



Insurance Programs  
and Analytic Services

# Revising the ISO Commercial Auto Classification Plan

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# THE EXISTING PLAN

# Context – ISO

	<b>Personal Lines</b>	<b>Commercial Lines</b>
<b>Property</b>	Homeowners, Dwelling	Commercial Property, BOP, Farmowners
<b>Auto</b>	Personal Auto	Commercial Auto
<b>Liability</b>	Personal Liability	General Liability, Professional Liability

# Context – ISO

	Personal Lines	Commercial Lines
Property	Homeowners, Dwelling	Commercial Property, BOP, Farmowners
Auto	Personal Auto	Commercial Auto
Liability	Personal Liability	General Liability, Professional Liability

# Context – Commercial Auto

Trucks, Tractors, and Trailers – Territory Rated

Trucks, Tractors, and Trailers – Zone Rated

Private Passenger Types

Hired Autos

Public Transportation

Dealerships

Garages

Miscellaneous Coverages

# Context – Commercial Auto

Trucks, Tractors, and Trailers – Territory Rated

Trucks, Tractors, and Trailers – Zone Rated

Private Passenger Types

Hired Autos

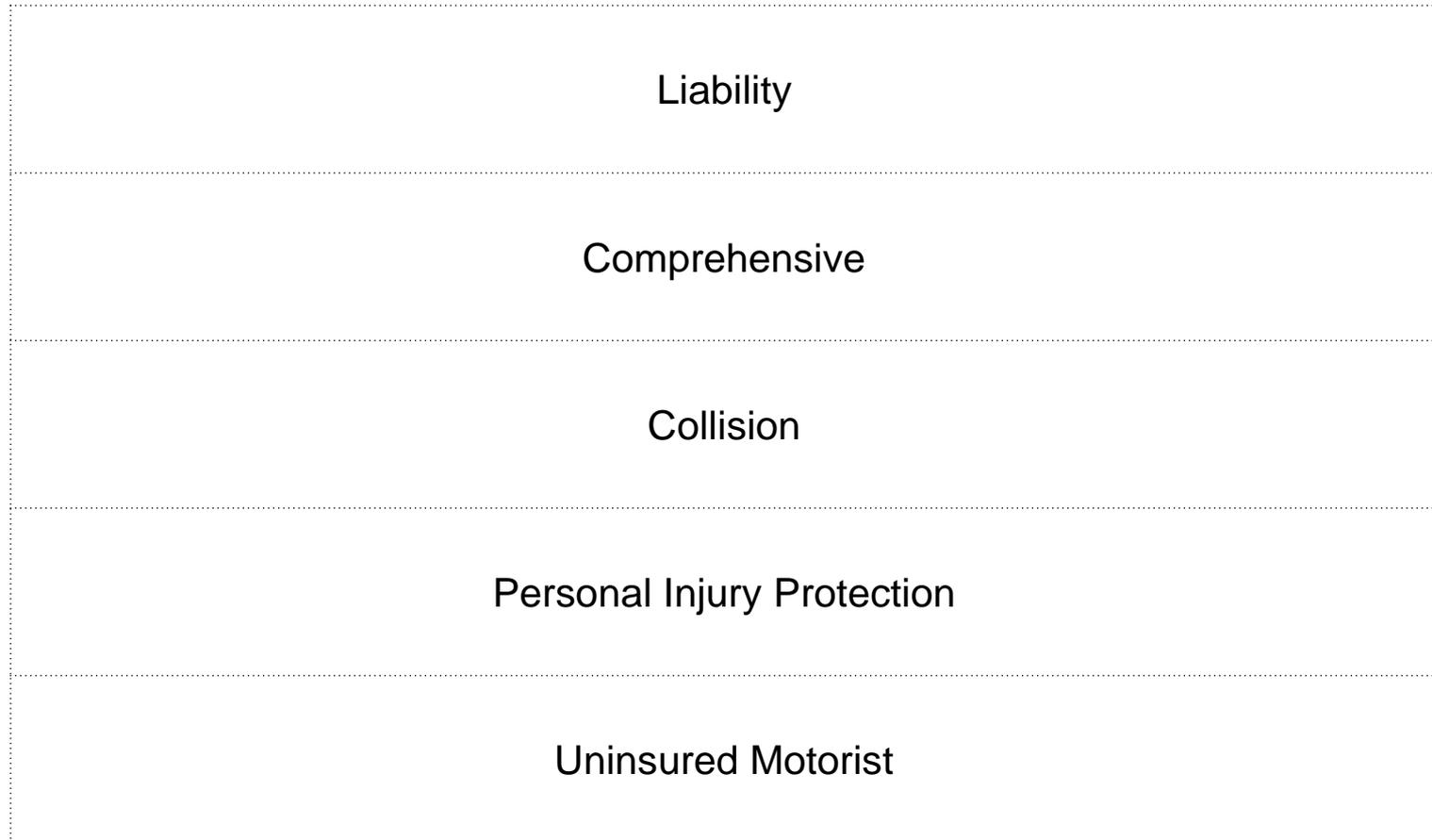
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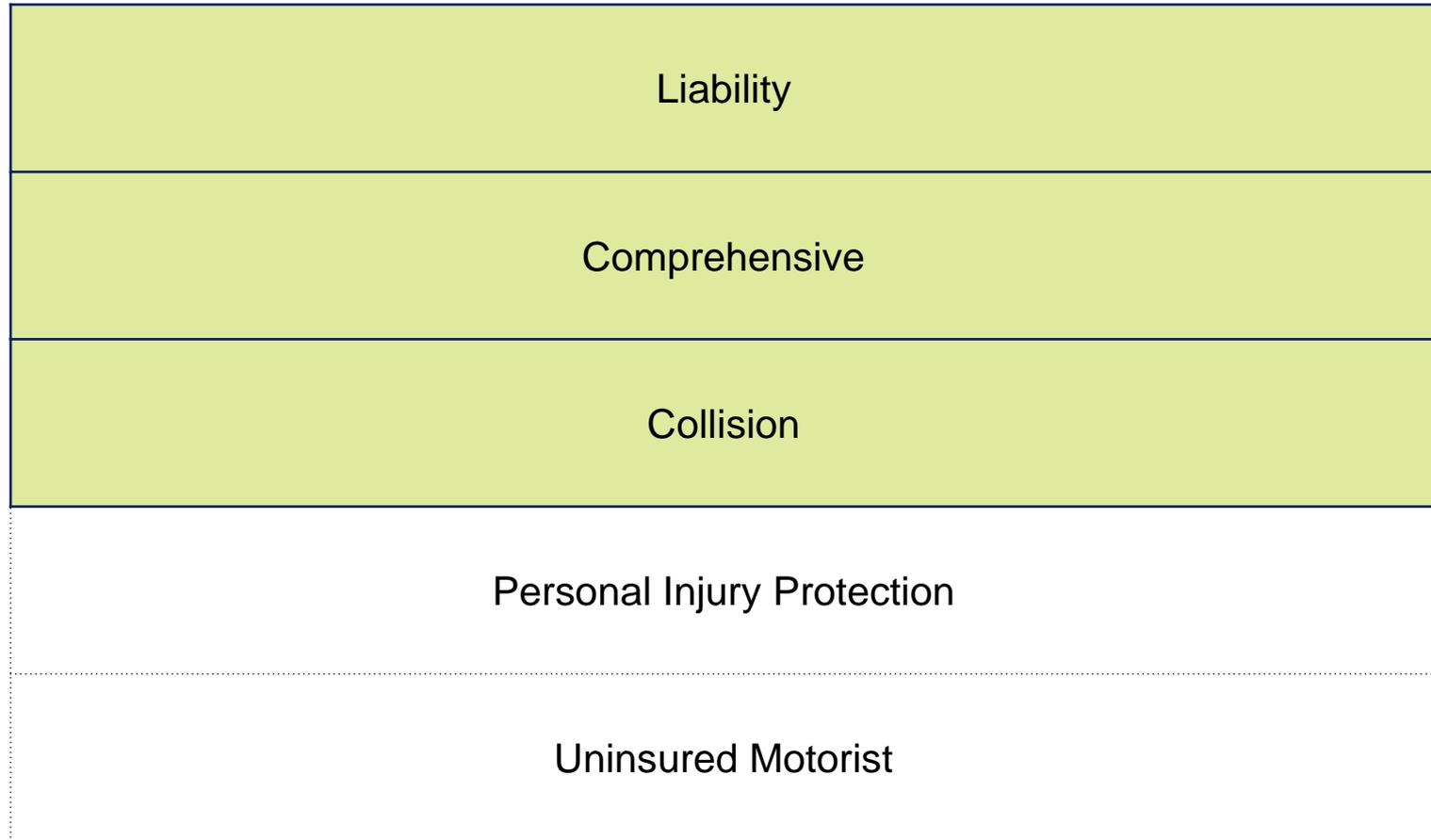
Garages

Miscellaneous Coverages

# Context – Truck, Tractors, and Trailers (Territory Rated)



# Context – Truck, Tractors, and Trailers (Territory Rated)



# Existing Rating Formula

(Size · Use · Radius + Secondary) · (Original Cost New - Deductible) · Age · Fleet · Territory

# Existing Rating Formula(s)

(Size · Use · Radius + Secondary) · (Original Cost New - Deductible) · Age · Fleet · Territory

- **Liability**

(Size · Use · Radius + Secondary) ·  
Fleet · Territory

- **Physical Damage**

(Size · Use · Radius + Secondary) ·  
(Original Cost New - Deductible) · Age ·  
Fleet · Territory

# Distribution of Exposure

(**Size** · Use · Radius + Secondary) · (Original Cost New - Deductible) · Age · Fleet · Territory

