

**GUY CARPENTER**



## **Reserve Risk Models: Grey, White and Black Swans**

Jessica Leong, FCAS, FIAA, MAAA  
Lead Casualty Specialty Actuary



“We are seeing things that were 25-standard deviation moves, several days in a row”

- David Viniar (2007), Goldman Sachs



“UBS’s specialists ...placed too much trust in statistical models.



“UBS’s specialists ...placed too much trust in statistical models.

In retrospect, models ...were far too optimistic and ultimately led to an underestimation of the risks.



“UBS’s specialists ...placed too much trust in statistical models.

In retrospect, models ...were far too optimistic and ultimately led to an underestimation of the risks.

By the end of 2009 ...UBS’s write-downs exceeded 50 billion francs.” (USD\$60 billion)

– UBS in transparency report to shareholders (2010)




“NASA seriously underestimated the dangers  
astronauts faced ...in the early 1980s...




“NASA seriously underestimated the dangers astronauts faced ...in the early 1980s...

At the time, managers thought there was only a 1-in-100,000 chance of losing a shuttle and its crew.




“NASA seriously underestimated the dangers astronauts faced ...in the early 1980s...  
At the time, managers thought there was only a 1-in-100,000 chance of losing a shuttle and its crew.  
Engineers thought the probability was closer to 1 in 100.



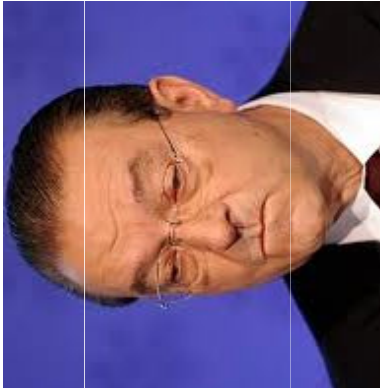


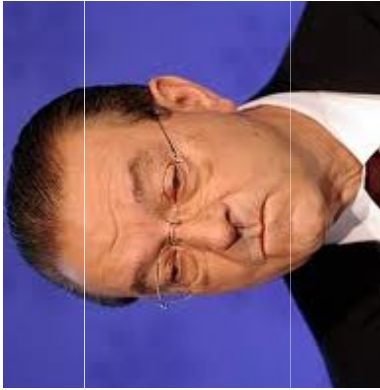
“NASA seriously underestimated the dangers astronauts faced ...in the early 1980s...  
At the time, managers thought there was only a 1-in-100,000 chance of losing a shuttle and its crew.  
Engineers thought the probability was closer to 1 in 100.  
But in reality, ...the odds were 1 in 10.”

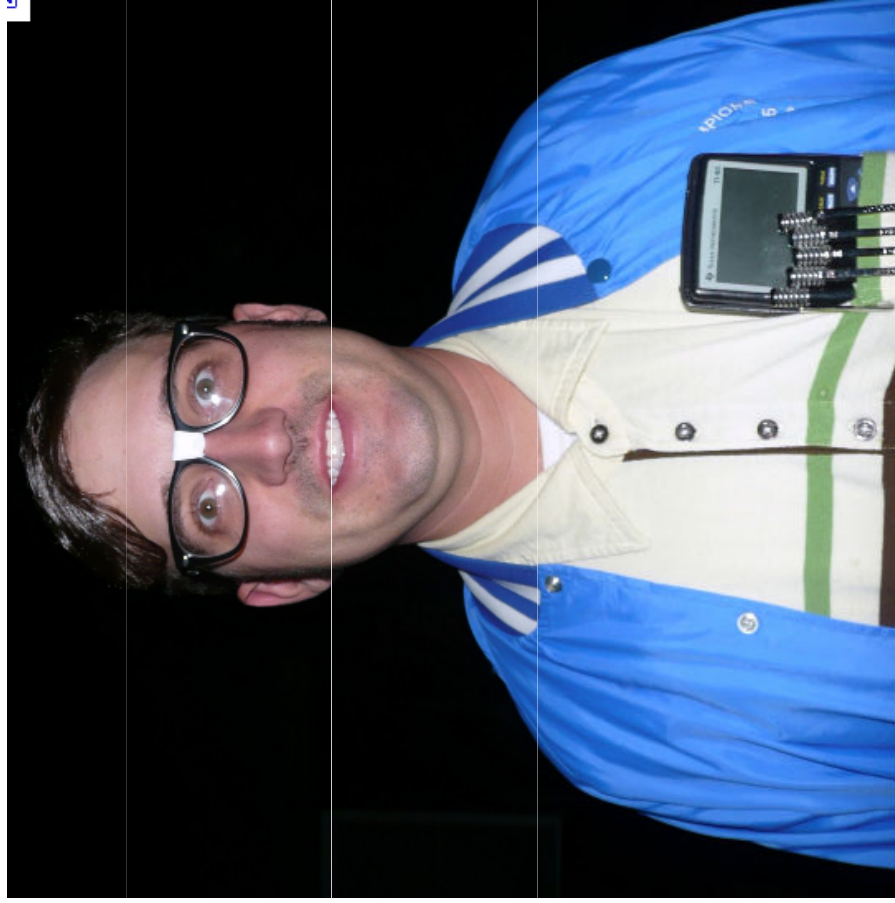
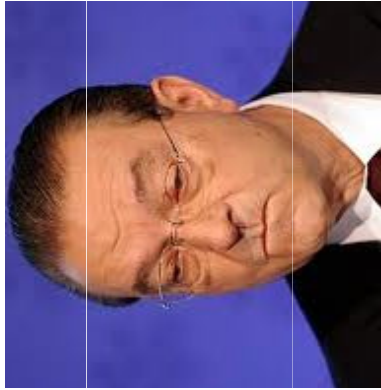


“NASA seriously underestimated the dangers astronauts faced ...in the early 1980s...  
At the time, managers thought there was only a 1-in-100,000 chance of losing a shuttle and its crew.  
Engineers thought the probability was closer to 1 in 100.  
But in reality, ...the odds were 1 in 10.”  
– USA Today (2010)









# GUY CARPENTER

Can we get it right??

1. Reserving
2. Reserve risk

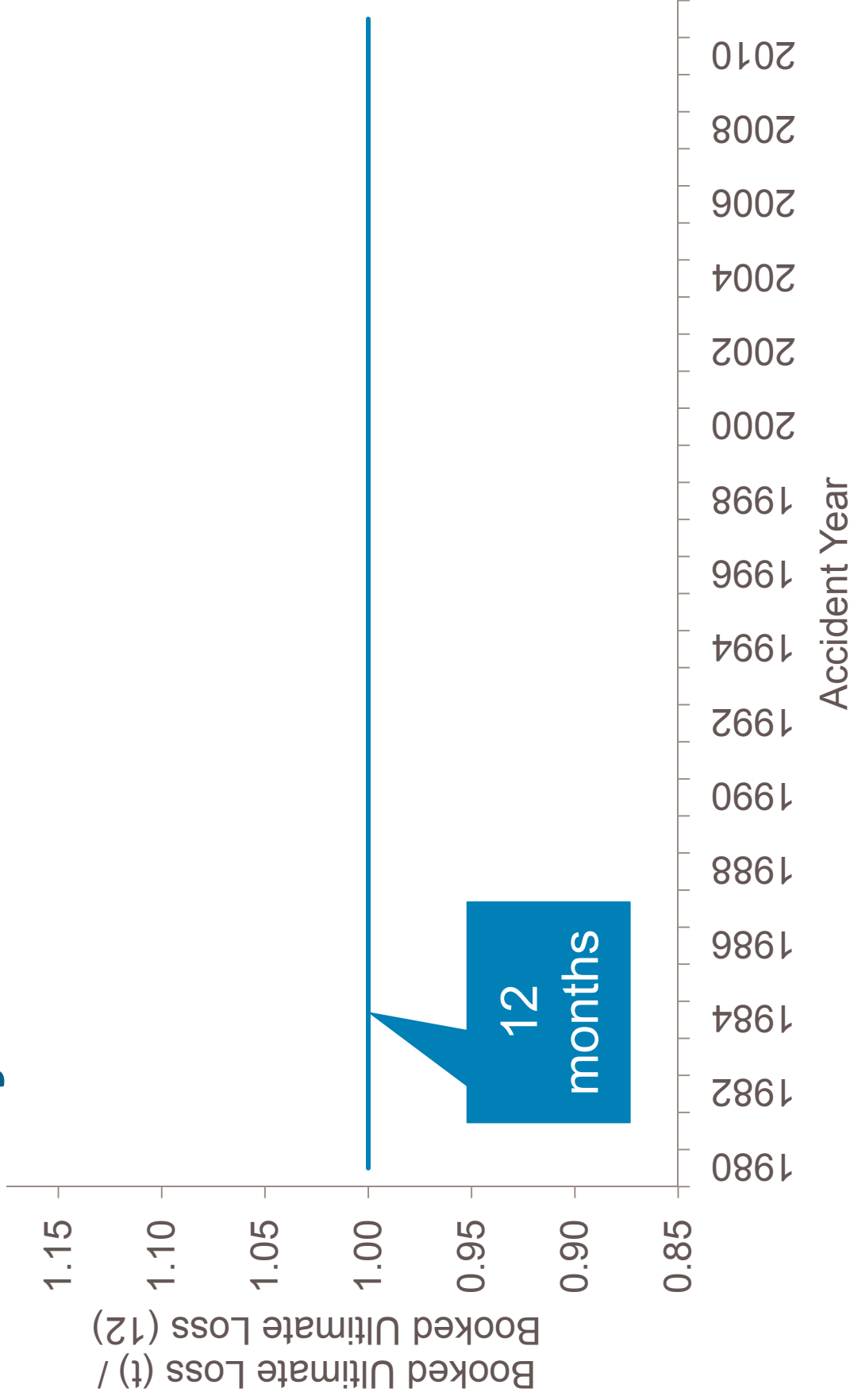
# GUY CARPENTER

Can we get it right??

