

# G-1: Twenty Five Years of Actuarial Research: Successes and Open Problems

Stephen Mildenhall

May 16, 2016

# Who can remember 1991?

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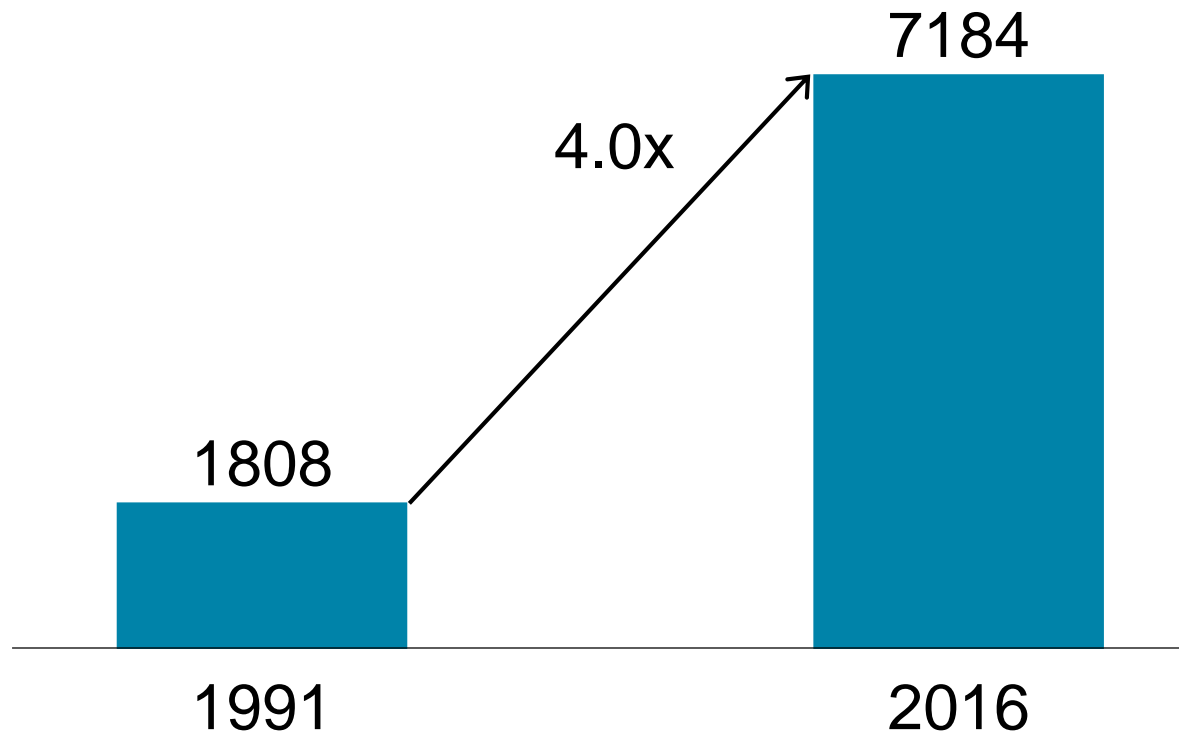
## Who was Vice President?



# 1991 and today: actuarial statistics

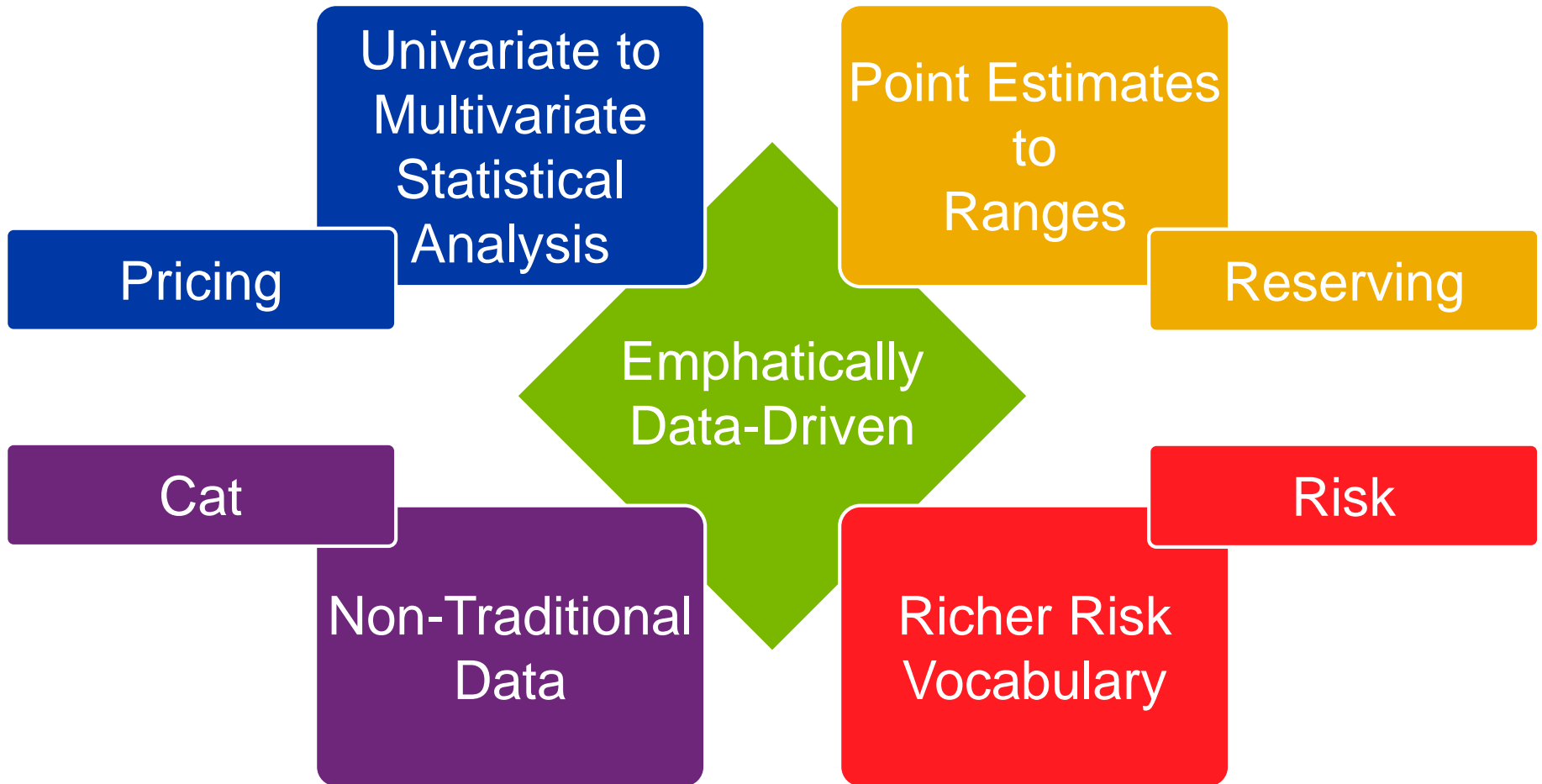
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## Number of Fellows and Associates



