# Predictive Modeling & Enterprise Risk Management – Implementation Issues

Roosevelt C. Mosley, Jr., FCAS, MAAA

Casualty Actuaries of the Southeast – Fall 2005

October 10, 2005

Atlanta, GA

PINNACLE
ACTUARIAL RESOURCES, INC.
Consulting Actuaries

# Topics for Discussion

- Actuarial Applications
  - Predictive Modeling
  - Enterprise Risk Management
- Discussion
  - Steps to Implementation
  - Considerations for Success

PINNACLE
ACTUARIAL RESOURCES, INC.
Consulting Actuaries

# Predictive Modeling

PINNACLE
ACTUARIAL RESOURCES, INC.
Consulting Actuaries

# Implementation Considerations - Predictive Modeling

- Define predictive modeling
- Define objectives
- Data
- Data summarization
- Model development
- Application

PINNACLE
ACTUARIAL RESOURCES, INC.
Consulting Actuaries

# Definitions

- **Predictive modeling** is an application of data mining

- **Data mining**: analysis of (often large) observational data sets to find unsuspected relationships and to summarize the data in novel ways that are both understandable and useful to the data owner

Principles of Data Mining. Hand et al, 2001.

PINNACLE
ACTUARIAL RESOURCES, INC.
Consulting Actuaries

# Predictive Modeling

- **Predictive modeling** is the data mining analysis of a historical dataset for the purposes of making predictions regarding the future
- Considerations
  - Understanding the past
  - Assumes future will be like the past
  - Separating the trend from the noise
  - Interference with “nature”

PINNACLE
ACTUARIAL RESOURCES, INC.
Consulting Actuaries

# Define Objectives

- Pricing
- Insurance Scoring
- Claims
- Customer Response
  - Marketing
  - Demand
  - Renewal
- Agency Evaluation
- Vehicle Symbols
- Fraud Detection

PINNACLE
ACTUARIAL RESOURCES, INC.
Consulting Actuaries

# Data Sources

Internal

- Rating
- Underwriting
- Agency
- Marketing
- Banking
- Affiliations
- Claims

External

- Credit bureaus
- Vehicle characteristics
- Demographic data
- Distance to fire station
- CLUE
- Current carrier

PINNACLE
ACTUARIAL RESOURCES, INC.
Consulting Actuaries

# Data Summarizations

**Example Tutorial - A worked example of the tutorial job**

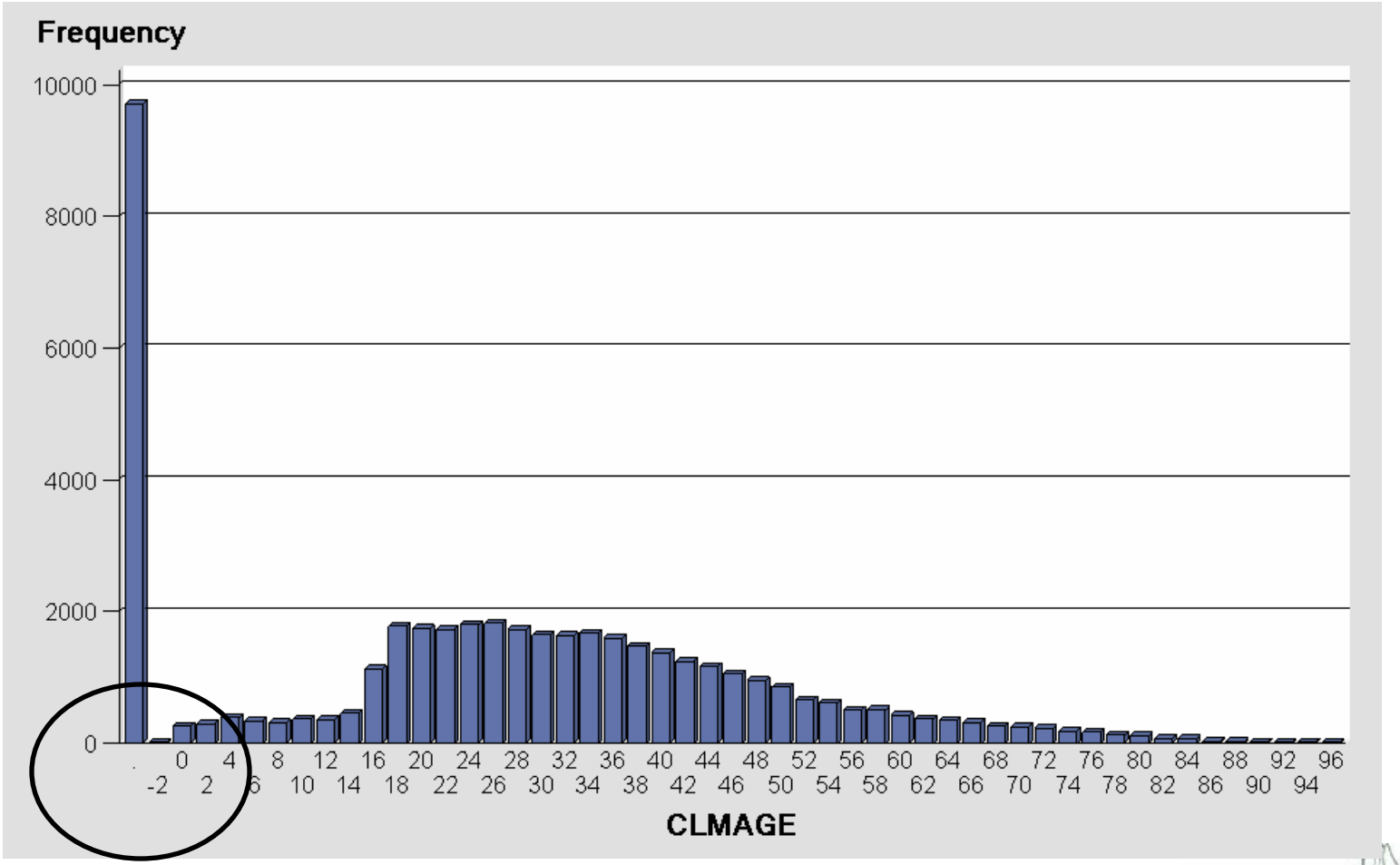
Claim type 1 - Third party property damage

