Insurance Programs
and Analytic Services

And The Winner Is…?
How to Pick a Better Model

Part 1 – Introduction to GLM and Model Lift

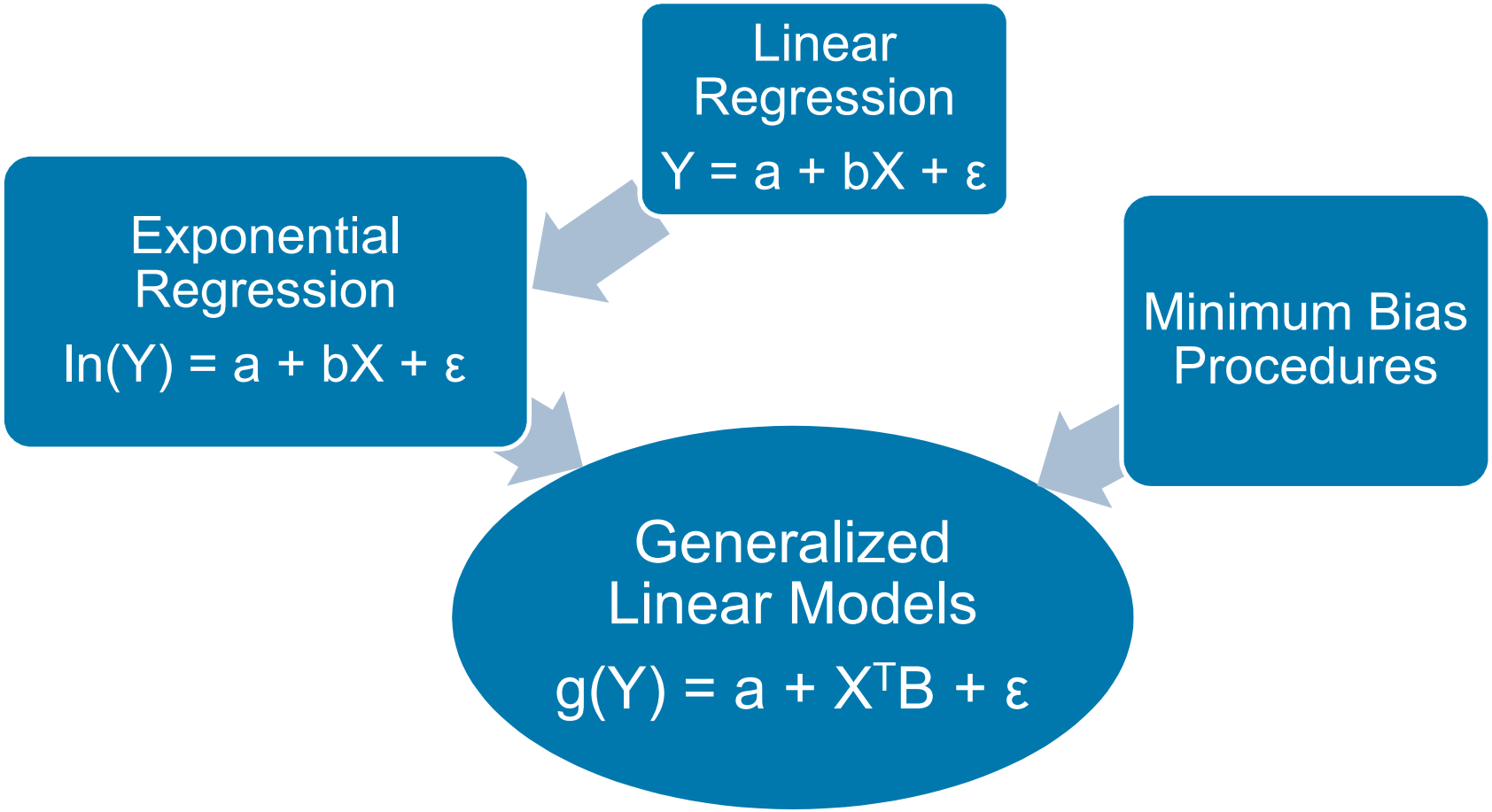
Hernan L. Medina, CPCU, API, AU, AIM, ARC

