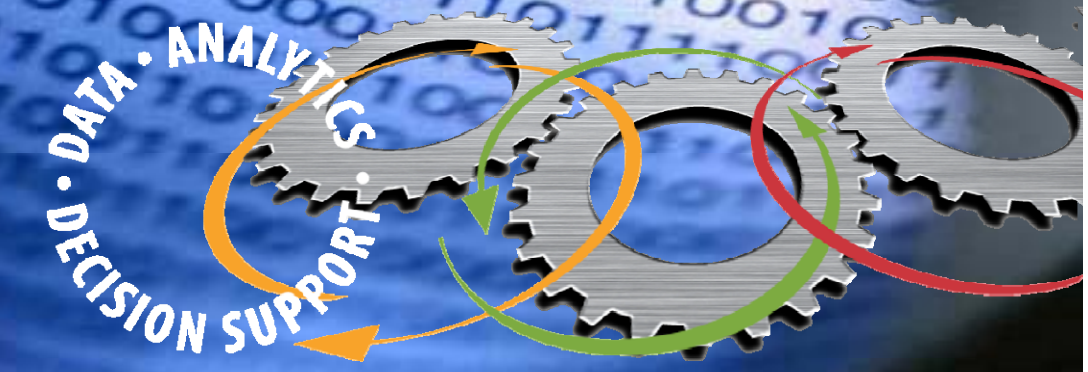
2009 Actuarial Research Conference

The Role of Research at ISO



Glenn Meyers
ISO Innovative Analytics

ISO Innovative Analytics

A UNIT OF ISO

The IIA Team

To develop and deliver IIA's sophisticated predictive modeling tools, IIA has pooled the talent of a highly credentialed group of individuals with more than 300 years combined experience in analytics. The members of this multidisciplinary team hold more than 30 advanced academic degrees with backgrounds in:

- statistics
- actuarial science
- mathematics/applied mathematics
- data management, warehousing, and mining
- analytics and modeling
- machine learning
- computer science
- personal and commercial insurance
- industrial/operational research
- finance
- economics/applied economics
- engineering geoscience

14 Ph.D.'s in the fields of Statistics, Mathematics, Economics, Finance, Machine Learning, Engineering

Three Fellows of Casualty Actuarial Society plus access to other ISO personnel.

More on iiA

- Predictive Modeling Projects
  - Refined Underwriting Tools (example to follow)
  - Fraud Detection
    - Property/Casualty Claims
    - Mortgage
    - Health Care
  - Premium Audit
  - Insurance Marketing
- Analytic Tools
  - PC SAS, SAS Enterprise Miner, R
  - Mapping Software

Territorial Ratemaking

- Territories should be big
  - Have a sufficient volume of business to make credible estimates of the losses.
- Territories should be small
  - "You live near that bad corner!"
  - Driving conditions vary within territory.

Some Environmental Features Related to Auto Accidents

- Proximity to Business Districts
  - Workplaces
    - Busy at beginning and end of work day
  - Shopping Centers
    - Always busy (especially on weekends)
  - Restaurants
    - Busy at mealtimes
  - Schools
    - Busy and beginning and end or school day

Some Environmental Features Related to Auto Accidents

- Weather
  - Rainfall
  - Temperature
  - Snowfall (especially in hilly areas)
- Traffic Density
  - More traffic sharing the same space increases odds of collision
- Others

Combining Environmental Variables at a Particular Garage Address

- Individually, the geographic variables have a predictable effect on accident rate and severity.
- Variables for a particular location could have a combination of positive and negative effects.
- ISO has built a model to calculate the combined effect of all variables.
  - Based on countrywide data – Actuarially credible

Data Used in Building Model

- Obtained loss, exposure, classification and address for individual policies from cooperating insurers
- ISO Statistical Plan data
- Third-Party Data
  - Traffic
  - Business Location
  - Demographic
  - Weather
  - etc
- Approximately 1,000 indicators