Policy duration (Poldur)

| Level | Number of records | Exposure | Premium | Number of claims | Incurred claims | Claim frequency | Average cost per claim | Burning cost | Loss ratio |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 20,590 | 18,443 | 10,037,445 | 3,873 | 2,953,796 | 21.0% | 763 | 160 | 29.4% |
| 1 | 17,517 | 15,702 | 8,261,851 | 2,690 | 1,936,835 | 17.1% | 720 | 123 | 23.4% |
| 2 | 15,329 | 13,755 | 7,029,307 | 2,314 | 1,718,638 | 16.8% | 743 | 125 | 24.4% |
| 3 | 12,575 | 11,260 | 5,742,554 | 1,928 | 1,406,528 | 17.1% | 730 | 125 | 24.5% |
| 4 | 10,682 | 9,621 | 4,952,596 | 1,540 | 1,133,001 | 16.0% | 736 | 118 | 22.9% |
| 5 | 9,030 | 8,117 | 4,148,383 | 1,245 | 906,714 | 15.3% | 728 | 112 | 21.9% |
| 6 | 8,136 | 7,274 | 3,784,031 | 1,148 | 814,855 | 15.8% | 710 | 112 | 21.5% |
| 7 | 7,503 | 6,741 | 3,461,998 | 1,045 | 758,537 | 15.5% | 726 | 113 | 21.9% |
| 8 | 6,778 | 6,084 | 3,197,012 | 928 | 675,221 | 15.3% | 728 | 111 | 21.1% |
| 9 | 6,893 | 6,169 | 3,244,523 | 939 | 669,787 | 15.2% | 713 | 109 | 20.6% |
| 10 | 6,437 | 5,792 | 3,025,498 | 816 | 581,260 | 14.1% | 712 | 100 | 19.2% |
| 11 | 6,390 | 5,750 | 2,901,246 | 716 | 539,501 | 12.5% | 753 | 94 | 18.6% |
| 12 | 5,846 | 5,250 | 2,732,067 | 753 | 559,620 | 14.3% | 743 | 107 | 20.5% |
| 13 | 5,342 | 4,780 | 2,458,125 | 657 | 498,439 | 13.7% | 759 | 104 | 20.3% |
| 14 | 5,481 | 4,912 | 2,543,214 | 589 | 461,281 | 12.0% | 783 | 94 | 18.1% |
| 15 | 5,492 | 4,933 | 2,544,594 | 607 | 448,065 | 12.3% | 738 | 91 | 17.6% |
| | **150,021** | **134,581** | **70,064,445** | **21,788** | **16,062,077** | **16.2%** | **737** | **119.35** | **22.9%** |

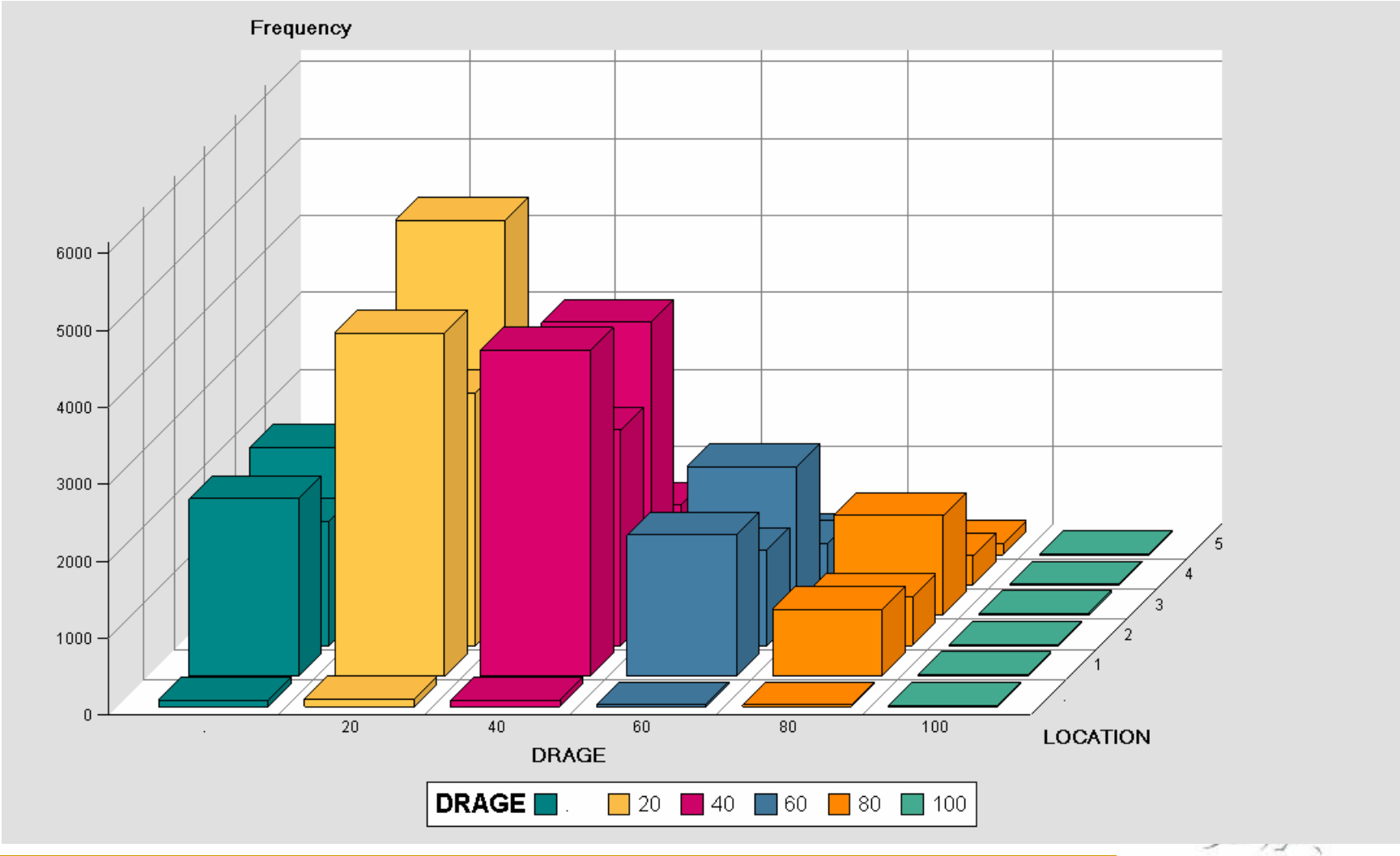
PINNACLE
ACTUARIAL RESOURCES, INC.
Consulting Actuaries