Motivation

- Models that appear to be strong may have weaknesses
  - Fit may not be good
  - Model may be overfit
  - Wrong distribution may have been chosen
  - Results may not be stable across data subsets or over time
  - Results may be highly influenced by several records
  - Model may underperform the status quo

- Model development is a major investment, and before implementing a model, we should fully understand its strengths and weaknesses

Some Models Used by Actuaries



Understanding & Validating a Model

- Model Lift
  - How well does the model differentiate between best and worst risks?
  - Does the model help prevent adverse selection?
  - Is the model better than the current rating plan?
- Goodness of Fit
  - What kind of model statistics are available, and how do you interpret them?
  - What kind of residual plots should you consider, and how do you interpret them?
  - What are some considerations regarding actual versus predicted plots?
- Internal Stability
  - How well does the model perform on other data?
  - How will the model perform over time?
  - How reliable are the model's parameter estimates?

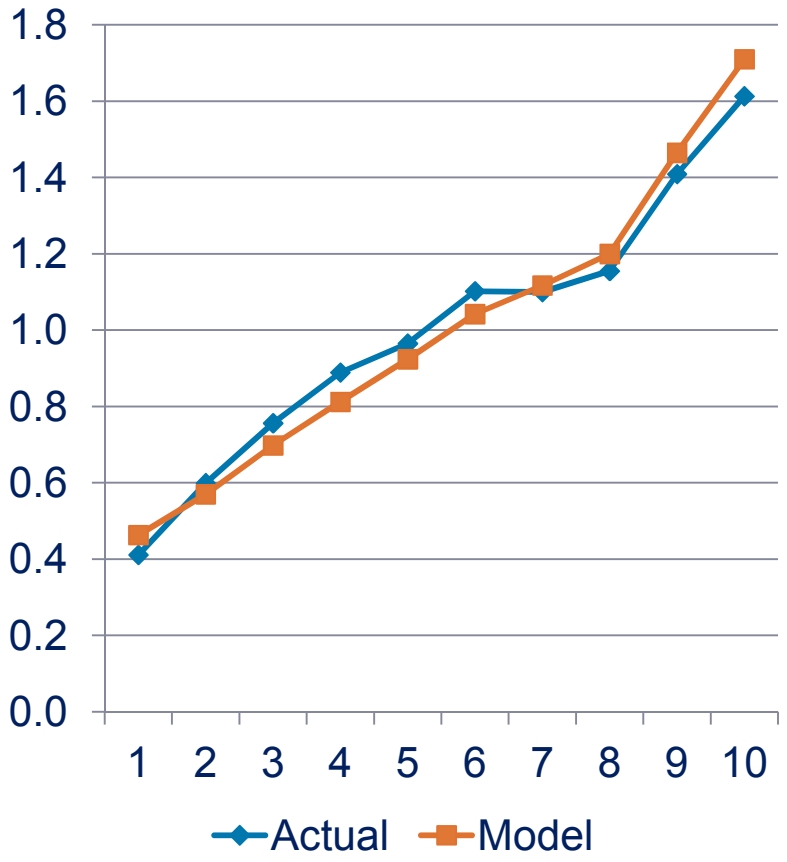
Model Lift

- Ability to differentiate between low and high cost policyholders
  - Sometimes called the “economic value” of the model