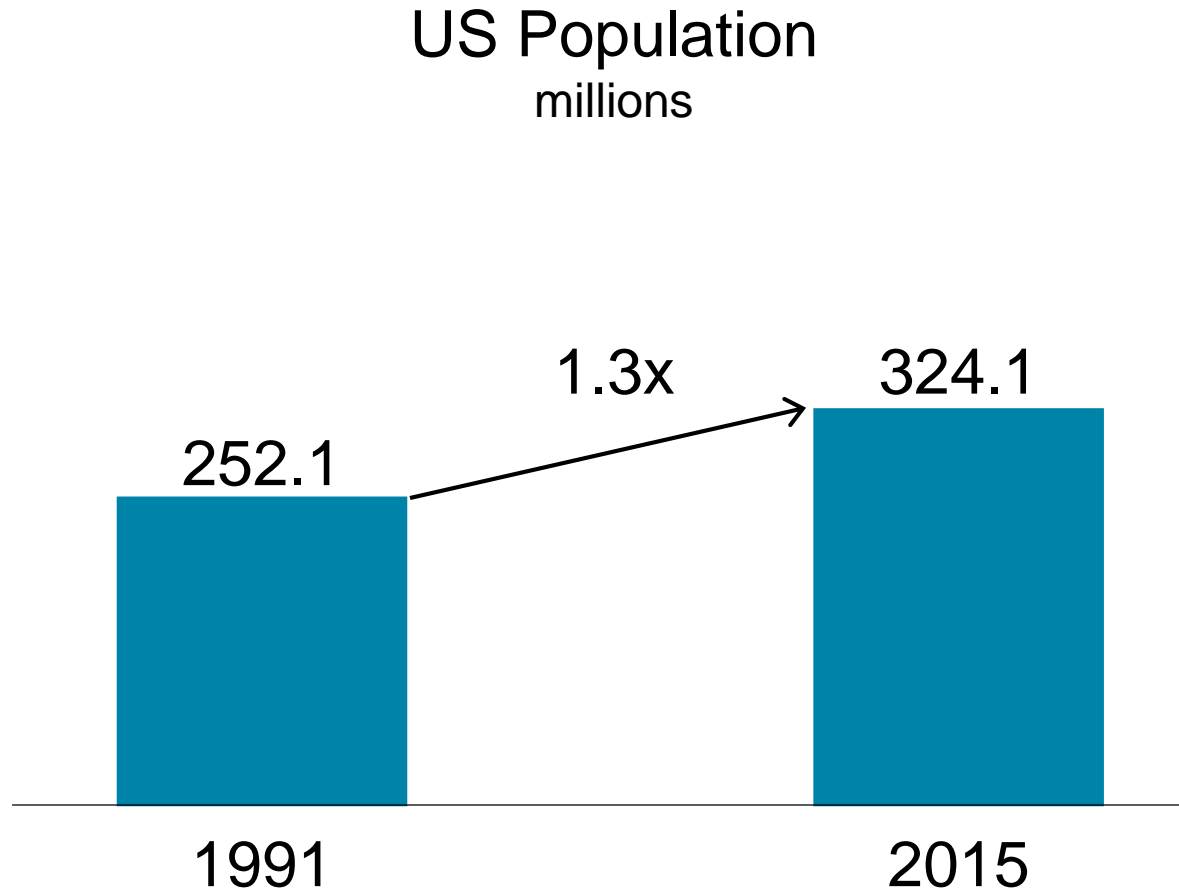
# Four themes and one unifying philosophy

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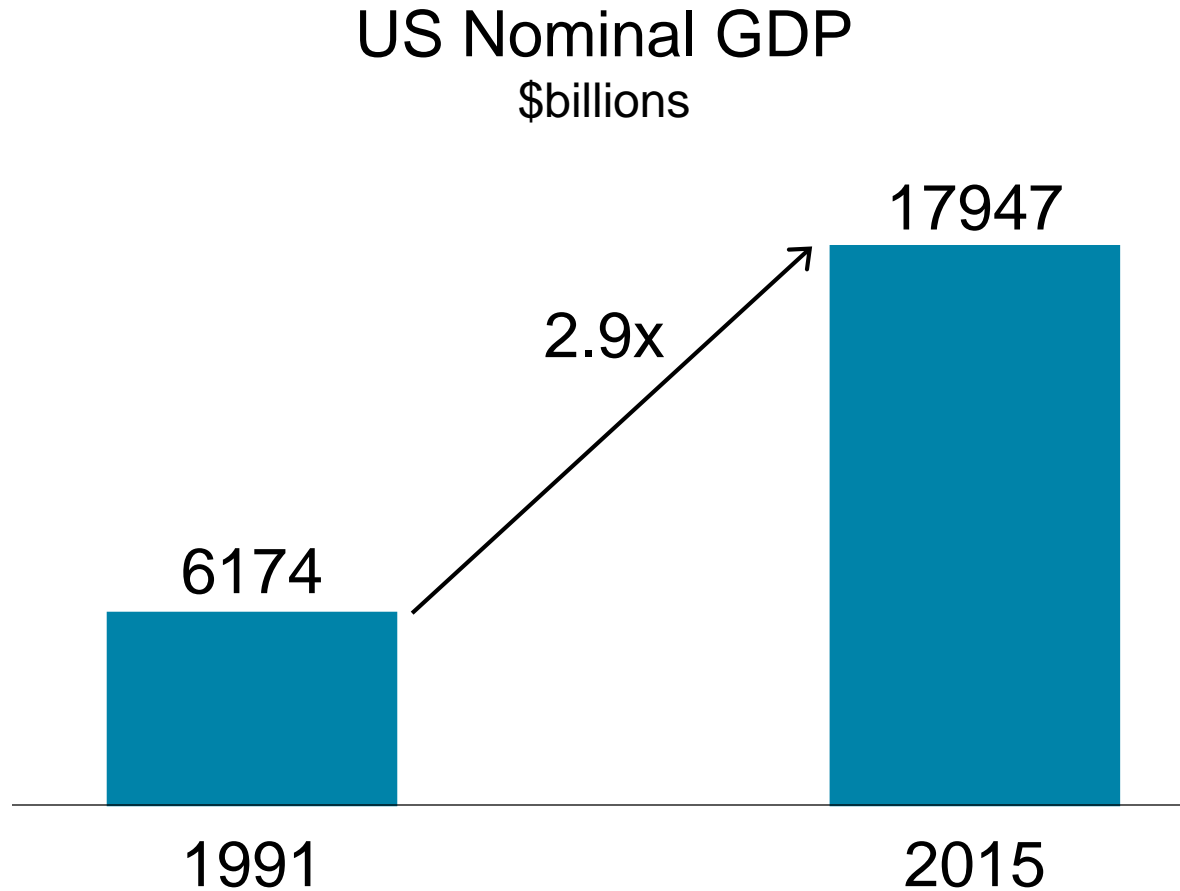
# 1991 and today: demographics

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# 1991 and today: economics

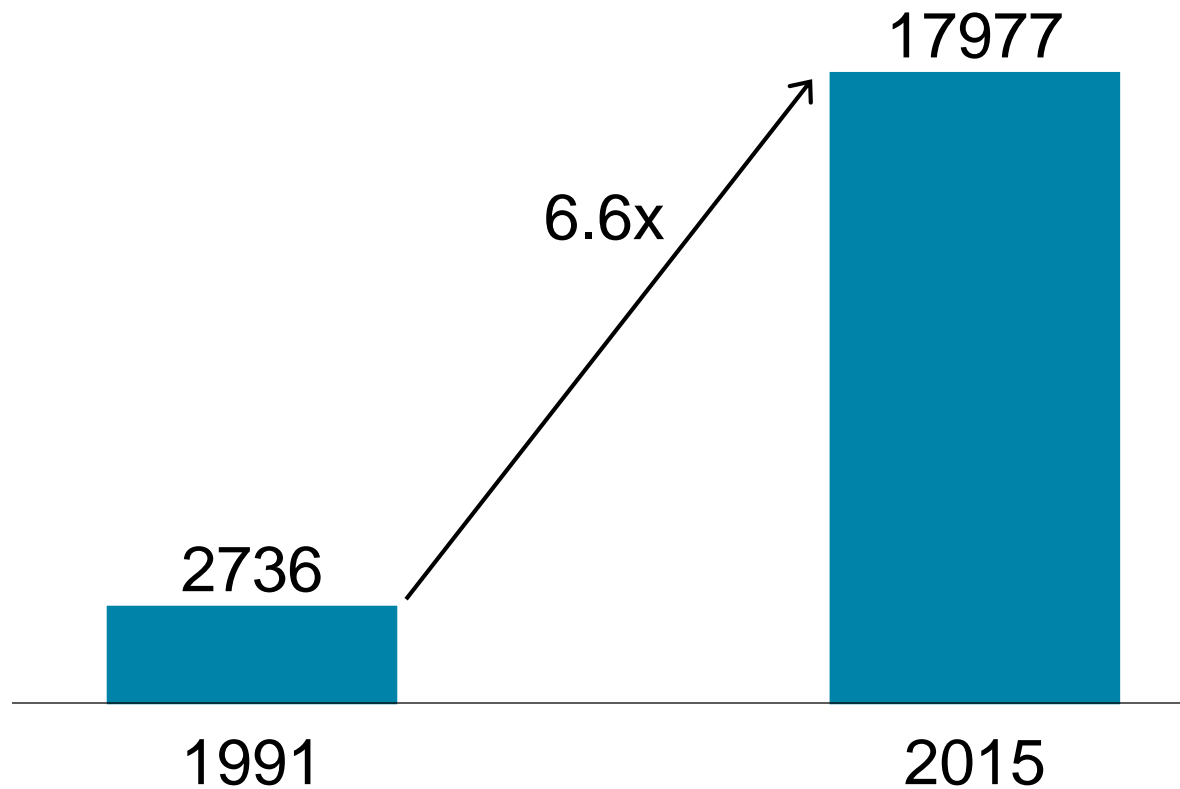
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# 1991 and today: financial