# Distribution of Claimants by Age



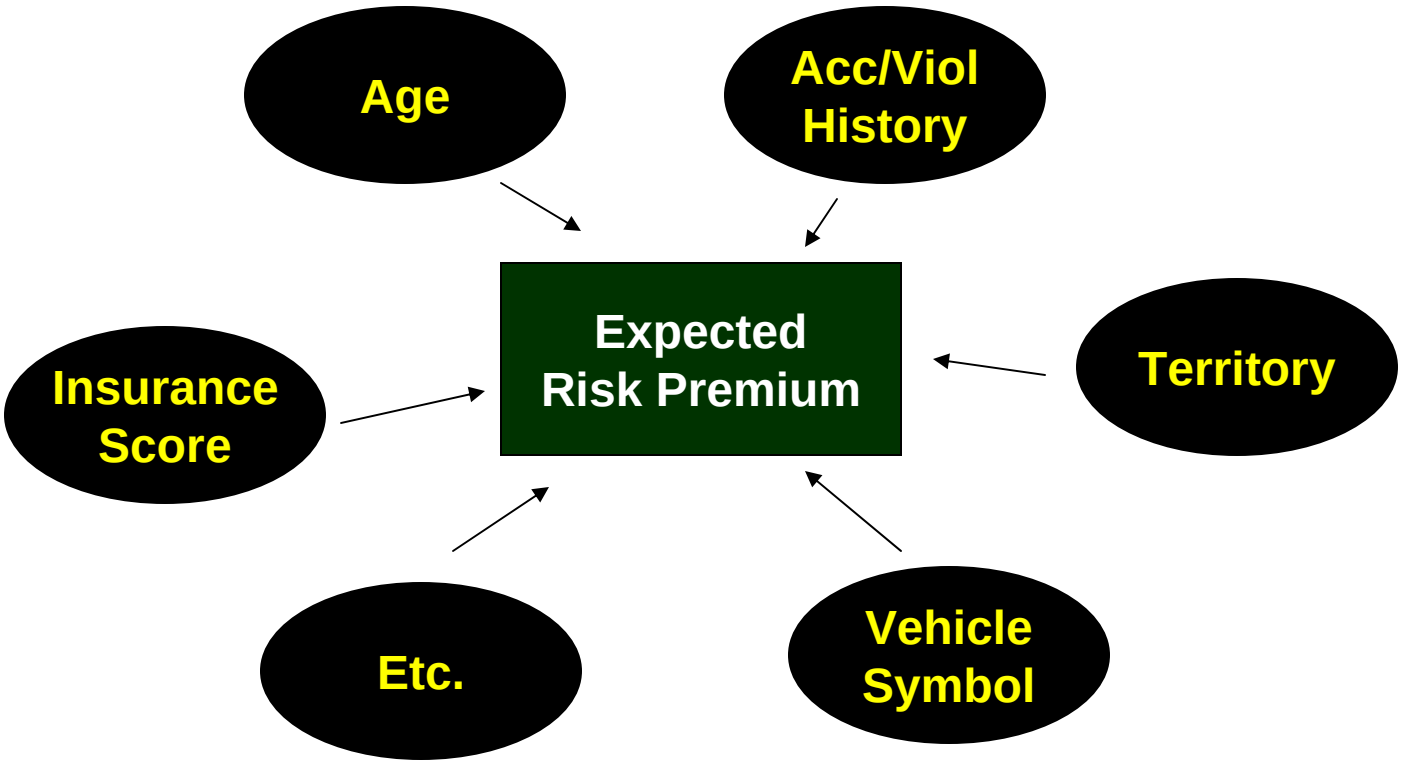

PINNACLE
ACTUARIAL RESOURCES, INC.
Consulting Actuaries

# Driver Age by Location



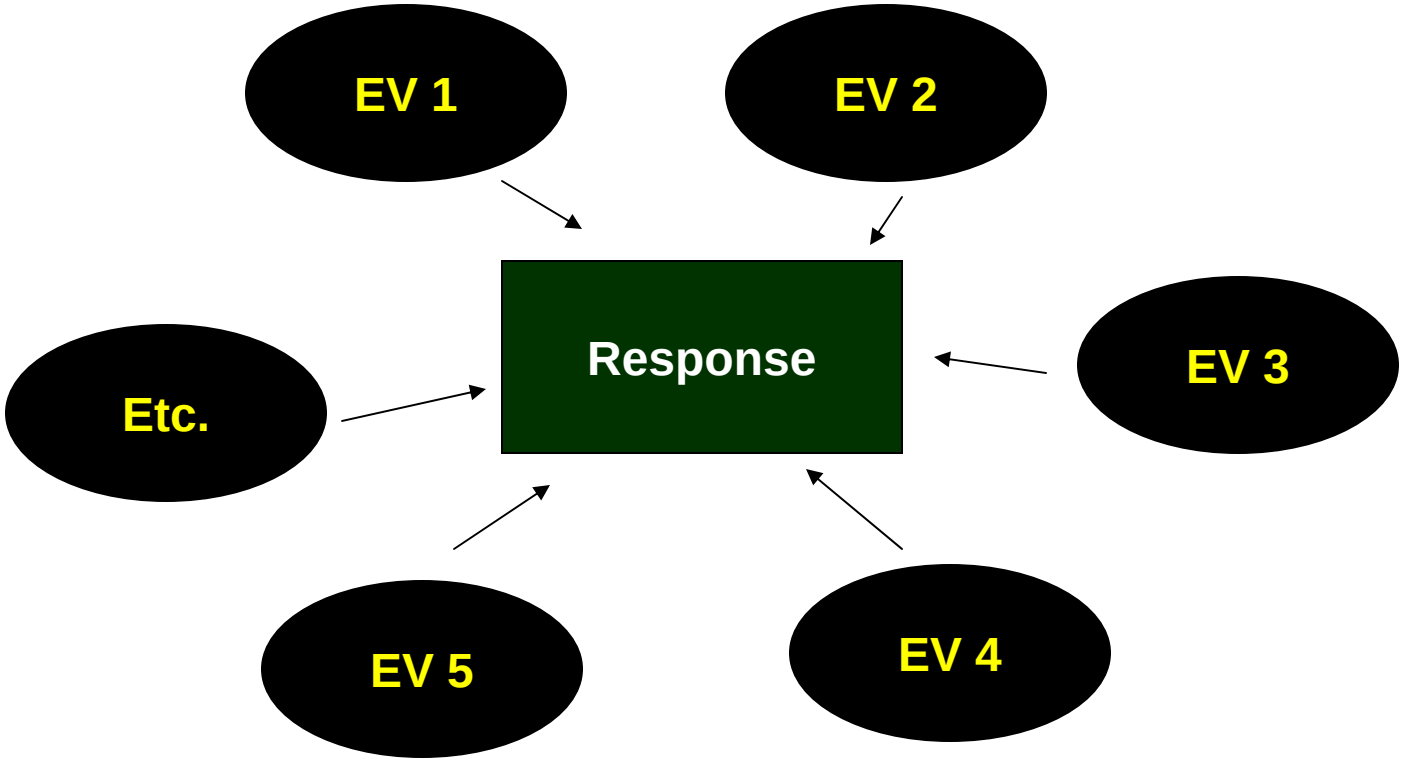

PINNACLE
ACTUARIAL RESOURCES, INC.
Consulting Actuaries

# Model Development - Example




PINNACLE
ACTUARIAL RESOURCES, INC.
Consulting Actuaries