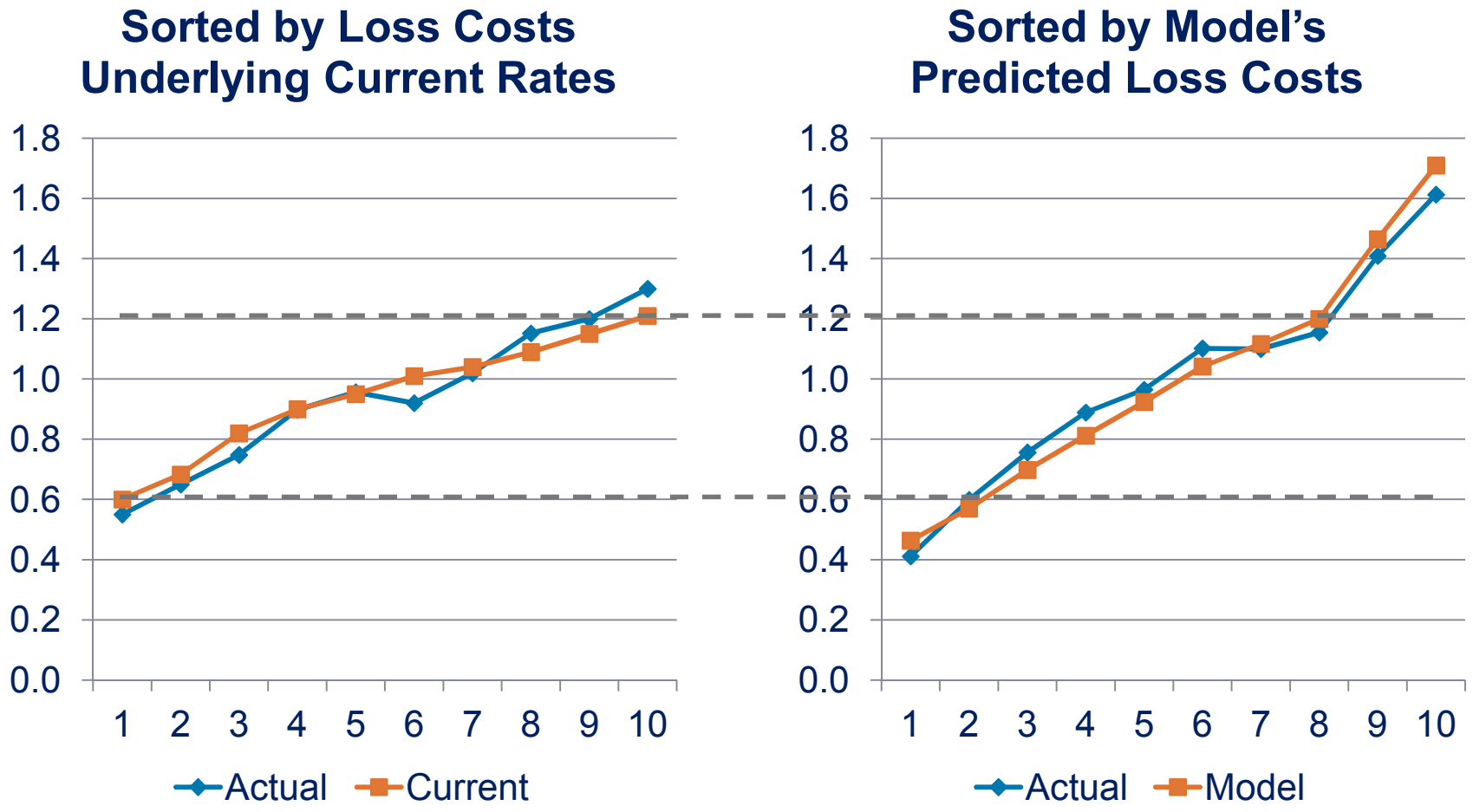
- Tools for measuring and illustrating model lift
  - Simple Quantile plots
  - Double lift charts
  - Gini index
  - Loss ratio charts

Model Lift – Simple Quantile Plots

- Creating a quantile plot
  - Use holdout sample.
  - Sort data based on predicted value (frequency, severity, loss cost).
  - Subdivide sorted data into quantiles (quartiles, quintiles, deciles) with equal weight (exposure, claim count).
  - Calculate average actual value and predicted value for each quantile and index to overall average.

