

**convex risk**

# When is Premium Riskier Than Loss?

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Aon Analytics Conference

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# Question 1: Background

When did the hardest market of the last one hundred years occur?

- a. 1929-31 during the great depression
- b. 1939-45 during WW2
- c. 1973-74 during “stagflation”
- d. 1984-86 during the liability crisis and LMX spiral
- e. 2000-02 during WTC, the dot com bust, etc.

## Question 2: Background

Historically, hard markets have coincided with which of the following?

### Answers

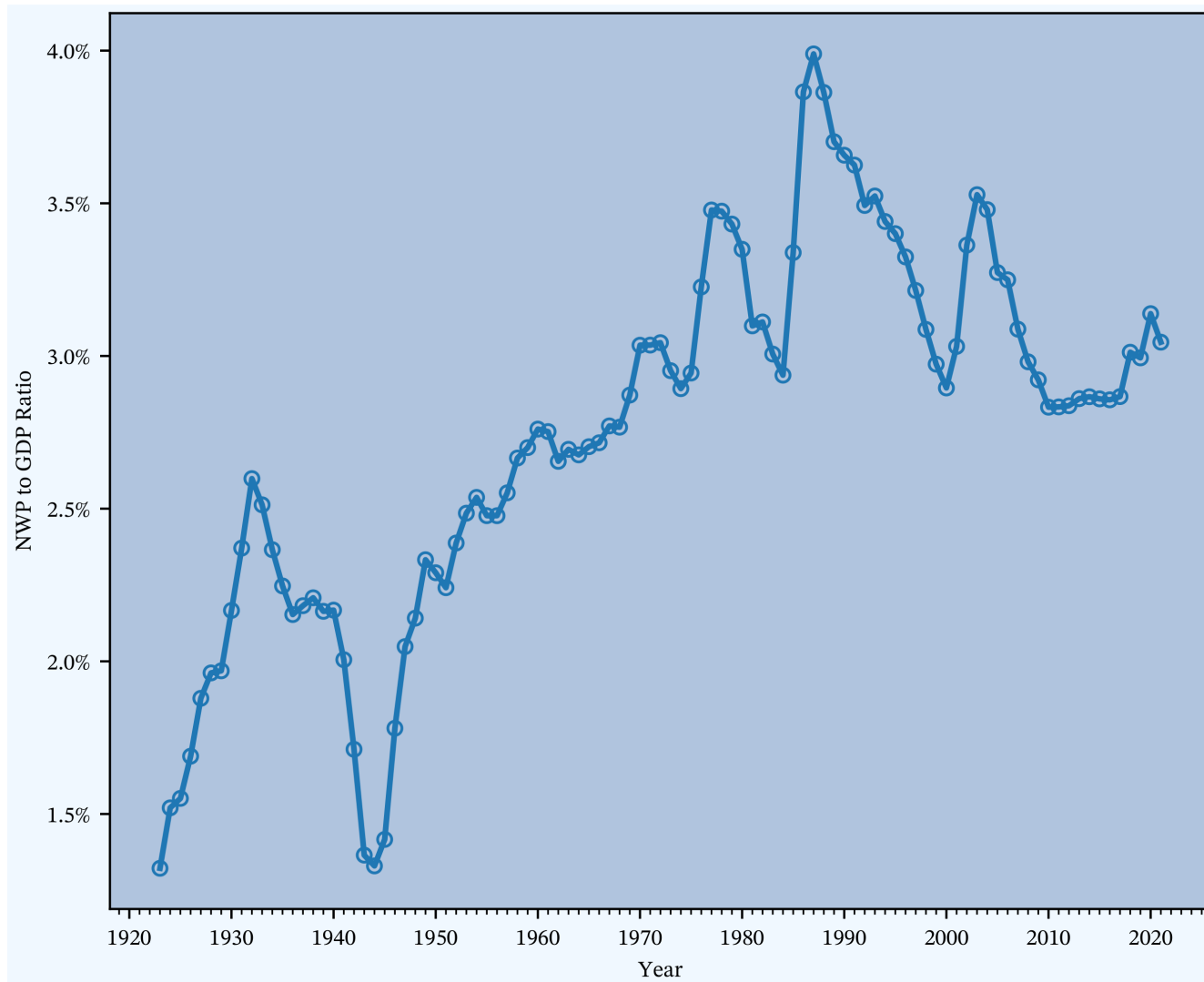
- a. Bad catastrophe losses
- b. Cumulative reserve inadequacy
- c. Raging inflation
- d. Bad catastrophe losses and cumulative reserve inadequacy
- e. Cumulative reserve inadequacy and raging inflation

# Question 3: Background

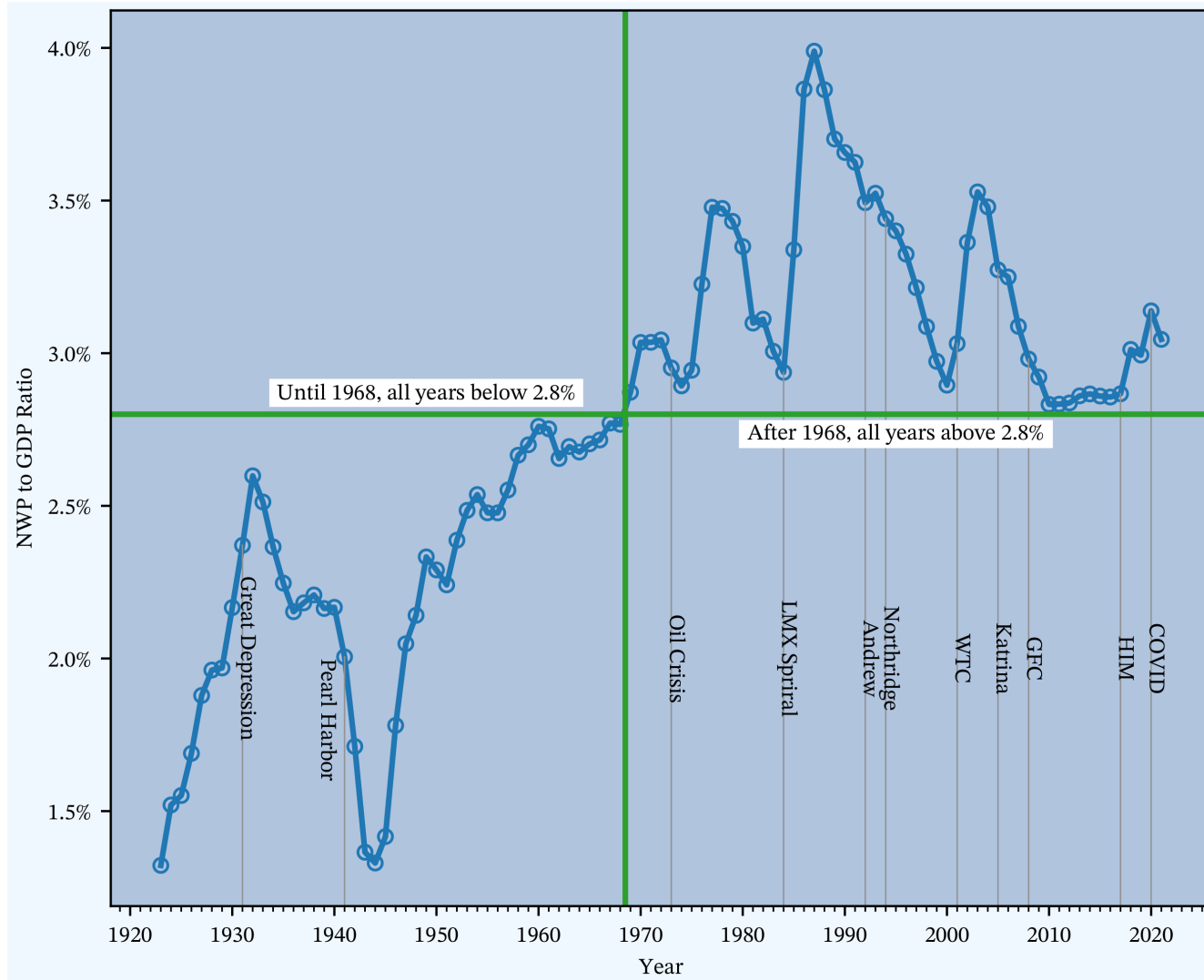
The last market-wide hard market occurred after

- a. 2001 post-WTC
- b. 2005 post-Katrina
- c. 2008 post-GFC
- d. 2012 post-Sandy
- e. 2017 post-Harvey, Irma, & Maria