Environmental Module Examples

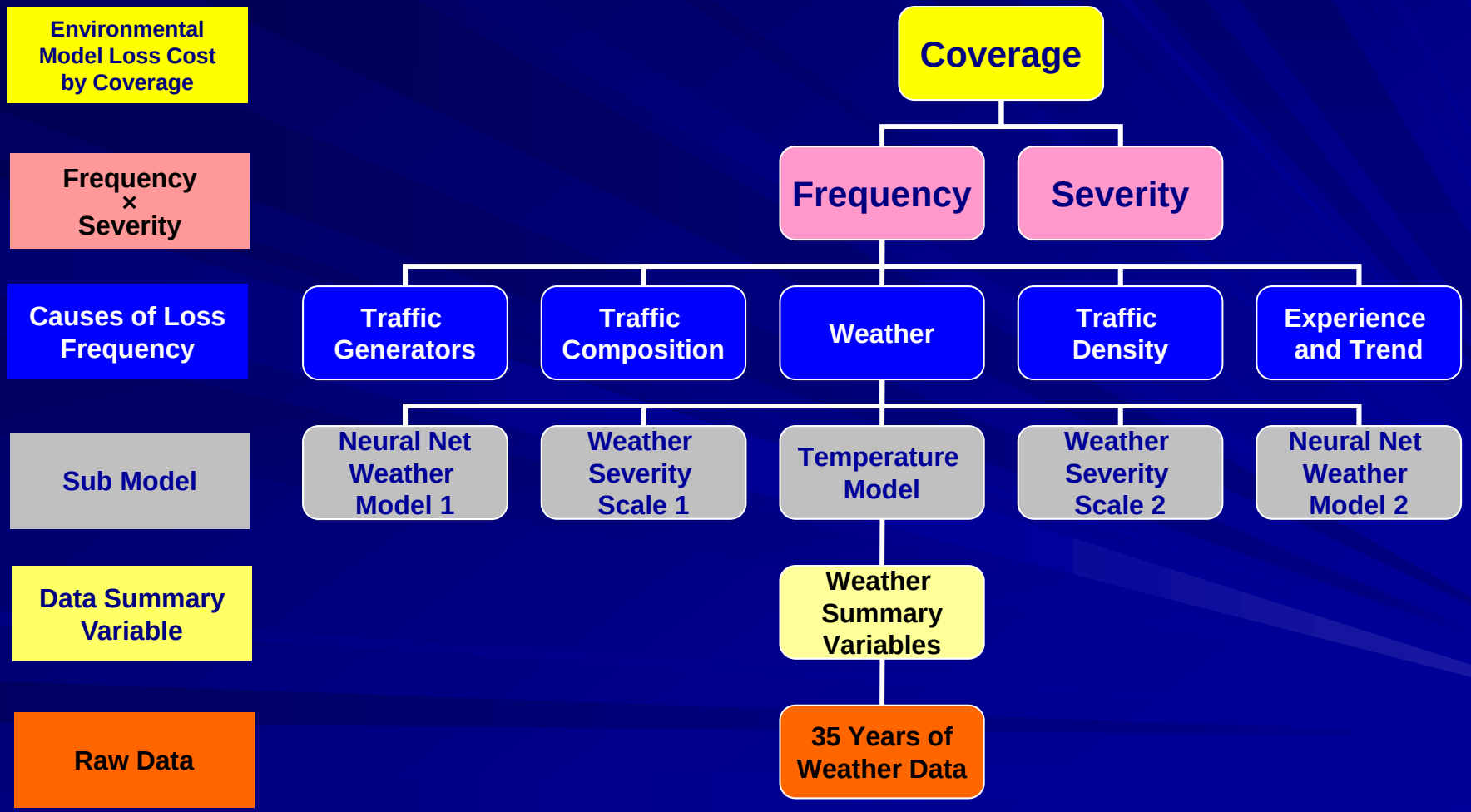
- **Comprised of over 1000 indicators**

- **Weather:**
  - Measures of snowfall, rainfall, temperature, wind and elevation
- **Traffic Density and Driving Patterns**:
  - Commute patterns
  - Public transportation usage
  - Population density
  - Types of housing
- **Traffic Composition**
  - Demographic groups
  - Household size
  - Homeownership
- Traffic Generators
  - Transportation hubs
  - Shopping centers
  - Hospitals/medical centers
  - Entertainment districts
- Experience and trend:
  - ISO loss cost
  - State frequency and severity trends from ISO lost cost analysis