# More General Model Development



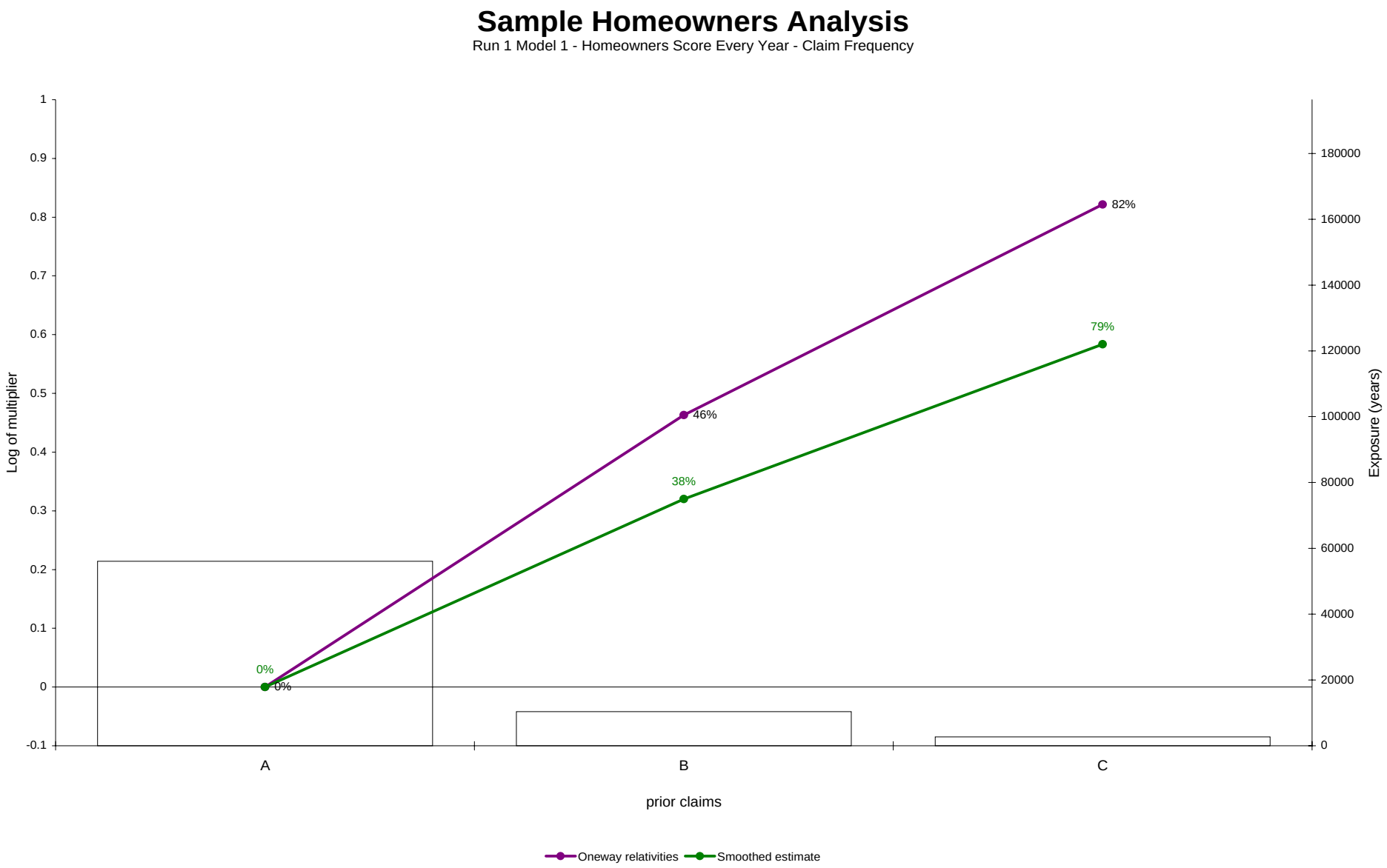

PINNACLE
ACTUARIAL RESOURCES, INC.
Consulting Actuaries

# Predictive Modeling Techniques

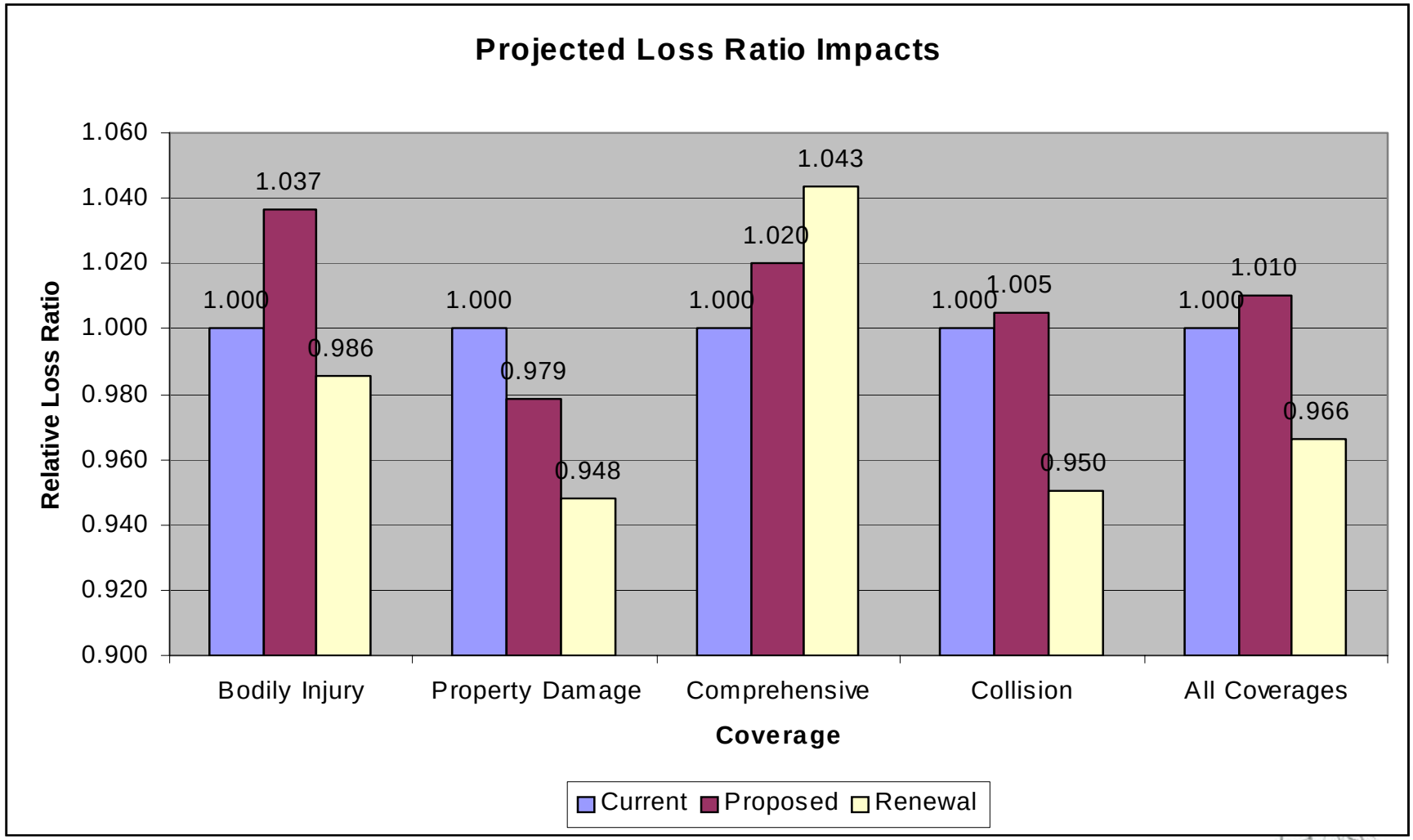
- Techniques
  - GLM (multiple regression analysis)
  - Decision trees
  - Clustering analysis
  - Principal components
  - Neural networks
- Considerations
  - Expertise
  - Software available
  - Application

PINNACLE
ACTUARIAL RESOURCES, INC.
Consulting Actuaries

# Pricing


Sample Homeowners Analysis
Run 1 Model 1 - Homeowners Score Every Year - Claim Frequency
Log of multiplier
Exposure (years)
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
180000
160000
140000
120000
100000
80000
60000
40000
20000
0
82%
79%
46%
38%
0%
0%
A
B
C
prior claims
Oneway relativities
Smoothed estimate