# Premium to GDP Ratio

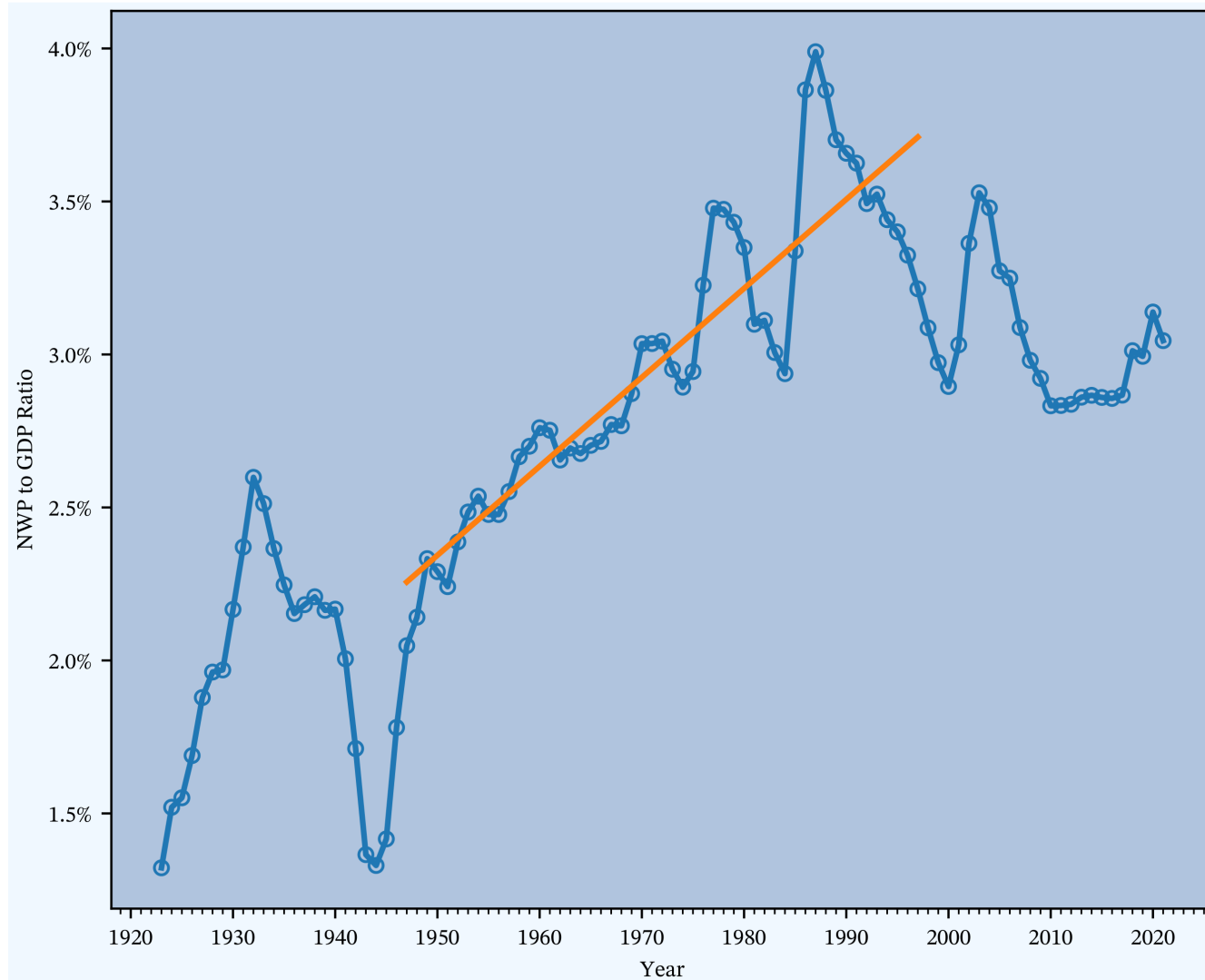


# Premium to GDP Ratio 1968 Watershed

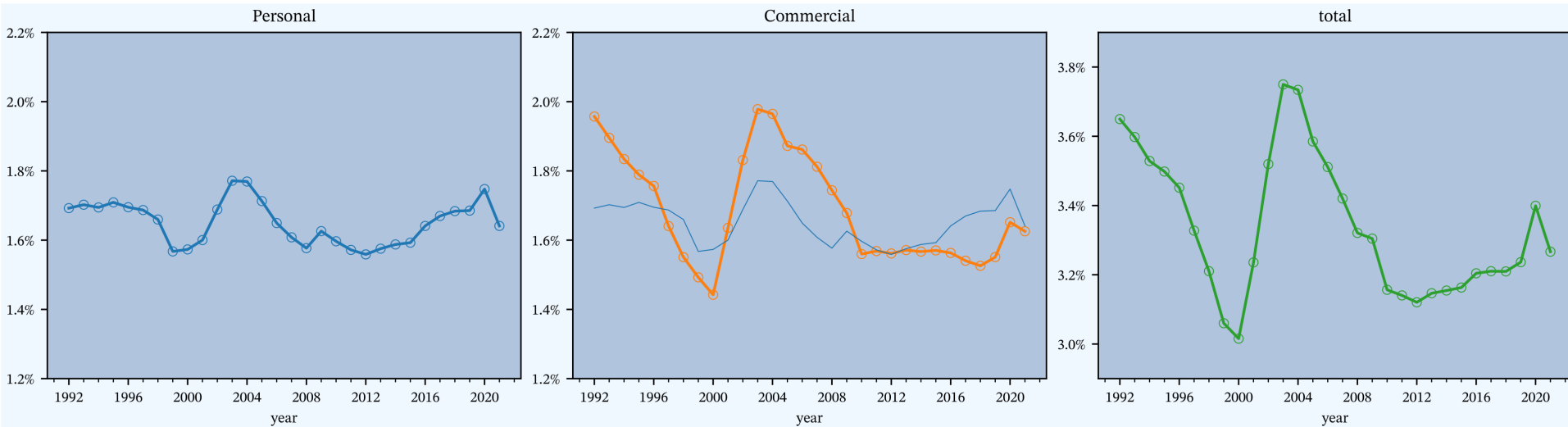


# Premium to GDP Ratio

## Cyclical Growth Between 1947 and 1997



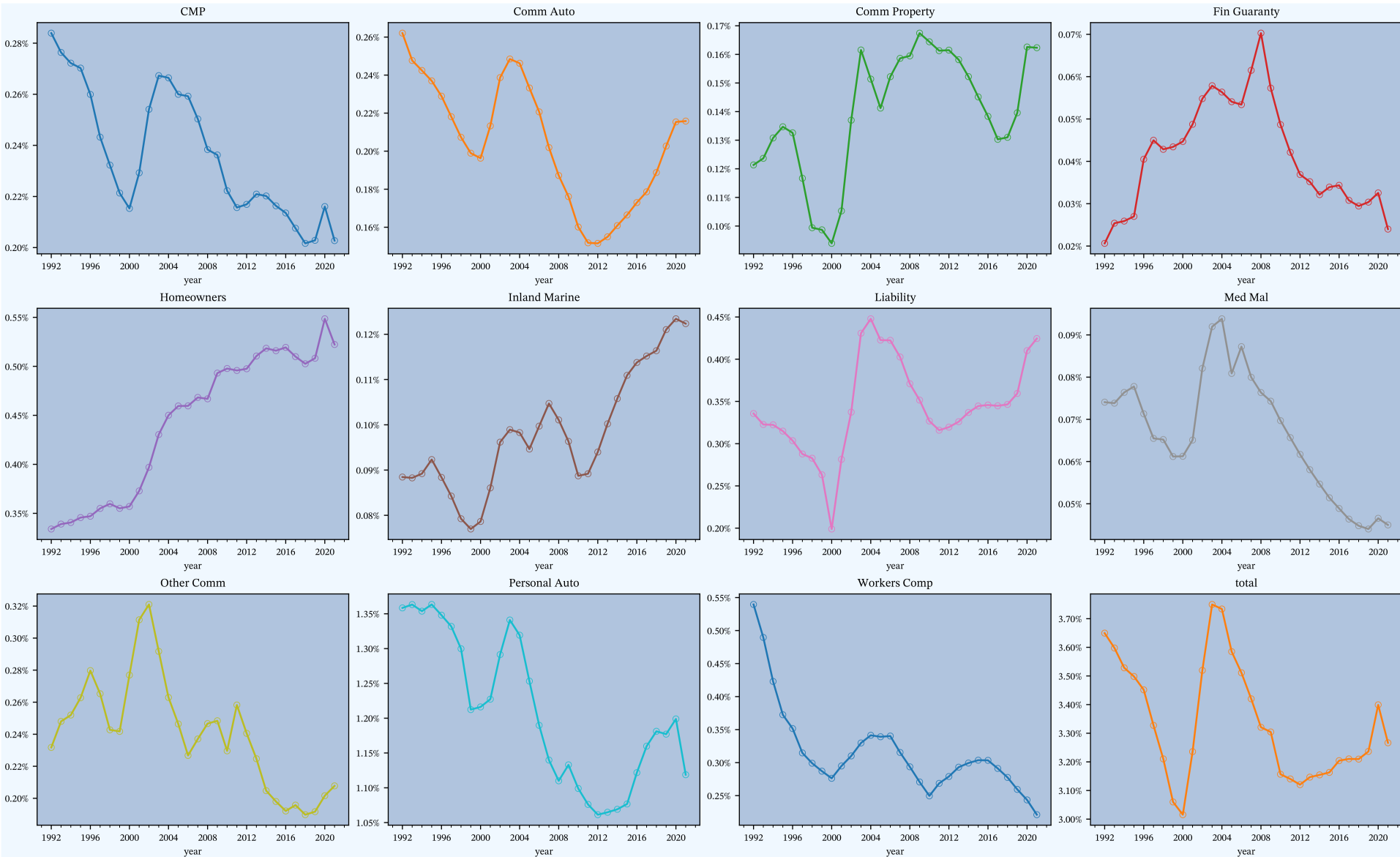
# The Underwriting Cycle Is Driven by Commercial Lines



Premium to GDP for personal lines vs. commercial shows the cycle is more driven by commercial



# Calm Surface Masks Inner Turmoil



## Question 4: Growth

Which line of business has seen the **fastest** cumulative premium growth since 1992?

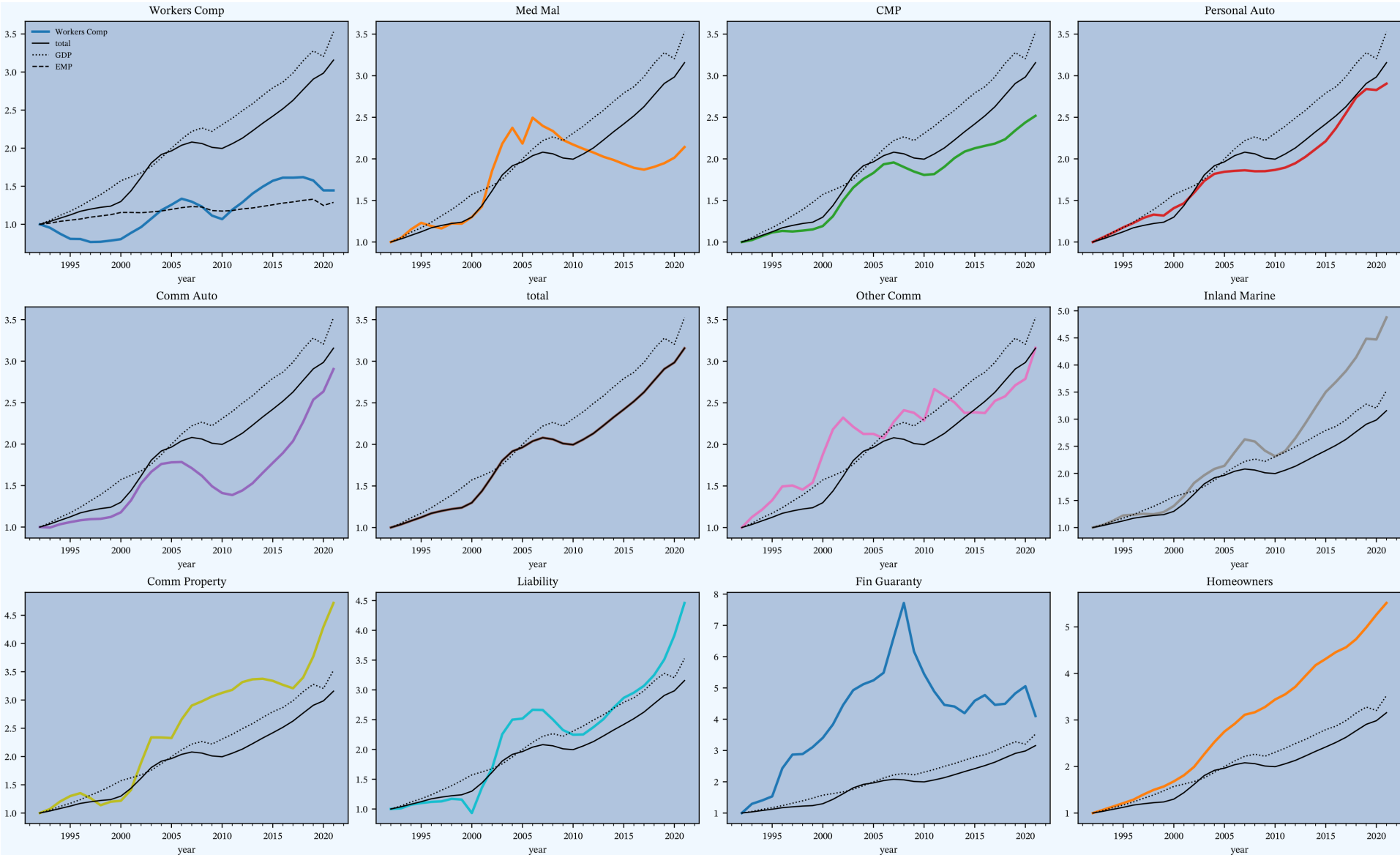
- a. Personal Auto
- b. Commercial Auto
- c. Workers Compensation
- d. Homeowners
- e. Medical Malpractice