Techniques Employed in Variable Reduction

- Variable Selection – univariate analysis, transformations, known relationship to loss
- Sampling
- Sub models/data reduction – neural nets, splines, principal component analysis, variable clustering
- Spatial Smoothing – with parameters related to auto insurance loss patterns

In Depth for Weather Component



Environmental Model

Loss Cost = Pure Premium

= Frequency x Severity

$$\text{Frequency} = \frac{e^{\lambda}}{1+e^{\lambda}}$$

λ = Intercept

+ Weather

+ Traffic Density

+ Traffic Generators

+ Traffic Composition

+ Experience and Trend

Environmental Model

Loss Cost = Pure Premium

= Frequency x Severity

Severity = e^{μ}

μ = Intercept

+ Weather

+ Traffic Density

+ Traffic Generators

+ Traffic Composition

+ Experience and Trend

Environmental Model

Loss Cost = Pure Premium

= Frequency x Severity

- **Separate Models by Coverage**
  - Bodily Injury Liability
  - No-Fault
  - Property Damage Liability
  - Collision
  - Comprehensive

Constructing the Components Frequency Model as Example

$\lambda =$ Intercept

$+ \alpha_1 \cdot x_1 + \ldots + \alpha_{n_1} \cdot x_{n_1}$	= Weather
$+ \alpha_{n_1+1} \cdot x_{n_1+1} + \ldots + \alpha_{n_2} \cdot x_{n_2}$	= Traffic Density
$+ \alpha_{n_2+1} \cdot x_{n_2+1} + \ldots + \alpha_{n_3} \cdot x_{n_3}$	= Traffic Generators
$+ \alpha_{n_3+1} \cdot x_{n_3+1} + \ldots + \alpha_{n_4} \cdot x_{n_4}$	= Traffic Composition
$+ \alpha_{n_4+1} \cdot x_{n_4+1} + \ldots + \alpha_{n_5} \cdot x_{n_5}$	= Experience & Trend