TRUCKS	Light Trucks	55%
	Medium Trucks	10%
	Heavy Trucks	10%
	Extra-Heavy Trucks	2%
TRUCK-TRACTORS	Heavy Truck-Tractors	1%
	Extra-Heavy Truck-Tractors	5%
TRAILERS	Semitrailers	5%
	Trailers	10%
	Service and Utility Trailers	2%

# Distribution of Exposure

(Size · **Use** · Radius + Secondary) · (Original Cost New - Deductible) · Age · Fleet · Territory

Service	55%
Retail	5%
Commercial	15%
None Specified	25%

# Distribution of Exposure

(Size · Use · **Radius** + Secondary) · (Original Cost New - Deductible) · Age · Fleet · Territory

Local (up to 50 miles)	90%
Intermediate Distance	10%
Long Distance (over 200 miles)	<1%

# Distribution of Exposure

(Size · Use · Radius + **Secondary**) · (Original Cost New - Deductible) · Age · Fleet · Territory

Logging	<1%
Truckers	2%
Food Delivery	2%
Specialized Delivery	<1%
Waste Disposal	1%
Farmers	5%
Dump Trucks	5%
Contractors	40%
Other	45%

# Distribution of Exposure

(Size · Use · Radius + Secondary) · (**Original Cost New** - Deductible) · Age · Fleet · Territory

\$0 - \$4,500	5%
\$4,500 - \$6,000	2%
\$6,000 - \$8,000	2%
\$8,000 - \$10,000	2%
\$10,000 - \$15,000	10%
\$15,000 - \$20,000	10%
\$20,000 - \$25,000	20%
\$25,000 - \$40,000	30%
\$40,000 - \$65,000	10%
\$65,000 - \$90,000	5%
Above \$90,000	5%

# Distribution of Exposure

(Size · Use · Radius + Secondary) · (Original Cost New - **Deductible**) · Age · Fleet · Territory

- Deductibles and Tweedie GLMs don't mix.
  - More on that later.
- In any case, we used traditional actuarial techniques to handle deductibles.

# Distribution of Exposure

(Size · Use · Radius + Secondary) · (Original Cost New - Deductible) · **Age** · Fleet · Territory

One Year	5%
Two Years	10%
Three Years	10%
Four Years	10%
Five Years	10%
Six Years	5%
Seven Years	5%
Eight Years	5%
Nine Years	5%
Ten Years	5%
Eleven Years	5%
Twelve or More Years	25%

# Distribution of Exposure

(Size · Use · Radius + Secondary) · (Original Cost New - Deductible) · Age · **Fleet** · Territory

Four or Fewer Vehicles	25%
Five or More Vehicles	75%

# Distribution of Exposure

(Size · Use · Radius + Secondary) · (Original Cost New - Deductible) · Age · Fleet · **Territory**

- Territory is outside the scope of this analysis.
- Possible approaches to pricing territories:
  - Traditional actuarial techniques
  - Advanced statistical techniques that explicitly account for external or environmental factors

## Summary: Issues With the Existing Plan

- Unintuitive additive/multiplicative structure
- Cannot apply secondary factor to trailer types
- Not rating on Age and OCN for Liability
- Not rating on other variables data exists for
- Lack of refinement within classes
- Lack of independence between coverages
- Traditional Baileys Minimum Bias procedure provides answers, not insight

# GLM Equivalence with Minimum Bias

- The existing plan parameters are derived through a multiplicative-additive Minimum Bias procedure with balance condition.
- A purely multiplicative Minimum Bias procedure with balance condition produces results equivalent to a Poisson GLM with a log link (see: Mildenhall, 1999).
- Even this naïve GLM is more attractive than the Minimum Bias procedure . . .

# Hierarchy of Some Modeling Options

Poisson/Gamma or Tweedie GLM

(is better than)

Poisson GLM

(is better than)

Purely Multiplicative Minimum Bias

(is better than)

Additive-Multiplicative Minimum Bias

# Alternatives

- Frequency/Severity approach: model frequency and severity separately, then combine the results to get pure premium.
- Pure Premium approach: model pure premium directly with the Tweedie.
- We chose the latter approach.
  - We have found the Tweedie to be easier to implement while yielding similar results – however, this view is far from universal.

# Initial Testing

- We ran an “apples-to-apples” test of the Tweedie Generalized Linear Model against the Minimum Bias procedure, using exactly the same data and variables.
- Result: the Tweedie procedure produced lift over the Minimum Bias procedure
- With these results in hand, we set the Minimum Bias procedure aside moved forward with refinement of the Tweedie – a lengthy process.

# CHALLENGES

# Refinement of the Fleet Factor

- We wanted to refine the fleet factor, but we have never explicitly collected detailed information about the size of insured fleets.
- As a stopgap, we aggregated records by policy and counted the number of vehicles attached to each policy.
- In the future, we anticipate that we will ask insurers to report the number of vehicles associated with each policy.