1. Reserving
2. Reserve risk

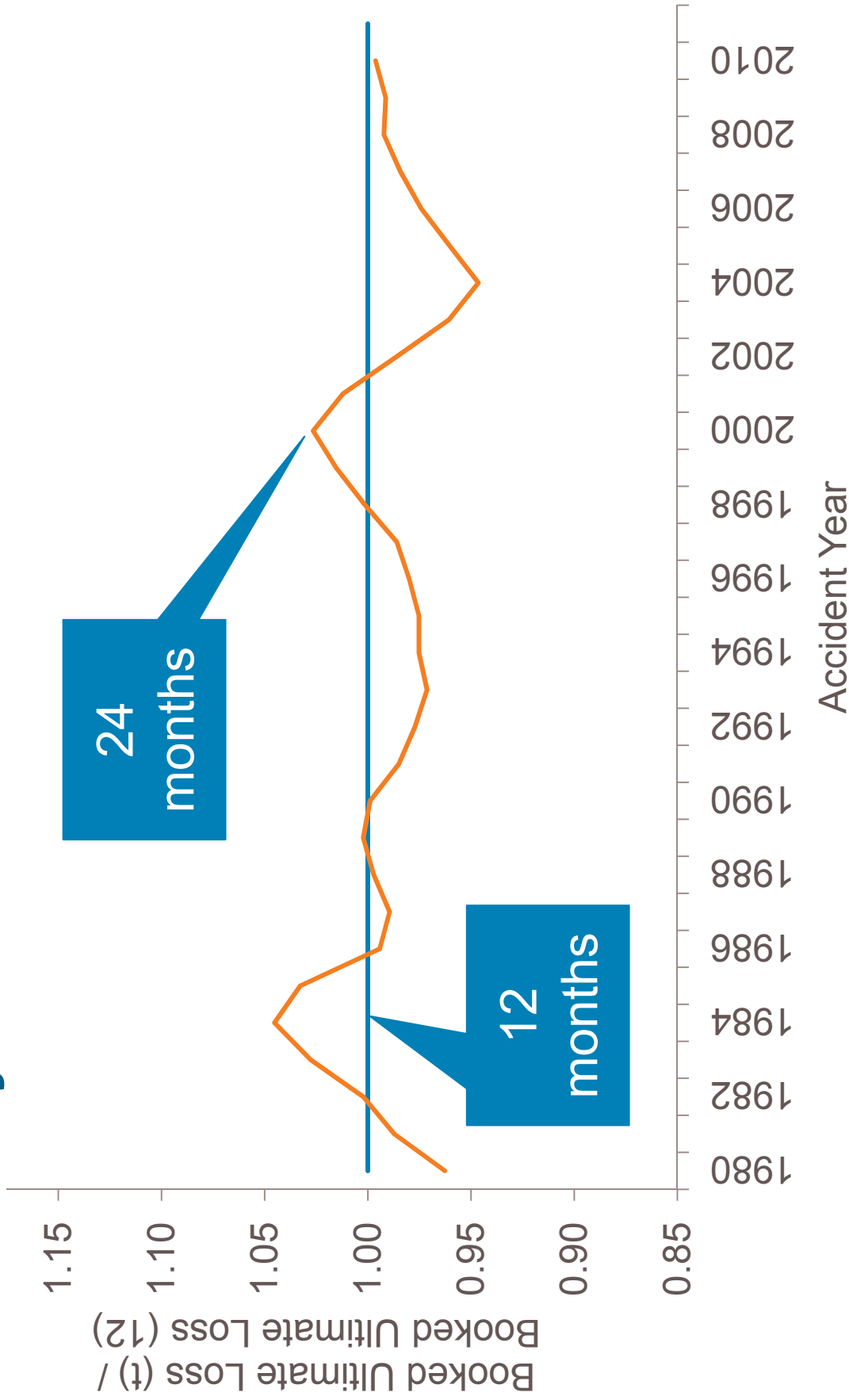


# Reserve Cycle



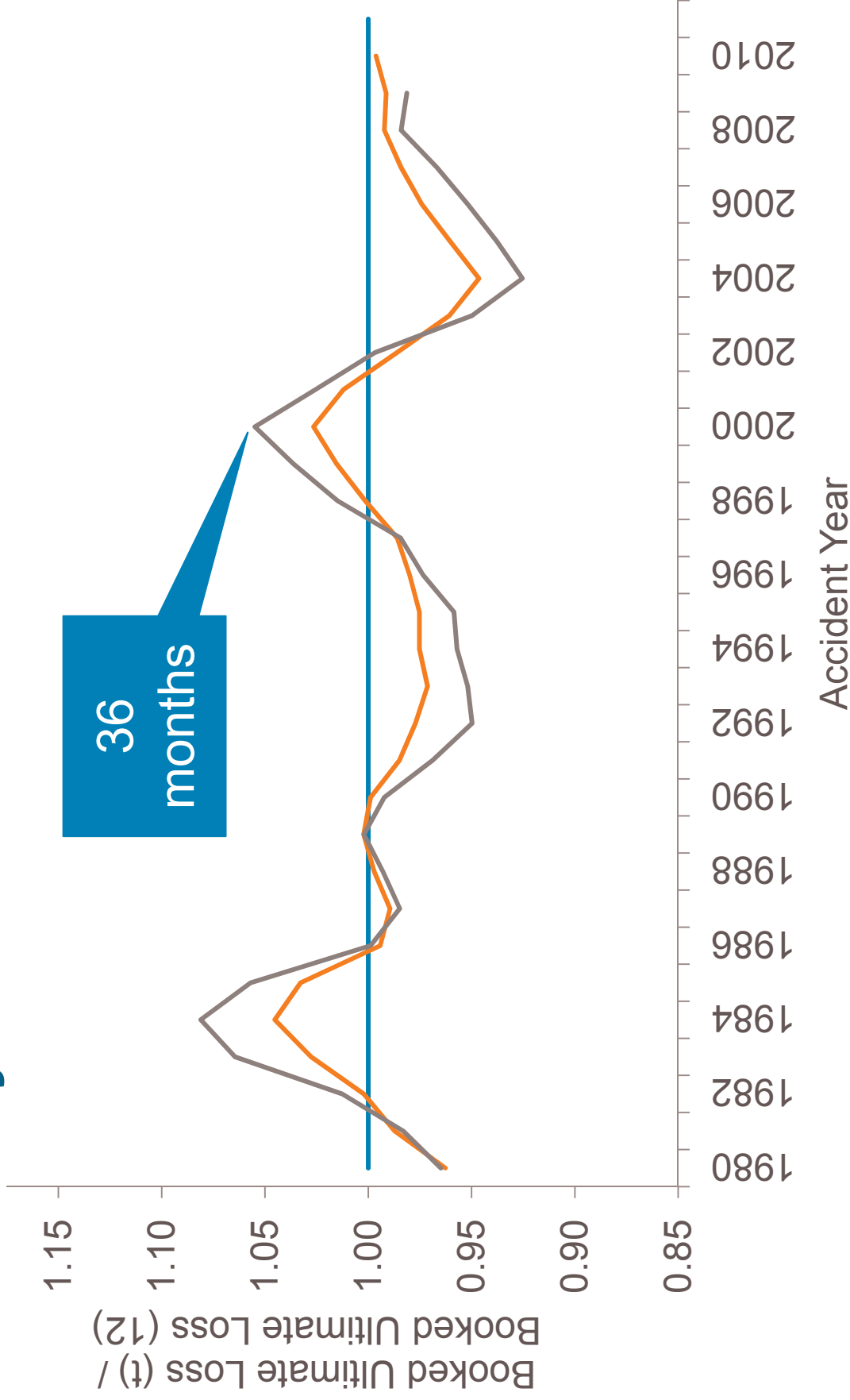
Sum of: Private Passenger Auto, Comm Auto Liab, CMP, Homeowners, Med Prof Liab, Other Liab, Products Liab, WC. Data to 12/2009 is from cleaned Schedule P database from Guy Carpenter & Risk Lighthouse (representing more than 95% of the industry), and updated for 12/2010 & 12/2011 financials using SNL and subject to change.

