 'Current' curve reflects the most recently filed prior methodology countrywide excess ratios.
The curve labeled 'New Curve, Old Severities & Weights' reflects the new curve-fitting methodology, but severities and weights consistent with those most recently filed using prior methodology.
The curve labeled 'New Curve, New Severities & Weights' reflects both the new curve-fitting methodology and severities and weights determined using the JAGS models.

Countrywide Excess Ratio Curve Comparisons Limits Above $2.5M



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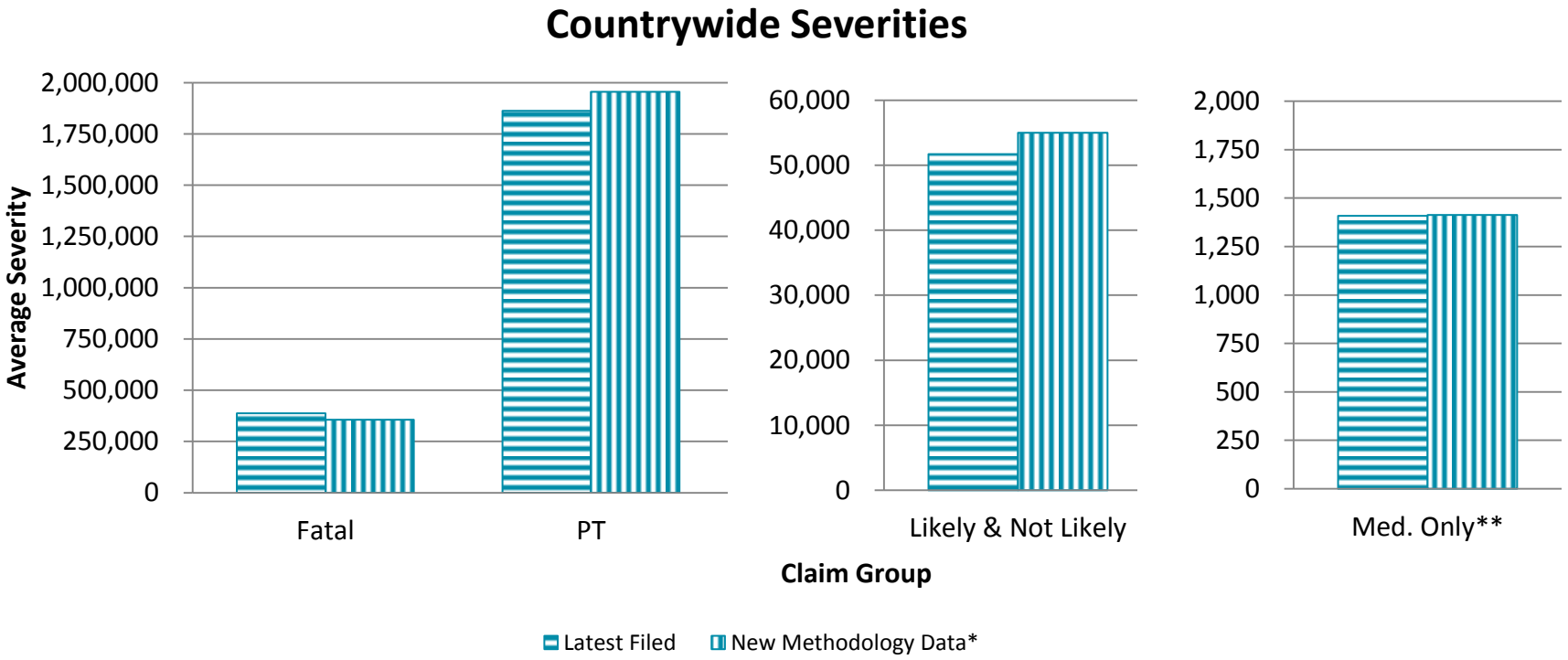
Severity Comparison: Current vs. New Methodology

The modeled severities resulted in small changes on a countrywide basis.



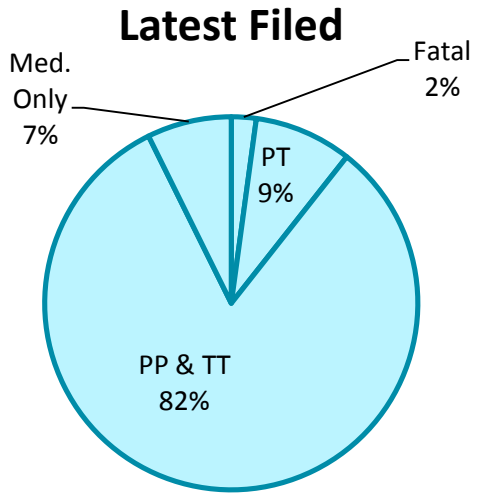
Note: Average severities are developed, on-leveled and trended to midpoints in 2014.

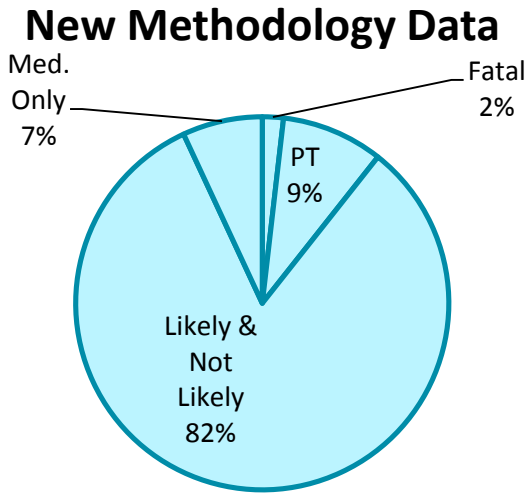
* Fitted severities are based on policy periods from 2000-2005 for PT and 2005-2010 for other claim groups. Florida pre-reform data is excluded.

** Medical only values are empirical, not modeled.

Loss Weight Comparison: Current vs. New Methodology

The loss weights are stable on a countrywide basis.





Countrywide Excess Ratio Observations

- The shape of the countrywide curve is changing
  - At lower loss limits, the weighted average excess ratios are higher
  - At higher loss limits, the weighted average excess ratios are lower
- The new curve for the fatal claim group resulted in lower excess ratios
- The permanent total excess ratios are higher for loss limits below $3 million and lower for loss limits above $3 million
- The likely PP&TT, not-likely PP&TT and medical only claim groups had higher excess ratios under the new methodology and data
- The countrywide excess loss curves for each claim group are located in the appendix
- Curves will vary by individual state

Adjustment of Countrywide Curves to State-Specific Curves

Adjustment of Countrywide Curves to State

- A coefficient of variation (CV) estimator is employed
- It uses the standard deviation of logged loss amounts, referred to below as a "proxy CV"
- Countrywide curve parameters are adjusted to the state level using a ratio called the R-value
- The R-value is a credibility-weighted state's proxy CV as a ratio to the countrywide proxy CV
- This is done separately for each state, claim group, and lognormal curve
- Advantages of this approach include:
  - Less susceptible to state data outliers
  - Straightforward adjustment
  - Spreadsheet friendly representation in a closed functional form
  - Credibility procedure stabilizes excess ratios
  - State differences easier to identify and visualize