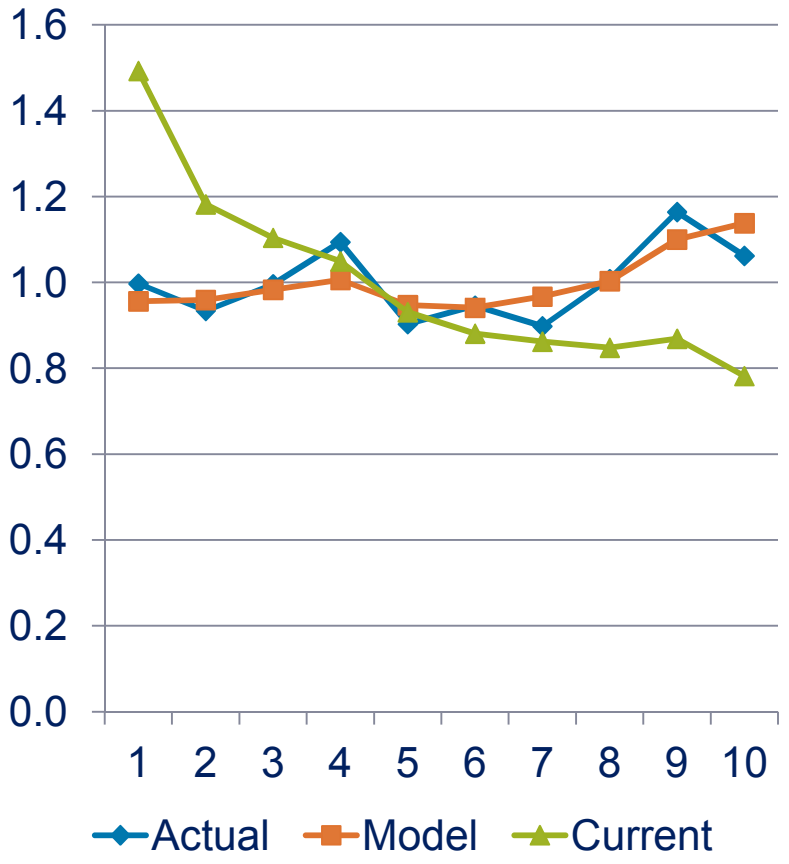


Model Lift – Simple Quantile Plots
Which Plot Shows Better Lift?



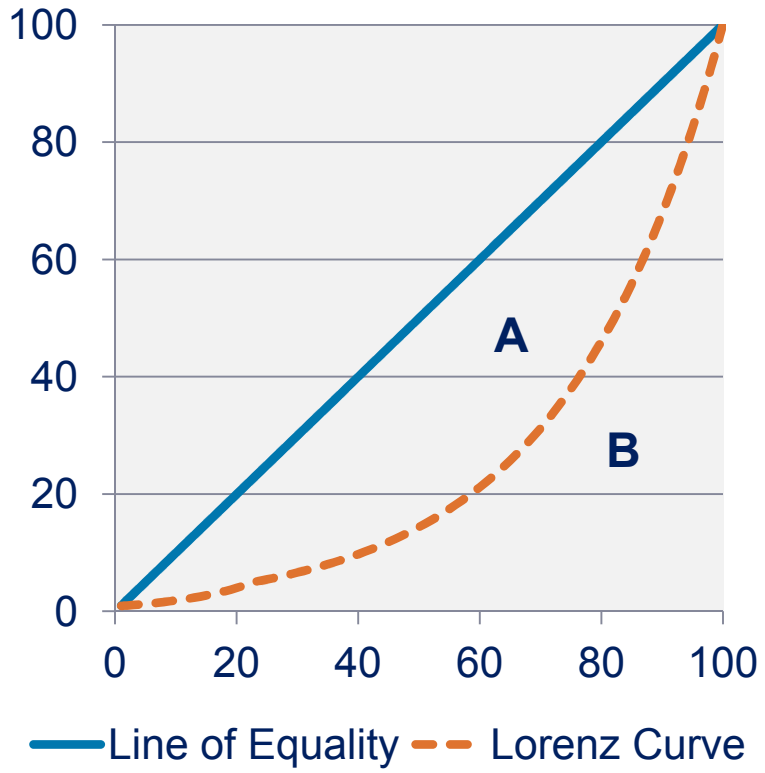
Model Lift – Double Lift Charts

- Creating a double lift chart
  - Sort data by ratio of model prediction to current premium
  - Subdivide sorted data into quantiles with equal exposure
  - For each quantile calculate average actual loss cost, average model predicted loss cost and the average loss cost underlying the current manual premium
  - Index the quantile averages to the overall averages.