# Reserve Cycle



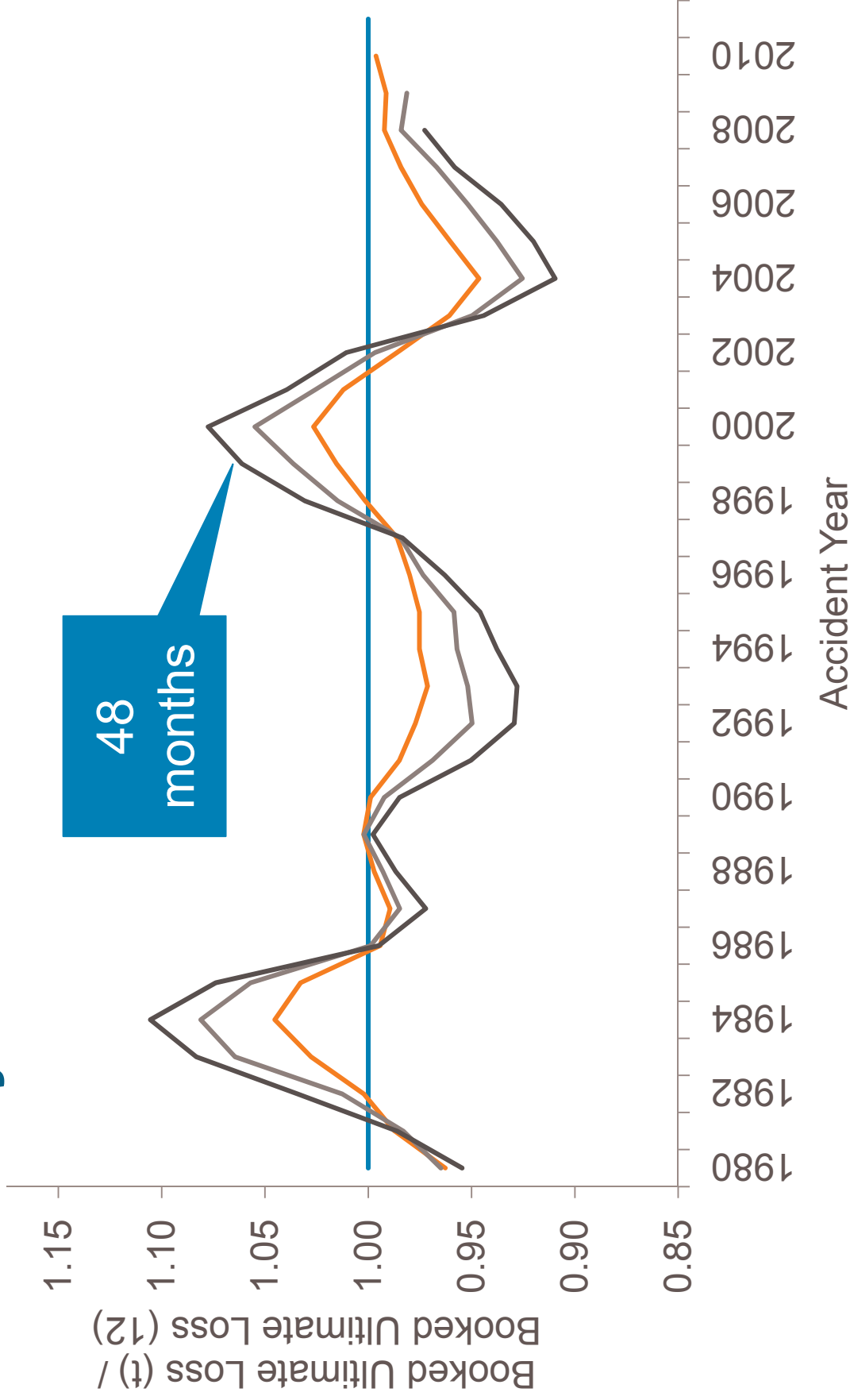
Sum of: Private Passenger Auto, Comm Auto Liab, CMP, Homeowners, Med Prof Liab, Other Liab, Products Liab, WC. Data to 12/2009 is from cleaned Schedule P database from Guy Carpenter & Risk Lighthouse (representing more than 95% of the industry), and updated for 12/2010 & 12/2011 financials using SNL and subject to change.

# Reserve Cycle



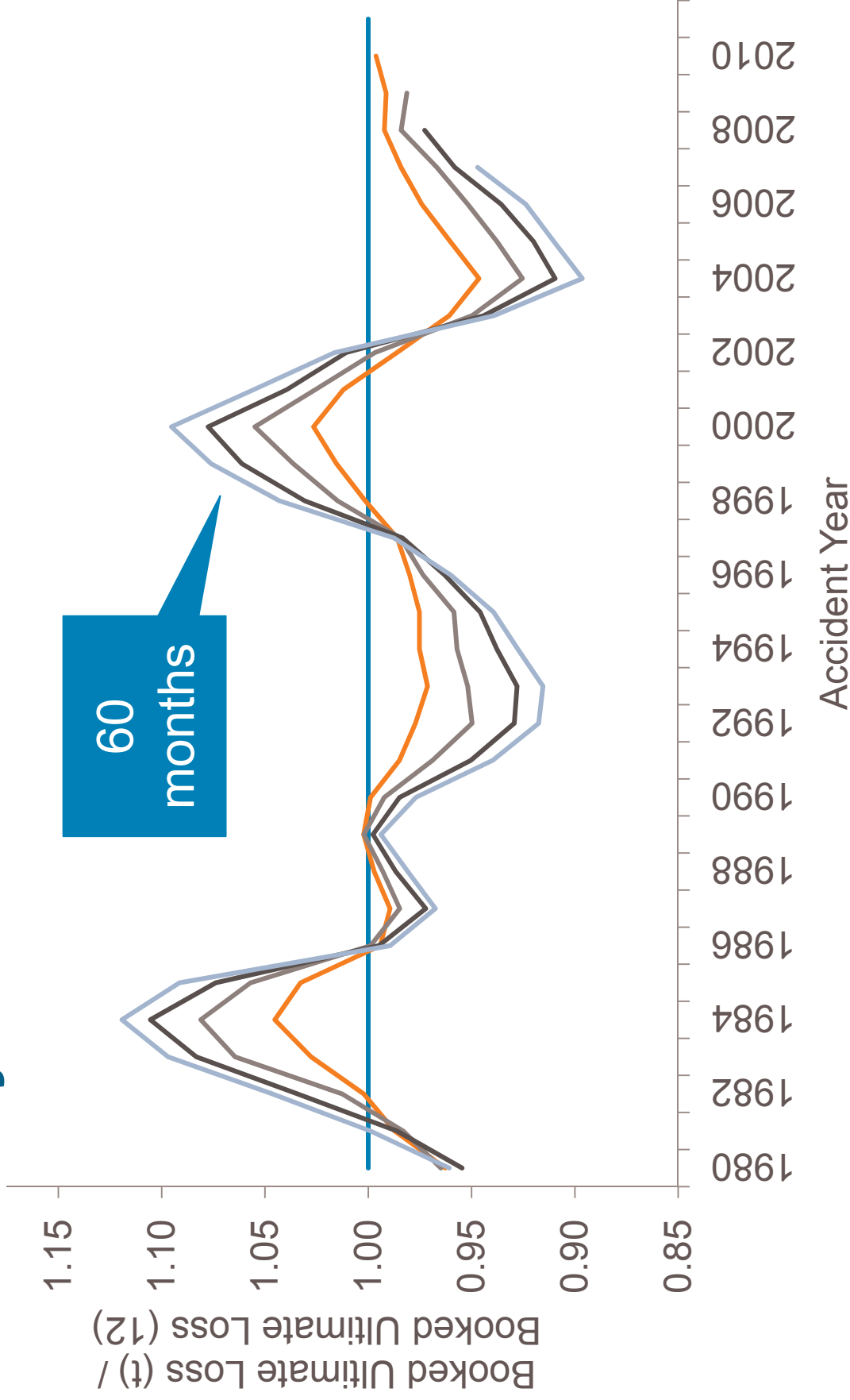
Sum of: Private Passenger Auto, Comm Auto Liab, CMP, Homeowners, Med Prof Liab, Other Liab, Products Liab, WC. Data to 12/2009 is from cleaned Schedule P database from Guy Carpenter & Risk Lighthouse (representing more than 95% of the industry), and updated for 12/2010 & 12/2011 financials using SNL and subject to change.