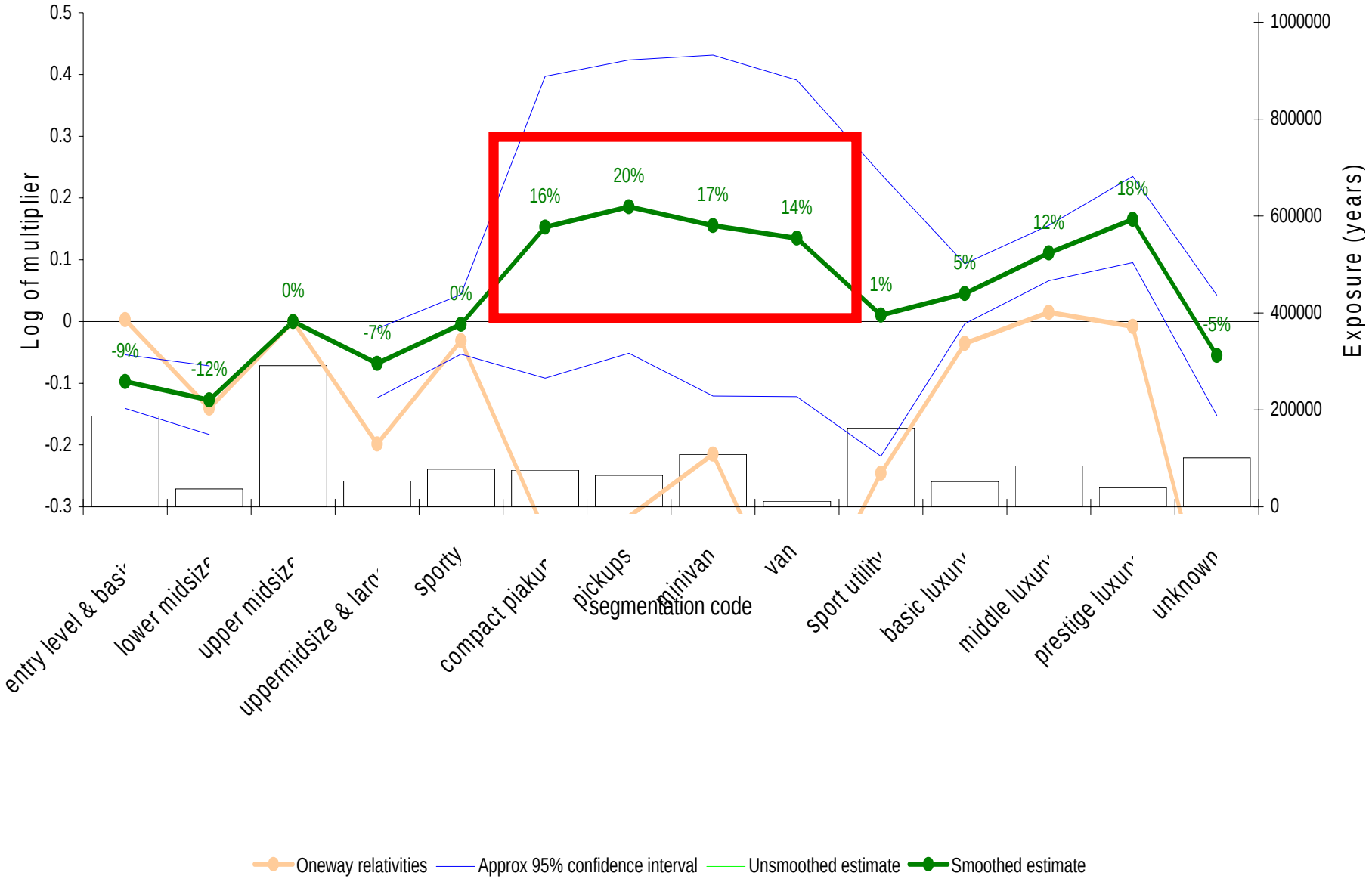
# Effective Rate Impacts




PINNACLE
ACTUARIAL RESOURCES, INC.
Consulting Actuaries

# Collision Vehicle Classification Analysis

Run 2 Model 1 - Model without Symbol - Collision Frequency



# Application Considerations

- Systems restrictions
- Impacts
- Competition
- “Way of life” shift

PINNACLE
ACTUARIAL RESOURCES, INC.
Consulting Actuaries

# Enterprise Risk Management

PINNACLE
ACTUARIAL RESOURCES, INC.
Consulting Actuaries

# Enterprise Risk Management Steps

- Determine the corporation's objectives
- Identify risk exposure (e.g., interest rate risk)
- Quantify the exposure (e.g., measure volatility)
- Assess the impact (Model)
- Examine financial risk management tools
  - Reinsurance, business plans
  - Forwards, futures, options, swaps
  - Contingent risk financing
- Select appropriate risk management approach
- Implement and monitor program

PINNACLE
ACTUARIAL RESOURCES, INC.
Consulting Actuaries

# Determine Objectives

## *Internal*

- Strategic Planning
- Ratemaking
- Reinsurance
- Valuation / M&A
- Market Simulation and Competitive Analysis
- Asset / Liability Management
- Reserve Ranges

## *External*

- External Ratings
- Communication with Financial Markets
- Regulatory /Risk-Based Capital
- Capital Planning / Securitization

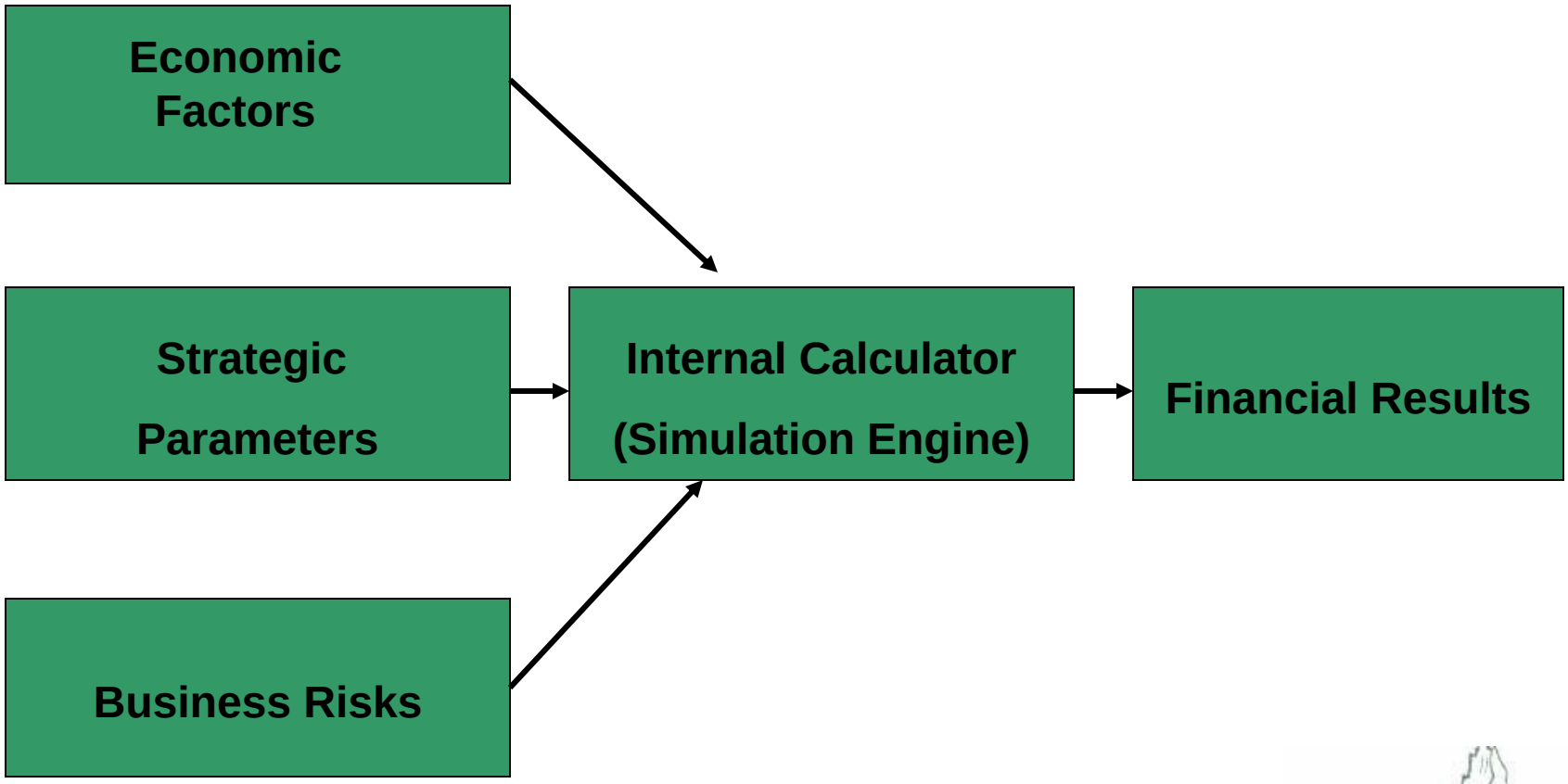
PINNACLE
ACTUARIAL RESOURCES, INC.
Consulting Actuaries

# Identify & Quantify Risk Exposure

- Hazard - quantifiable
- Financial - quantifiable
- Operational
- Strategic
- The Model Itself
  - Change in process
  - Wrong parameters