## Question 5: Growth

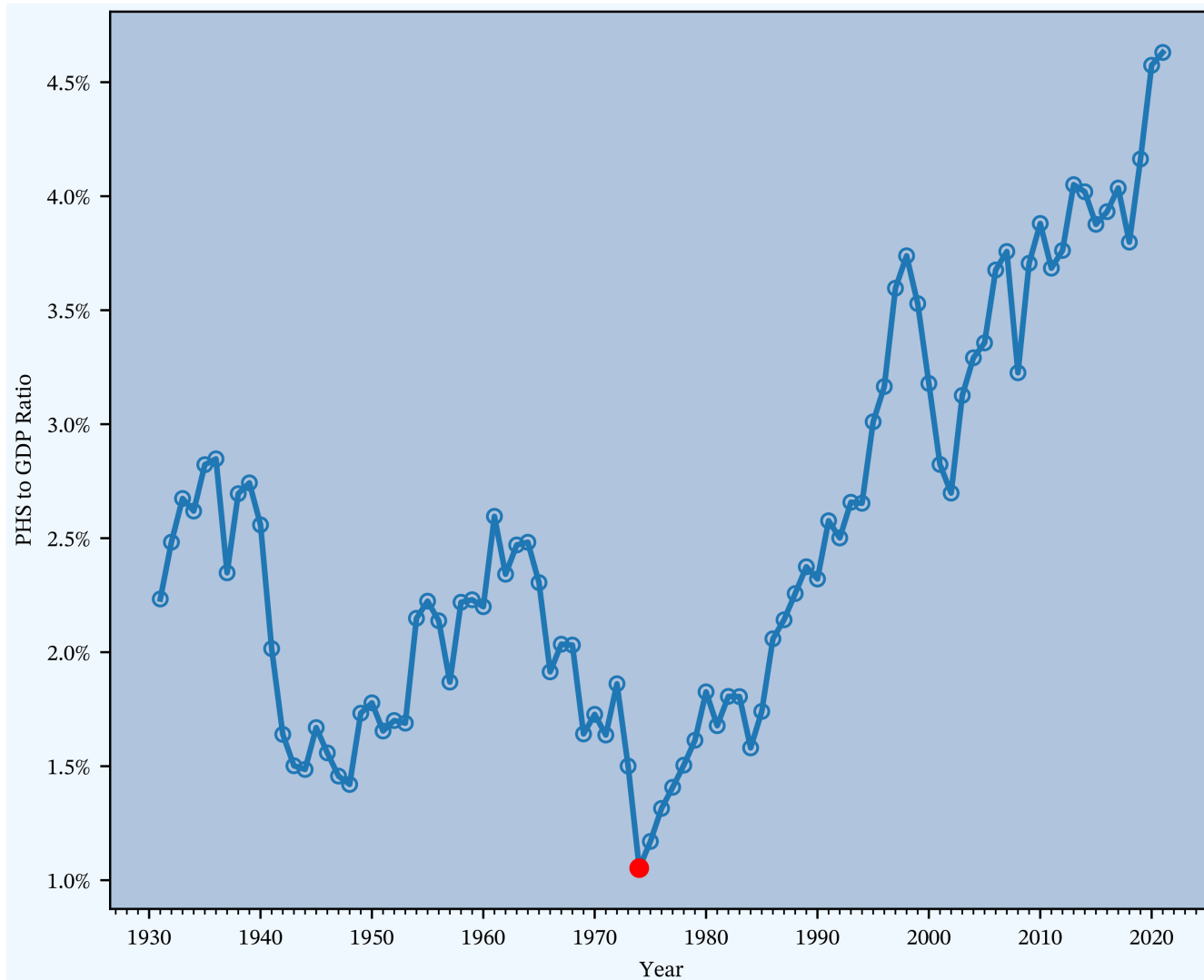
Which line of business has seen the **slowest** cumulative premium growth since 1992?

- a. Personal Auto
- b. CMP
- c. Workers Compensation
- d. Inland Marine
- e. Medical Malpractice

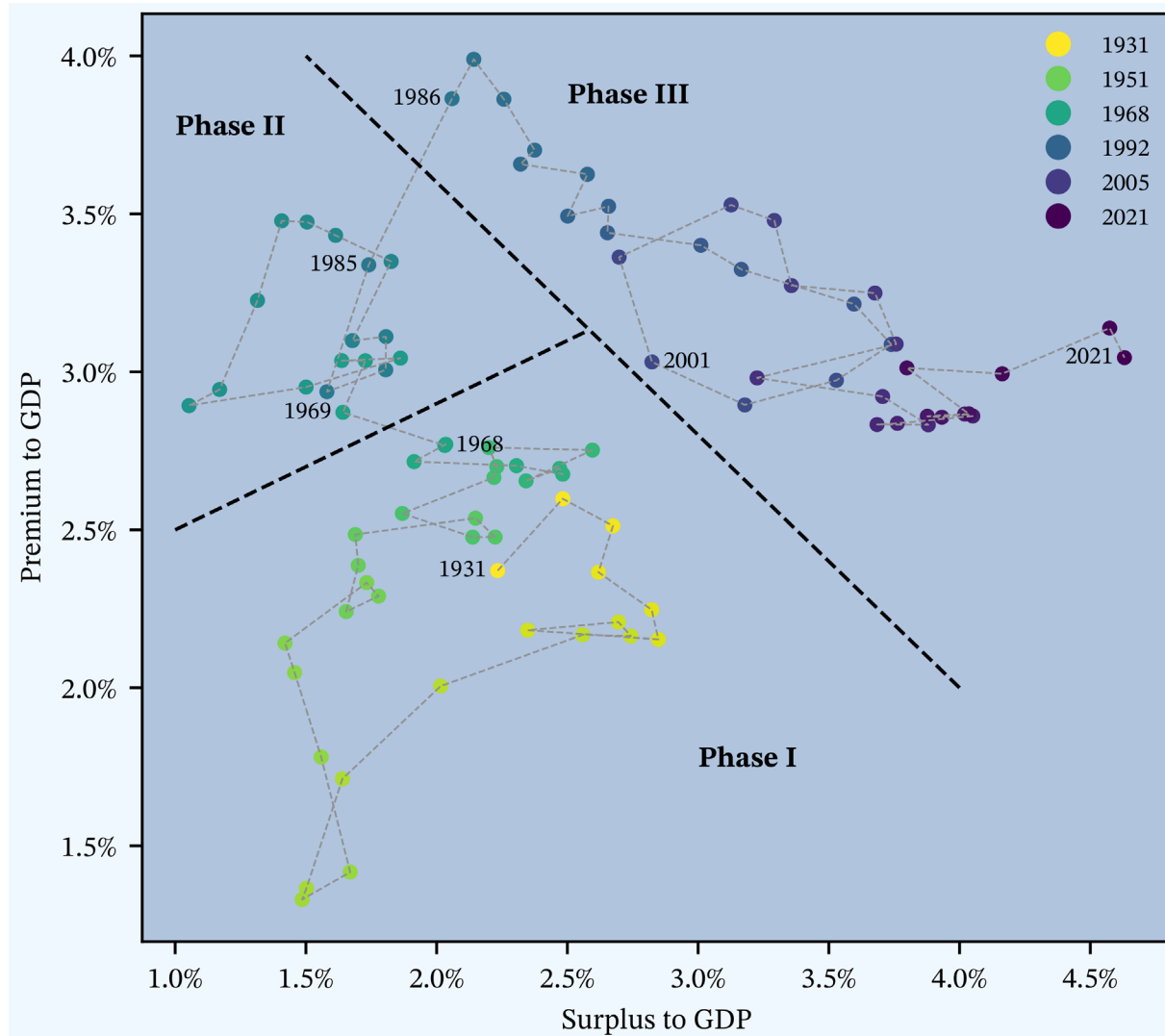
# Premium and GDP Growth Since 1992 (1992=1.0)