# Reserve Cycle



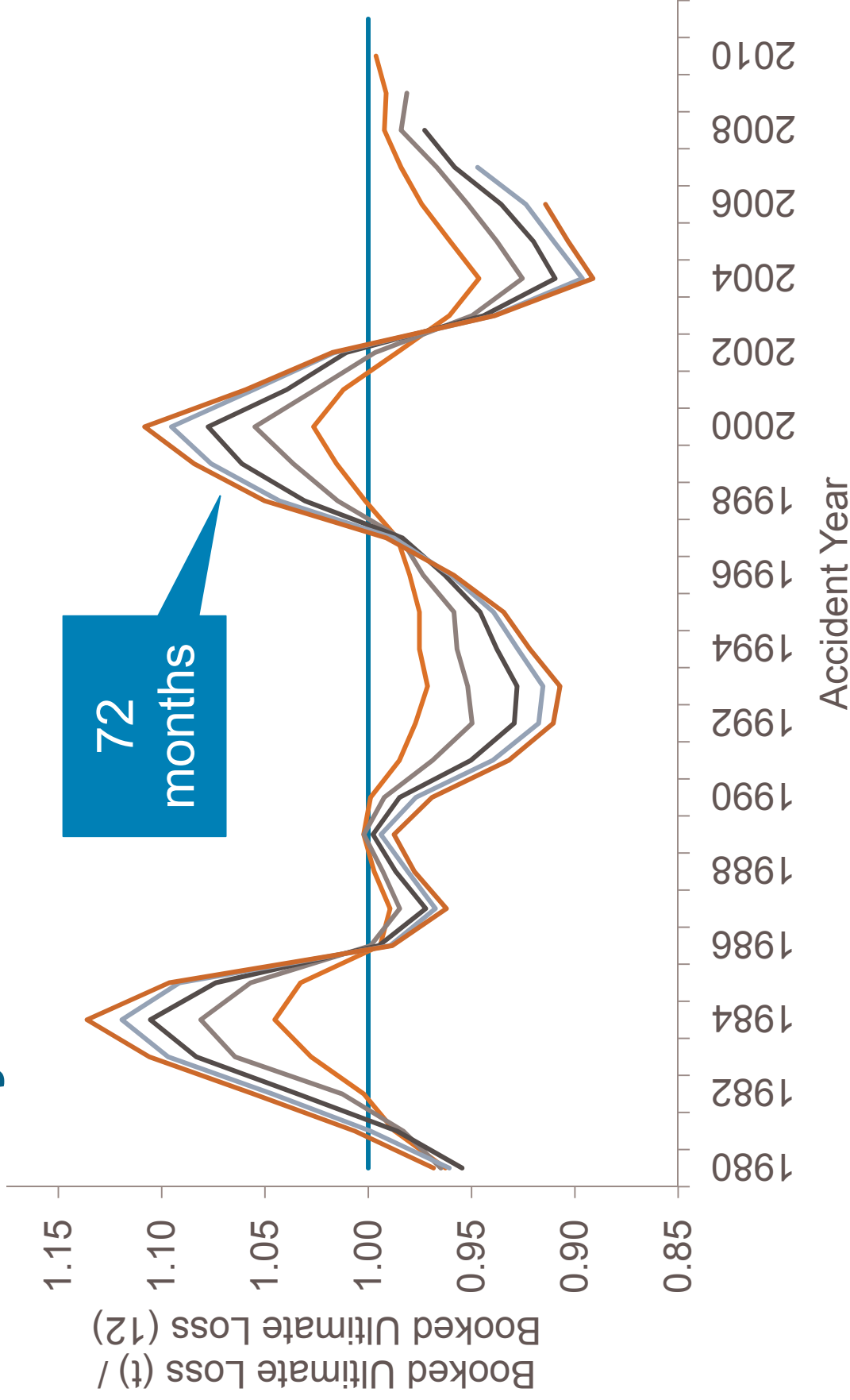
Sum of: Private Passenger Auto, Comm Auto Liab, CMP, Homeowners, Med Prof Liab, Other Liab, Products Liab, WC. Data to 12/2009 is from cleaned Schedule P database from Guy Carpenter & Risk Lighthouse (representing more than 95% of the industry), and updated for 12/2010 & 12/2011 financials using SNL and subject to change.

# Reserve Cycle



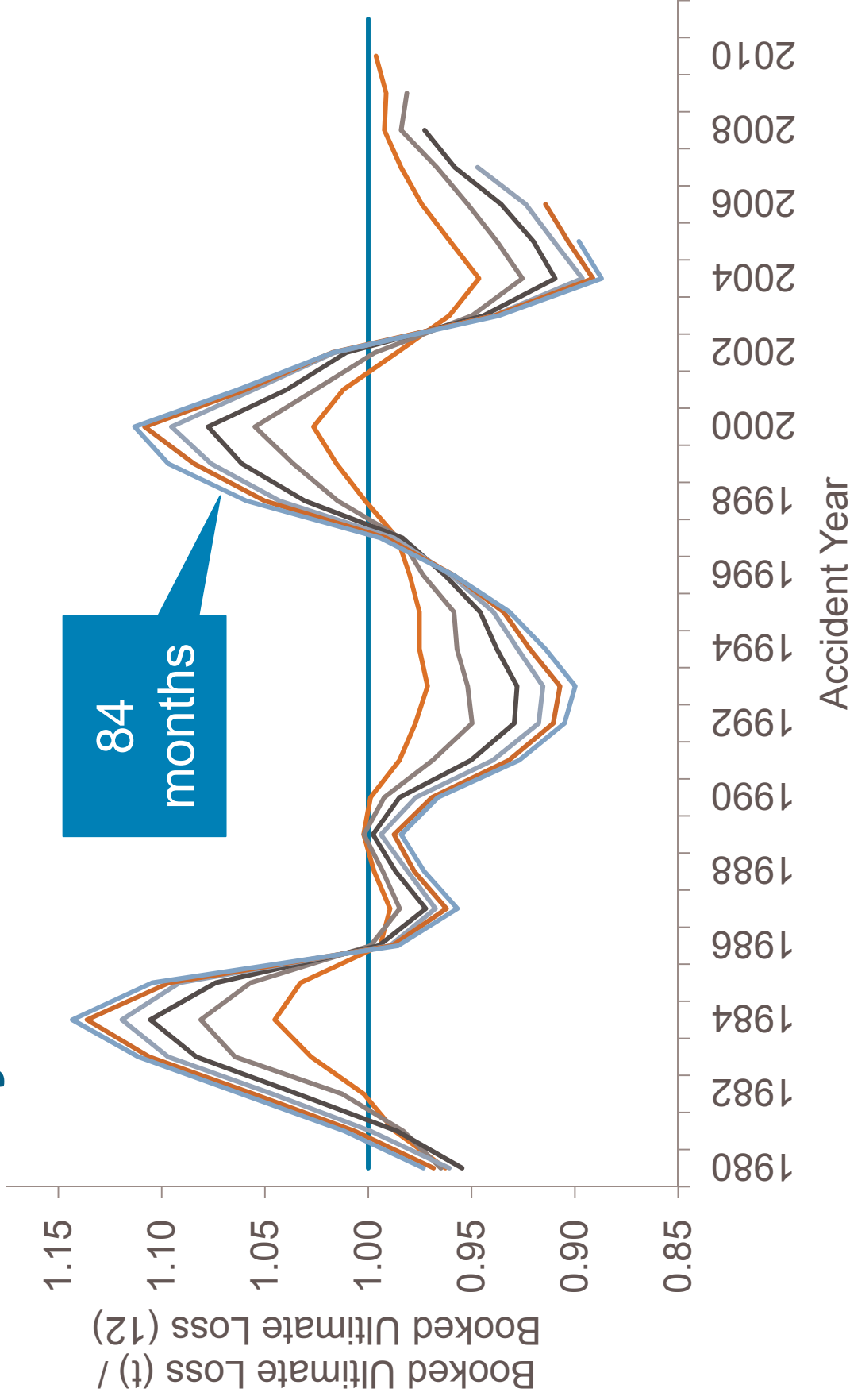
Sum of: Private Passenger Auto, Comm Auto Liab, CMP, Homeowners, Med Prof Liab, Other Liab, Products Liab, WC. Data to 12/2009 is from cleaned Schedule P database from Guy Carpenter & Risk Lighthouse (representing more than 95% of the industry), and updated for 12/2010 & 12/2011 financials using SNL and subject to change.