Adjustment of Countrywide Curves to State

$$R = Z \times \frac{\sigma_{ST}}{\sigma_{CW}} + (1 - Z)$$

R = statewide relativity adjustment factor
Z = credibility assigned to the state standard deviation
σ_{ST} = standard deviation of logged claim amounts for the state
σ_{CW} = standard deviation of logged claim amounts countrywide

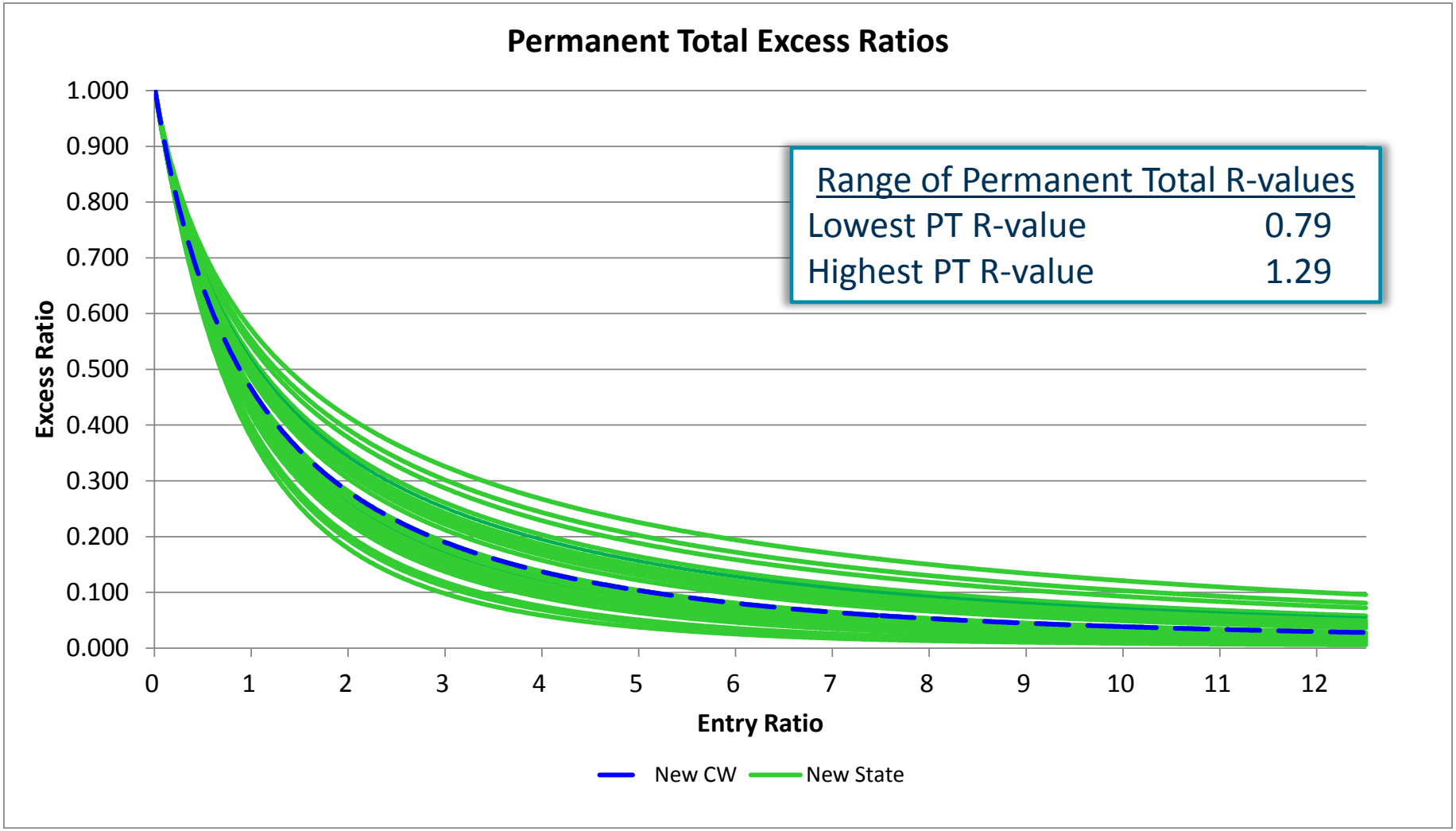
- After renormalizing, the final parameter adjustments are:

$$\mu_{i,ST} \rightarrow R_i \times \mu_{i,j,CW} - Log(M_i)$$

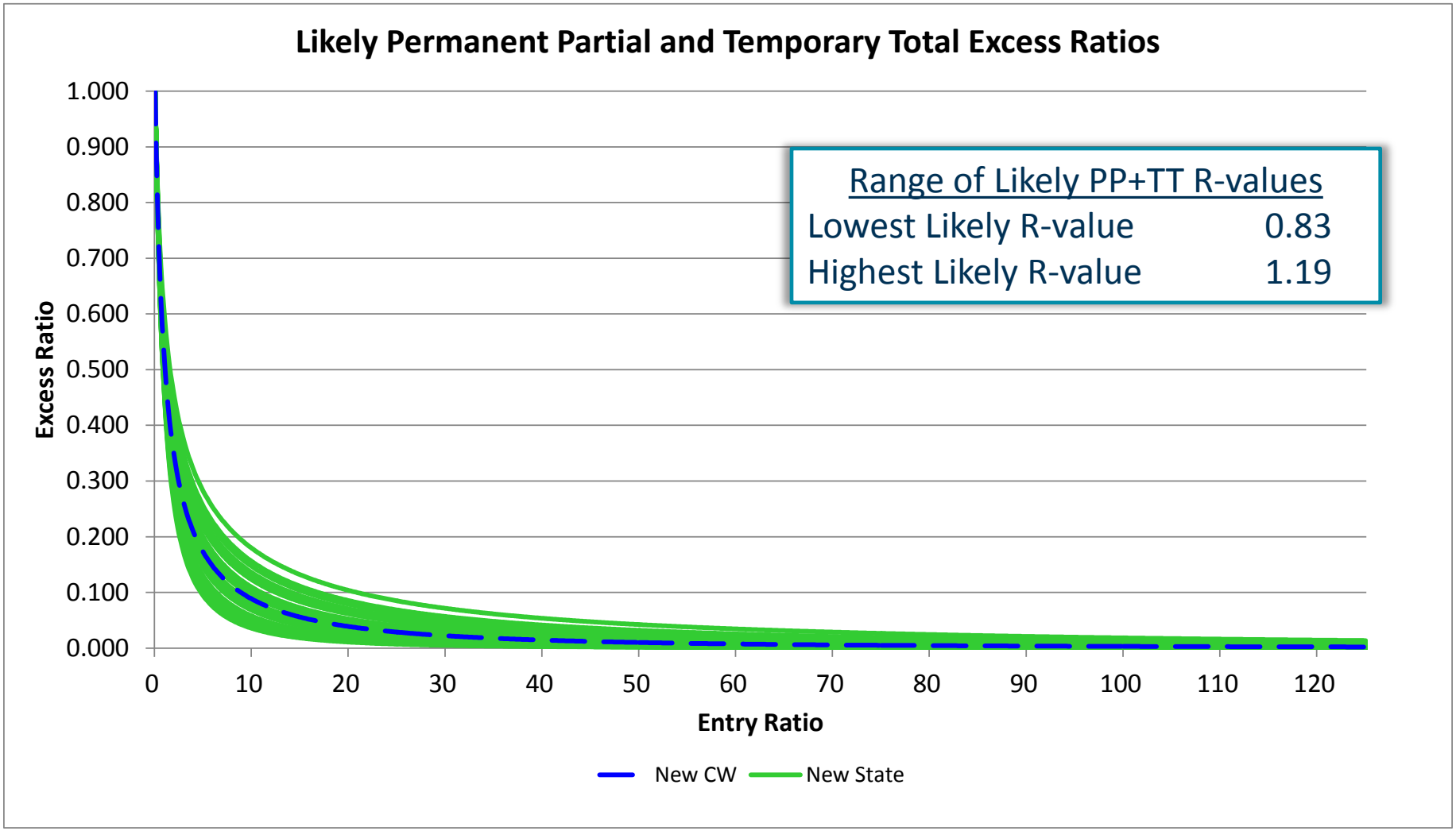
$$\sigma_{i,j,ST} \rightarrow R_i \times \sigma_{i,j,CW}$$