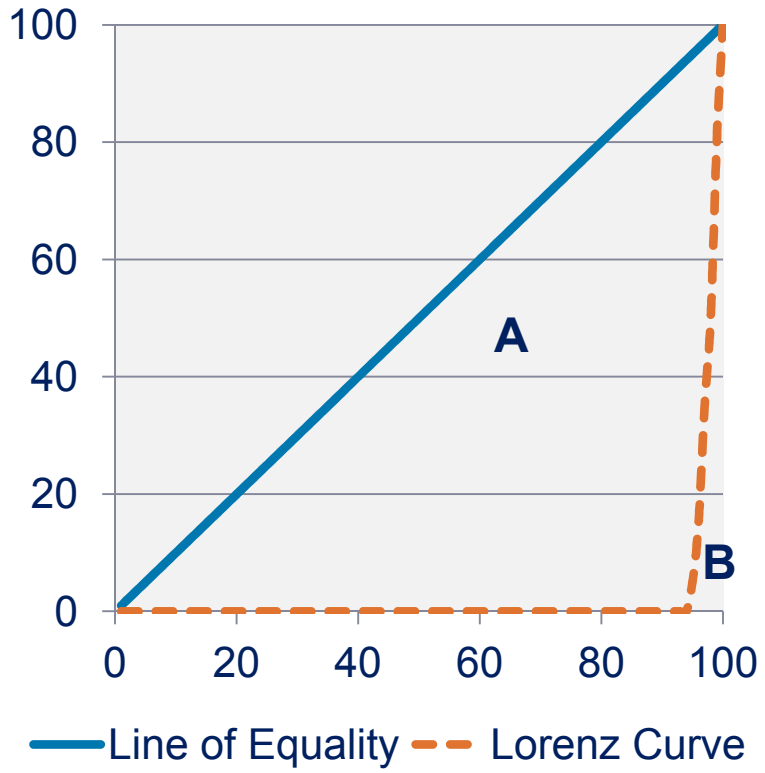
Economics – The Gini Index

- Gini coefficient or Gini ratio
  - Named after Corrado Gini
- Measure of income inequality
  - Horizontal axis = percentage of country's population
  - Vertical axis = percentage of country's income
  - A = Area between line of equality and Lorenz Curve
  - B = Area beneath Lorenz Curve
  - Gini index = A / (A + B)



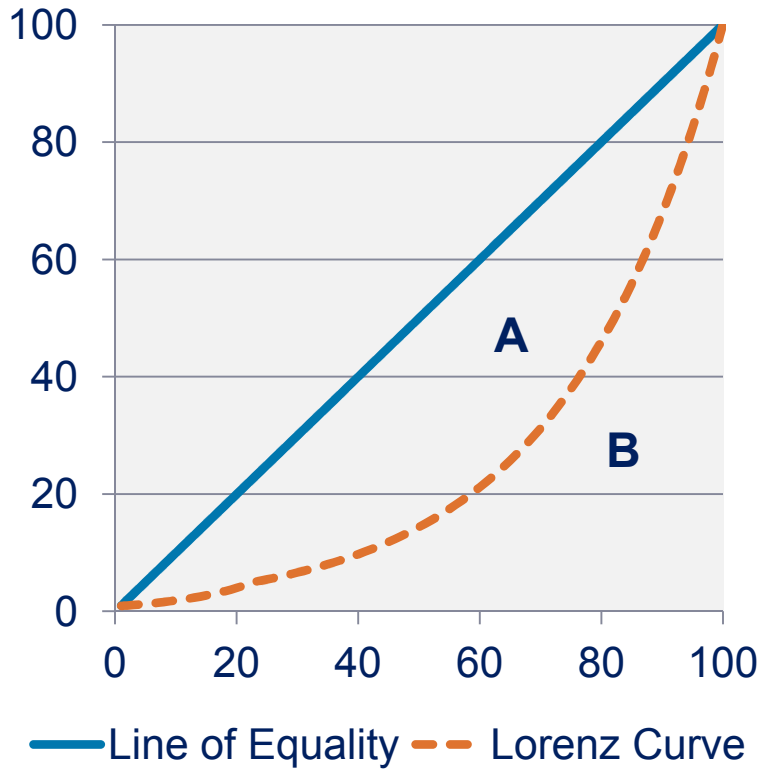
Model Lift – Simple Gini Index

- Adapting to car insurance
  - Assume claim frequency = 5%
- "The perfect model"
  - Prediction = actual loss, which is $0 for 95% of exposures
  - Sort holdout data set by model prediction.
  - Horizontal axis = percentage of total car years
  - Vertical axis = Percentage of total losses
  - Gini Index = A / (A+ B) is very high