# Reserve Cycle



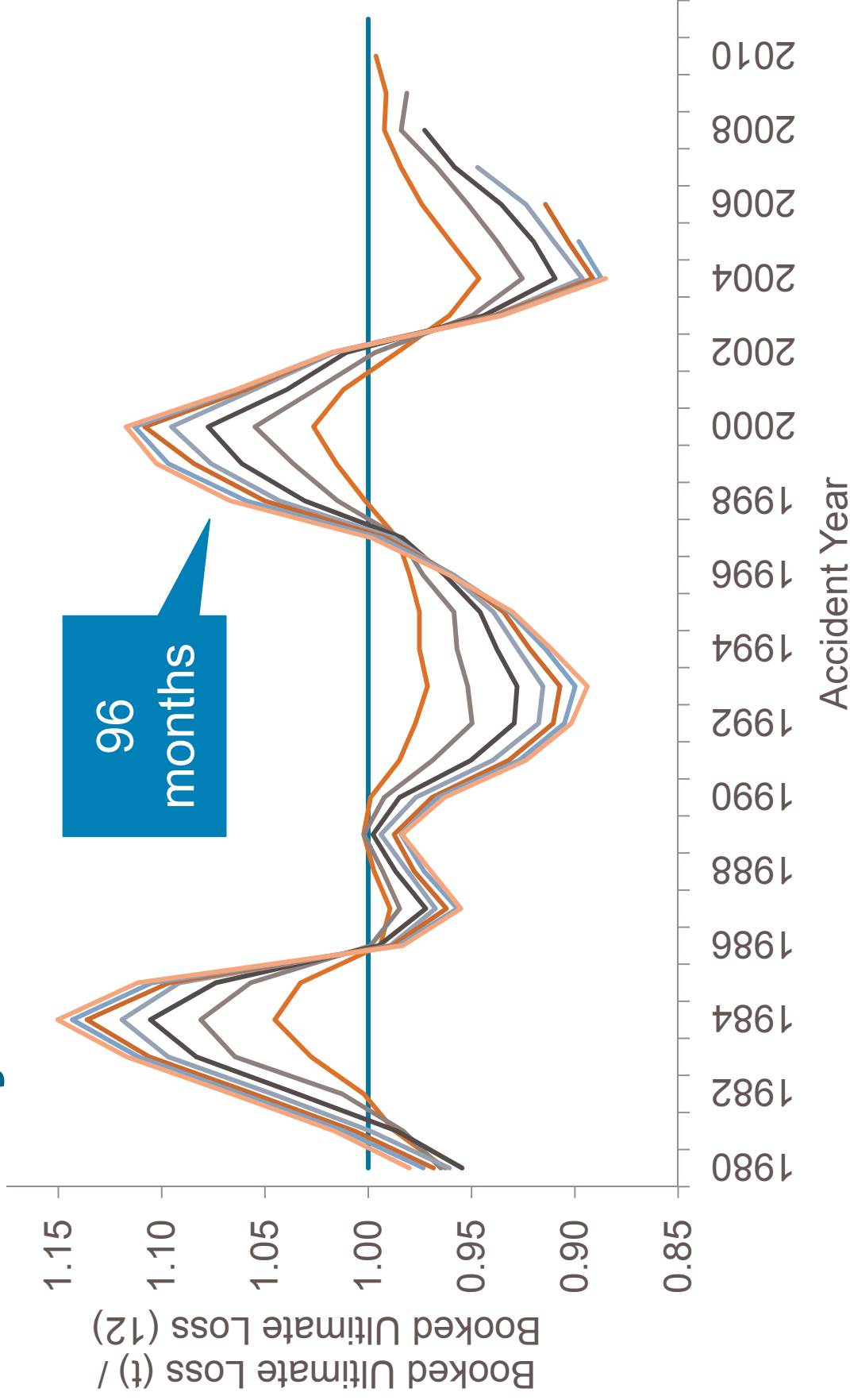
Sum of: Private Passenger Auto, Comm Auto Liab, CMP, Homeowners, Med Prof Liab, Other Liab, Products Liab, WC. Data to 12/2009 is from cleaned Schedule P database from Guy Carpenter & Risk Lighthouse (representing more than 95% of the industry), and updated for 12/2010 & 12/2011 financials using SNL and subject to change.

# Reserve Cycle



Sum of: Private Passenger Auto, Comm Auto Liab, CMP, Homeowners, Med Prof Liab, Other Liab, Products Liab, WC. Data to 12/2009 is from cleaned Schedule P database from Guy Carpenter & Risk Lighthouse (representing more than 95% of the industry), and updated for 12/2010 & 12/2011 financials using SNL and subject to change.

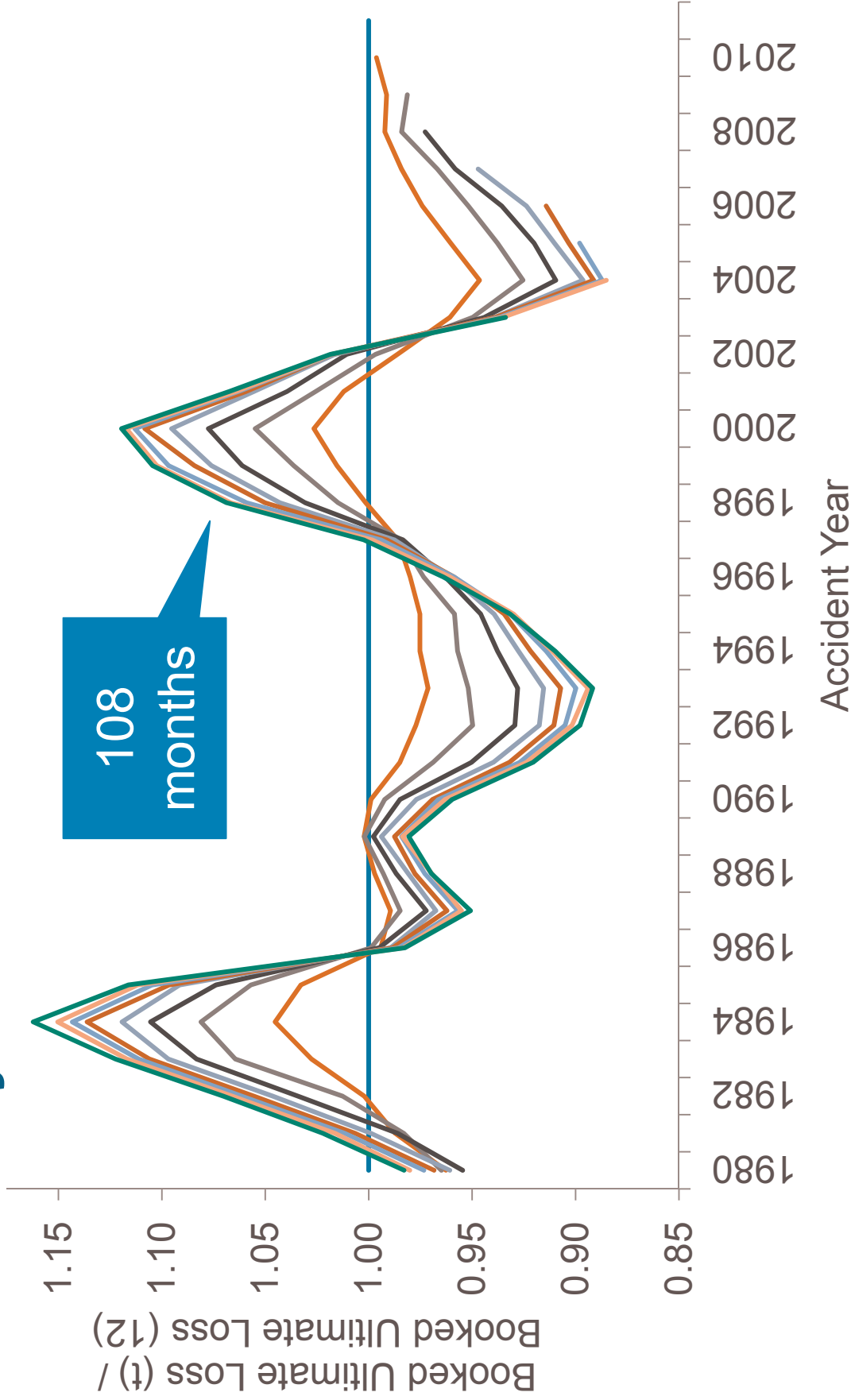
# Reserve Cycle



Sum of: Private Passenger Auto, Comm Auto Liab, CMP, Homeowners, Med Prof Liab, Other Liab, Products Liab, WC. Data to 12/2009 is from cleaned Schedule P database from Guy Carpenter & Risk Lighthouse (representing more than 95% of the industry), and updated for 12/2010 & 12/2011 financials using SNL and subject to change.