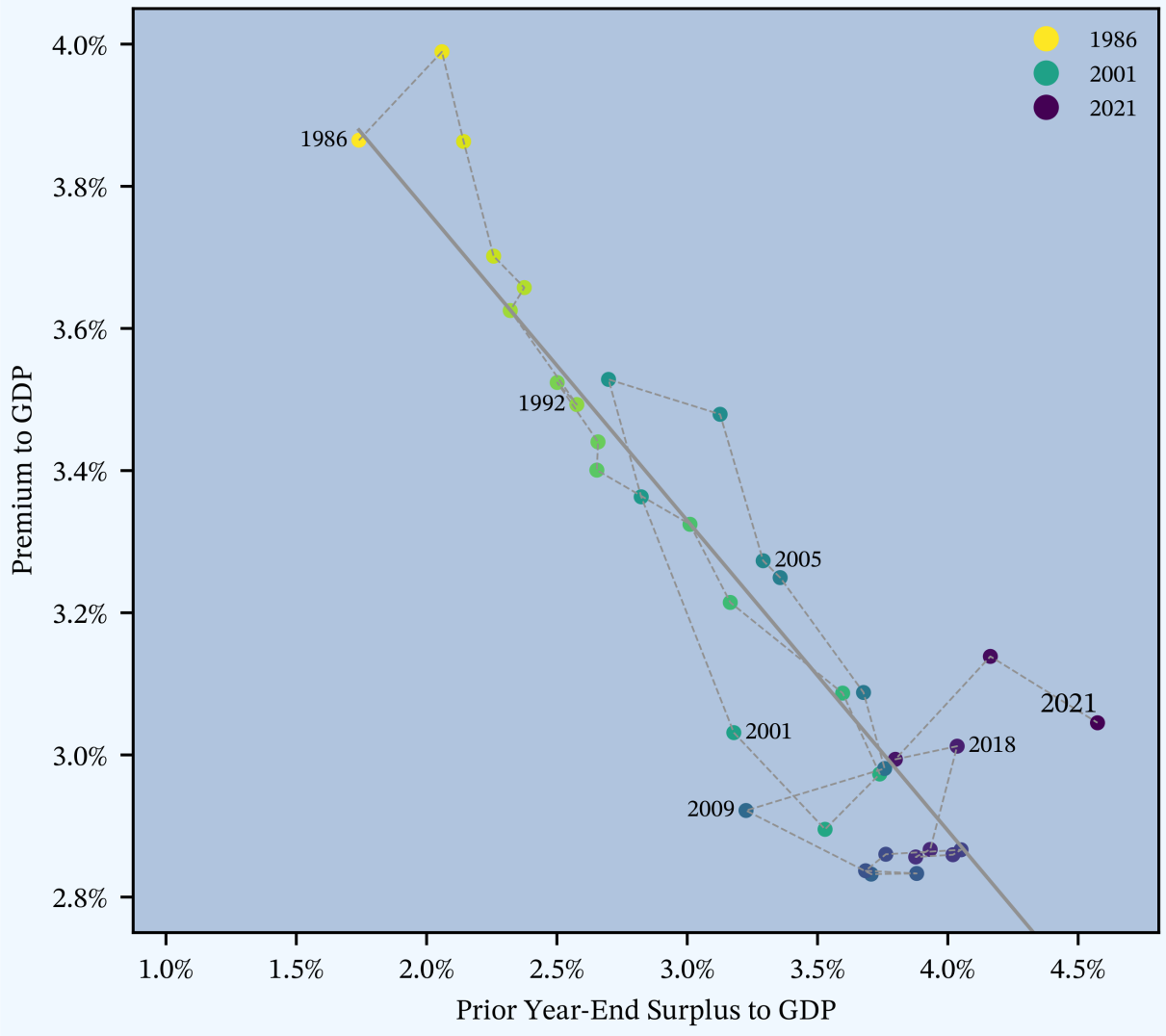
# Surplus to GDP Ratio, 1931-2020e



# Three Phases of Market Dynamics Since 1931



# Market Dynamics Since 1986 Explained by Prior Year Surplus Levels



## Question 6: Risk and Volatility

Which line of business has seen the **highest** standard deviation of loss ratio since 1992

- a. Commercial Auto
- b. CMP
- c. Workers Compensation
- d. Financial Guaranty
- e. Homeowners



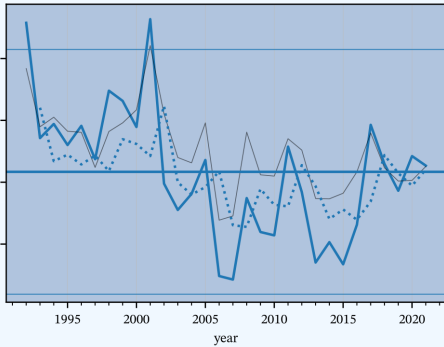
## Question 7: Risk and Volatility

Which line of business has seen the **lowest** standard deviation of loss ratio since 1992

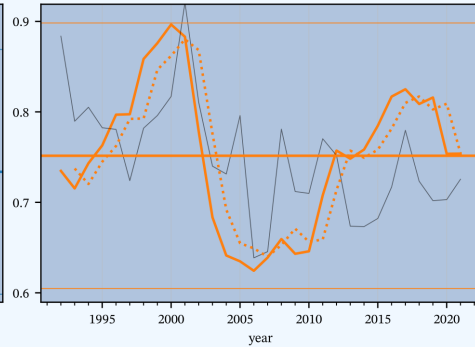
- a. Commercial Auto
- b. Personal Auto
- c. Workers Compensation
- d. General Liability
- e. Homeowners

# Direct Loss Ratio Time Series by Major Line

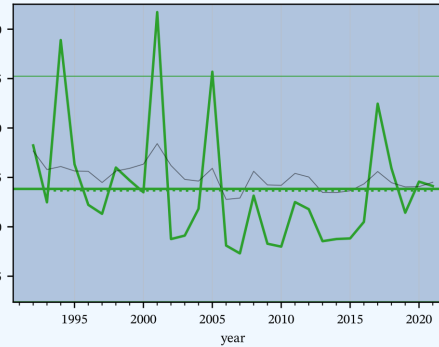
CMP; SD=0.107 (0.0634), cor=0.893  
ar fit, r2=0.263, rse0=0.0862



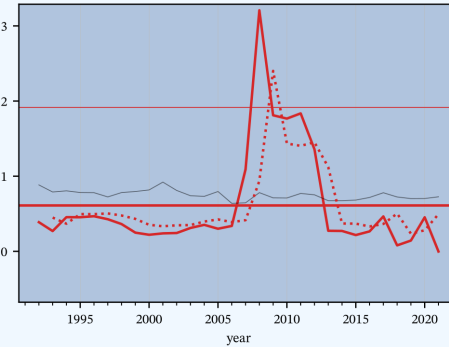
Comm Auto; SD=0.0794 (0.0502), cor=0.405  
ar fit, r2=0.78, rse0=0.0385



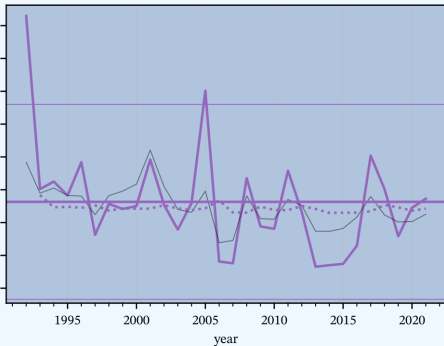
Comm Property; SD=0.309 (0.151), cor=0.709  
ar fit, r2=6.07e-06, rse0=0.317



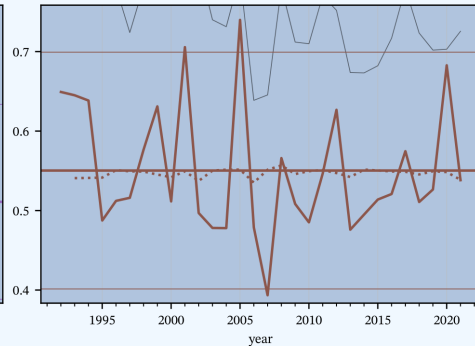
Fin Guaranty; SD=0.706 (0.56), cor=-0.0453  
ar fit, r2=0.468, rse0=0.533



Homeowners; SD=0.161 (0.104), cor=0.766  
ar fit, r2=0.00902, rse0=0.124



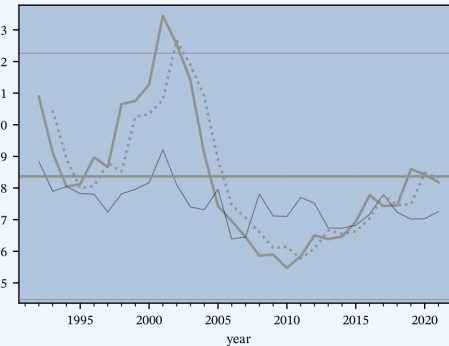
Inland Marine; SD=0.0806 (0.0424), cor=0.633  
ar fit, r2=0.0041, rse0=0.0811



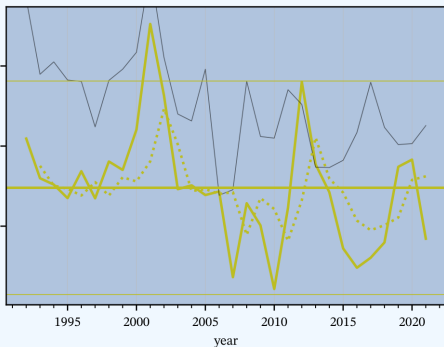
Liability; SD=0.159 (0.126), cor=0.704  
ar fit, r2=0.665, rse0=0.0938



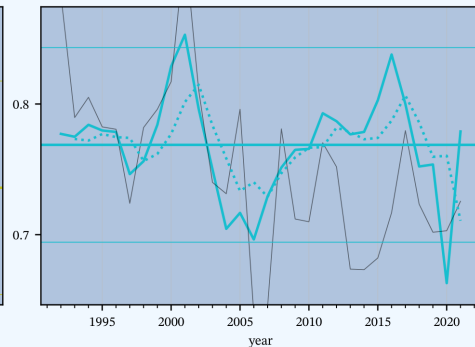
Med Mal; SD=0.211 (0.156), cor=0.661  
ar fit, r2=0.789, rse0=0.0976



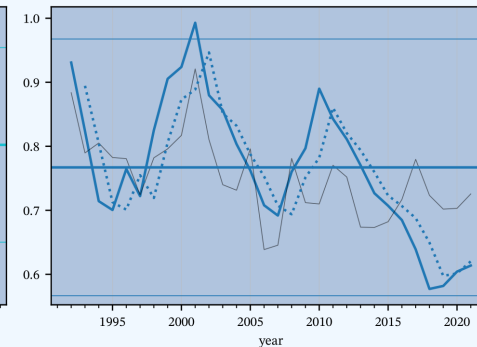
Other Comm; SD=0.0721 (0.0414), cor=0.599  
ar fit, r2=0.248, rse0=0.0639



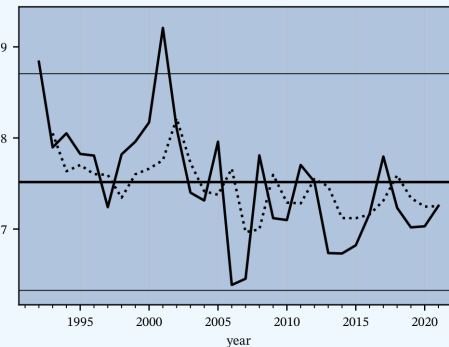
Personal Auto; SD=0.0403 (0.026), cor=0.481  
ar fit, r2=0.299, rse0=0.0349



Workers Comp; SD=0.108 (0.0714), cor=0.611  
ar fit, r2=0.712, rse0=0.0578



total; SD=0.0643 (0.0425), cor=1  
ar fit, r2=0.23, rse0=0.0539



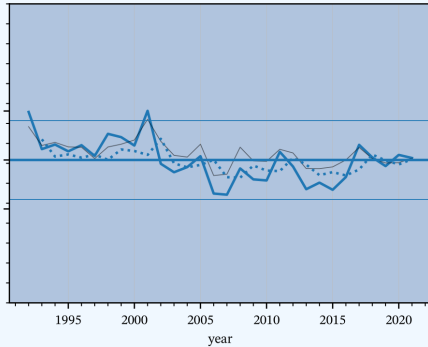
# Loss Ratio Time Series by Major Line

- Title decoder: CMP; SD=0.107 (0.0634), cor=0.893 ar fit, r2=0.263, rse0=0.0862
  - Line; standard deviation
  - Down-side semi-deviation is shown in parenthesis (explain)
  - Correlation of the line with total on the first line
  - (second line) shows the  $R^2$  and residual standard error of an autoregressive loss ratio model
- Interpretation
  - When the rse is much lower than SD it suggests the market cycle is predictable
  - Tends to occur in casualty lines (e.g., commercial auto, medical malpractice, private passenger auto, and workers compensation)
  - The cycle for property lines tends to be idiosyncratic, for obvious reasons.
- Line Legend
  - Thin gray line in each plot shows the total loss ratio, for context
  - The horizontal lines show the mean (thicker) and mean  $\pm \Phi^{-1}(30/31) = \pm 1.85$  standard deviations
    - If the loss ratios were normally distributed, we expect all observations from 30 years (1992-2021) to fall within these tram lines
    - They provide a surprisingly good estimate of the range of loss ratio, except for Financial Lines (which uses a different tick spacing, note).