where M_i is the mean of the lognormal distribution for claim group i after scaling the parameters and j is the lognormal distribution within the mixture

Range of Excess Ratio Curves Across States



Range of Excess Ratio Curves Across States



New Per Occurrence Model

New Per Occurrence Model

- A per occurrence excess ratio, for all claim groups combined, is determined by interpolation from a new Per Claim to Per Occurrence Conversion Table
- The table was developed by modeling occurrences via simulation from historical countrywide data using:
  - Policy number and effective date
  - Accident date
- The model accounts for observed positive correlation (0.25) in claim size between claims within an occurrence
- NCCI estimates that 2.0% of all claims were part of a multi-claim occurrence
- The following table illustrates the result of the new model for select excess ratios

Countrywide Per Claim to Per Occurrence Conversion Table

Overall Per Claim Excess Ratio (Loss Only)	Per Occurrence Excess Ratio
1.00	1.000000
0.91	0.910305
0.81	0.810835
0.71	0.711530
0.61	0.612377
0.51	0.513395
0.41	0.414580
0.31	0.315832
0.21	0.216794
0.11	0.116673
0.05	0.055563
0.01	0.012971

Treatment of Catastrophes

Catastrophe Provisions: Impact on ELFs

- NCCI publishes two non-ratable catastrophe provisions in its states
- Account for events beyond $50 million related to:
  - Certified Acts of Terrorism
  - Catastrophes Other than Terrorism (Industrial Accidents, Earthquake)
- Losses from such events are removed from all ratemaking data
- The excess ratios are adjusted to remove the provision greater than $50M, and rescaled
- The following adjustment to the per occurrence excess ratio is made to limit occurrences to $50M:

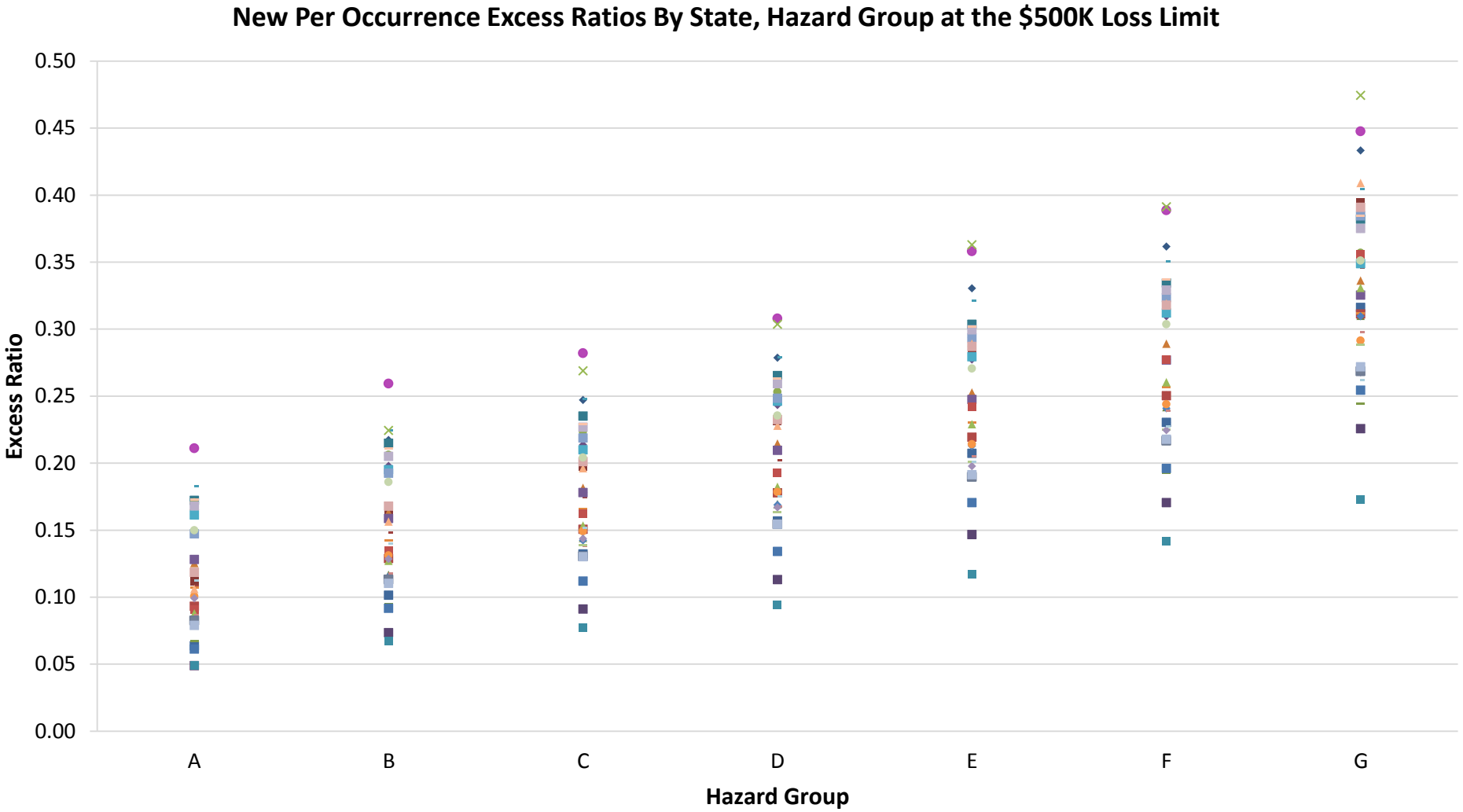
$$\tilde{E}(L) = \frac{E(L) - E(\$50M)}{1 - E(\$50M)}$$

Summary of R-1408 Filed Excess Ratios

National Item-Filing R-1408

- After adjusting countrywide curves to the state level using the state R-value, the multilevel models determine the severities and weights by claim group and hazard group for each state
  - The severities are used to calculate the entry ratios for each loss limit by hazard group and claim group
  - The loss weights are used to combine the claim groups
- NCCI filed R-1408 on June 17th, 2014, introducing the new methodology in 32 loss cost states
- For rate states and Virginia, the new methodology was introduced within each state's latest filing
- The new ELF methodology is approved in 32 states as of October 27th, 2014
- The next slides show the filed per occurrence excess ratios by state and hazard group under the new methodology for loss limits of $500K, $1M, and $5M