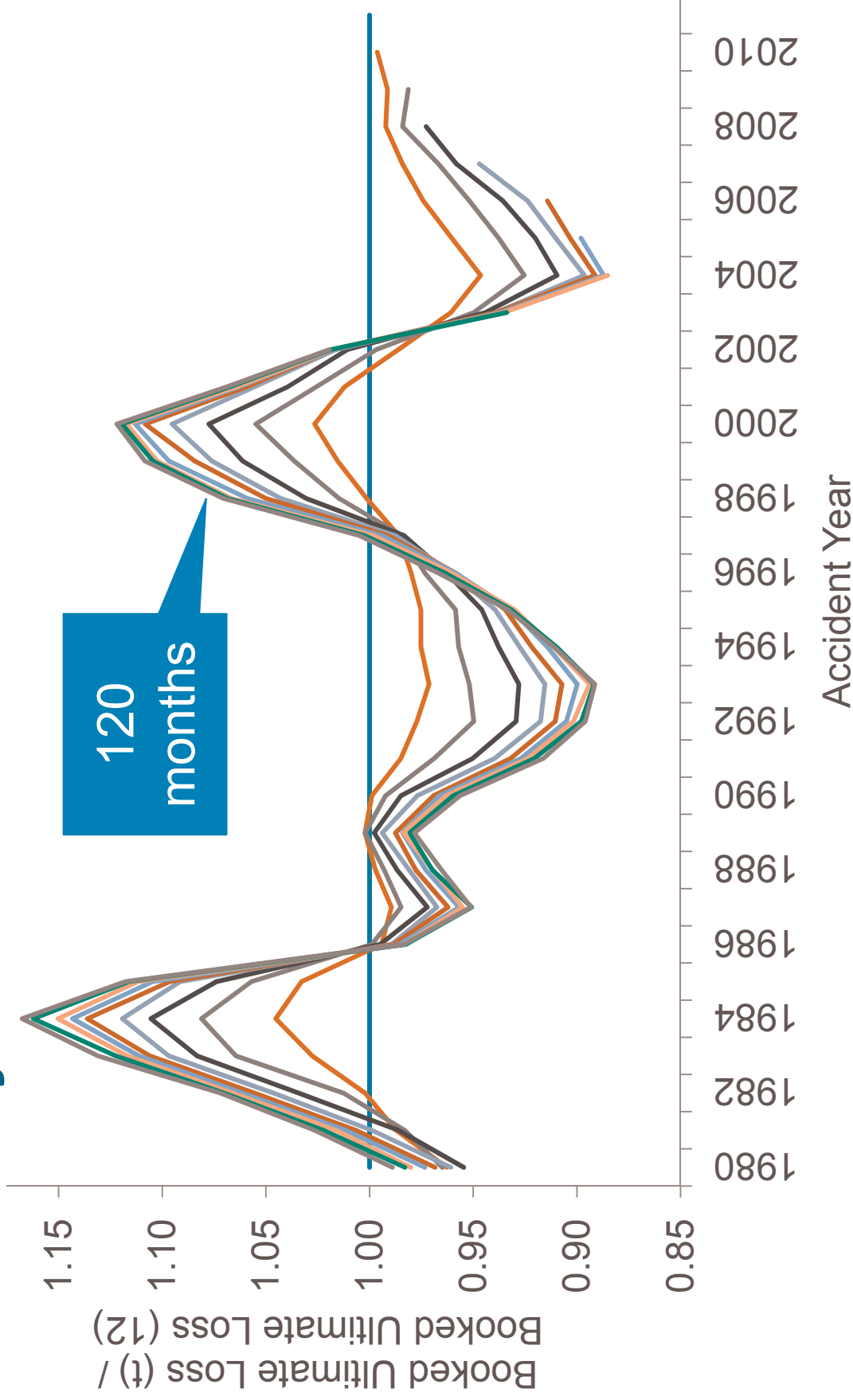


# Reserve Cycle



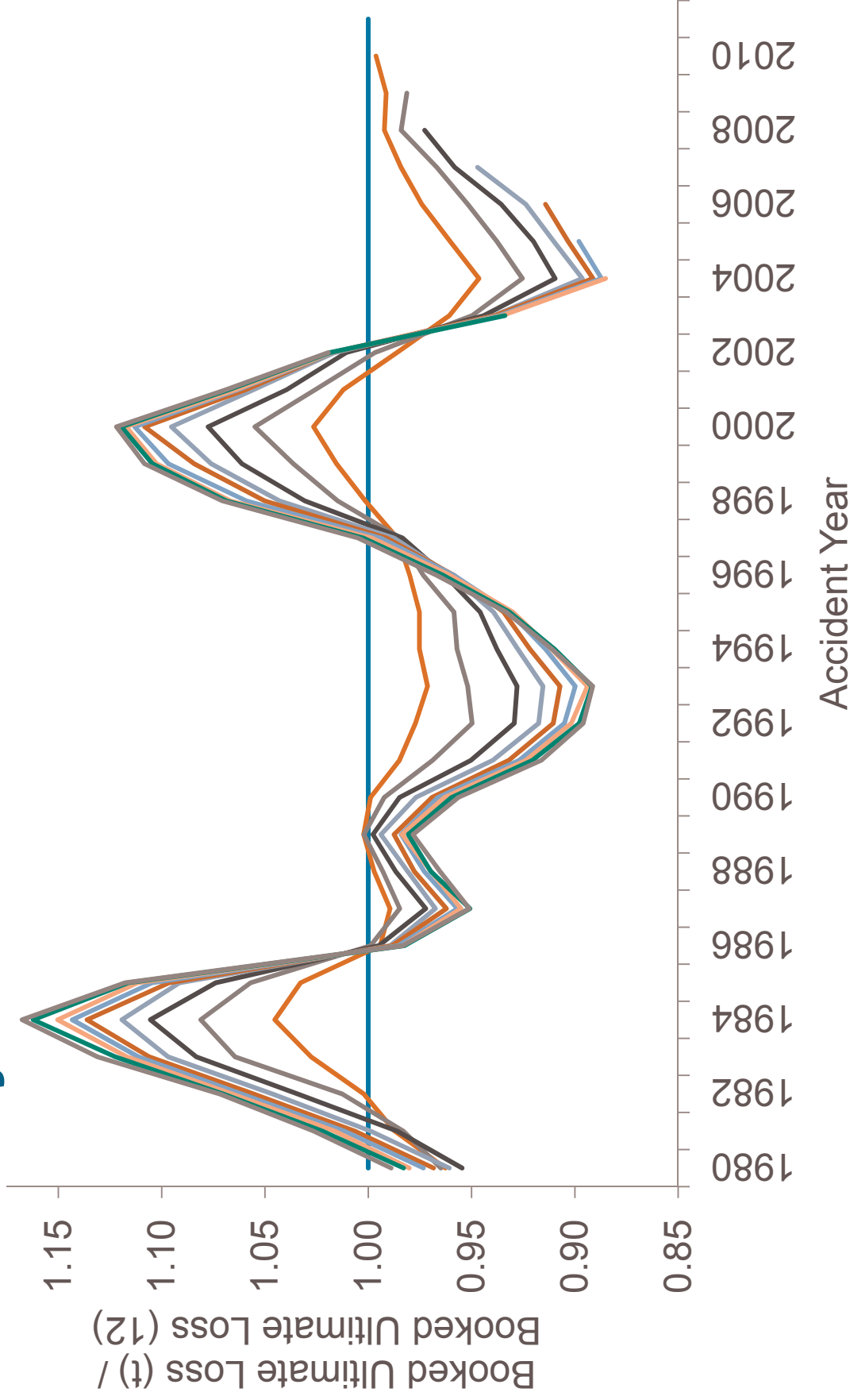
Sum of: Private Passenger Auto, Comm Auto Liab, CMP, Homeowners, Med Prof Liab, Other Liab, Products Liab, WC. Data to 12/2009 is from cleaned Schedule P database from Guy Carpenter & Risk Lighthouse (representing more than 95% of the industry), and updated for 12/2010 & 12/2011 financials using SNL and subject to change.

# Reserve Cycle



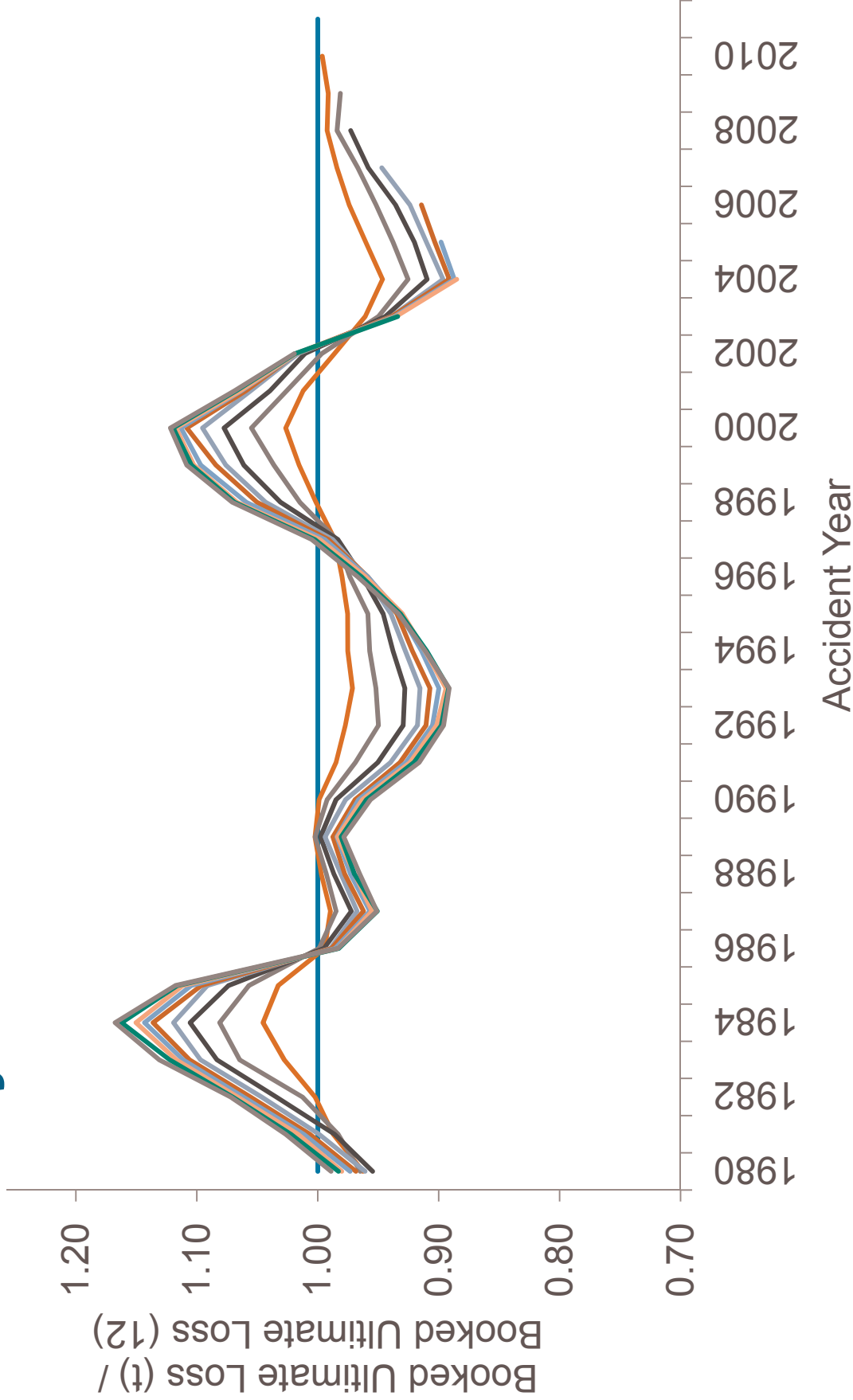
Sum of: Private Passenger Auto, Comm Auto Liab, CMP, Homeowners, Med Prof Liab, Other Liab, Products Liab, WC. Data to 12/2009 is from cleaned Schedule P database from Guy Carpenter & Risk Lighthouse (representing more than 95% of the industry), and updated for 12/2010 & 12/2011 financials using SNL and subject to change.