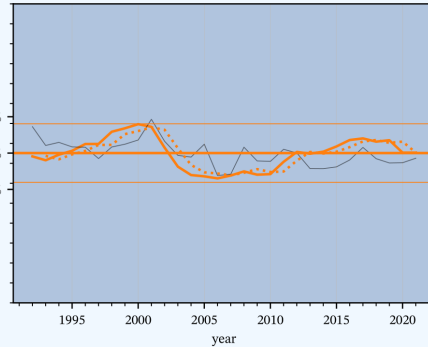
# Direct Loss Ratio Time Series by Major Line

## Loss Ratio Scale 0 to 150 Percent

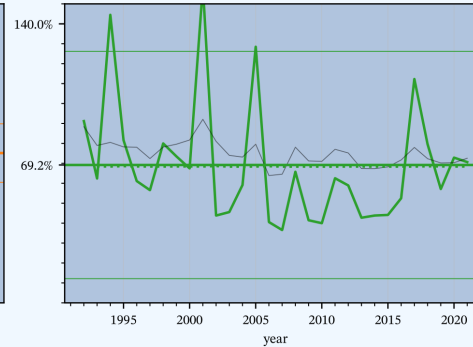
CMP; SD=0.107 (0.0634), cor=0.893  
ar fit, r2=0.263, rse0=0.0862



Comm Auto; SD=0.0794 (0.0502), cor=0.405  
ar fit, r2=0.78, rse0=0.0385



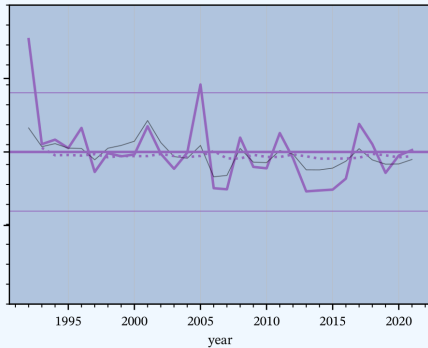
Comm Property; SD=0.309 (0.151), cor=0.709  
ar fit, r2=6.07e-06, rse0=0.317



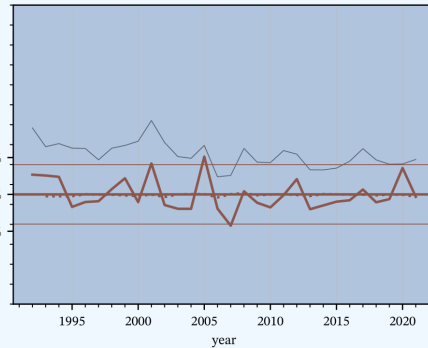
Fin Guaranty; SD=0.706 (0.56), cor=-0.0453  
ar fit, r2=0.468, rse0=0.533



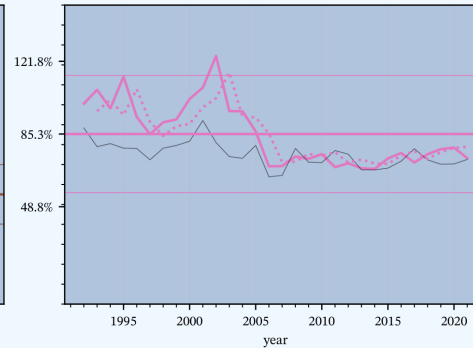
Homeowners; SD=0.161 (0.104), cor=0.766  
ar fit, r2=0.00902, rse0=0.124



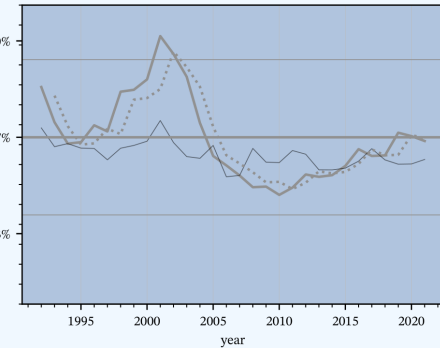
Inland Marine; SD=0.0806 (0.0424), cor=0.633  
ar fit, r2=0.0041, rse0=0.0811



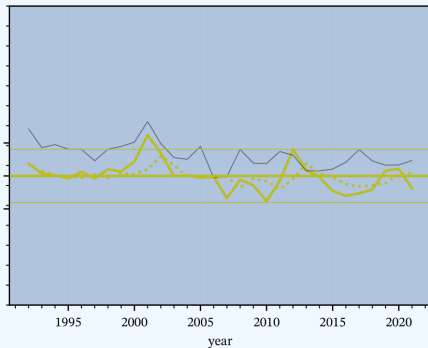
Liability; SD=0.159 (0.126), cor=0.704  
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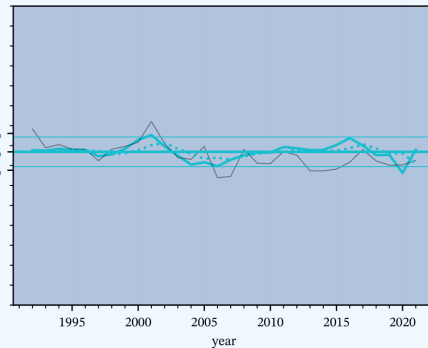
Med Mal; SD=0.211 (0.156), cor=0.661  
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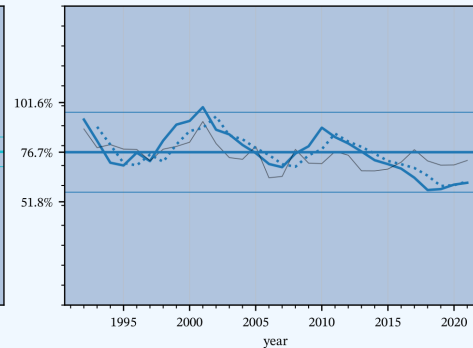
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ar fit, r2=0.248, rse0=0.0639



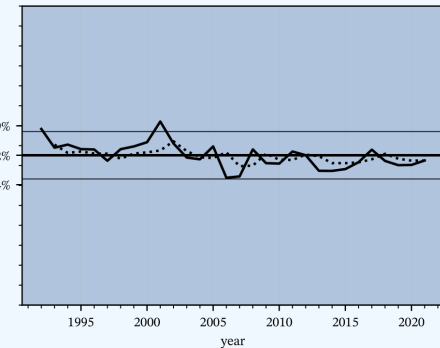
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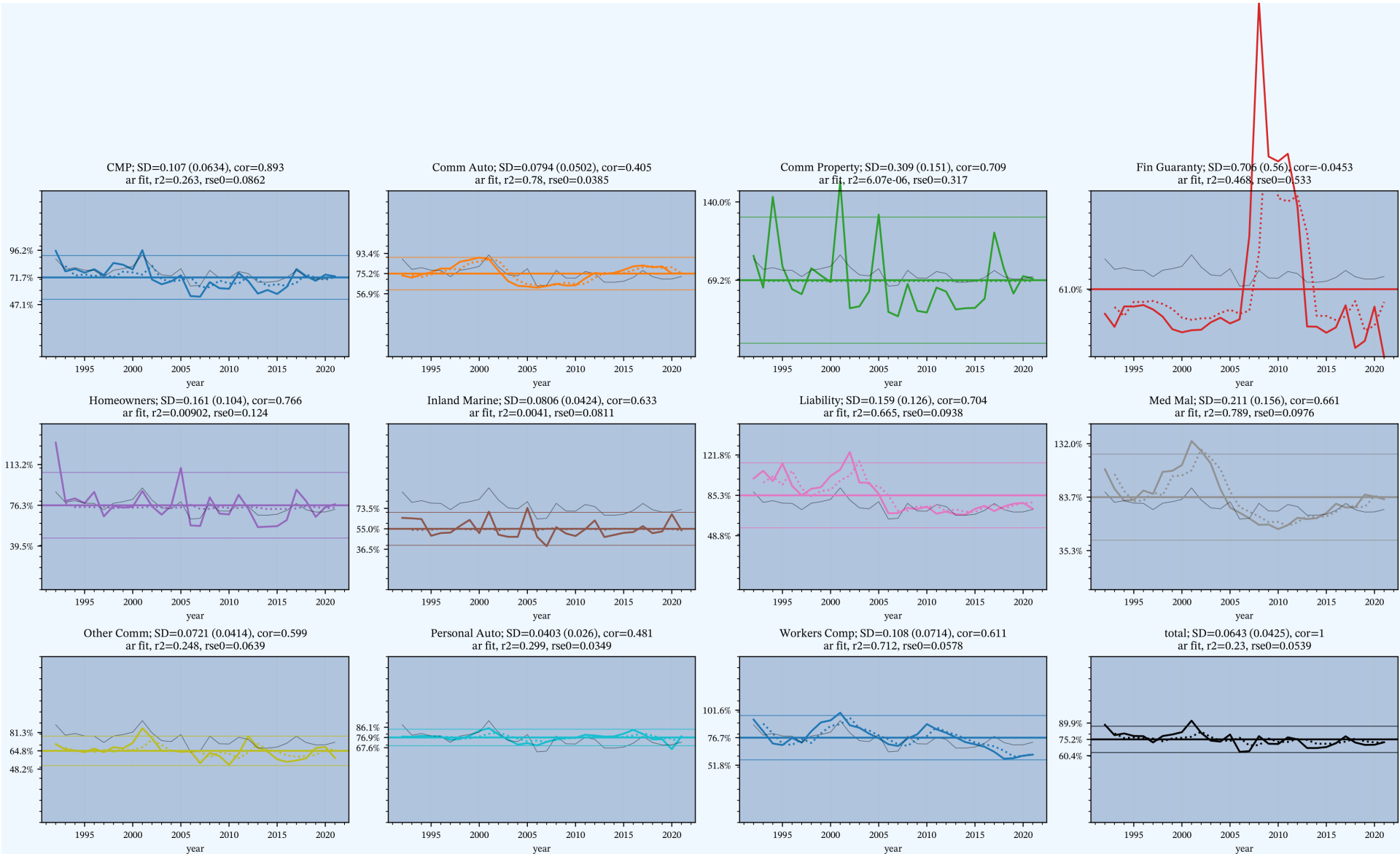
Workers Comp; SD=0.108 (0.0714), cor=0.611  
ar fit, r2=0.712, rse0=0.0578



total; SD=0.0643 (0.0425), cor=1  
ar fit, r2=0.23, rse0=0.0539



# Some Lines Are More Volatile Than Others...



## Question 8: Capstone

Premium is riskier than loss for which of the following combinations of lines?