Range of Per Occurrence Filed Excess Ratios Across 36 States



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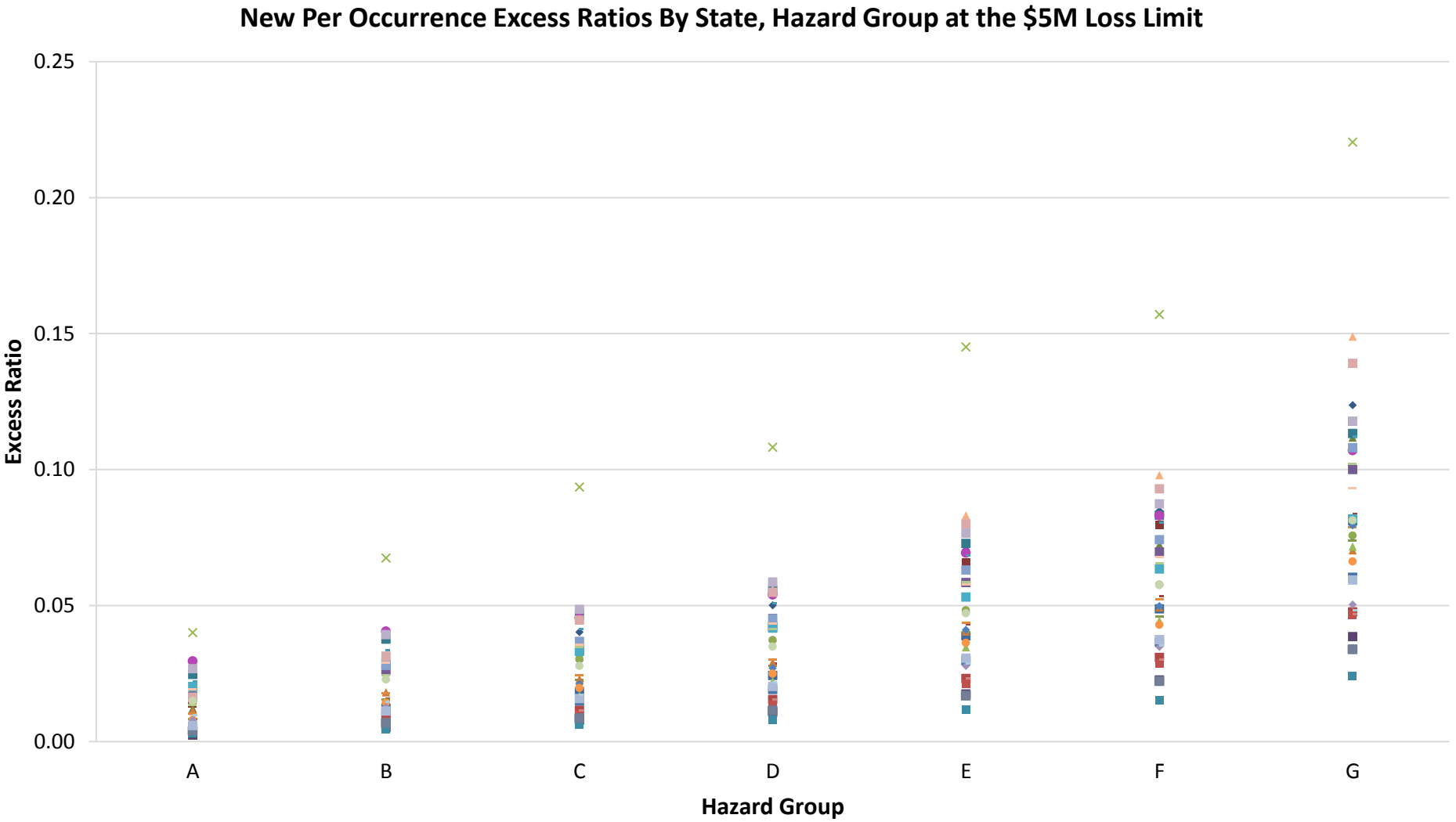
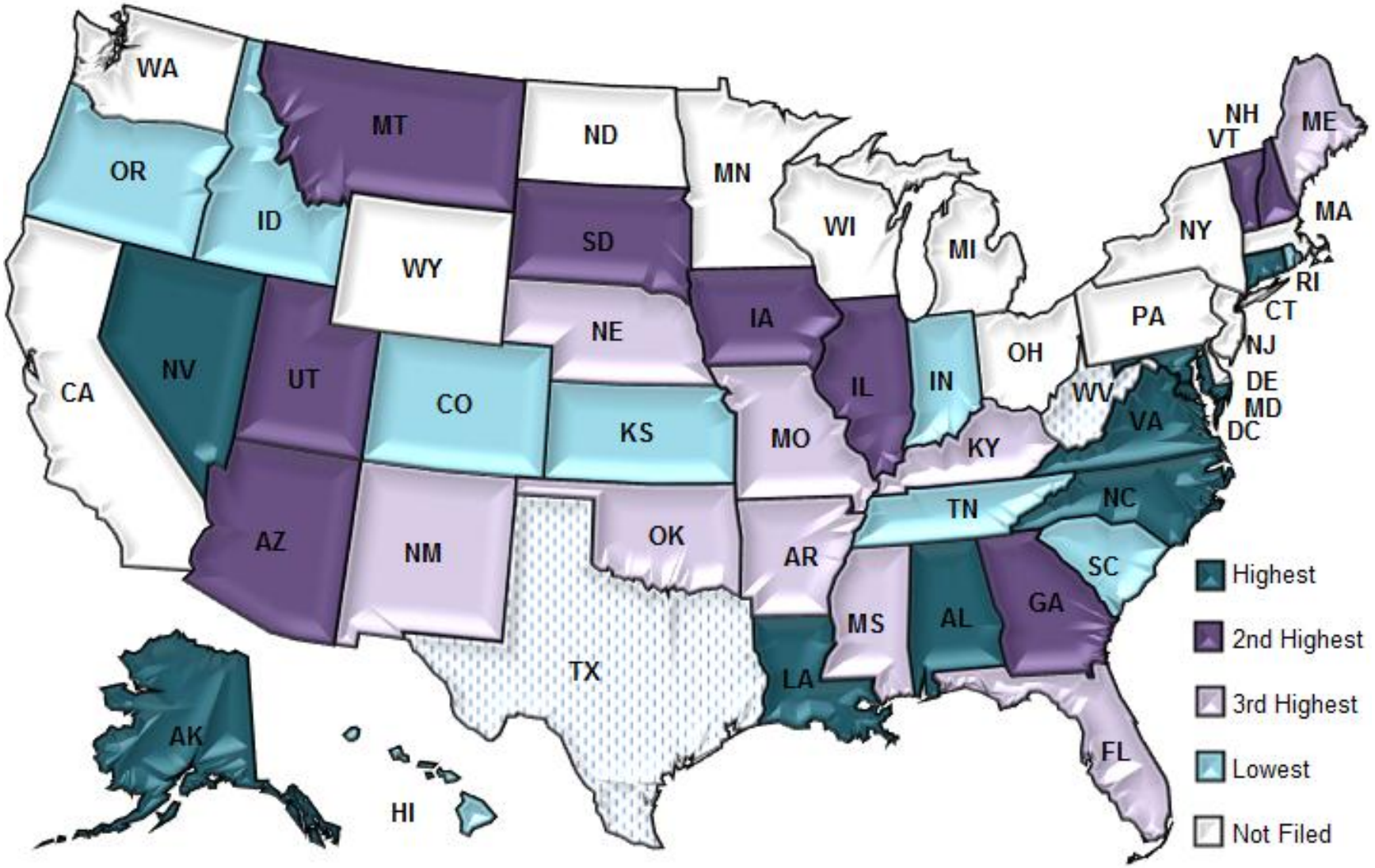