# Reserve Cycle



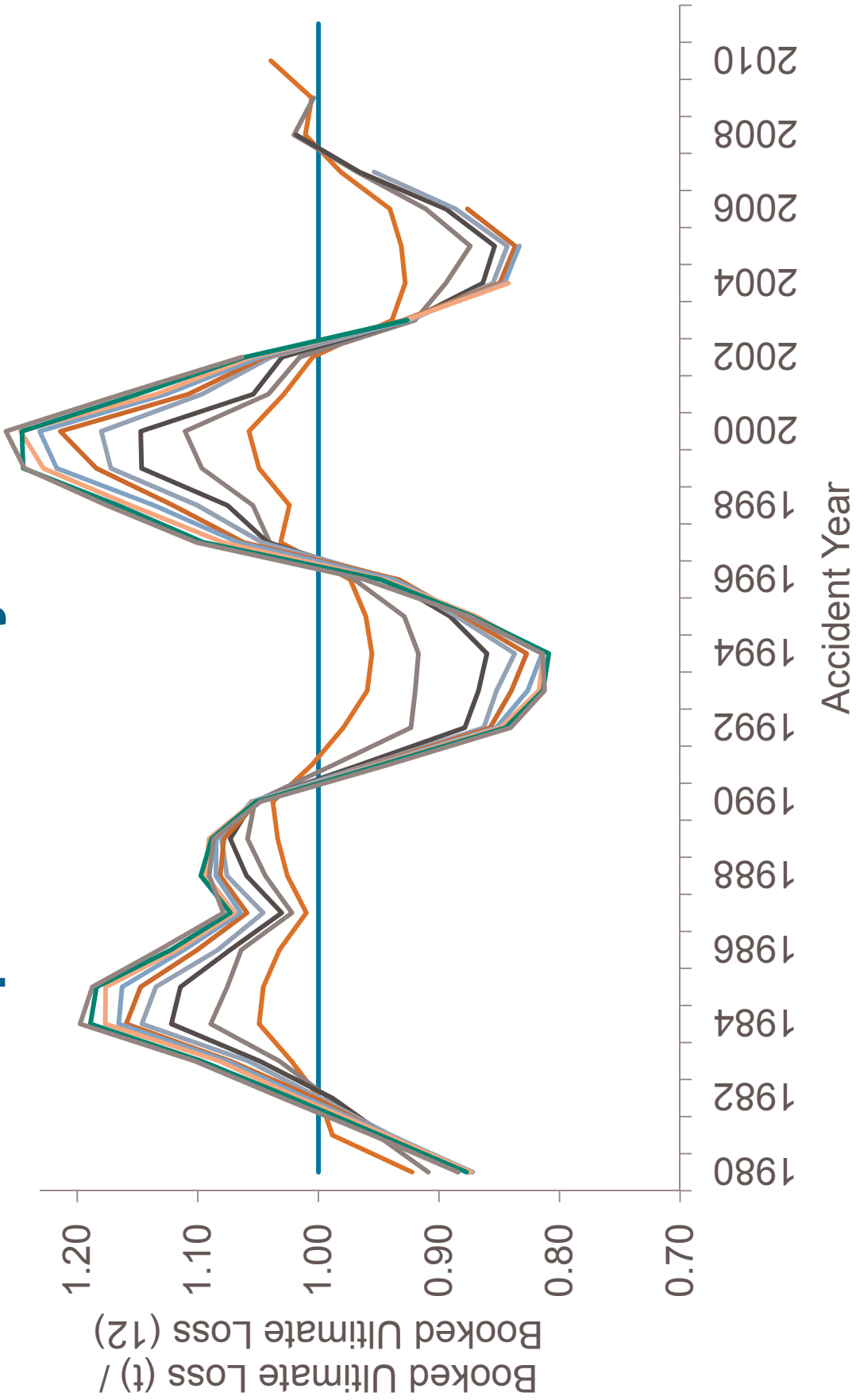
Sum of: Private Passenger Auto, Comm Auto Liab, CMP, Homeowners, Med Prof Liab, Other Liab, Products Liab, WC. Data to 12/2009 is from cleaned Schedule P database from Guy Carpenter & Risk Lighthouse (representing more than 95% of the industry), and updated for 12/2010 & 12/2011 financials using SNL and subject to change.

# Reserve Cycle



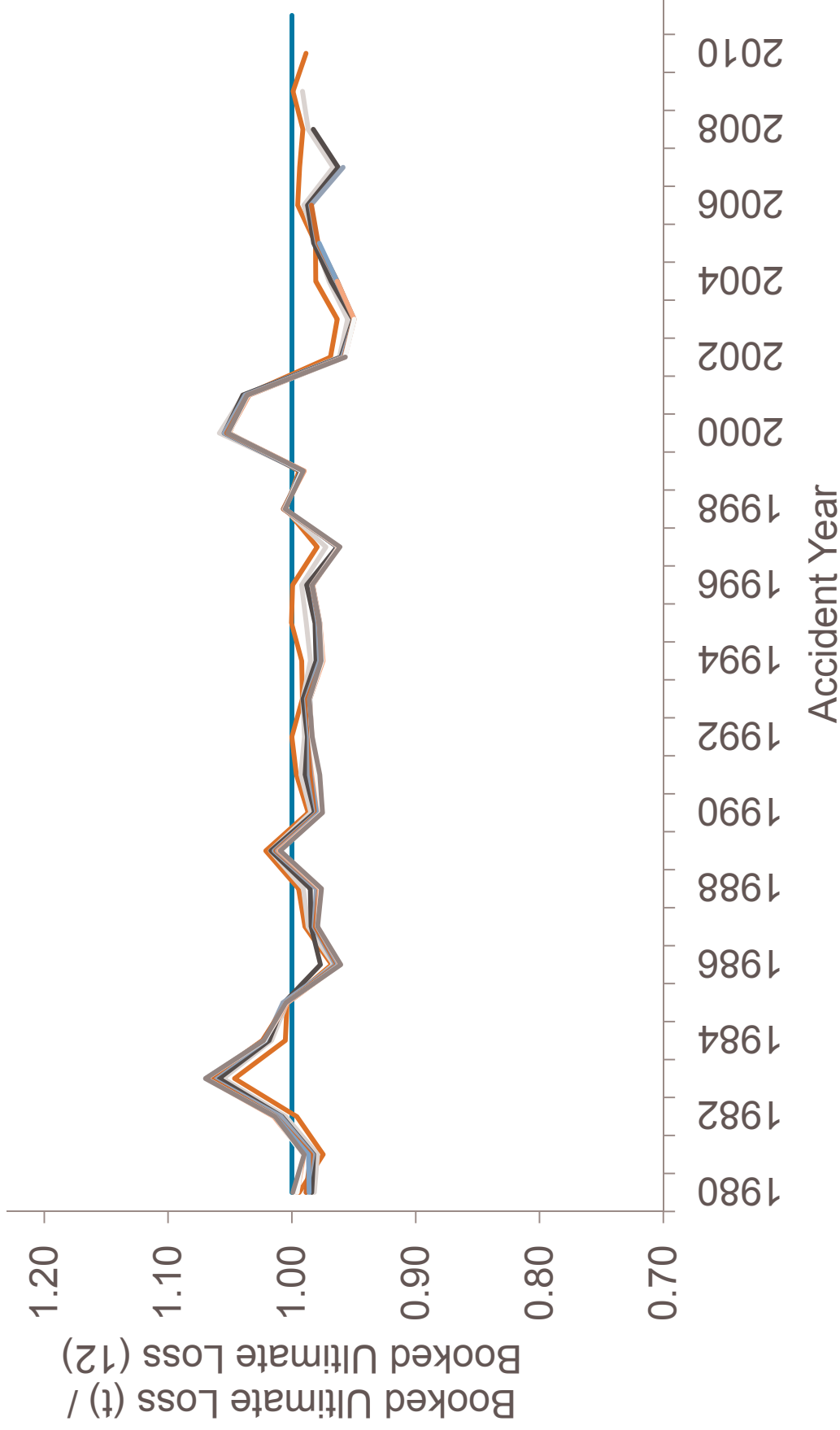
Sum of: Private Passenger Auto, Comm Auto Liab, CMP, Homeowners, Med Prof Liab, Other Liab, Products Liab, WC. Data to 12/2009 is from cleaned Schedule P database from Guy Carpenter & Risk Lighthouse (representing more than 95% of the industry), and updated for 12/2010 & 12/2011 financials using SNL and subject to change.