$+$ Other Classifiers

Customized Model

Loss Cost = Pure Premium

= Frequency x Severity

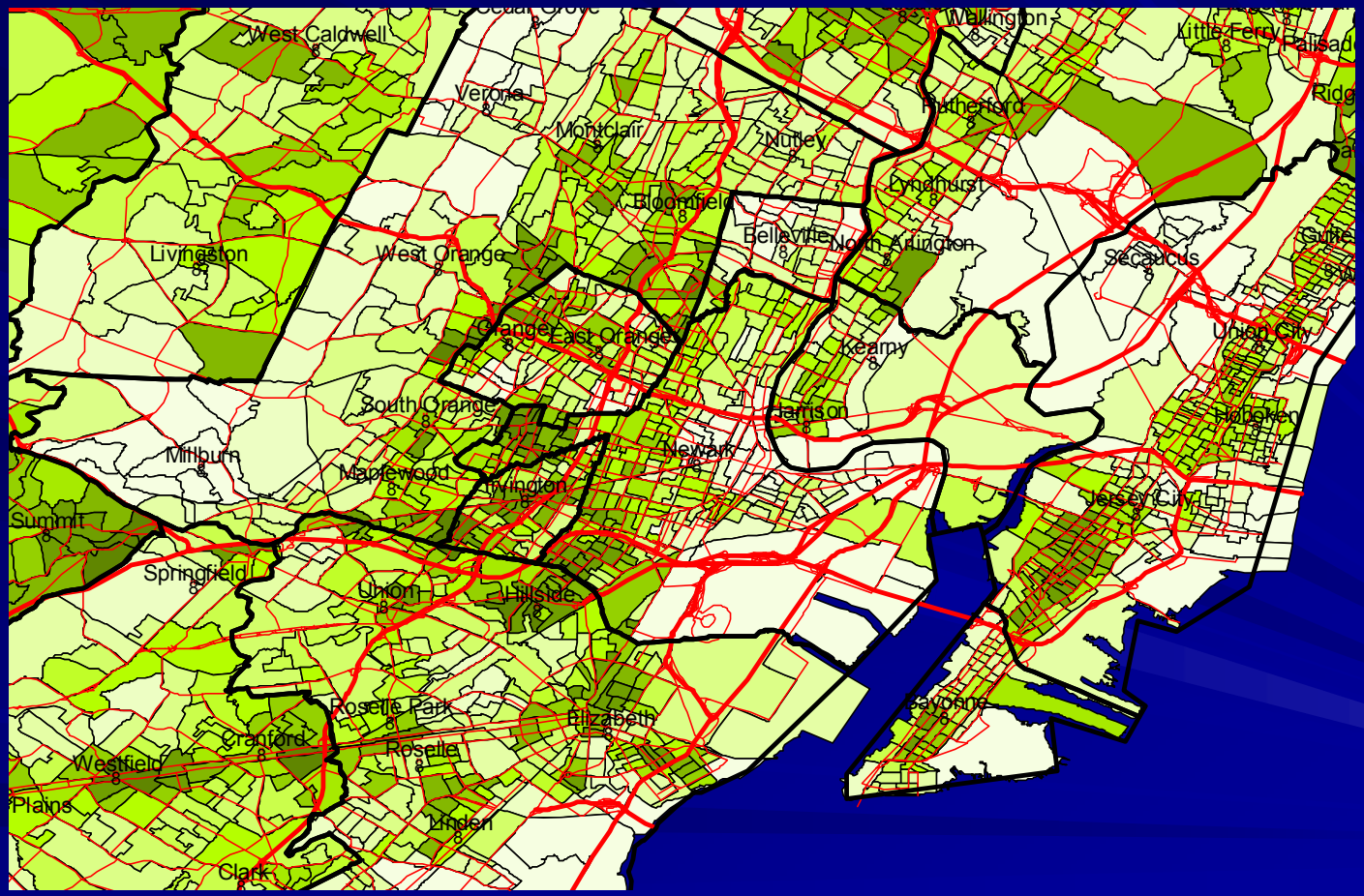
$$\text{Frequency} = \frac{e^{\lambda}}{1+e^{\lambda}}$$

$$\lambda = \alpha_0 + \alpha_1 \cdot \text{Weather} + \alpha_2 \cdot \text{Traffic Density} + \alpha_3 \cdot \text{Traffic Generators} + \alpha_4 \cdot \text{Traffic Composition} + \alpha_5 \cdot \text{Experience and Trend} + \text{Other Classifiers}$$

$\alpha_1 \ldots \alpha_5 \equiv 1$
in industry model

Severity model
customized similarly

Newark NJ Area Combined Relativity



Research Activities Connected with Modeling

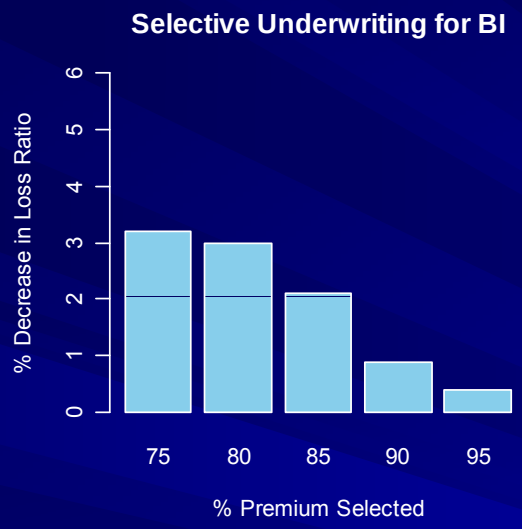
- Evaluate data sources
- Treating partial year exposures in GLM
- Discrepancies in geographic parameters
- Pure premium vs Frequency/Severity?
  - Settled on Tweedie for pure premium
- Correlation between coverages/perils
- Evaluating models
  - Goodness of fit does not work
  - Target audience is customers