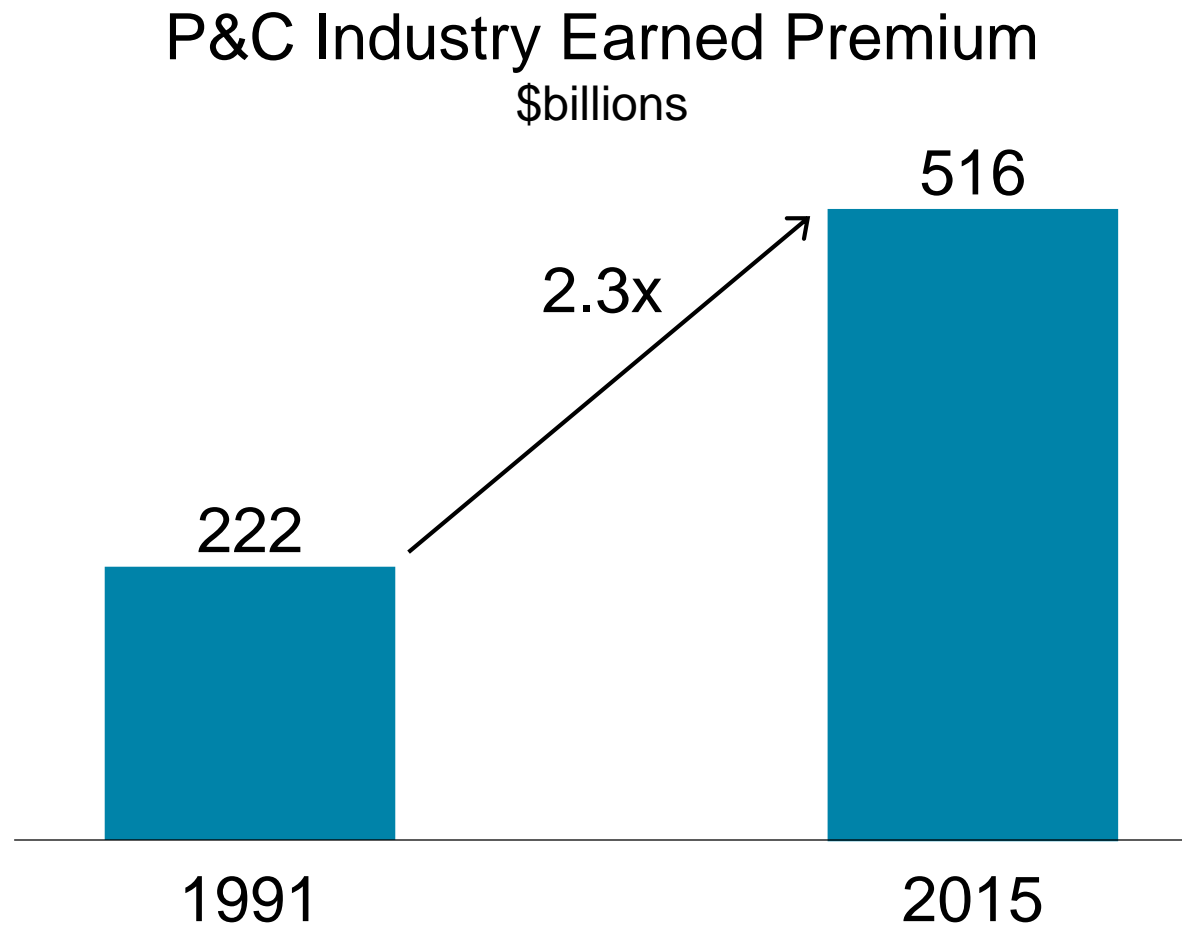
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## Dow Jones Industrial Average