# Definition of a Fleet

- Question: What constitutes a “fleet vehicle”?
- Answer: We plugged a few different definitions into the model, and they all performed about the same, so we went with a definition closest to the current definition: “all vehicles except for trailers”.

# Age and Original Cost New for Liability

- Similar in character to the Fleet size problem.
  - We don't collect these fields for Liability, but we do for Physical Damage.
- Matching and merging allowed us assign values to Age and Original Cost New for enough Liability records to get useful results.
- In the future, we anticipate that we will ask insurers to report Age and Original Cost New on the Liability record.

# Treatment of Deductibles

- Deductibles do not work well with a Tweedie.
  - Reason #1: It is unwise to explicitly price for selection effects. (This applies to all models.)
  - Reason #2: Underlying the Tweedie is an assumption that each regressor will shift both frequency and severity in the same direction. This is never the case for deductible.
- We researched a few workarounds, but ultimately stuck with the traditional (non-modeling) approach.

# Appropriateness of a Single Collision Model

- Re-fitting the model on subsets of your initial dataset is a good way to spot check model fit.
- When the same collision model was fit on Trucks without Trailers, and then Trailers without Trucks, the resulting parameter estimates were *dramatically* different.
- This was especially true for Age factors.

# Illustration: Age Factors For Two Collision Models

	<b>Trucks Factor</b>	<b>Trailers Factor</b>
<b>Age 1</b>	1.00	1.00
<b>Age 2</b>	1.20	0.86
<b>Age 3</b>	1.10	0.84
<b>Age 4</b>	0.75	0.82
<b>Age 5</b>	0.70	0.80
<b>Age 6</b>	0.55	0.78
<b>Age 7</b>	0.40	0.76
<b>Age 8</b>	0.35	0.74
<b>Age 9</b>	0.30	0.73
<b>Age 10</b>	0.20	0.72
<b>Age 11</b>	0.15	0.71
<b>Age 12+</b>	0.10	0.70

# Interpretation and Treatment

- The Age factor captures the depreciation.
- Trailers are basically boxes on wheels.
- Boxes on wheels don't depreciate very much.
- Trucks depreciate *a whole lot*.
- These (and other) differences are so extreme that we decided to completely separate the Trucks and Trailers Collision models. The factors for these coverages were created by runs of independent GLMs.

# Standard Industrial Classification Code

- Good news!
  - There are thousands of different SIC codes, representing every imaginable industry.
  - SIC codes come with a convenient hierarchy.
  - We have been collecting SIC codes for years.
- Bad news!
  - There are thousands of different SIC codes, representing every imaginable industry.
  - Only some of our data has an SIC code.

# How We Handled the SIC Code

- Started at the lowest (most detailed) level.
- Added to the model only those SIC codes with a “reasonable” number of exposures.
- Set aside any SIC codes that the model finds to be significant – they’ll stay in the model.
- Aggregated all of the data *not* corresponding to a significant code up to the next level.
- Repeated the process at the next level, and at the level after that, and at the level after that.

# Continuous Variables

- To the extent that they aren't log-linear, continuous variables can be difficult to deal with in a GLM setting.
- Common ways of handling problems:
  - Capping
  - Kinking
  - Bucketing

# Continuous Variables (Continued)

- We used all of these, plus *ad-hoc splines*.
- Procedure:
  - Fit the model and observe the partial residual plot of the continuous variable of interest.
  - In an area of the continuous variable where there appears to be a deviation from log-linearity, fit a function that predicts %error.
  - Divide loss by this function; refit the model.
  - Multiply indicated factors by this function.