Observations of Excess Ratio Comparisons

- The range of excess ratios across states widens from hazard group A to G
  - However, as a percentage of the average excess ratio for the hazard group, the range narrows from hazard group A to G
- The range of excess ratios across states narrows as the loss limit increases
  - As a percentage of the average excess ratio for the hazard group, the range widens as the loss limit increases

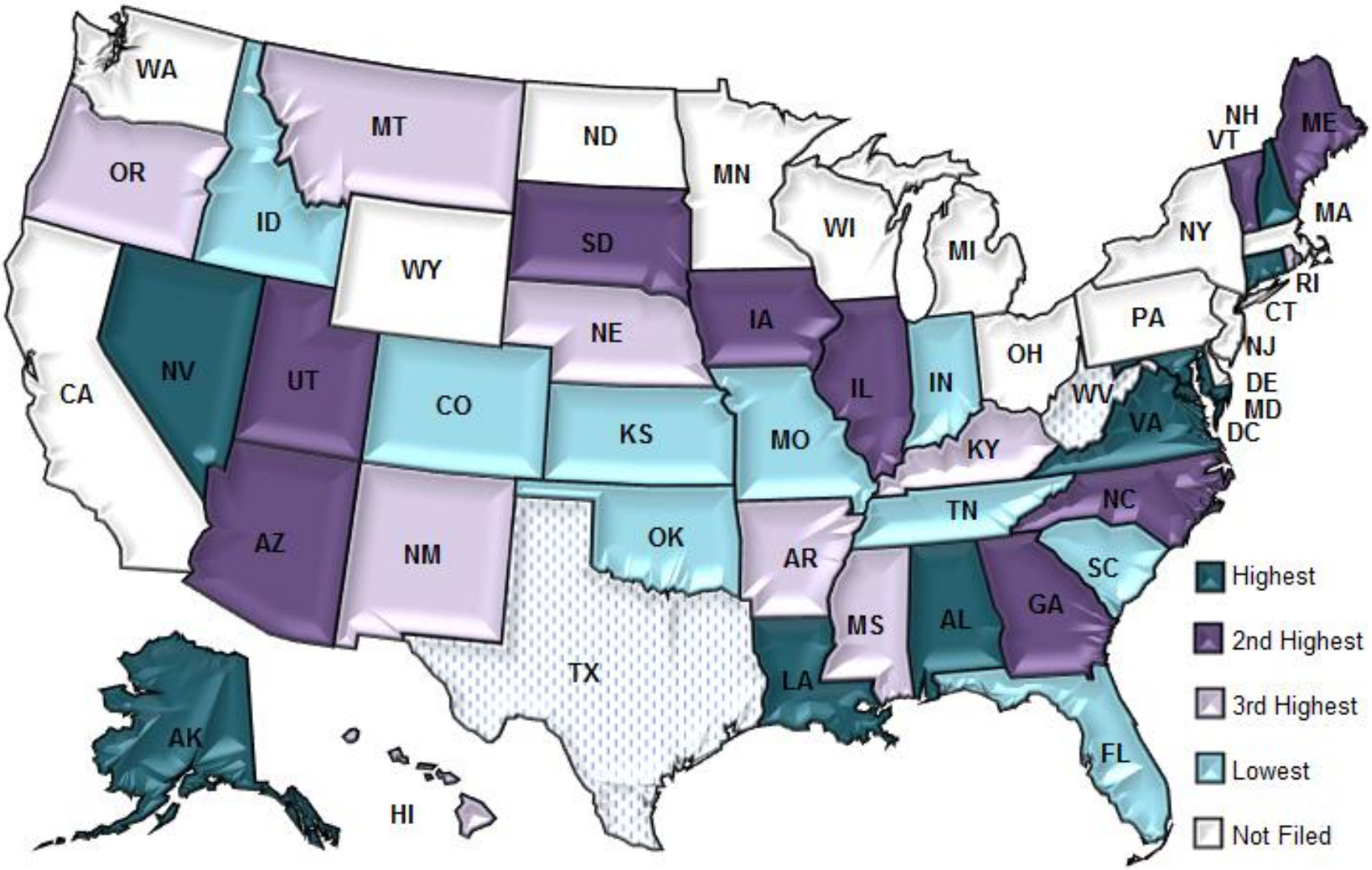
State Comparisons

Filed Per Occurrence Excess Ratios by State: HG F at $500,000



Note: Texas uses prior methodology. For WV, NCCI applied new countrywide curves.

Filed Per Occurrence Excess Ratios by State: HG B at $1,000,000



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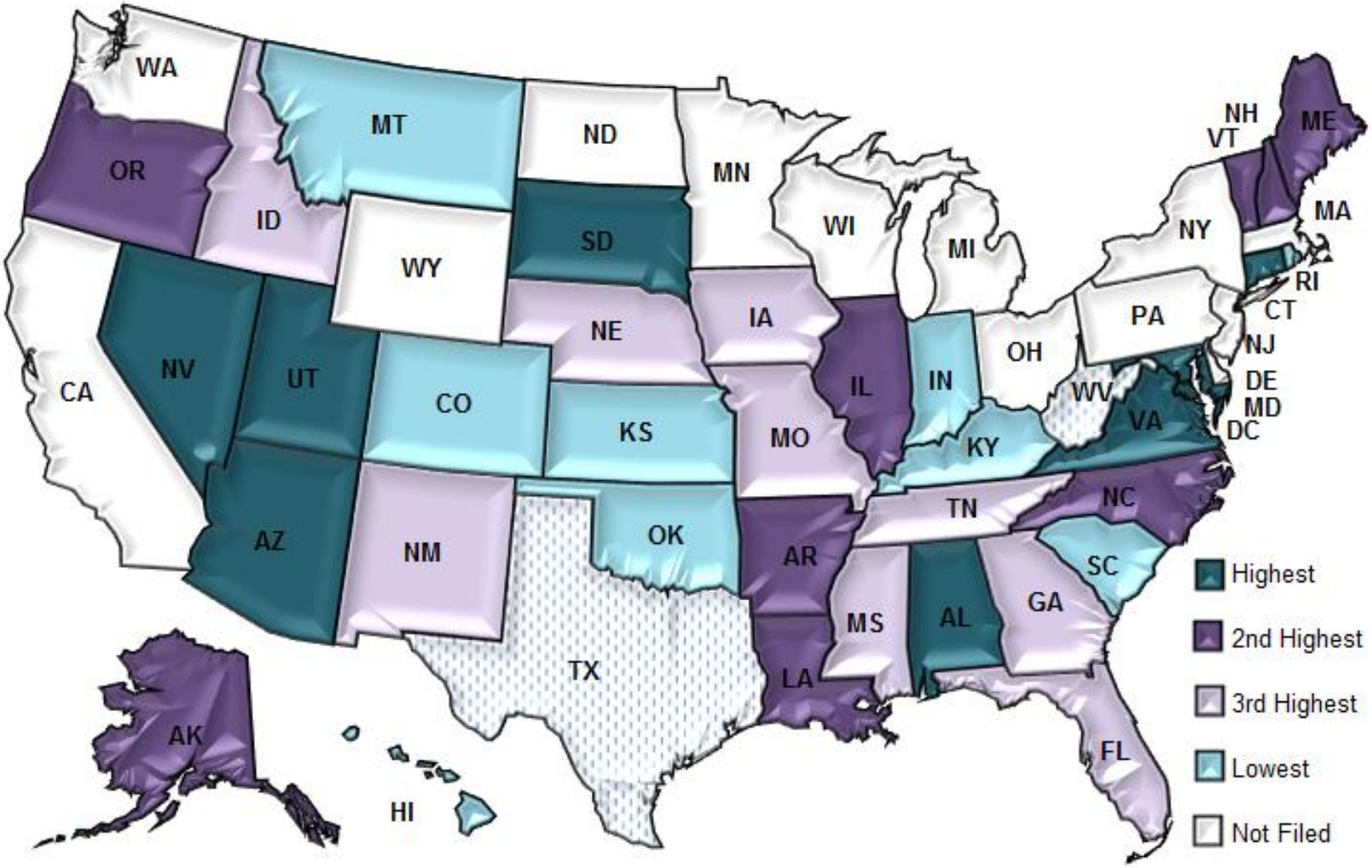
Filed Per Occurrence Excess Ratios by State: HG F at $5,000,000