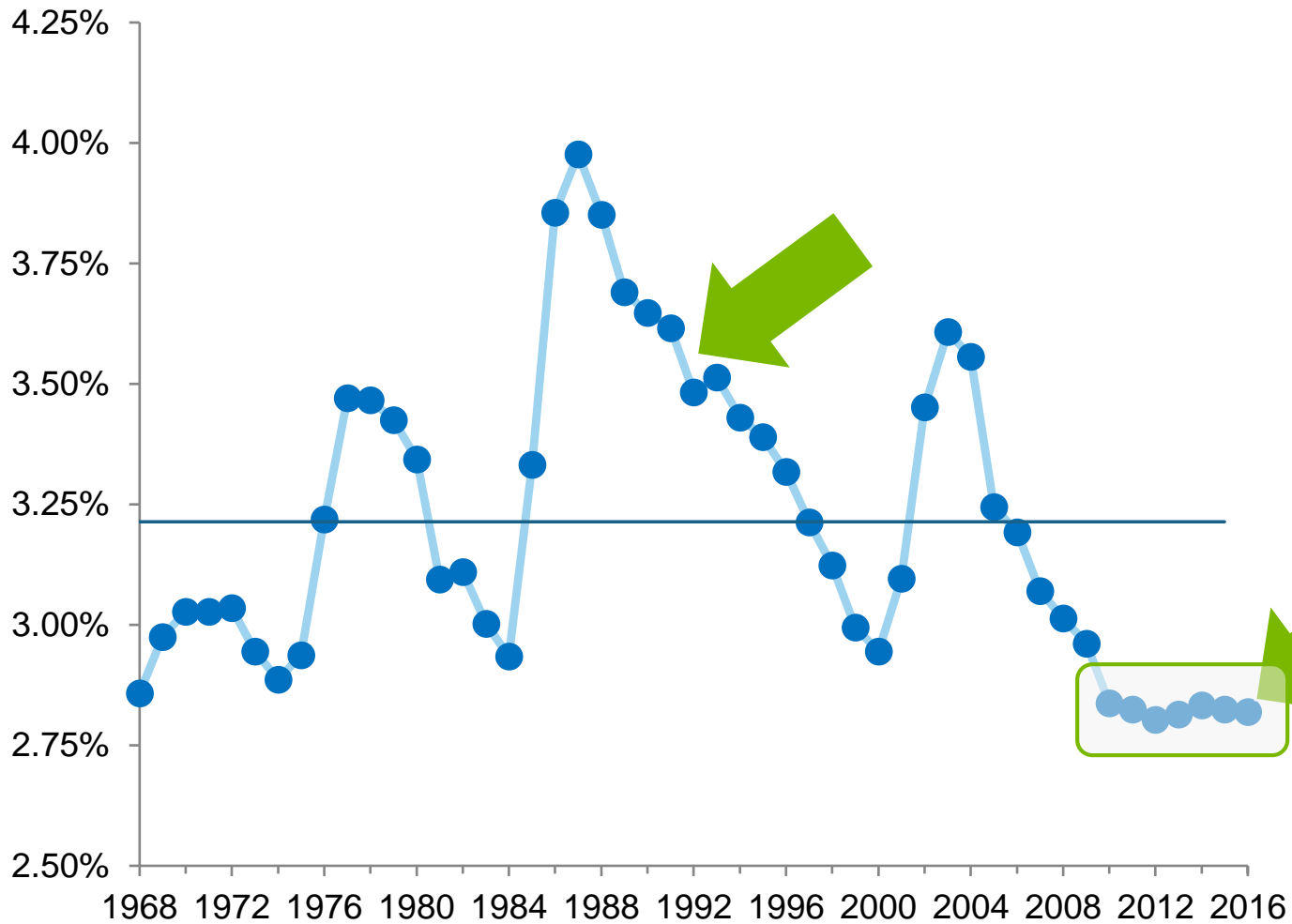
# 1991 and today: insurance

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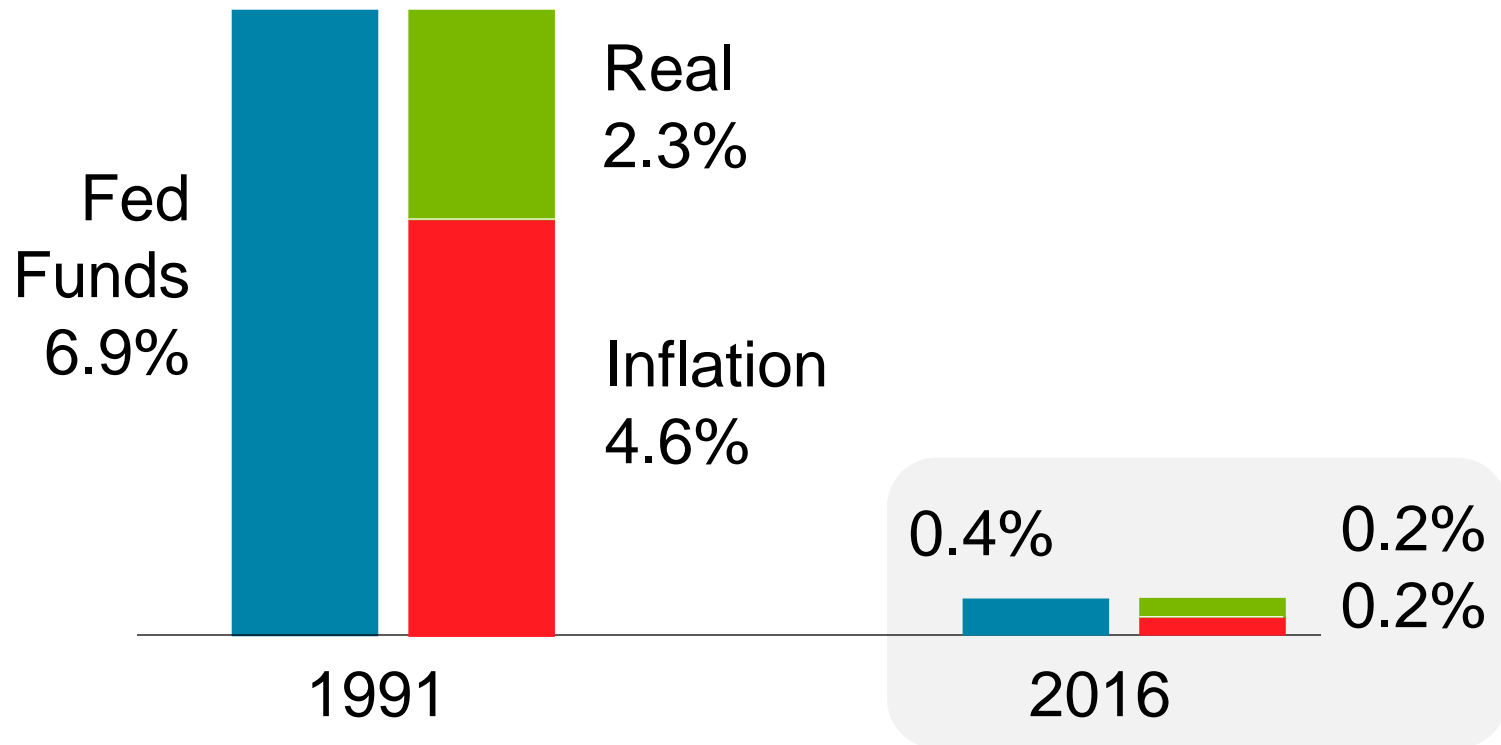