# Continuous Variables (Continued)

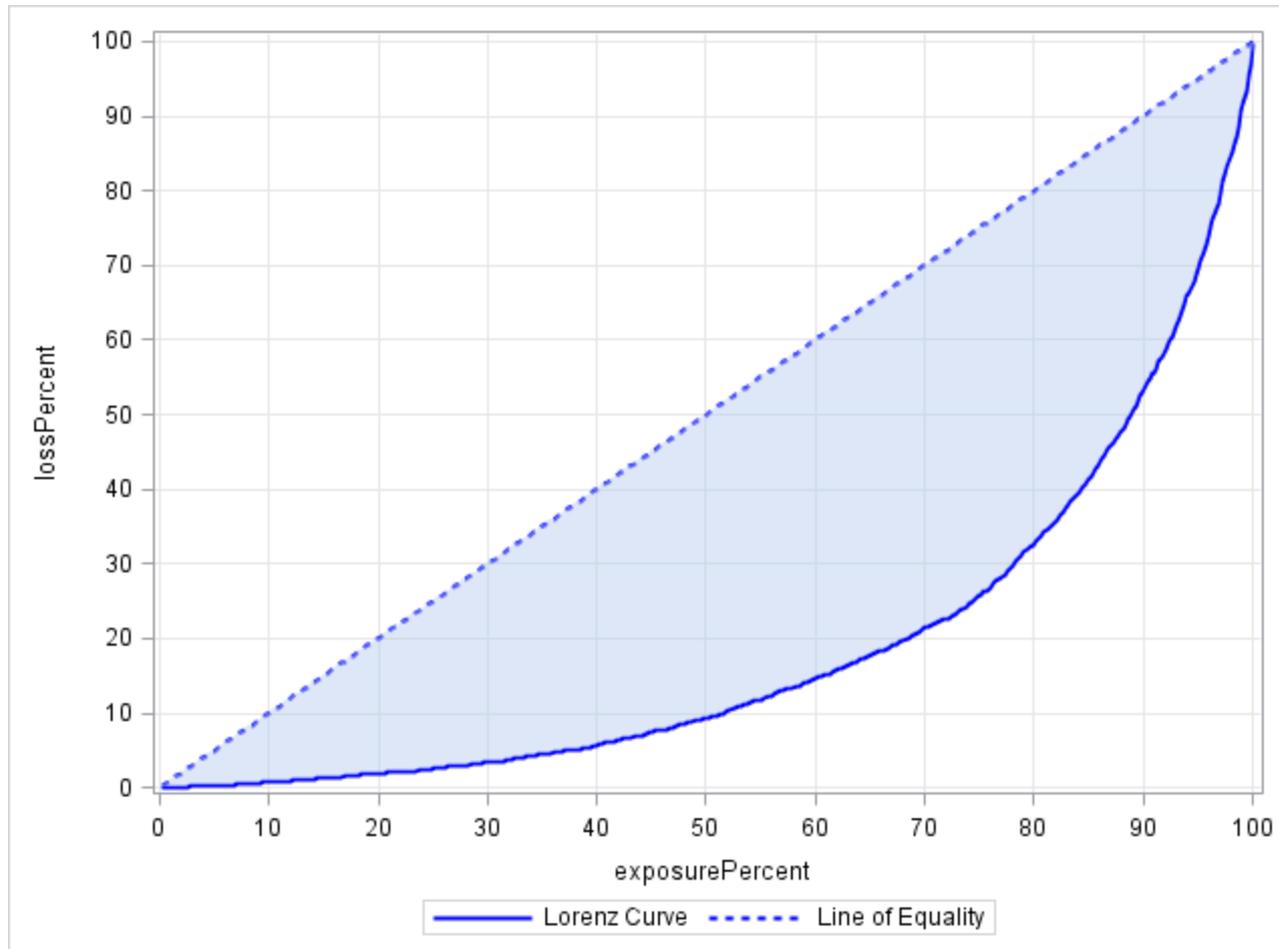
- End result: a continuous variable that properly reflects odd departures from log-linearity.
- Be cautioned that this sort of procedure shouldn't be done unless you are *near certain* that the patterns you are seeing in the partial residual plot are not simply the result of noise.
  - This can be confirmed with bootstrapping.

# Don't Forget About Interactions!

- Limiting the model to only main effects would not be appropriate – interactions can be extremely significant.
- The only way to be confident that no interactions are being missed is to check for the significance of every single one.
- This sort of search is easy to code, but might take a very long time to run.