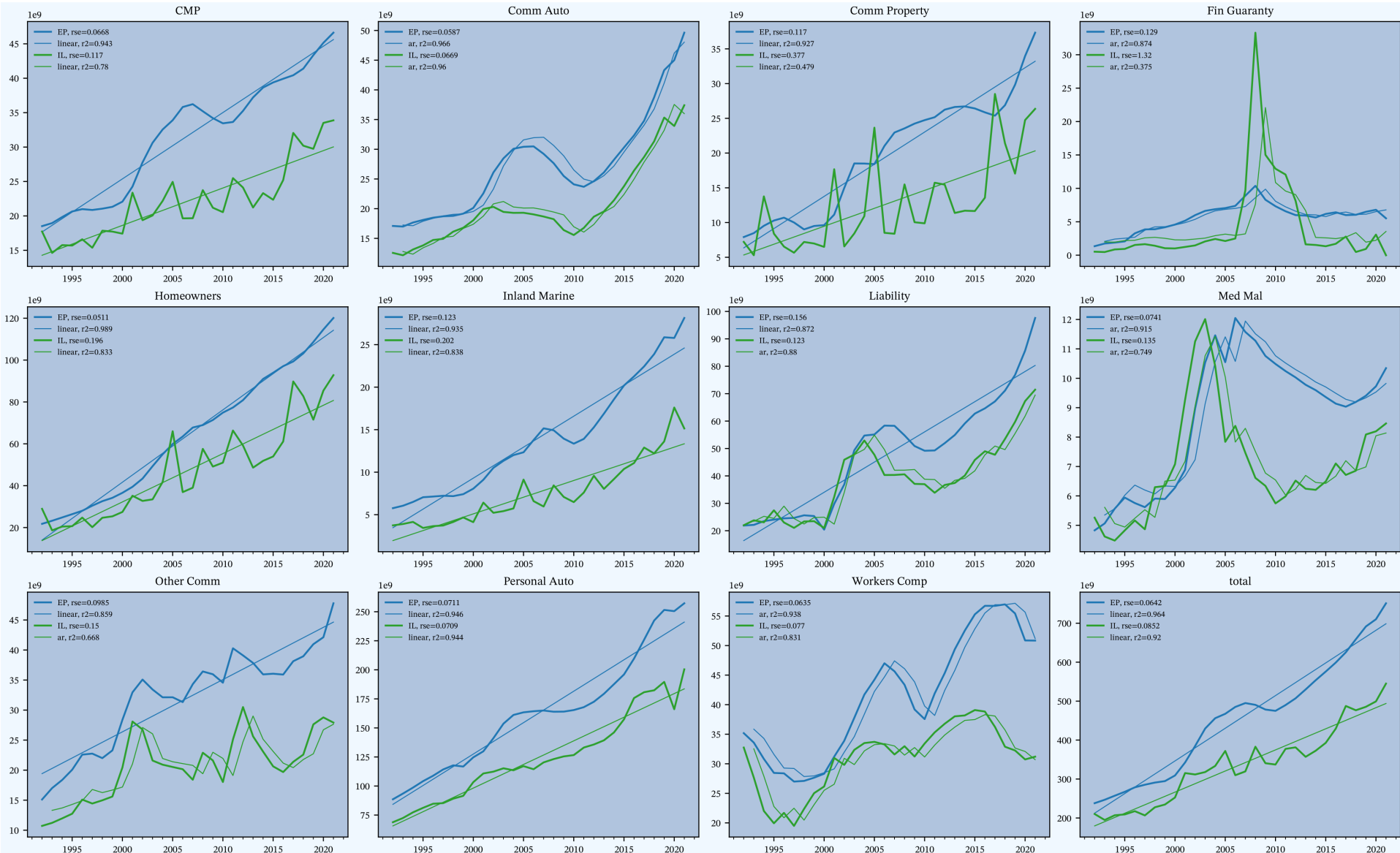
### Answers

- a. Personal Auto and Commercial Auto
- b. Commercial Auto and Workers Compensation
- c. Commercial Auto and Liability
- d. Commercial Auto, Liability, and Workers Compensation
- e. Personal Auto and Liability