# Industry premium to GDP – long-term perspective



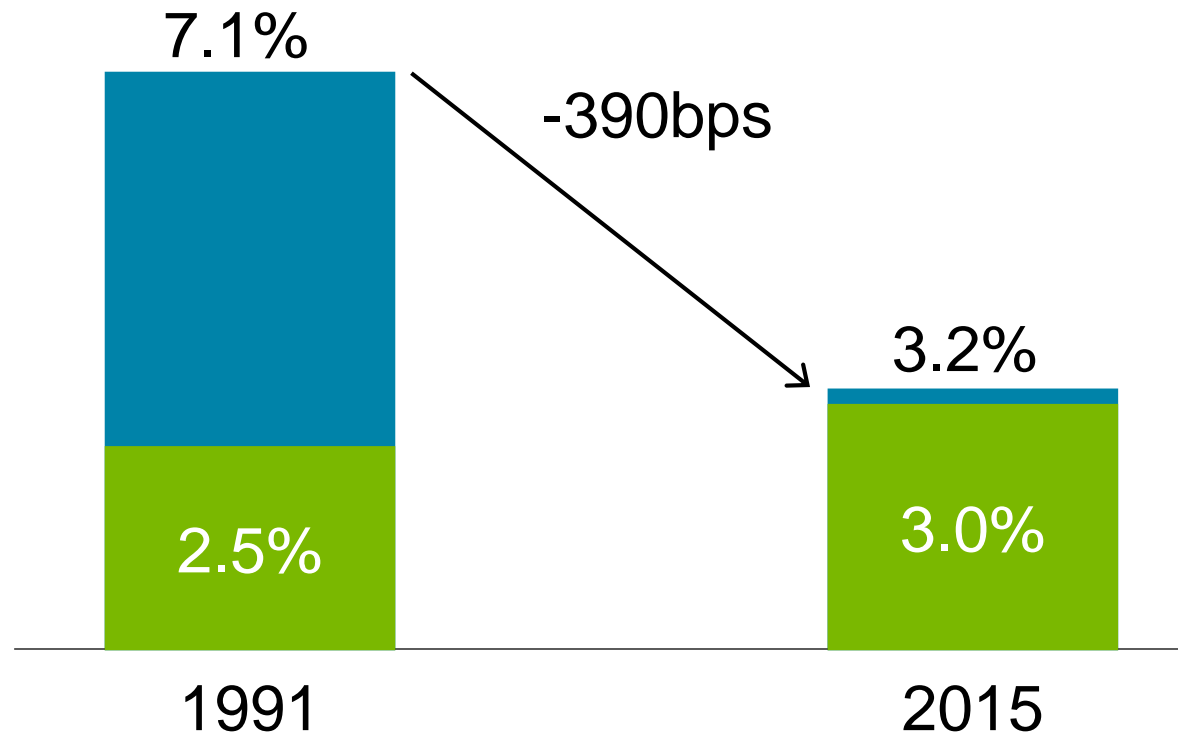
# 1991 and today: monetary

## Fed Funds, Inflation, & Real Interest Rates



# 1991 and today: insurance

## P&C Industry Investment Yield

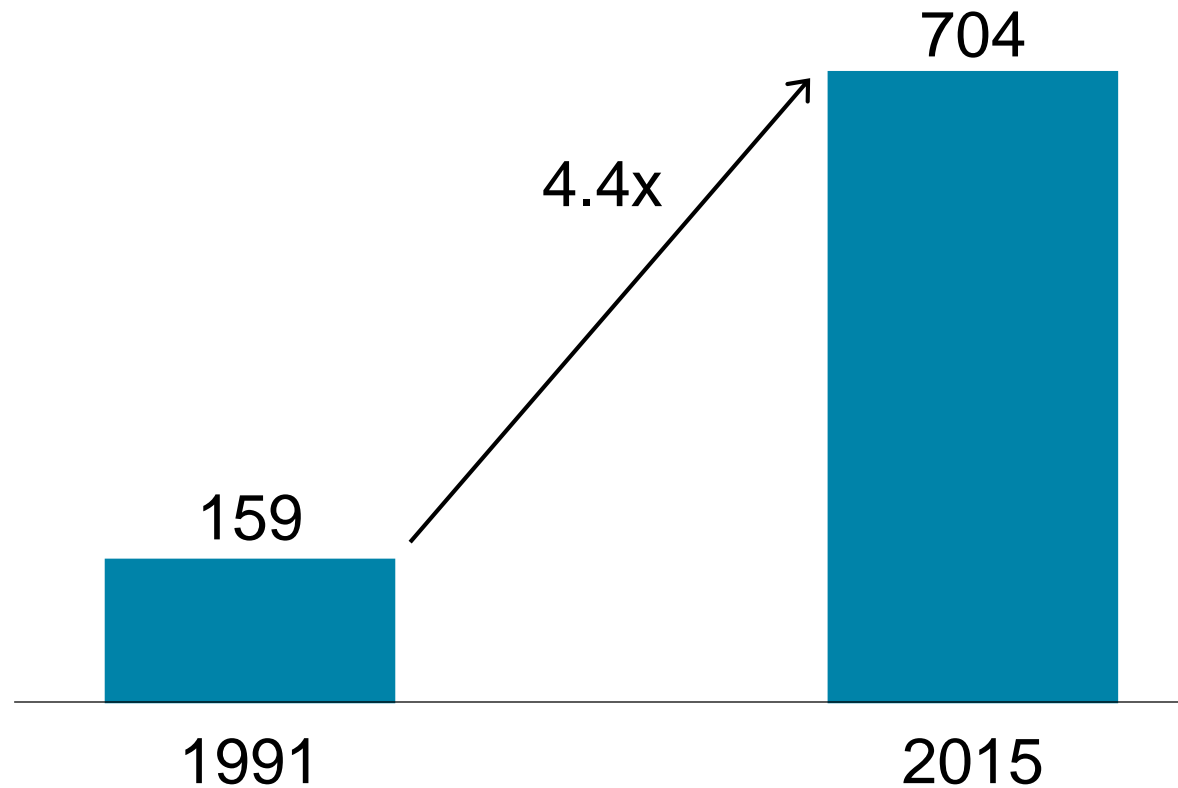


Inv. Inc. to Surplus: 28%

8%

# 1991 and today: insurance

## P&C Industry Surplus \$billions

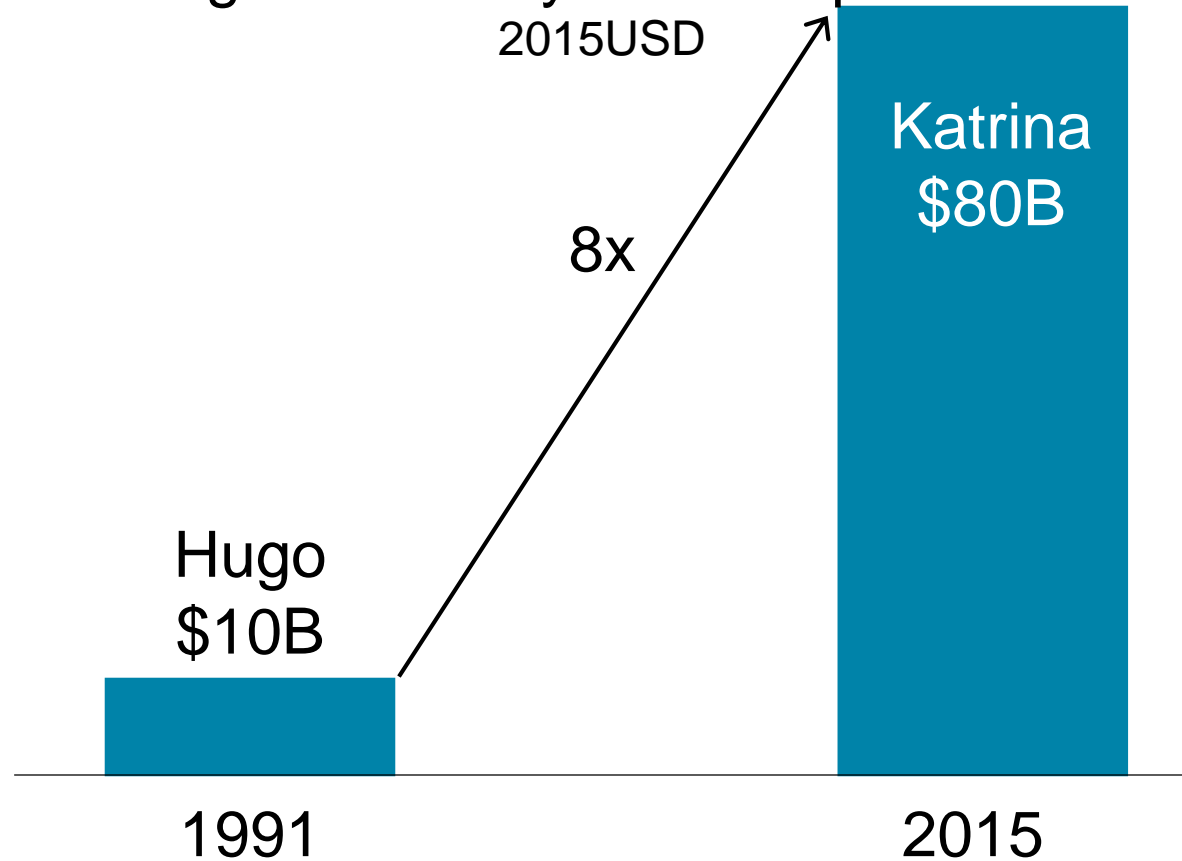


Premium to Surplus:	1.4x
Reserve to Surplus:	1.9x

0.7x
0.9x

# 1991 and today: insurance

## Largest Industry Catastrophe Loss



Current Dollars:

5B

1989

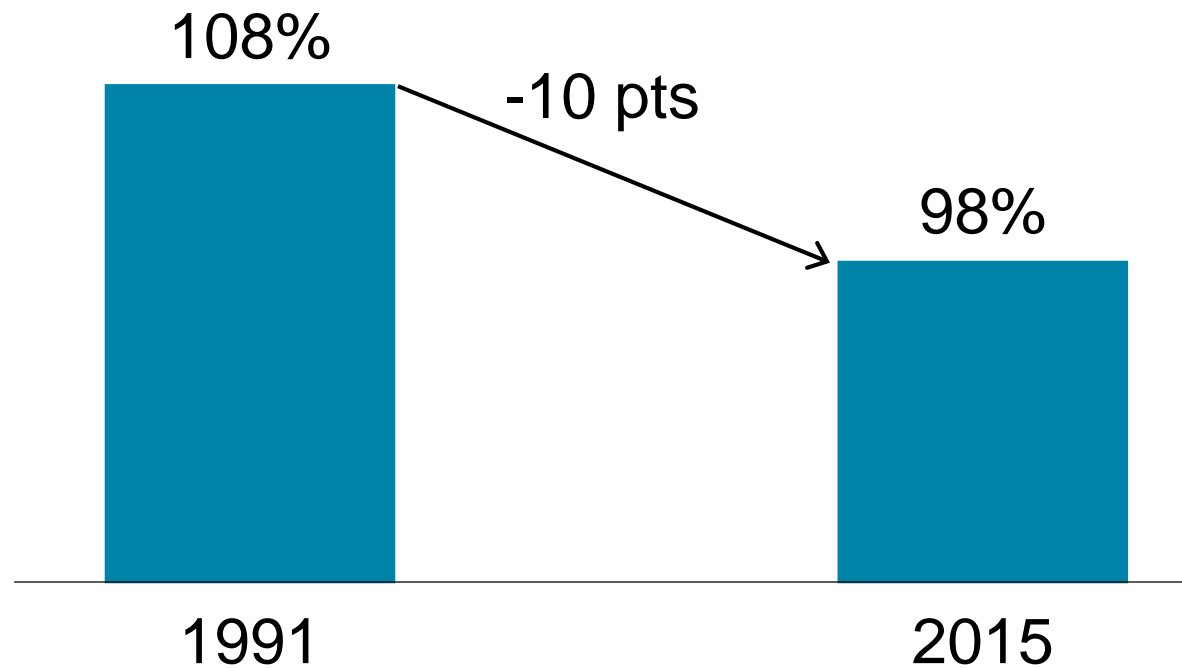
67B

2005

# 1991 and today: insurance

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## Industry Combined Ratio



Last year u/w profit: 1978

2015, 14, 13

# 1991 insurance issues

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**WHAT TO DO ABOUT WORKERS' COMP** The costs are killing business.

THE WORKERS' compensation system is socking it to companies, and they are howling. Last year employers had to pour more than \$70 billion into this insurance program.. That's twice the bill of only six years ago.

FORTUNE Magazine

“#1 Priority of corporate risk managers: spiraling cost of WC benefits, exceeding even the concern with the health cost spiral.”