# MODEL RESULTS

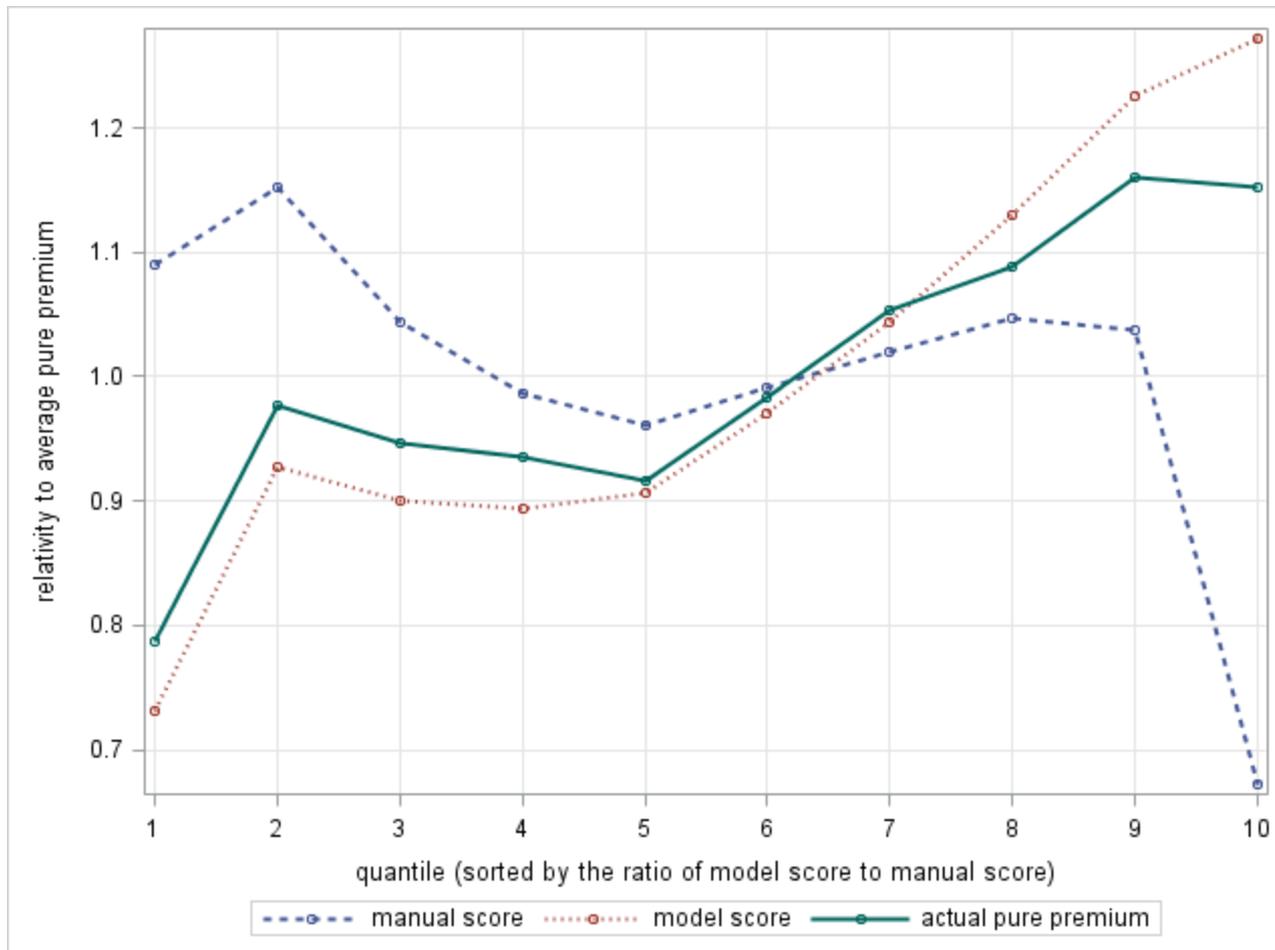
# Illustration – Gini Determination



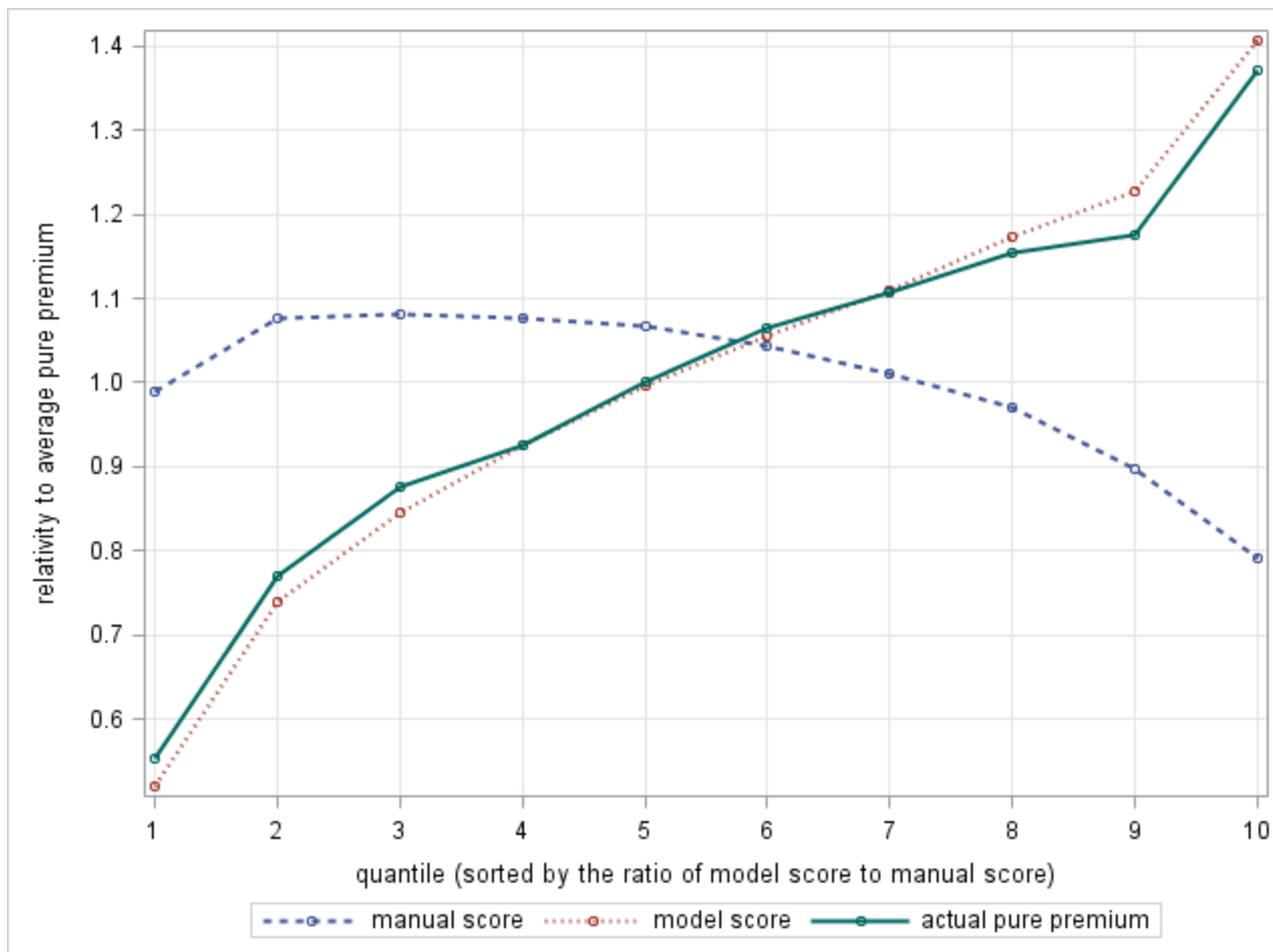
# Simple Ginis

	Liability		Comprehensive		Collision	
	Trucks	Trailers	Trucks	Trailers	Trucks	Trailers
Gini of Current Plan	31.50	29.62	33.08	34.00	32.35	55.62
Gini of GLM Approach	33.46	42.66	34.56	39.21	34.34	62.85
<b>Percent Lift of GLM Over Current Plan</b>	<b>6.24%</b>	<b>44.04%</b>	<b>4.50%</b>	<b>15.30%</b>	<b>6.15%</b>	<b>13.00%</b>