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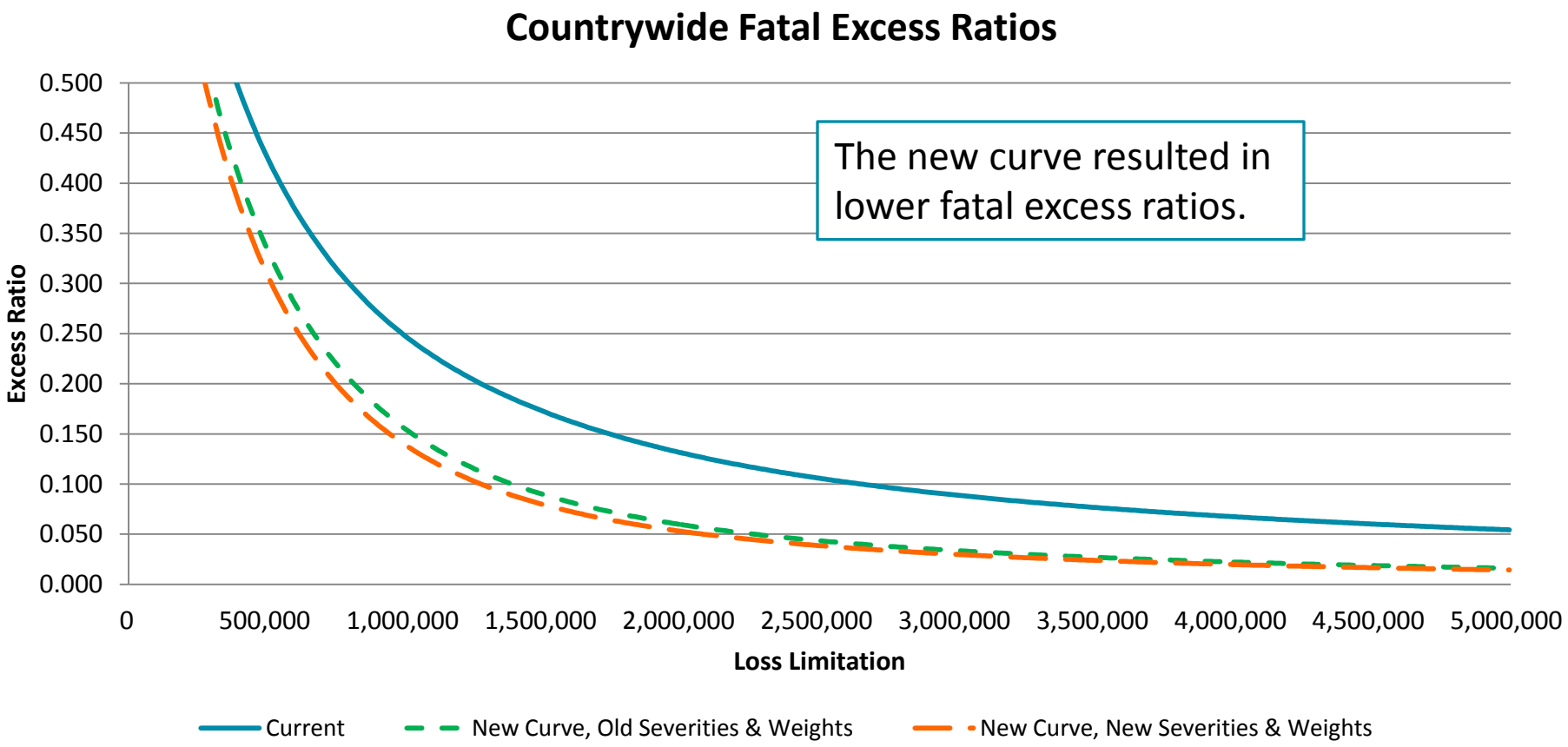
Summary

- Staff vetted the new ELF methodology thoroughly with the Individual Risk Rating Working Group
- Many advances to the methodology are being implemented
- The shape of the excess ratio curves are changing
- Upon implementation, the new ELF methodology:
  - Adjusts parameters of CW curves to derive state curves
  - Provides more year-to-year stability in ELFs
- The spread of excess ratios across the states is greater under the new methodology