Model Lift – Simple Gini Index

- A real model
  - Prediction = expected loss cost > 0 for each policyholder
  - Sort holdout data set by prediction.
  - Horizontal axis = percentage of total car years
  - Vertical axis = Percentage of total losses
  - Gini Index = A / (A+ B)
- A high Gini index implies
  - There is loss cost inequality
  - The model reflects it well



Model Lift – Simple Gini Index

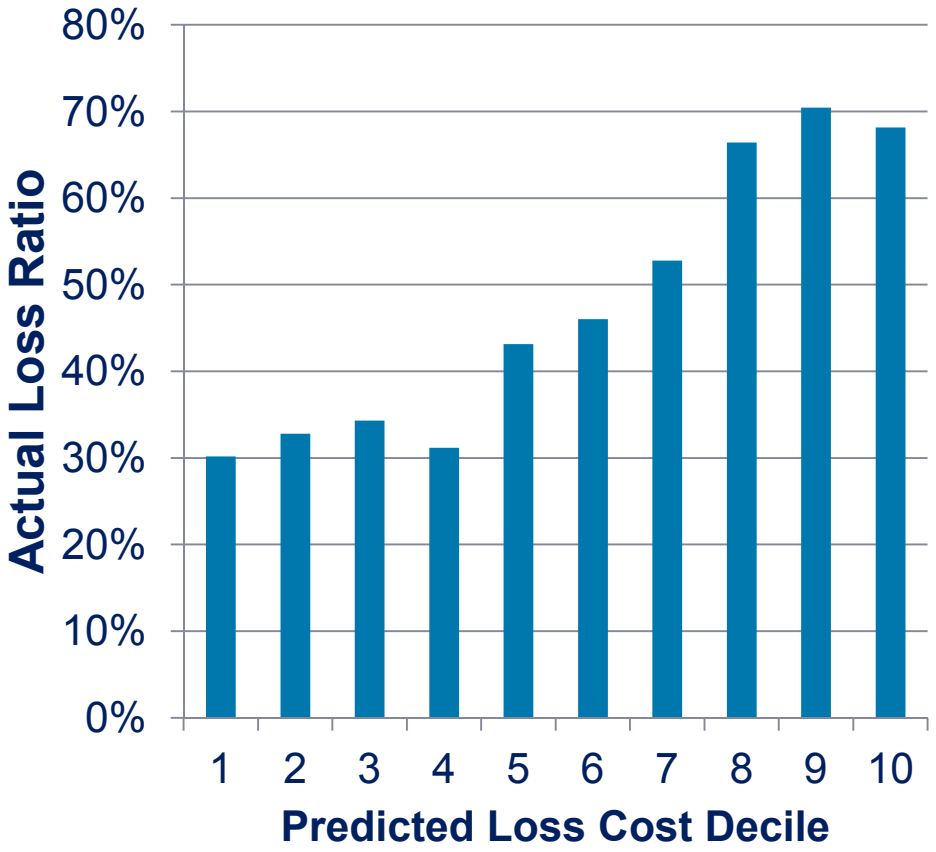
- Gini Index measures how well the model classifies policyholders

- Exercise:
  - Assume Model X prediction = expected loss cost
  - Assume Model Z prediction = 2.0 (Model X prediction)
  - Which model has the highest Gini index?

- Model A has a Gini index of 15.9 and B has a Gini index of 15.4
  - Is that difference significant, or is it just a quirk of the holdout data?
  - Use bootstrap samples

Model Lift – Loss Ratio Charts 1

- Lift charts and Gini index
  - May be unfamiliar to some stakeholders
- Loss ratios
  - Widely used in the industry
- Ranking by predicted loss cost
  - Rank data into quantiles by predicted model loss cost
  - Calculate loss ratio for each quantile



Model Lift – Summary

- Simple Quantile plots
  - Illustrate how well the model helps prevent adverse selection
  - Compare against current rating plan or other model
- Double lift charts
  - Compare competing models
  - Compare new model against current rating plan
- Simple Gini Index
  - Summarizes model lift into one number
- Loss ratio charts
  - Puts lift in context most people in insurance industry can understand
  - Can be distorted by redundancy or inadequacy of current rating plan

Questions?