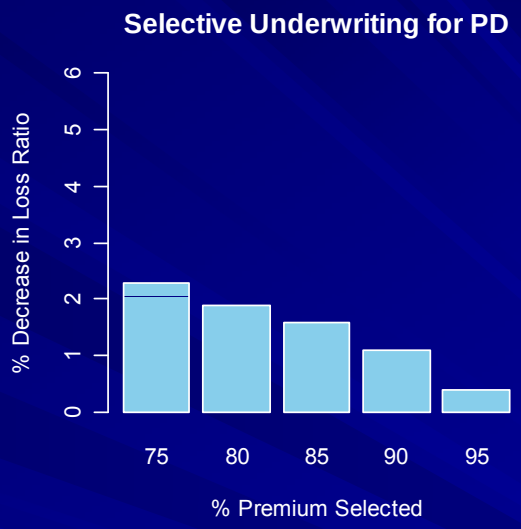
Evaluating the Lift of the Environmental Model

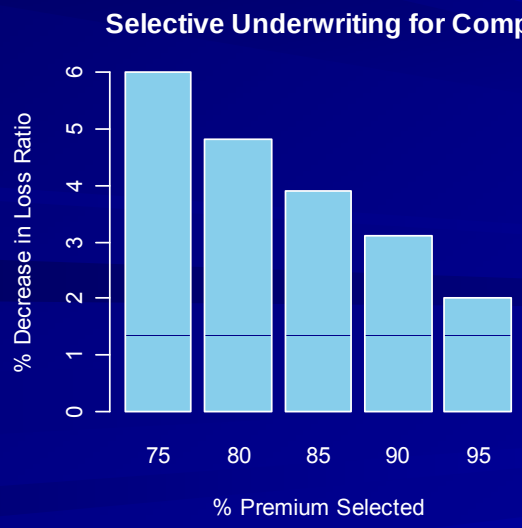
- Demonstrate the ability to select the more profitable risks
- Demonstrate the adverse effect of competitors “skimming the cream”
- Calculate the “Value of Lift” statistic

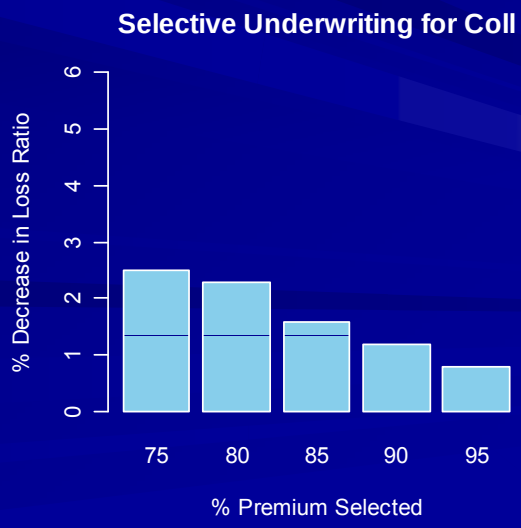
- Once insurers see the value of lift other actions are possible
  - Change prices (etc)