Risk and Insurance, 1991

**WC residual market premium peaked at 14% of premium in 1992 compared to less than 3% today**

# CAS Database of Actuarial Research Enquiry (DARE)

<b>What we do</b>	<b>Papers 1990s</b>	<b>Papers 2000s</b>	<b>Papers 2010s</b>	<b>Total 1910-</b>	<b>Total 1990-</b>
Actuarial Applications and Methodologies	1745	1436	230	5950	3411
Ratemaking	339	205	19	1181	563
Reserving	376	244	51	992	671
Dynamic Risk Modeling	176	178	25	452	379
Regulation and Law	147	90	13	426	250
Accounting and Reporting	79	87	1	308	167
Capital Management	75	108	22	242	205
Investments	116	59	1	228	176
Valuation	55	92	3	223	150
Enterprise Risk Management	60	85	11	185	156
Actuarial Systems	13	16	0	39	29

- Highest proportion of papers published since 1990 in DARE
  - **Dynamic risk modeling** **84%**
  - **Capital management** **85%**
  - **ERM** **84%**
- All other topics **53%**



# CAS Database of Actuarial Research Enquiry (DARE)

How we do it...methods	Papers 1990s	Papers 2000s	Papers 2010s	Total 1910-	Total 1990-
Financial and Statistical Methods	1161	1058	185	3920	2404
Statistical Models and Methods	176	261	50	586	487
Risk Pricing and Risk Evaluation Models	162	125	14	502	301
Loss Distributions	112	108	8	364	228
Credibility	102	67	17	363	186
Asset and Econometric Modeling	93	46	9	212	148
Aggregation Methods	60	74	10	192	144
Simulation	52	87	25	183	164
Extreme Event Modeling	31	28	2	88	61
Risk Measures	11	37	10	69	58
Risk loading	0	11	0	21	11

- Highest proportion of papers published since 1990 in DARE
  - **Statistical models & methods** **83%**
  - **Simulation** **90%**
  - **Risk measures** **84%**
- All other topics **55%**

# CAS Database of Actuarial Research Enquiry (DARE)

<b>Line of application</b>	<b>Papers 1990s</b>	<b>Papers 2000s</b>	<b>Papers 2010s</b>	<b>Total 1910-</b>	<b>Total 1990-</b>
<b>Business Areas</b>	1033	822	149	3896	2004
Workers Compensation	152	58	18	718	228
Reinsurance	87	75	20	335	182
Other Lines of Business	72	76	0	297	148
Accident and Health	49	47	1	220	97
Automobile	47	36	3	191	86
Homeowners	49	32	6	142	87
Fire and Allied Lines	37	19	0	140	56
Professional Liability	18	15	1	62	34
General Liability - Occurrence	11	10	1	60	22
Latent Exposures	32	14	1	57	47
General Liability - Claims-Made	10	6	2	49	18
Warranty/Service Contracts	11	7	2	28	20
Surety	6	2	0	23	8
Crop-Hail	1	8	0	20	9
Products Liability	1	2	0	20	3
Aircraft	0	3	0	19	3
Credit	1	2	2	15	5
Fidelity Broker	0	1	0	14	1
Marine	1	2	1	14	4
Boiler & Machinery	0	0	0	13	0
Residual Value	0	2	0	12	2

# CAS Database of Actuarial Research Enquiry (DARE)

<b>Who we work for</b>	<b>Papers 1990s</b>	<b>Papers 2000s</b>	<b>Papers 2010s</b>	<b>Total 1910-</b>	<b>Total 1990-</b>
<b>Practice Areas</b>					
International Areas	56	93	0	239	149
Risk Management	44	55	8	121	107
Governmental Agencies	16	21	0	95	37
Private Entities	0	24	0	47	24
Consulting	16	2	0	28	18
Public Entities	0	13	0	25	13
Non-Profit Organizations	0	1	0	12	1

- Highest proportion of papers published since 1990 in DARE
  - **Risk Management** **88%**
- All other topics **54%**

# Topics with greatest increase in publications 2000s vs 1990s

Topic	Papers 1990s	Papers 2000s	Trend 2000s to 1990s	Total All Years
Generalized Linear Modeling	36	87	142%	149
Capital Allocation	41	69	68%	137
Simulation	52	87	67%	183
Valuation	55	92	67%	223
International Areas	56	93	66%	239
Statistical Models and Methods	176	261	48%	586
Capital Management	75	108	44%	242
Enterprise Risk Management	60	85	42%	185
Collective Risk Model	30	41	37%	104
Reserve Variability	54	69	28%	169
Capital Requirements	34	43	26%	114
Risk Management	44	55	25%	121
Aggregation Methods	60	74	23%	192
Severity	44	52	18%	145
Dynamic Financial Analysis (DFA)	68	75	10%	161
Accounting and Reporting	79	87	10%	308

## Topics with greatest decrease in publications 2000s vs 1990s

Topic	Papers 1990s	Papers 2000s	Trend 2000s to 1990s	Total All Years
Trend and Loss Development	74	19	-74%	173
Increased Limits	30	10	-67%	105
Utility Theory	42	16	-62%	114
Workers Compensation	152	58	-62%	718
Probability of Ruin	27	11	-59%	105
Rate Regulation	51	25	-51%	130
Asset and Econometric Modeling	93	46	-51%	212
Investments	116	59	-49%	228
Fire and Allied Lines	37	19	-49%	140
Solvency	53	28	-47%	136
Aggregate Excess/Stop Loss	49	28	-43%	178
Ratemaking	339	205	-40%	1181
Data Management and Information	81	49	-40%	214
Regulation and Law	147	90	-39%	426
Large Loss and Extreme Event Loading	55	35	-36%	110
Reserving	376	244	-35%	992

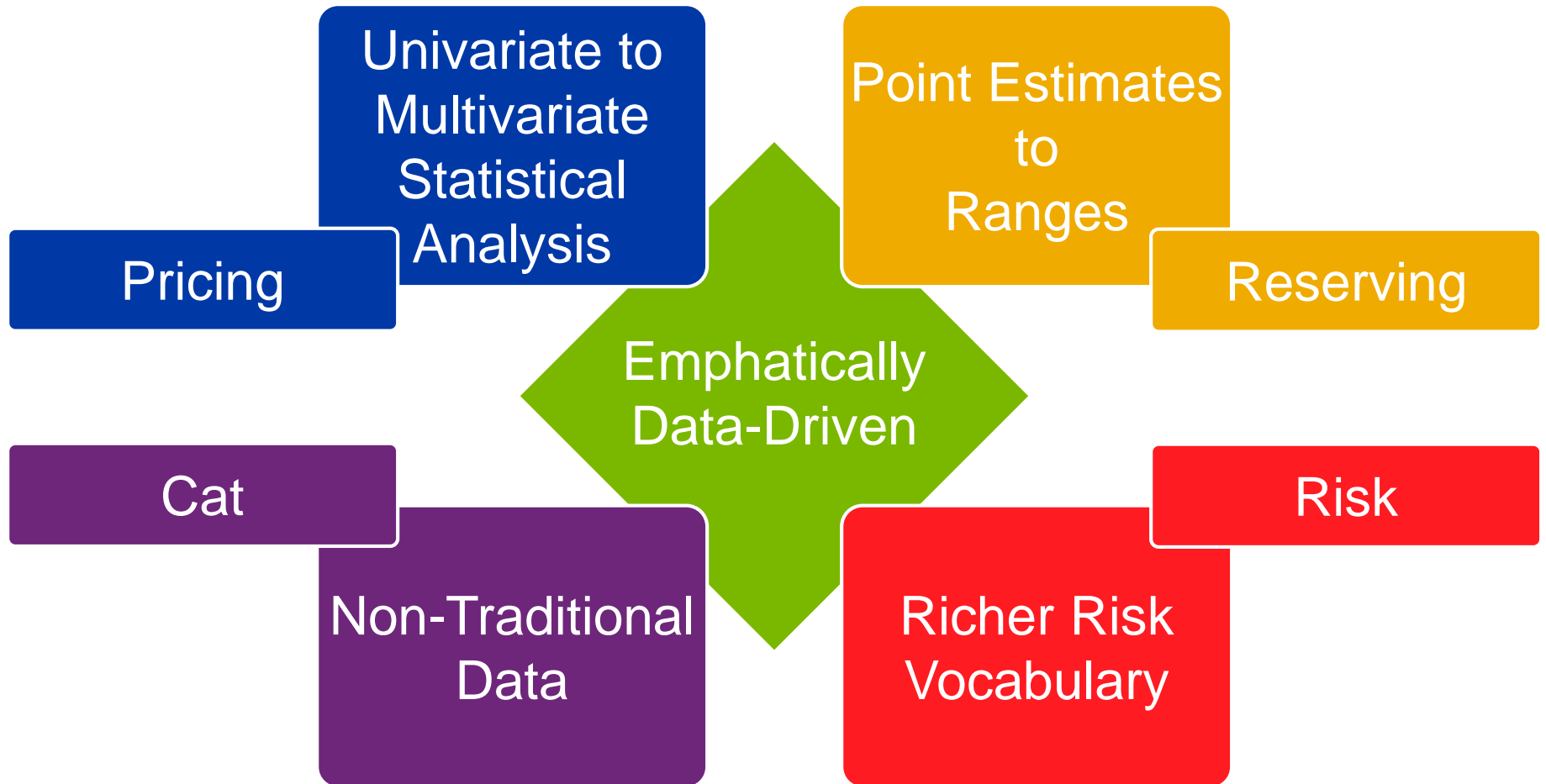
# Prize winning papers by topic (subjective) area