# COVID...

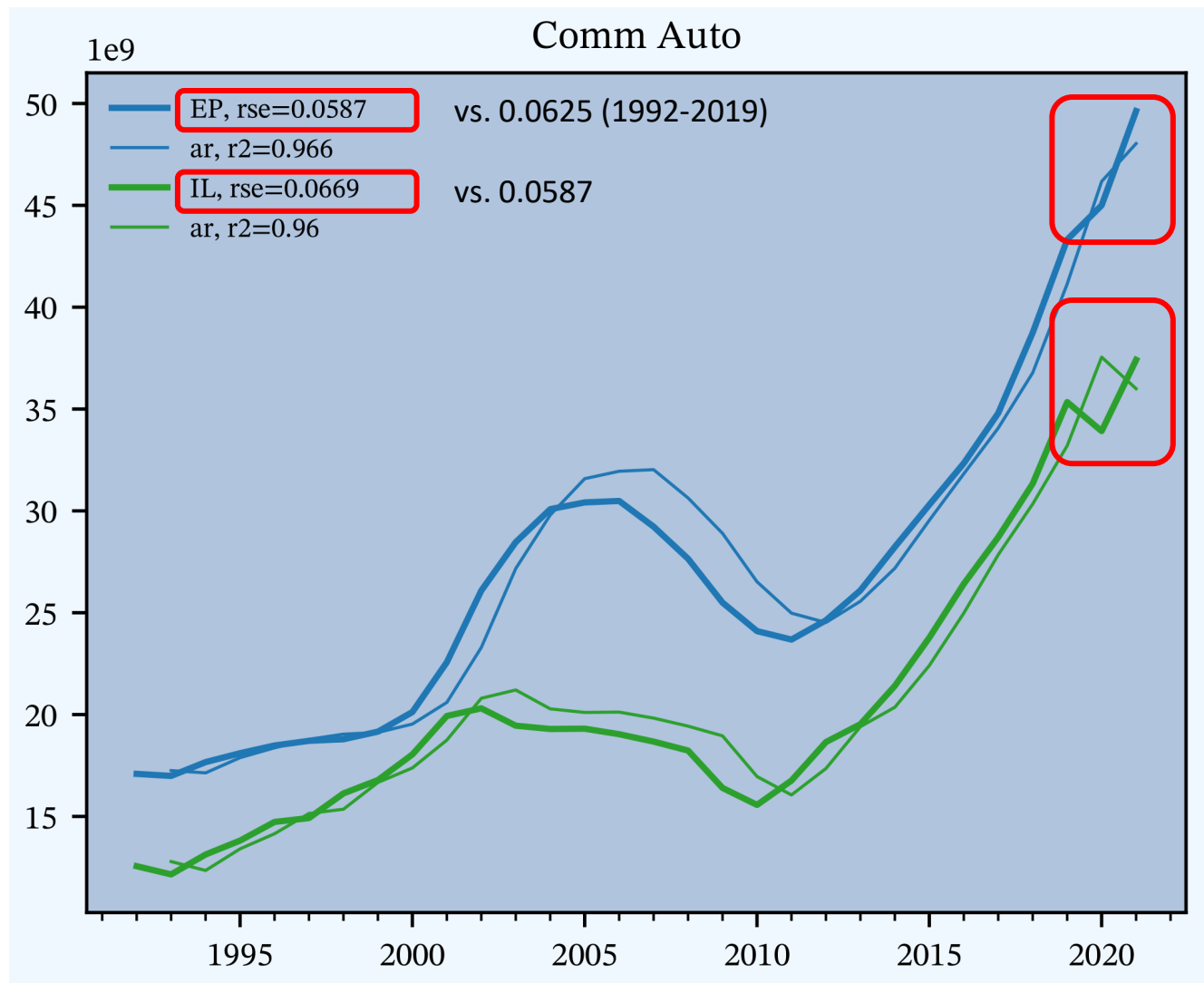


# Direct Premium and Loss Dynamics: 1992-2021

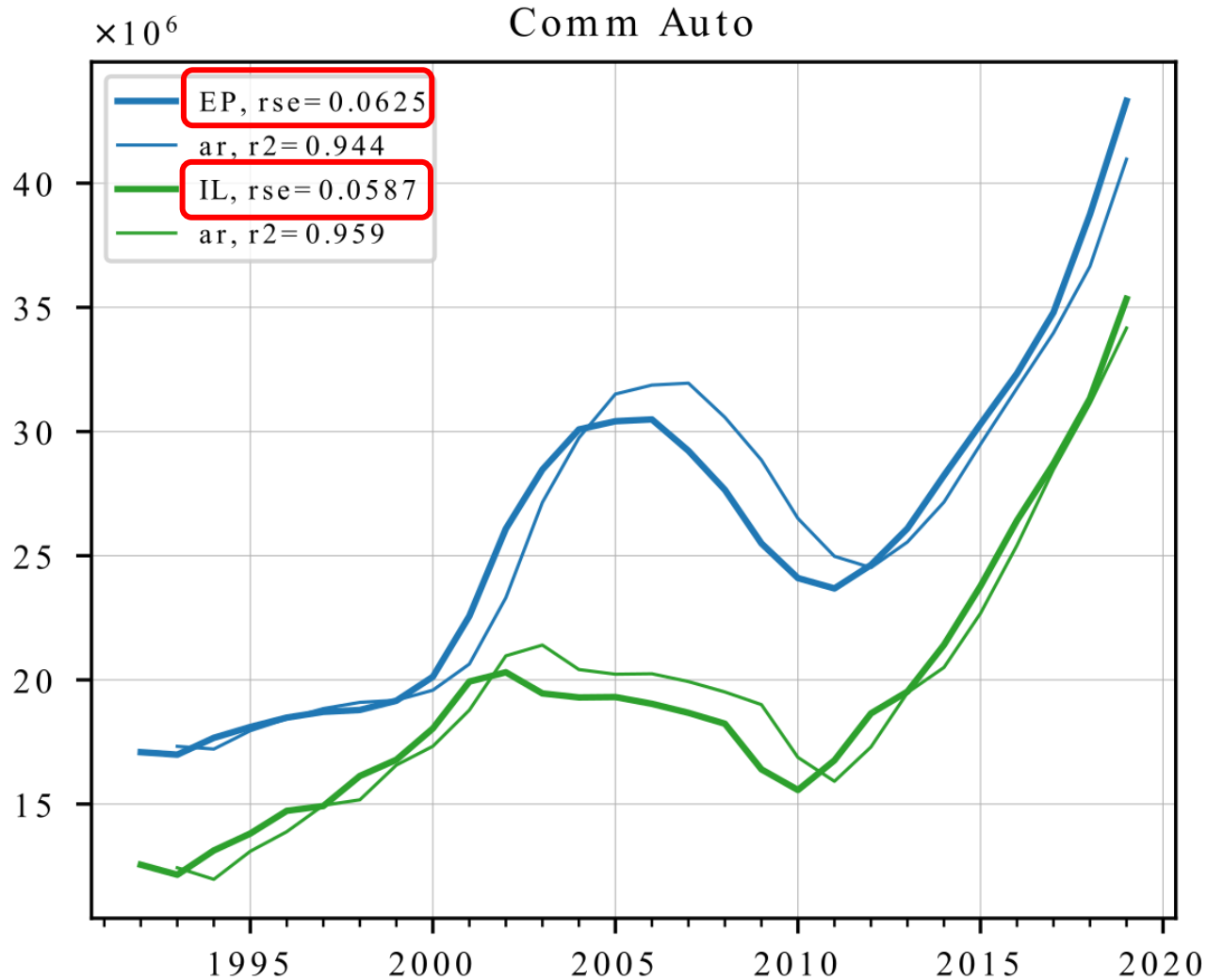




# Direct Premium and Loss Dynamics: 1992-2021



# Direct Premium and Loss Dynamics: 1992-2019



# Implications for Risk Management Decision Making

1. Use residual volatility: must take out what is known

2. Property lines dominated by event-driven loss volatility

3. Casualty lines combine loss volatility and underwriting cycle uncertainty: AY emergence vs. CY moving-average loss

4. Underwriting cycle is event-driven and is unpredictable

# Implications for Risk Management Decision Making

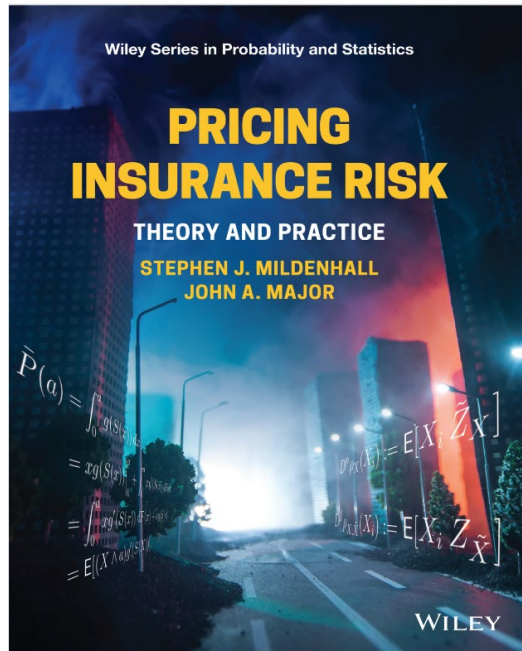
## 5. Loss ratio-based risk modeling with fixed premium

- Broadly reasonable for property
- Understates risk for casualty
- Makes it harder to model pricing-driven correlations

## 6. Quota share protection covers premium risk and is more valuable than a loss ratio model indicates

- “[C]apability of the model is consistent with the intended purpose” (ASOP 50)

# More Resources



- <https://www.pricinginsurancerisk.com>
- <https://www.convexrisk.com/pirc>

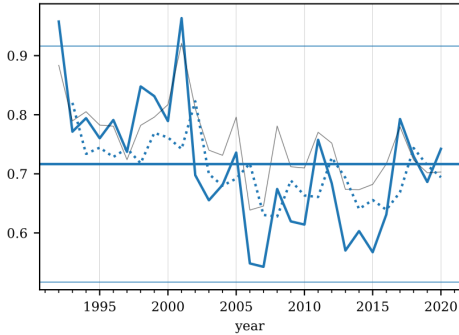


- [Stephen Mildenhall & David Wright: The Macro Environment in Insurance - YouTube](#)
- [Stephen Mildenhall & David Wright: The Macro History of Insurance Part 2 - YouTube](#)
  - <https://podcast.notunreasonable.com/>

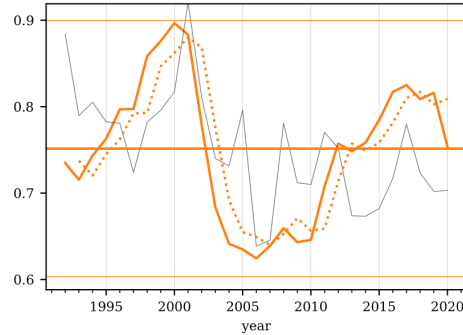
# Appendix - Selected Prior Year Slides

# Direct Loss Ratio Time Series by Major Line, 1992-2020

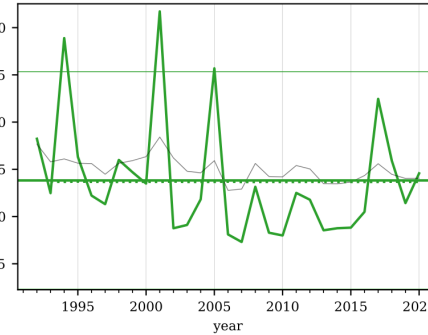
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ar fit, r2=0.262, rse0=0.0878



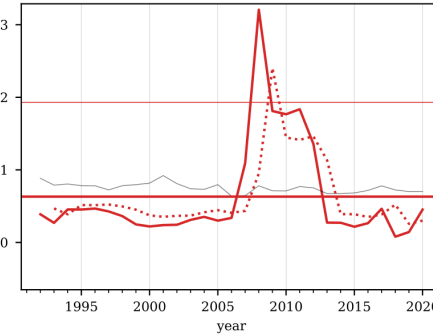
Comm Auto; SD=0.0808 (0.0507), cor=0.407  
ar fit, r2=0.78, rse0=0.0393



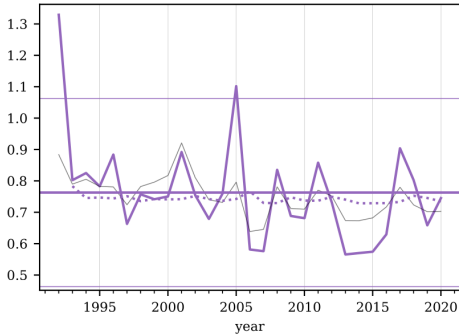
Comm Property; SD=0.314 (0.154), cor=0.712  
ar fit, r2=4.63e-06, rse0=0.323



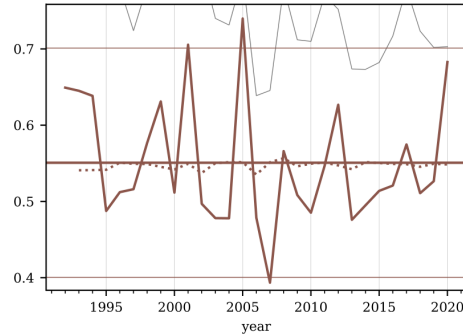
Fin Guaranty; SD=0.709 (0.561), cor=-0.0588  
ar fit, r2=0.471, rse0=0.534



Homeowners; SD=0.163 (0.106), cor=0.769  
ar fit, r2=0.00922, rse0=0.126



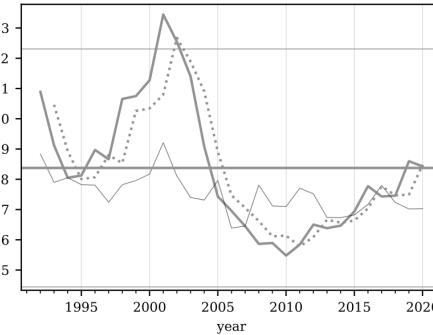
Inland Marine; SD=0.082 (0.0425), cor=0.632  
ar fit, r2=0.00367, rse0=0.0826



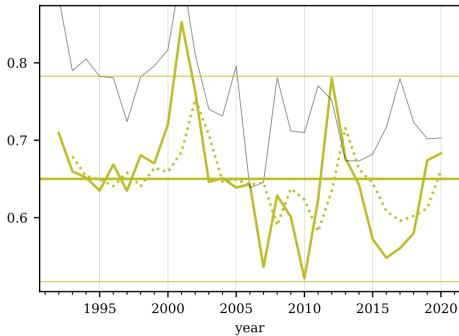
Liability; SD=0.16 (0.126), cor=0.703  
ar fit, r2=0.663, rse0=0.0949



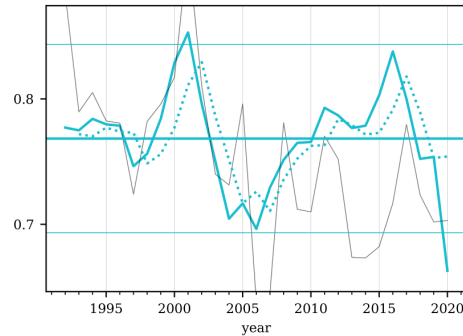
Med Mal; SD=0.214 (0.159), cor=0.662  
ar fit, r2=0.79, rse0=0.0994



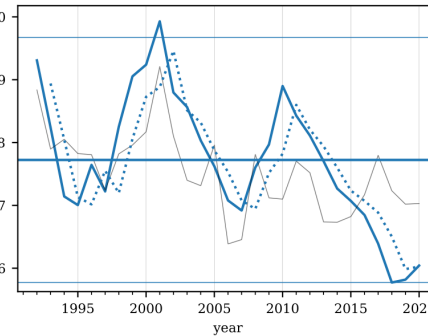
Other Comm; SD=0.0723 (0.0419), cor=0.596  
ar fit, r2=0.272, rse0=0.0633



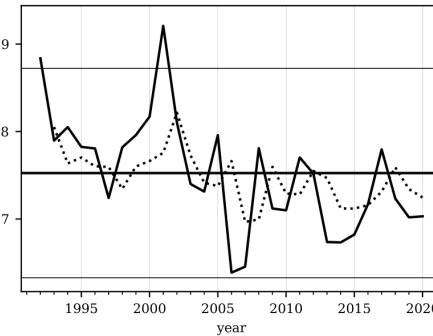
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ar fit, r2=0.434, rse0=0.0319