Effect of Selecting Lower Relativities

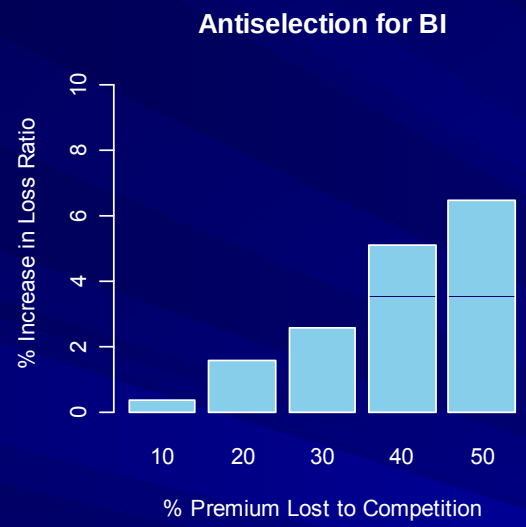


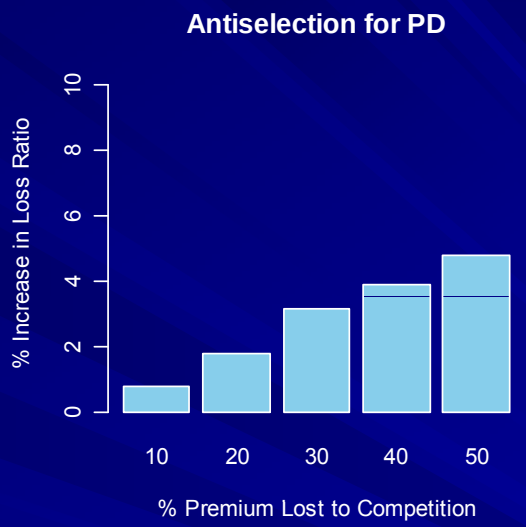


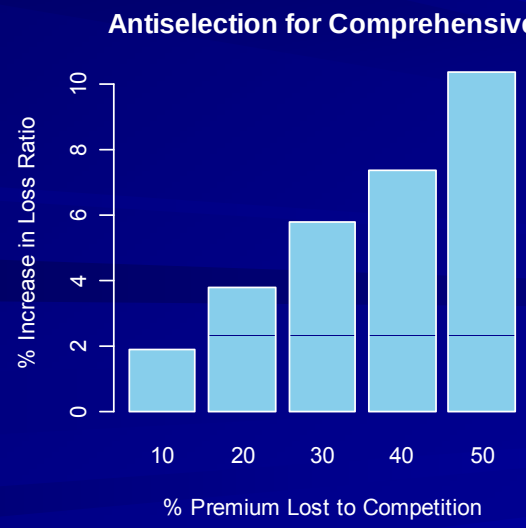


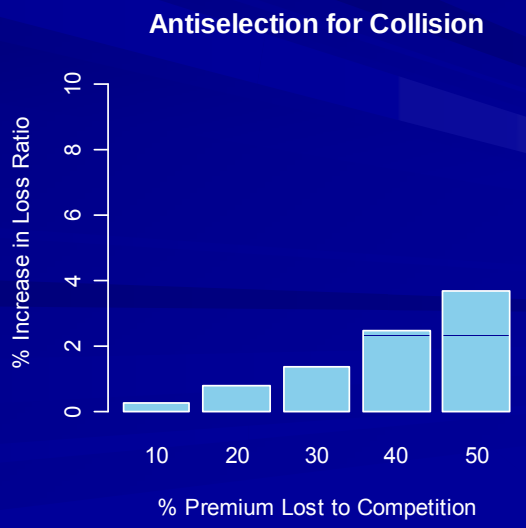


Effect of Competitors Selecting Lower Relativities









Assumptions of The Formula Value of Lift (VoL)

- Assume a competitor comes in and takes away the business that is less than your class average.
- Because of adverse selection, the new loss ratio will be higher than the current loss ratio.
- *What is the value of avoiding this fate?*
- VoL is proportional to the difference between the new and the current loss ratio.
- Express the VoL as a $ per car year.

The VoL Formula

- L_C = Current losses
- P_C = Current Loss Cost
- L_N = New losses of business remaining
  - After adverse selection
- P_N = New Loss Cost
  - After adverse selection
- E_C = Current exposure in car years

The VoL Formula

$$VoL = \frac{\left(\frac{L_N}{P_N} - \frac{L_C}{P_C}\right) \cdot P_N}{E_C}$$

- The numerator represents $ value of the potential cost of competitors skimming the cream.
- Dividing by E_C expresses this value as a $ value per car year.

Value of Lift Results on Pilot Testers

Coverage	Value of Lift
BI Liability	$4.99
PD Liability	$3.63
Collision	$1.61
Comprehensive	$4.85
PIP	$15.04
Combined	$13.29

Summary

- ISO is committed to making use of cutting edge research to solve industry problems.