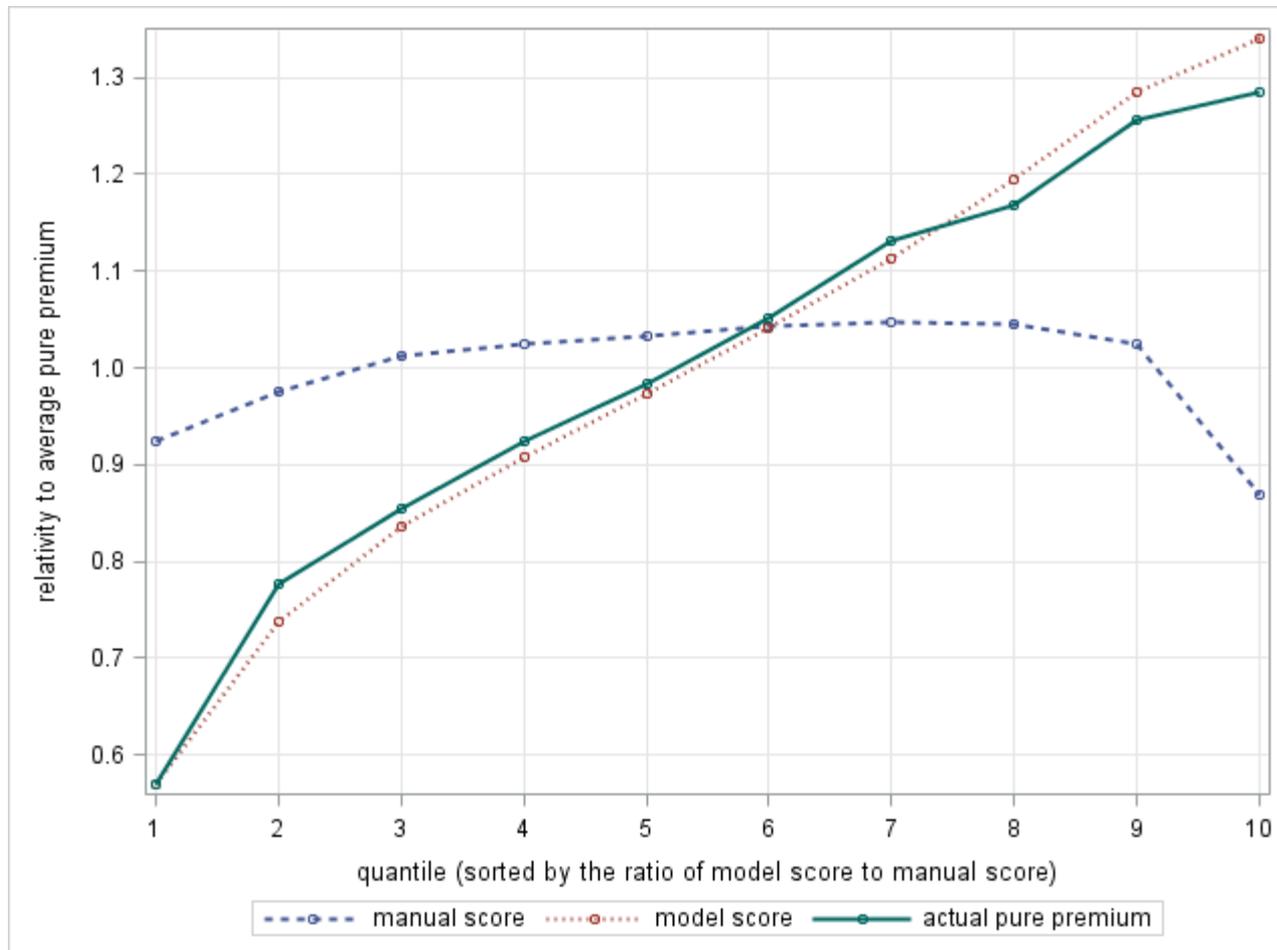
# Double Lift Chart – Liability



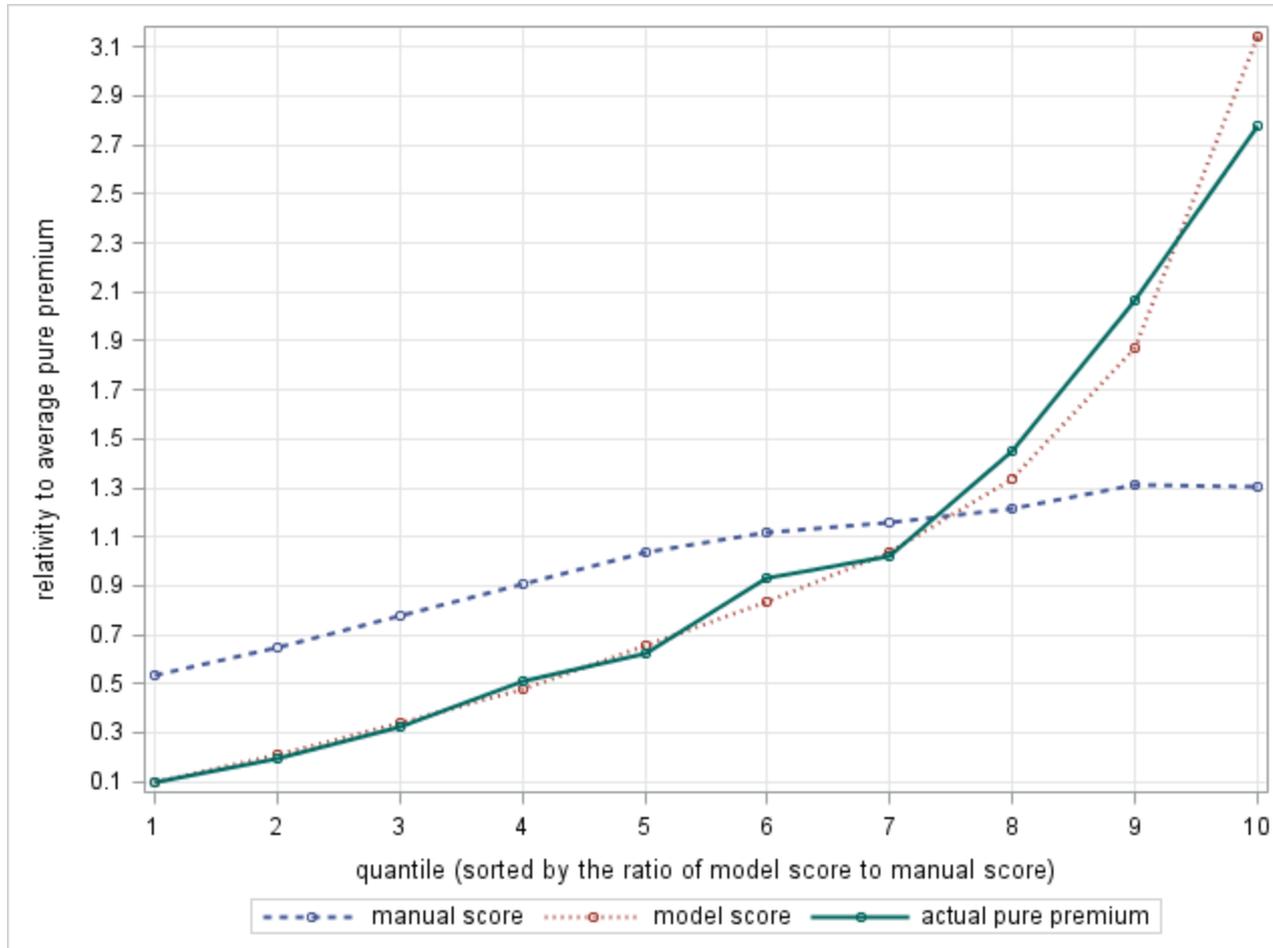
# Double Lift Chart – Comprehensive



# Double Lift Chart – Trucks Collision



# Double Lift Chart – Trailers Collision



# Questions?