PINNACLE
ACTUARIAL RESOURCES, INC.
Consulting Actuaries

# Assess the Impact - Model




PINNACLE
ACTUARIAL RESOURCES, INC.
Consulting Actuaries

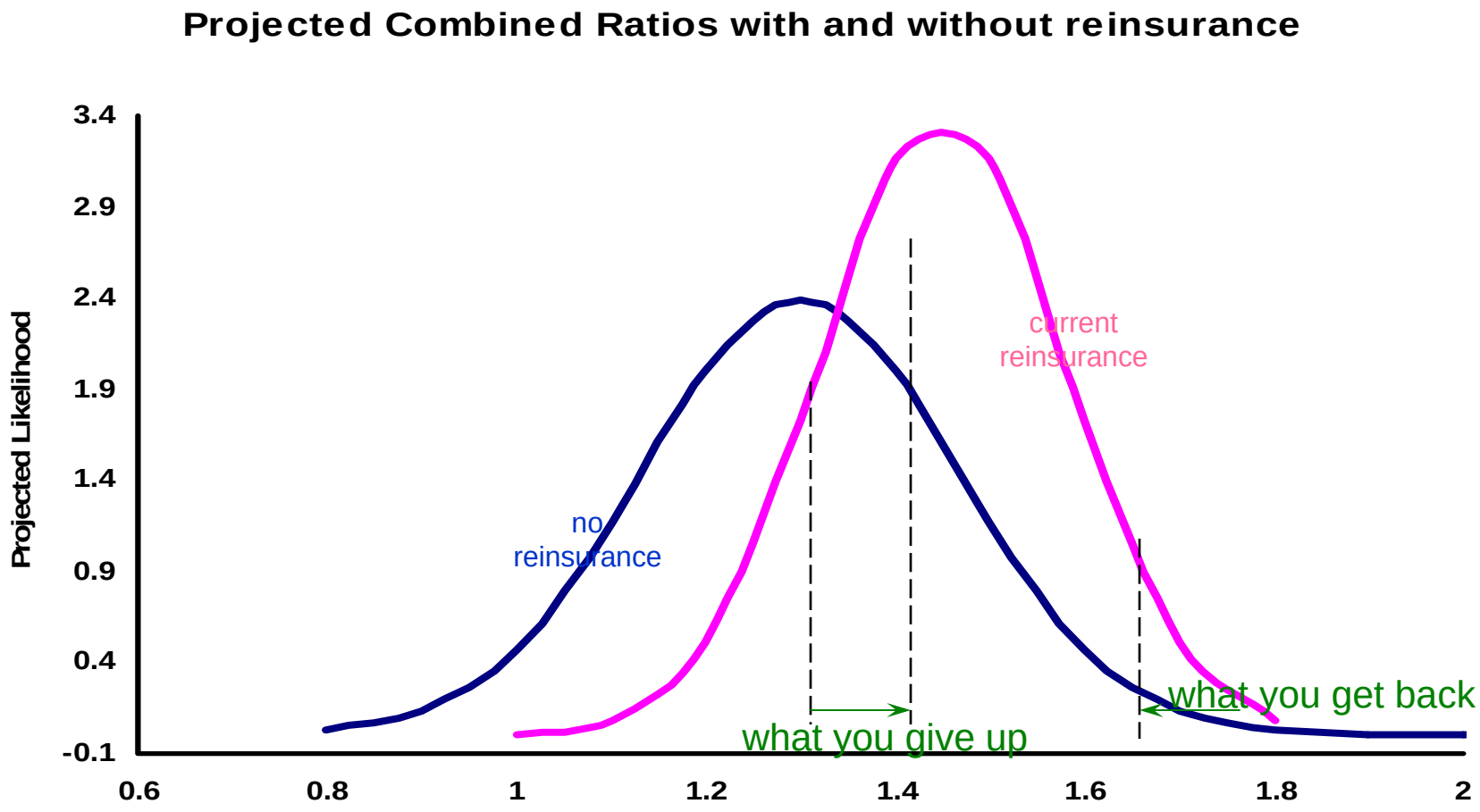
# Assess the Impact

## Types of Variables to be Modeled

- Strategies – Controllable variables
  - Growth
  - Investment strategy
- Risk Variables – Non-controllable variables
  - Economic factors
  - Hazards

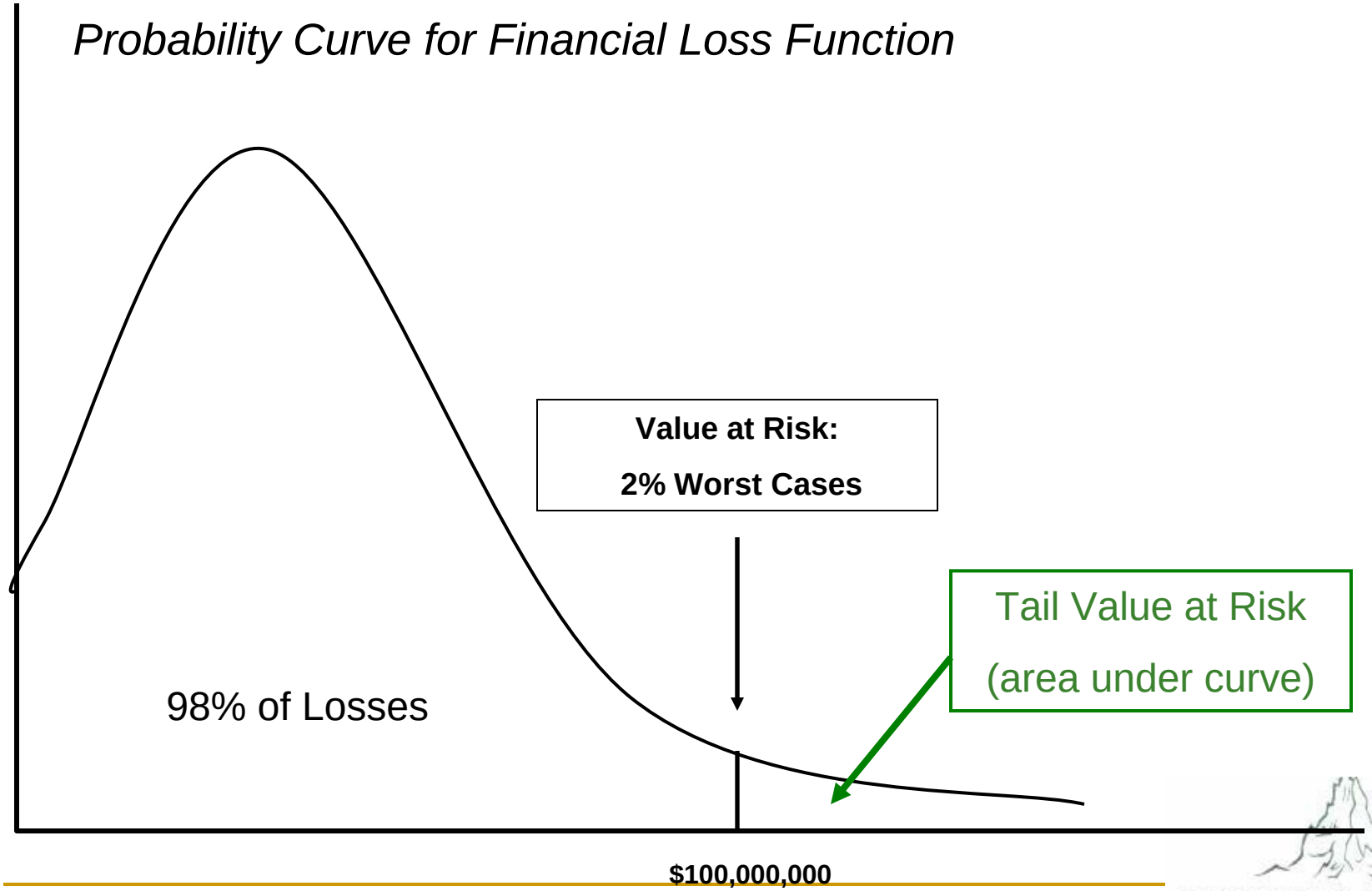
PINNACLE
ACTUARIAL RESOURCES, INC.
Consulting Actuaries