Year	Hachemeister	Variance / Dorweiler	ARIA
2016	Rserving		Pricing
2015	Risk		Pricing
2014	Risk	Rserving	Rserving
2013	Risk	Risk	Risk
2012	Risk	Risk	Pricing
2011	Rserving	Risk	Risk
2010	Pricing	Rserving	Risk
2009	Rserving	Rserving	Risk
2008	Rserving	Risk	Pricing
2007	Rserving	Rserving	Risk
2006	Rserving	Rserving	Risk
2005	Risk	Risk	Risk
2004	Risk	Risk	Pricing
2003	Risk	Risk	Pricing
2002	Pricing	no award	Risk
2001	Risk	Rserving	Risk
2000	Cat	no award	Risk
1999	no award	Rserving	Risk
1998	Cat	Risk	Risk
1997	Risk	Risk	
1996	Pricing	Risk	
1995	Cat	Rserving	
1994	Rserving	Cat	
1993		Risk	
1992		Risk	
1991		Risk	

Prize	Awards	Pct
Rserving	16	25%
Risk	34	54%
Pricing	9	14%
Cat	4	6%
Total	63	100%

# Four themes and one unifying philosophy

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# Univariate to Multivariate Statistical Analysis

Then	Now	Future
<p>Separate univariate factor analyses</p> <p>Minimum bias method</p>	<p>Multivariate, statistical approach</p> <p>Management, regulatory, and consumer challenges</p> <p>Automation removed inappropriate human bias</p> <p>Equivocal good</p> <p>First mover advantage</p> <p>“Price optimization”</p> <p>Applied discipline</p>	<p>Expanded use of Big Data</p> <p>Undermining basis of insurance?</p> <p>Statistics vs. “machine learning”</p> <p>Kaggle philosophy</p> <p>Educational challenge</p> <p>iCAS credential &amp; syllabus</p>



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## The Journal of Risk and Insurance

### **BIOLOGICAL AND PSYCHOBEHAVIORAL CORRELATES OF CREDIT SCORES AND AUTOMOBILE INSURANCE LOSSES: TOWARD AN EXPLICATION OF WHY CREDIT SCORING WORKS**

Patrick L. Brockett  
Linda L. Golden

“... a man drives as he lives.”

Tillman and Hobbs, 1949, p. 329

# Reserving techniques and the use of ranges

Point Estimates  
to  
Ranges

Reserving

Then	Now	Future
Straight or weighted?	Ranges common	Macro loss drivers and “top-down” estimates
Nominal or discounted?	Regulatory adoption, APRA	Transactional data and “bottom-up” estimates
Point estimates	Back-testing	Understand 1999-02 and 2002-present
Latent exposures	Bayesian methods, MCMC Dependence & multi-triangle methods	

# A better understanding of risk

Then	Now	Future
<p>Many basics in place</p> <p>Underwriting betas</p>	<p>Capital is costly and needs allocating</p> <p>Universal language for cat risk through VaR, TVaR</p> <p>Stated risk tolerance</p> <p>Coherent risk measures</p> <p>Diversification</p> <p>Dependence beyond correlation</p> <p>Influenced pricing, rating agency &amp; regulatory capital</p>	<p>Framework for non-cat risk</p> <p>Firmer foundation for capital modeling</p> <p>Internal model vs. standard model, regulatory arbitrage</p> <p>Risk emergence over time</p> <p>Multiyear considerations</p>

# Cat modeling: use of non-traditional data

Then	Now	Future
Flying blind...Andrew huge shock	<p>Unequivocal good, industry changing</p> <p>Established currency of risk</p> <p>Cost of risk cannot be ignored</p> <p>\$70B+ alternative capital</p> <p>“PML” educational gap</p>	<p>Bigger role for actuaries as risk-expert model quarterbacks</p> <p>Expand techniques to price emerging risk without traditional experience</p>

## FINANCIAL TIMES

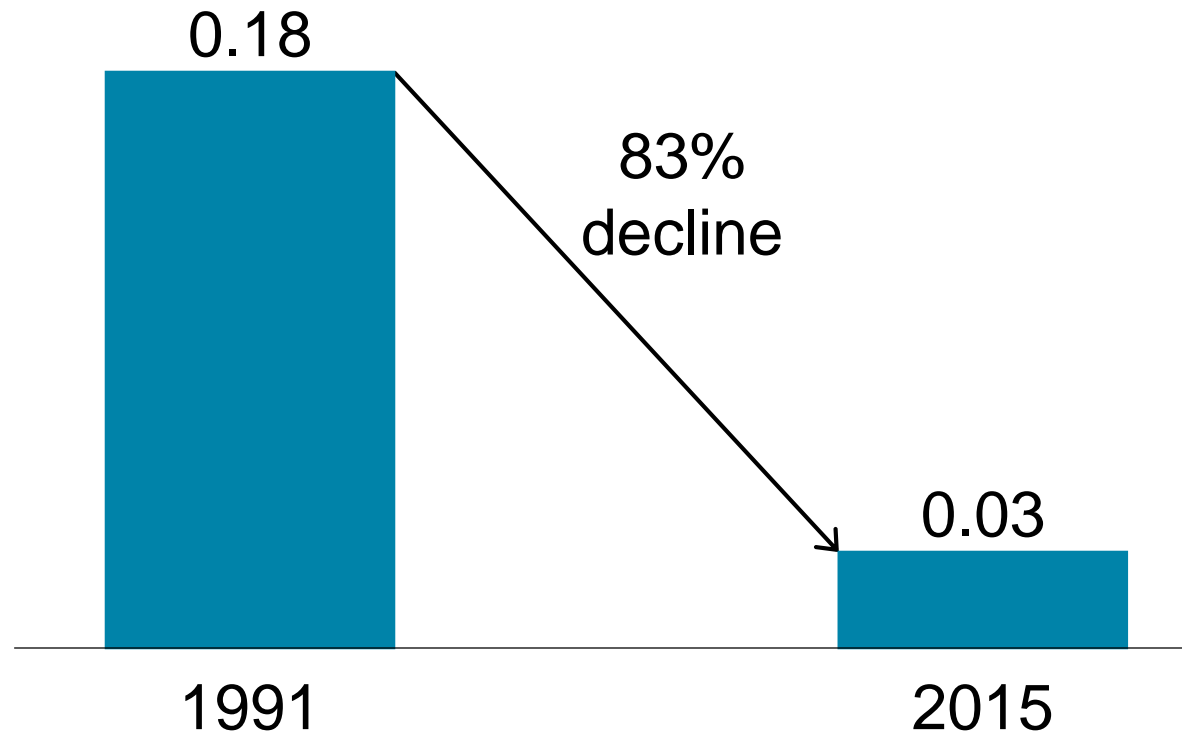
“We were seeing things that were 25-standard deviation moves, several days in a row,” said David Viniar, Goldman’s chief financial officer. “There have been issues in some of the other quantitative spaces. But nothing like what we saw last week.”