Appendix

- Countrywide Loss-Only Curve Comparisons by Claim Group

Countrywide Excess Ratio Curves



The 'Current' curve reflects the most recently filed countrywide excess ratios.
The curve labeled 'New Curve, Old Severities & Weights' reflects the new curve-fitting methodology, but severities and weights consistent with those most recently filed.
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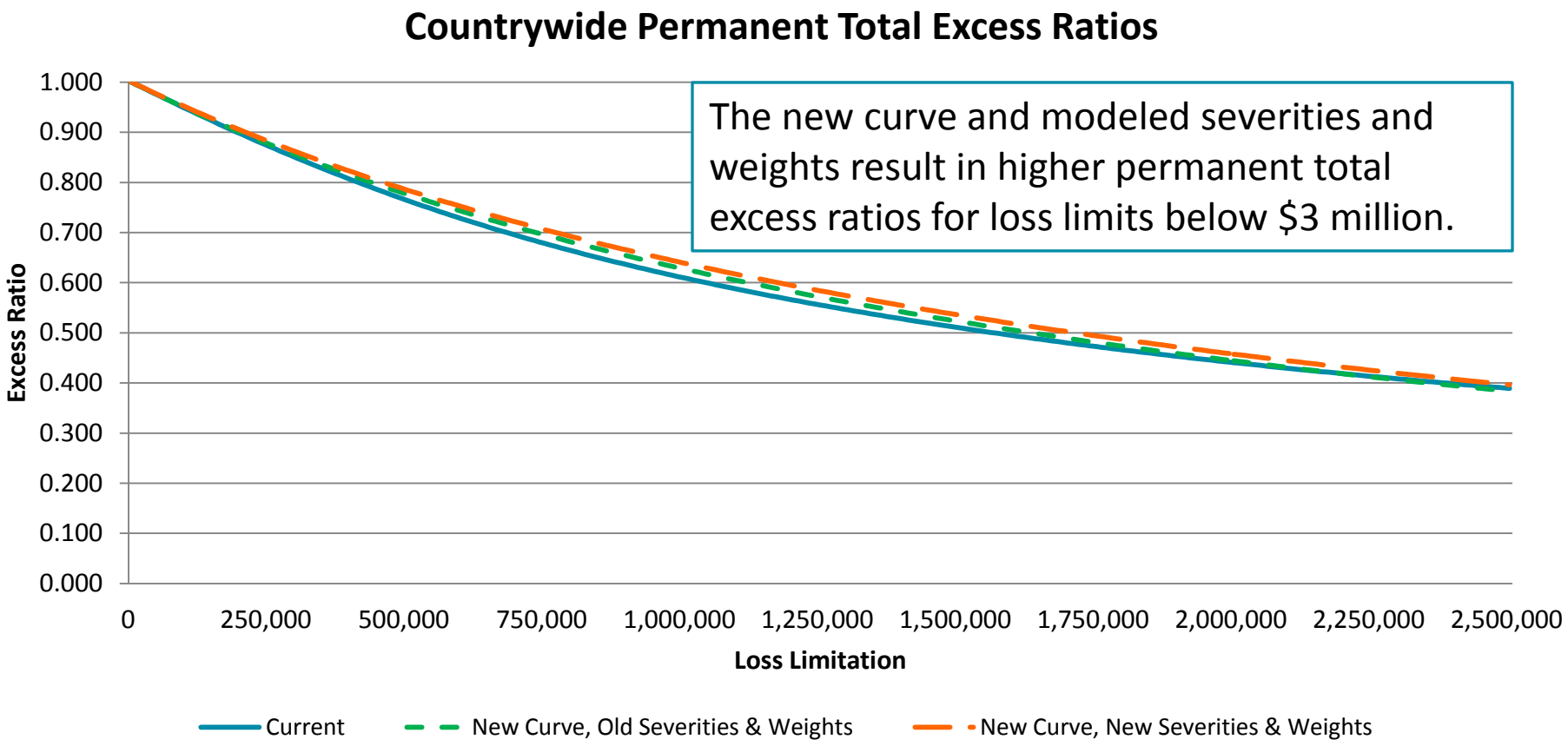
Countrywide Excess Ratio Curves



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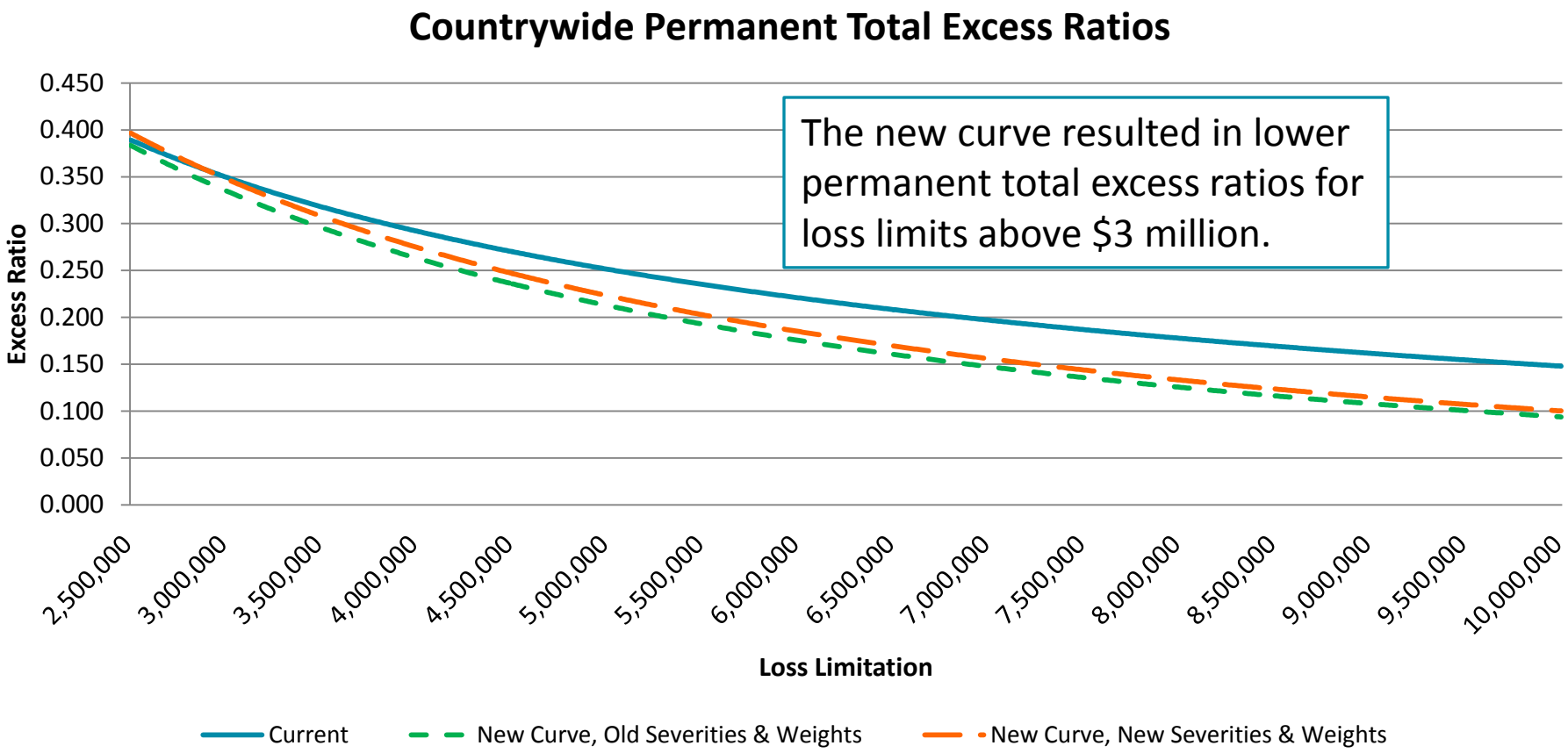
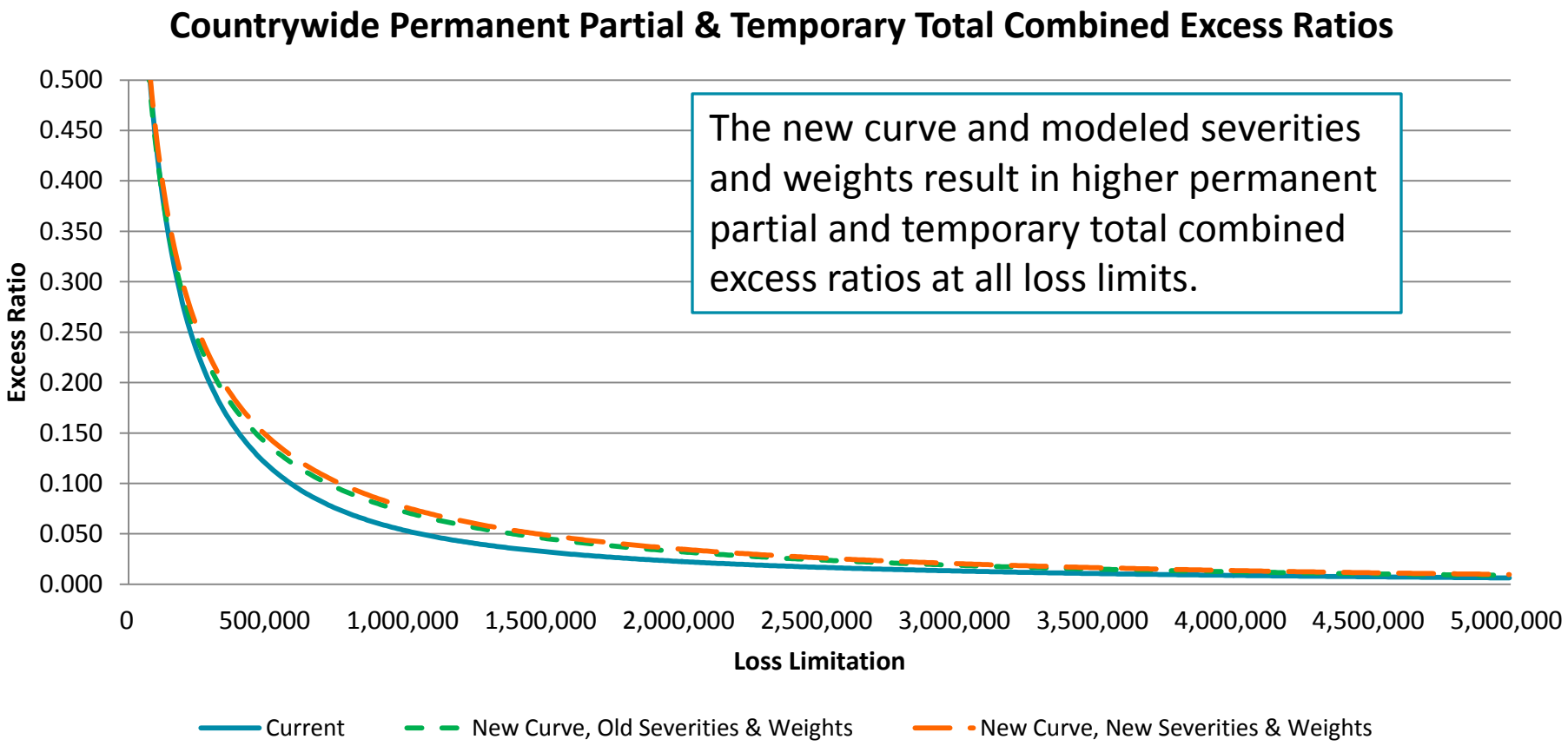
Countrywide Excess Ratio Curves