# Assess the Impact




PINNACLE
ACTUARIAL RESOURCES, INC.
Consulting Actuaries

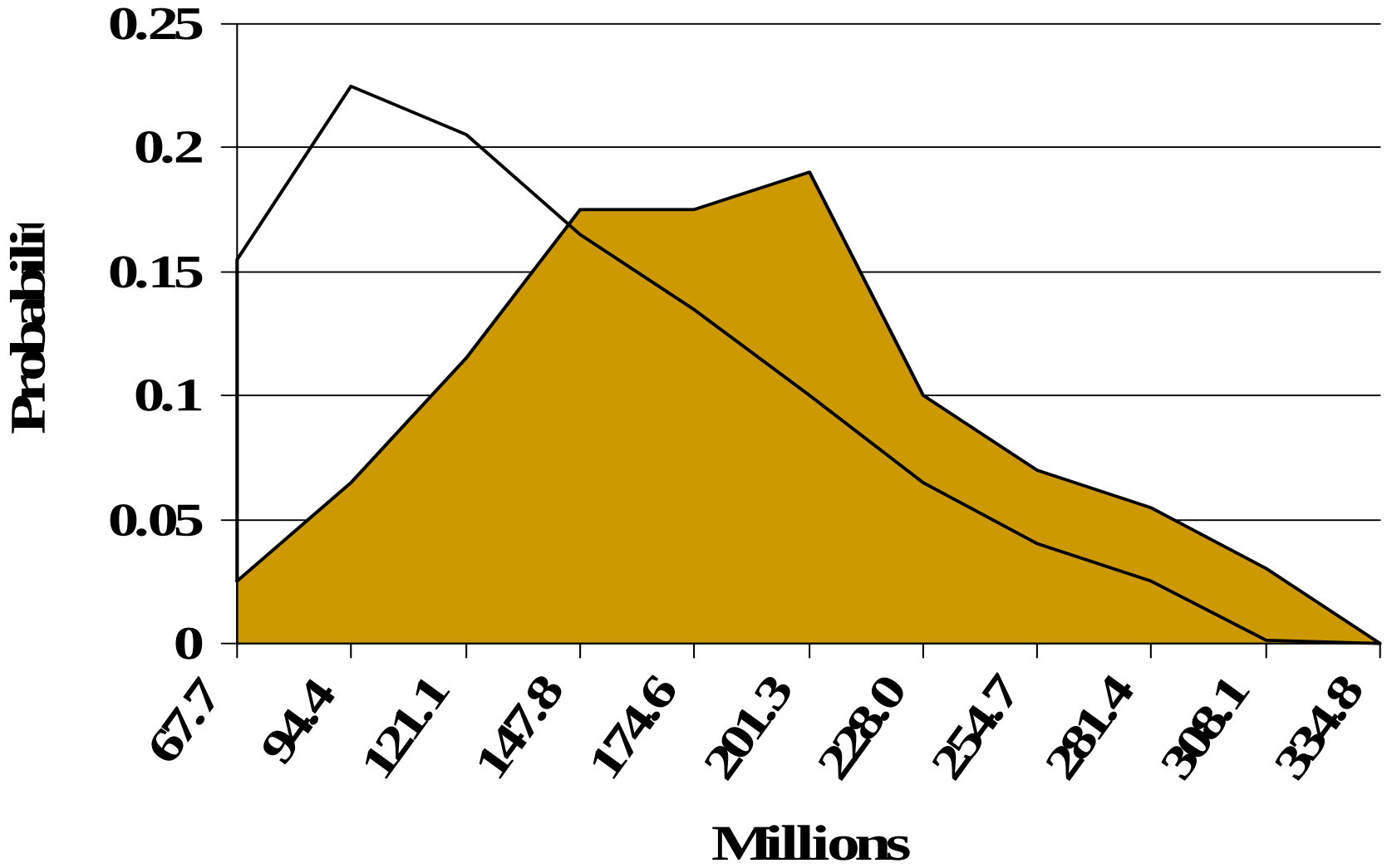
# Capital Measurement




PINNACLE
ACTUARIAL RESOURCES, INC.
Consulting Actuaries

# Year 2002 Surplus Distribution

## Constrained Growth Assumptions



# Enterprise Risk Management Steps

- Determine the corporation's objectives
- Identify risk exposure (e.g., interest rate risk)
- Quantify the exposure (e.g., measure volatility)
- Assess the impact (Model)
- **Examine financial risk management tools**
  - **Reinsurance, business plans**
  - **Forwards, futures, options, swaps**
  - **Contingent risk financing**
- **Select appropriate risk management approach**
- **Implement and monitor program**

PINNACLE
ACTUARIAL RESOURCES, INC.
Consulting Actuaries