Under a  
normal  
distribution  
assumption

The probability of a 25  
sigma event is comparable  
to the **probability of  
winning the [UK] lottery  
21 or 22 times in a row.**

# Loss of research community

Pages of published research per actuary per year  
Proceedings 1991-93 vs. Variance 2012-14



# Looking ahead...what research should the CAS sponsor?

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The most important research problem facing the actuarial profession today is in the area of

risk measurement

development of mass tort liabilities

I can't decide

7093 votes on 50 ideas

Add your own idea here...

Take the survey at [http://www.allourideas.org/actuarial\\_research\\_problems](http://www.allourideas.org/actuarial_research_problems)

# Looking ahead...survey results

Top 10 of 50 user & seed ideas based on over 7000 votes by 266 user sessions

## The most important research problem facing the actuarial profession today is in the area of

Answer	Score	Source
Ability to price for new exposures and coverage innovations (e.g. drones, sharing economy, cyber, etc.)	82	User
Quantification and modeling of dependencies	73	Seed
Quantifying and communicating uncertainty	72	User
Detecting trend turning points	70	User
Dynamic incorporation of new information sources into risk assessment	69	User
Uncertainty (the limits of quantification, communication, engagement of decision makers etc.)	68	User
Improved statistical modeling for insurance data	68	Seed
Changes coming to the insurance industry due to technological developments and climate variability	68	User
Emerging risk quantification	66	Seed
Trend detection and quantification	64	Seed

[http://www.allourideas.org/actuarial\\_research\\_problems](http://www.allourideas.org/actuarial_research_problems)





# G-1: Twenty Five Years of Actuarial Research: Successes and Open Problems

Stephen P. D'Arcy, FCAS, CERA, Ph.D.  
Professor Emeritus of Finance  
University of Illinois

# Loss Reserving

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- Need to allow Loss Development Factors to be stochastic
- Factors influencing LDFs should include inflation

# Capital Modeling and Enterprise Risk Management

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- Capital allocation is the key to ERM
- If incentive compensation is based on realistic capital allocation, effective ERM will follow
- No widely accepted capital allocation method is yet available
- Ruhm-Mango-Kreps algorithm is a very useful tool for calculating the capital allocation based on any method
- Until an ideal method is developed, calculate capital allocations similar to loss reserves by using a variety of different methods

# Catastrophe Modeling

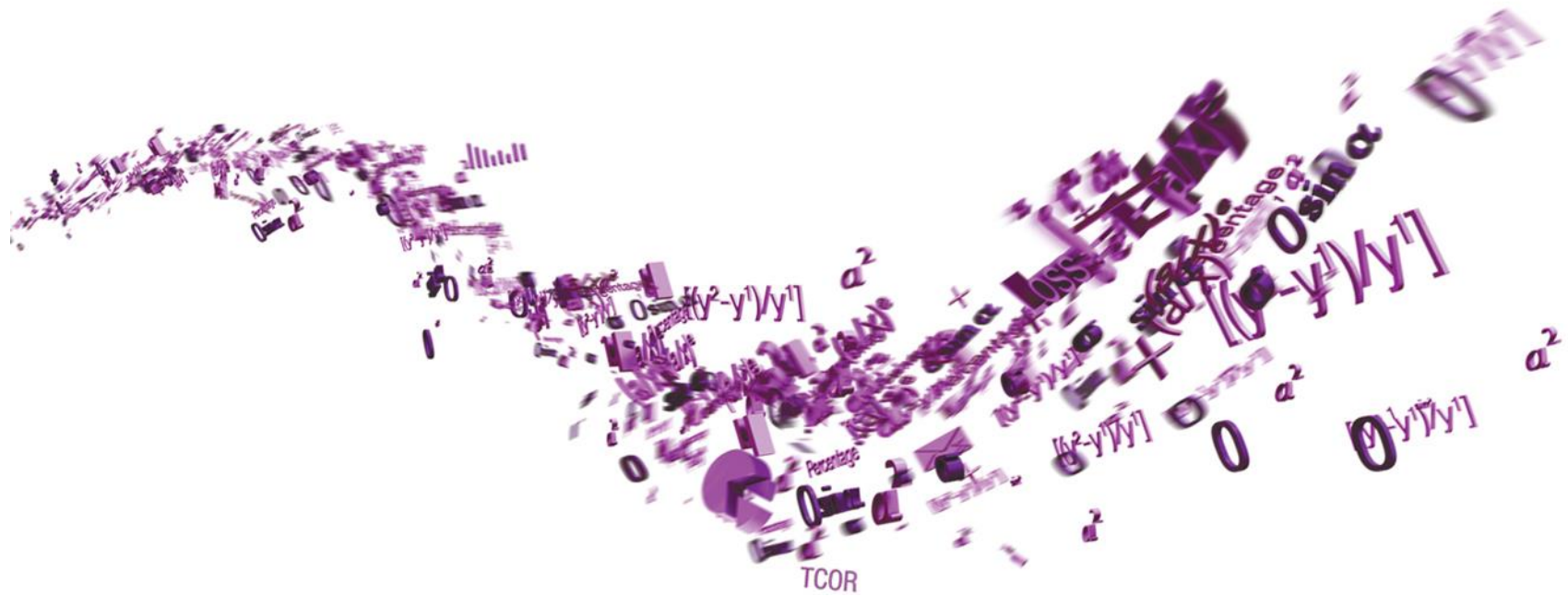
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- Property cat modeling is well advanced
- Casualty cat modeling needs to be developed to the same level
  - Past and potential casualty cat losses are at least as great as property cats
  - Regulators, rating agencies and companies give less attention to casualty cats than property cats
  - This discrepancy needs to change
- Casualty cats session C-25 Tuesday afternoon

# Predictive Modeling

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- Current hot technique for risk assessment
  - Fraud detection
  - Underwriting
  - Pricing
- However, this creates the potential for inappropriate application
  - Risk of having an illegal disparate effect on a class of business
  - White House Report, May 2016 - Big Data: A Report on Algorithmic Systems, Opportunity, and Civil Rights
- Modeling needs to be overseen by someone who understands insurance regulations



## G-1: Twenty Five Years of Actuarial Research: Successes and Open Problems

Stephen Lowe, FCAS, CERA, MAAA  
President, Casualty Actuarial Society  
Managing Director Emeritus, Willis Towers Watson

# Research: career highlights

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- 1991: Risk-Based Capital
- 1995: Catastrophe portfolio optimization system
- 1996: Catastrophe securitization
- 2001: Economic capital model for global insurer
- 2001: Implications of 9-11
- 2003: Managing Overconfidence
- 2004: Fair Value of P&C Liabilities
- 2005: Economic capital model for global insurer
- 2005: Implications of Katrina
- 2009: Performance testing of liability estimates
- 2014: Attributing cost of capital in pricing

# Research conferences: highlights

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- The Velcro wall
- Sumo wrestling suits
- A warning about unseasonal weather
- Australian drinking games
- Midnight sun in Icelandic hot springs
- Barbeque in the desert with Sheila Tequila
- Singing “Ode to Joy” (in German)
- Arm wrestling to the extreme



In choosing between expert clinical judgment and outcome-based statistics, its best to bet on the latter

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Clinical Experts	Statisticians
Baseball scouts	Bill James' Sabermetrics, used by Billy Beane and Theo Epstein
Wine connoisseurs	Orly Ashenfelter's regression equation, relating wine quality to local rainfall and temperature in Bordeaux
83 legal experts – professors and legal scholars	Martin & Quinn – two political scientists' six factor decision tree

*Of course, it is best to combine the two!*

# Going forward, actuaries will need the capabilities to contribute to the new insurer value chain

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## *Acquiring and Managing Data*

From Vendors

- Credit/Financial
- Vehicle/Driving
- Purchasing/Lifestyle

Internal to Company

- Claim History
- Payment History
- Longevity

Supplied by Customers

- Application

## *Applying Advanced Analytics*

Predictive & Prescriptive Modeling to Determine Revenue and Cost Drivers

## *Integrating Into Business Processes*

Better Business Decisions

- Product
- Underwriting
- Pricing
- Claim
- Advertising
- Talent