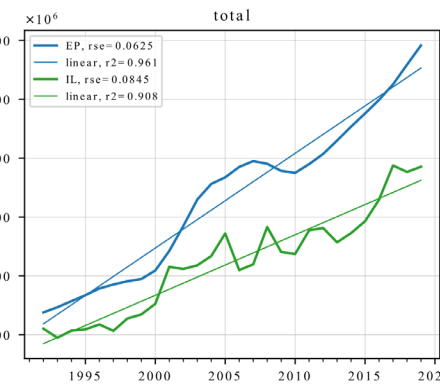
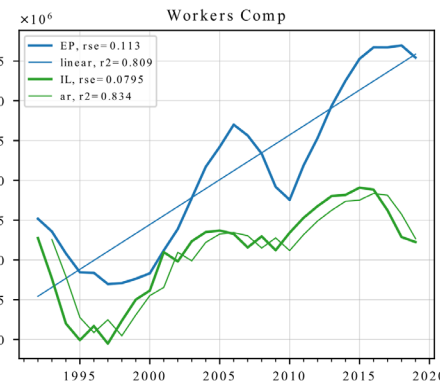
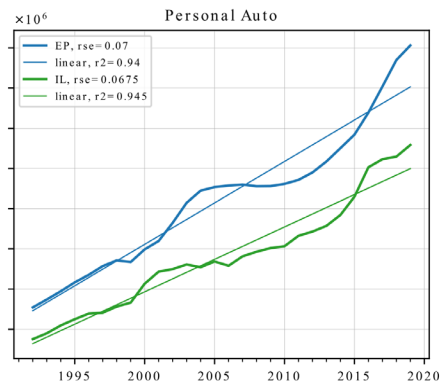
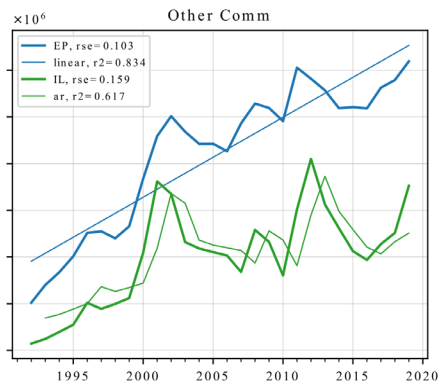
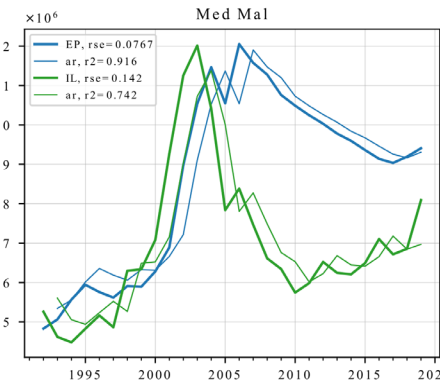
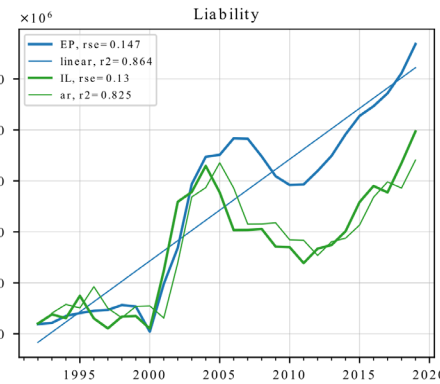
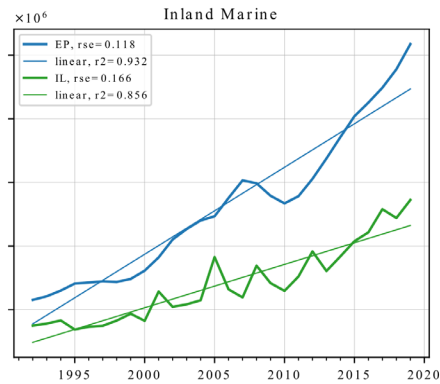
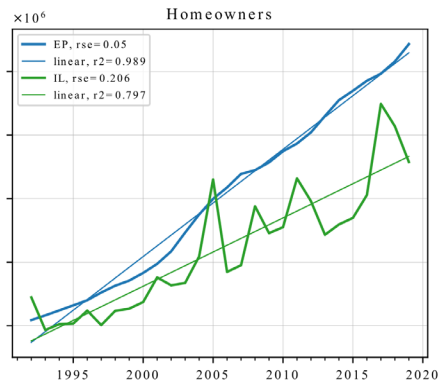
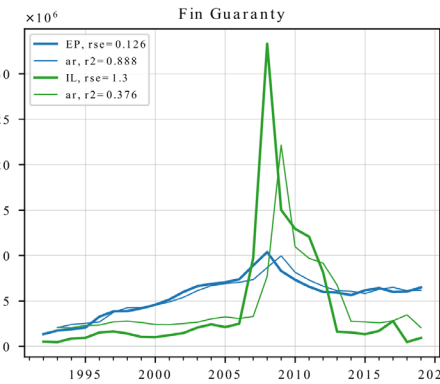
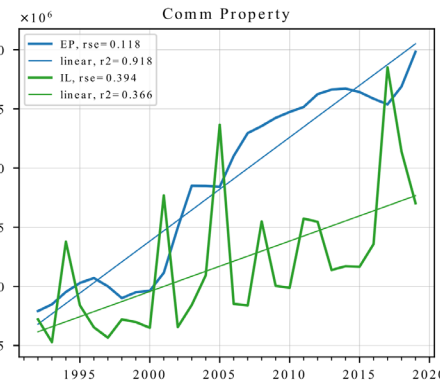
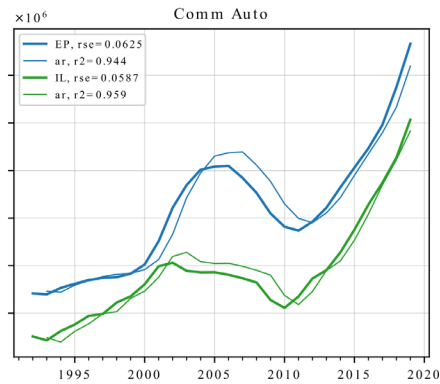
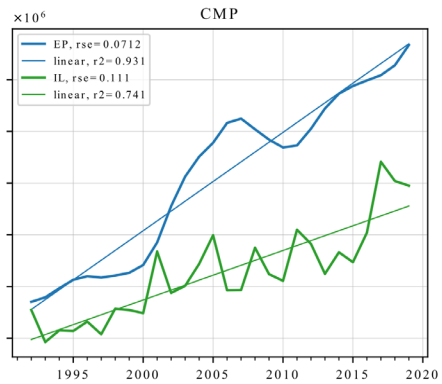
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total; SD=0.0653 (0.0429), cor=1  
ar fit, r2=0.226, rse0=0.055

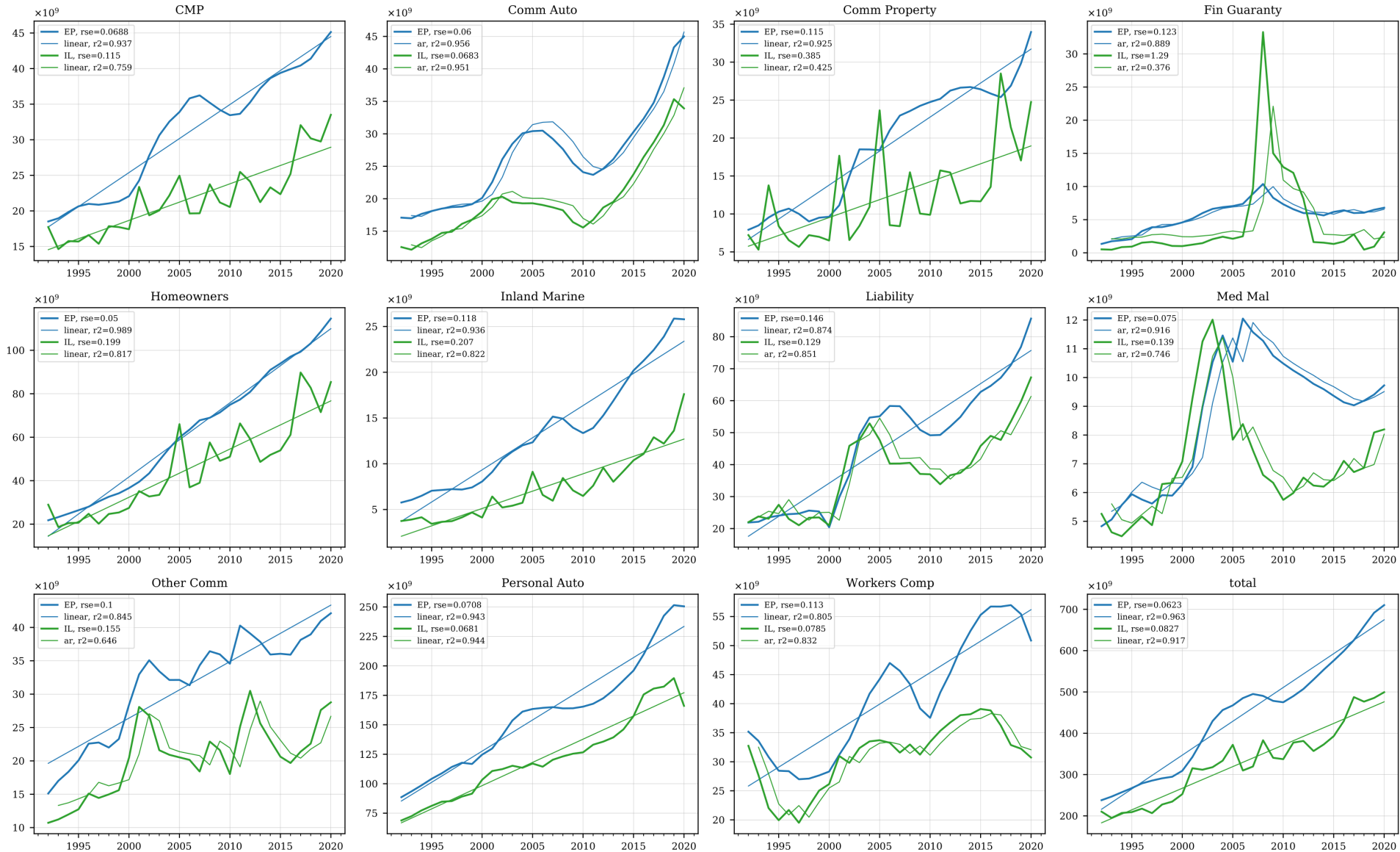


# Direct Premium and Loss Dynamics: 1992-2019





# Direct Premium and Loss Dynamics: 1992-2020



# Direct Premium and Loss Dynamics: 1992-2020