The 'Current' curve reflects the most recently filed countrywide excess ratios.
The curve labeled 'New Curve, Old Severities & Weights' reflects the new curve-fitting methodology, but severities and weights consistent with those most recently filed.
The curve labeled 'New Curve, New Severities & Weights' reflects both the new curve-fitting methodology and severities and weights determined using the JAGS models.

Countrywide Excess Ratio Curves



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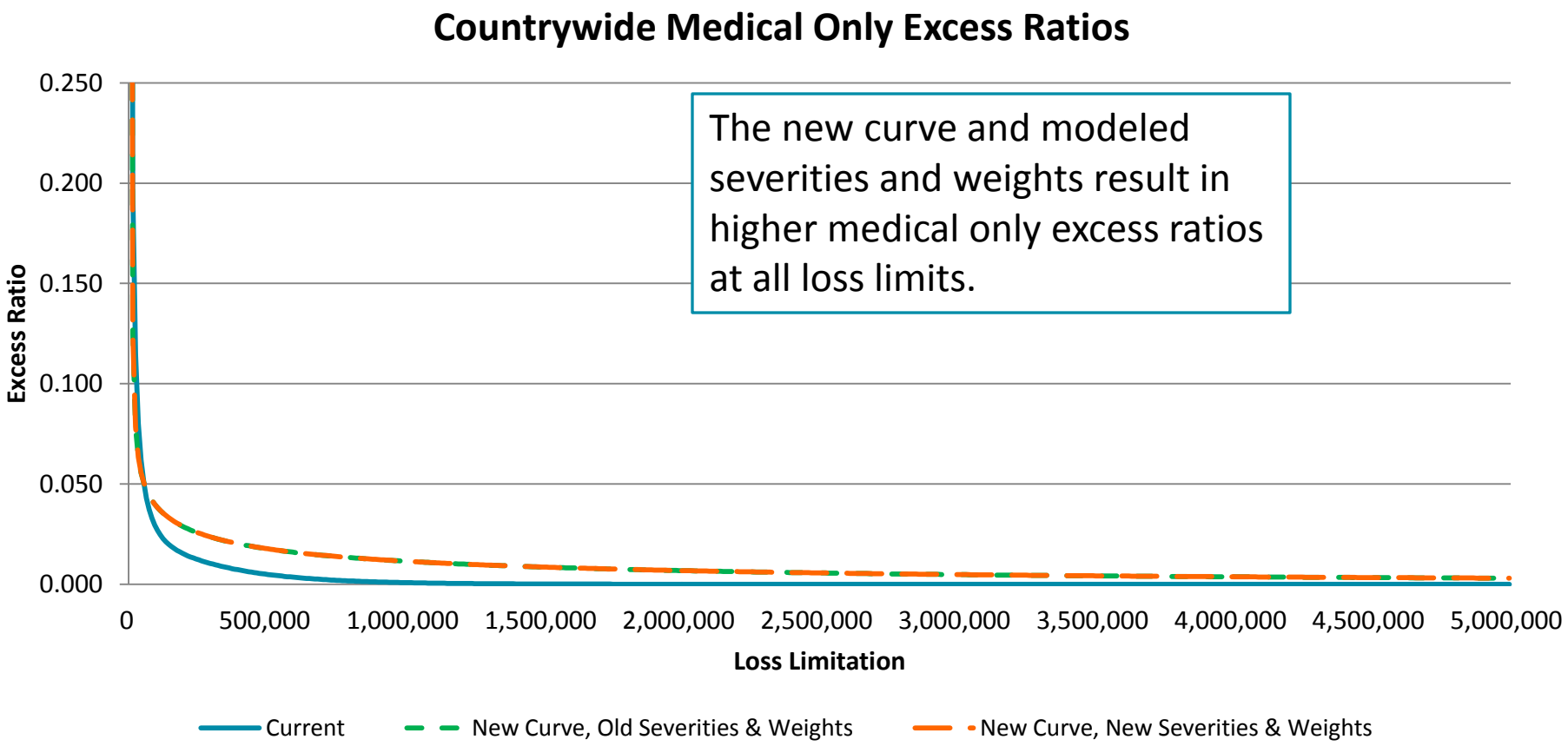
Countrywide Excess Ratio Curves



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