# Workers Compensation Cycle



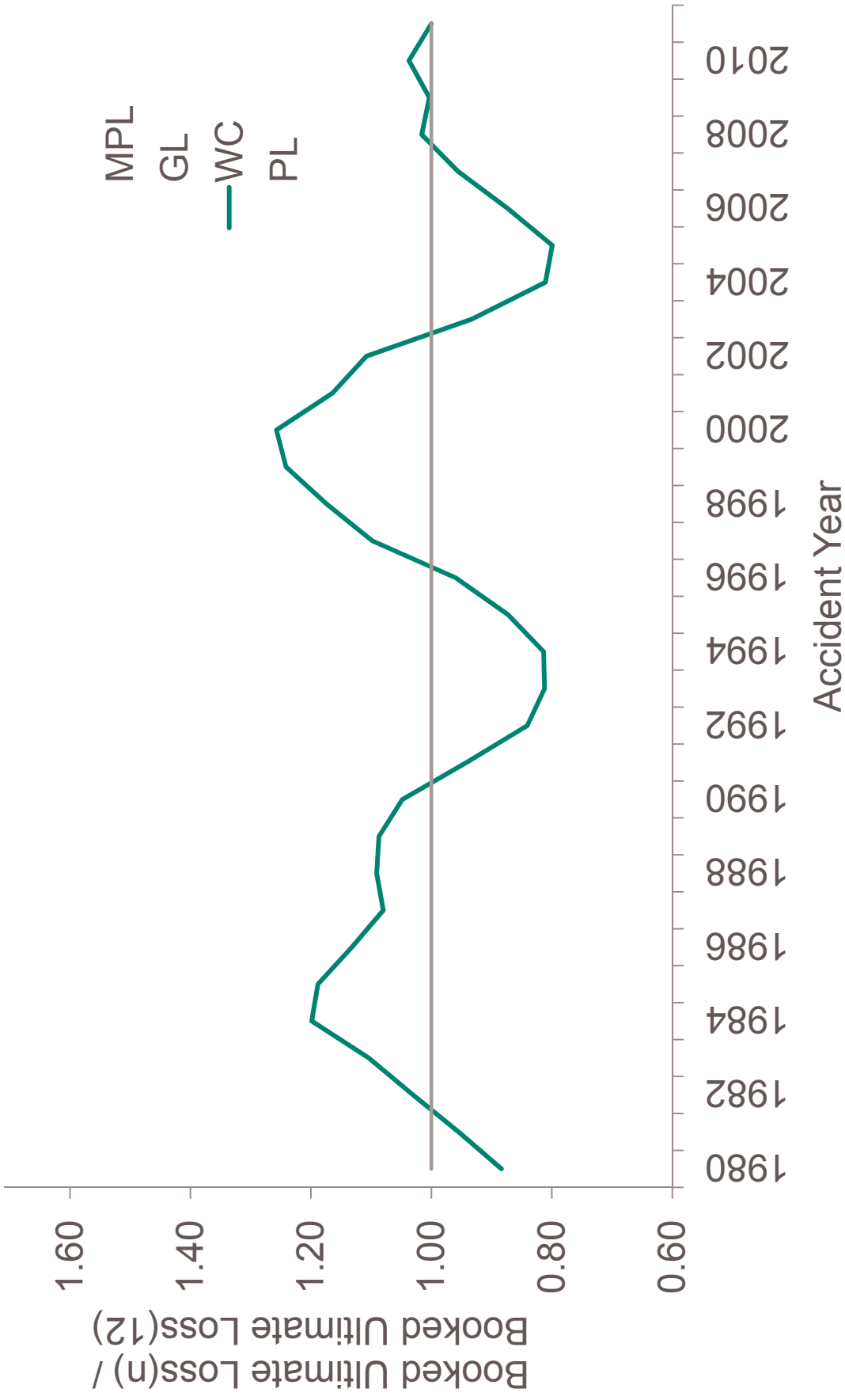
Data is from cleaned Schedule P database from Guy Carpenter and Risk Lighthouse

# Homeowners Cycle

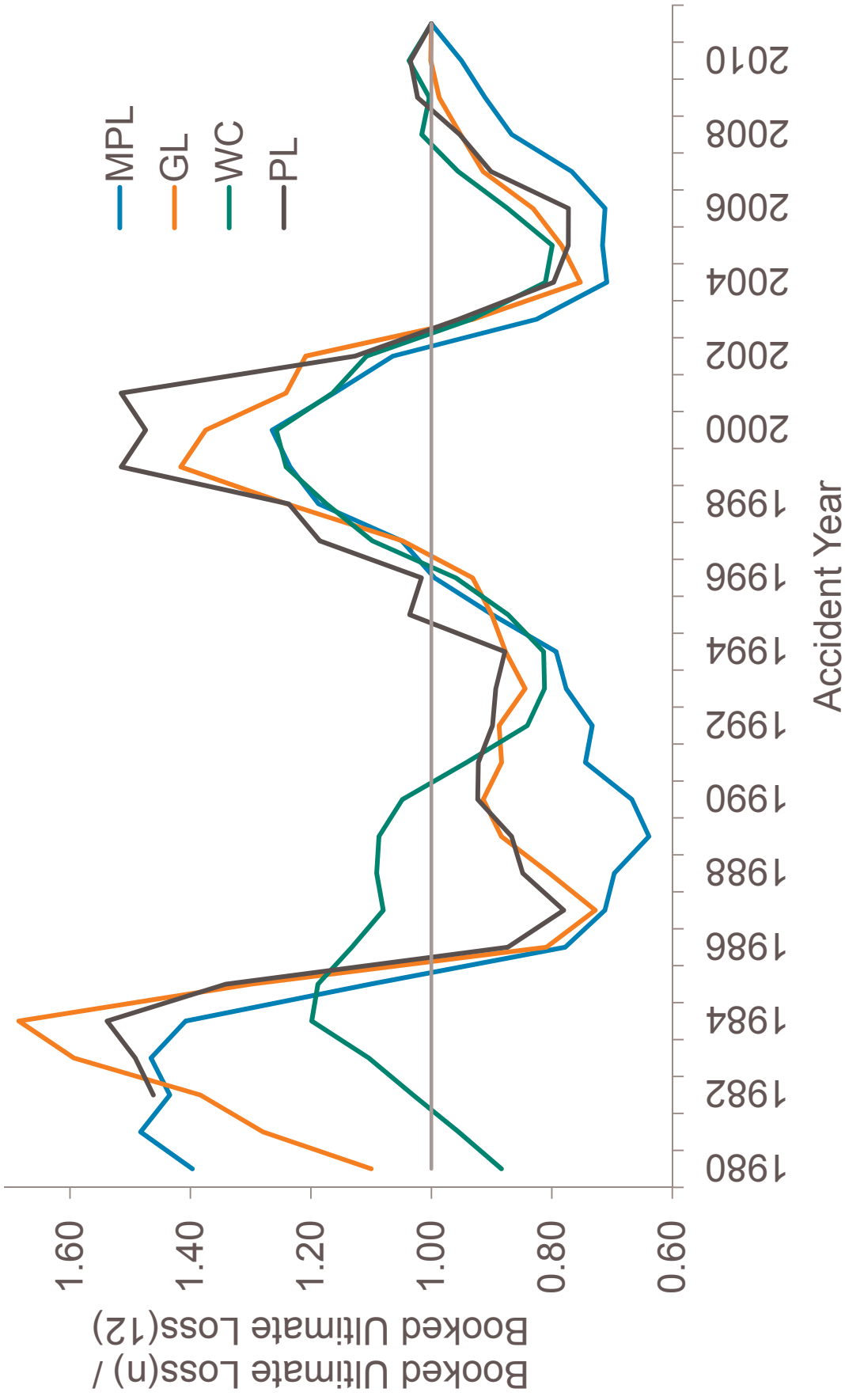


Data is from cleaned Schedule P database from Guy Carpenter and Risk Lighthouse

# Cycles by line of business

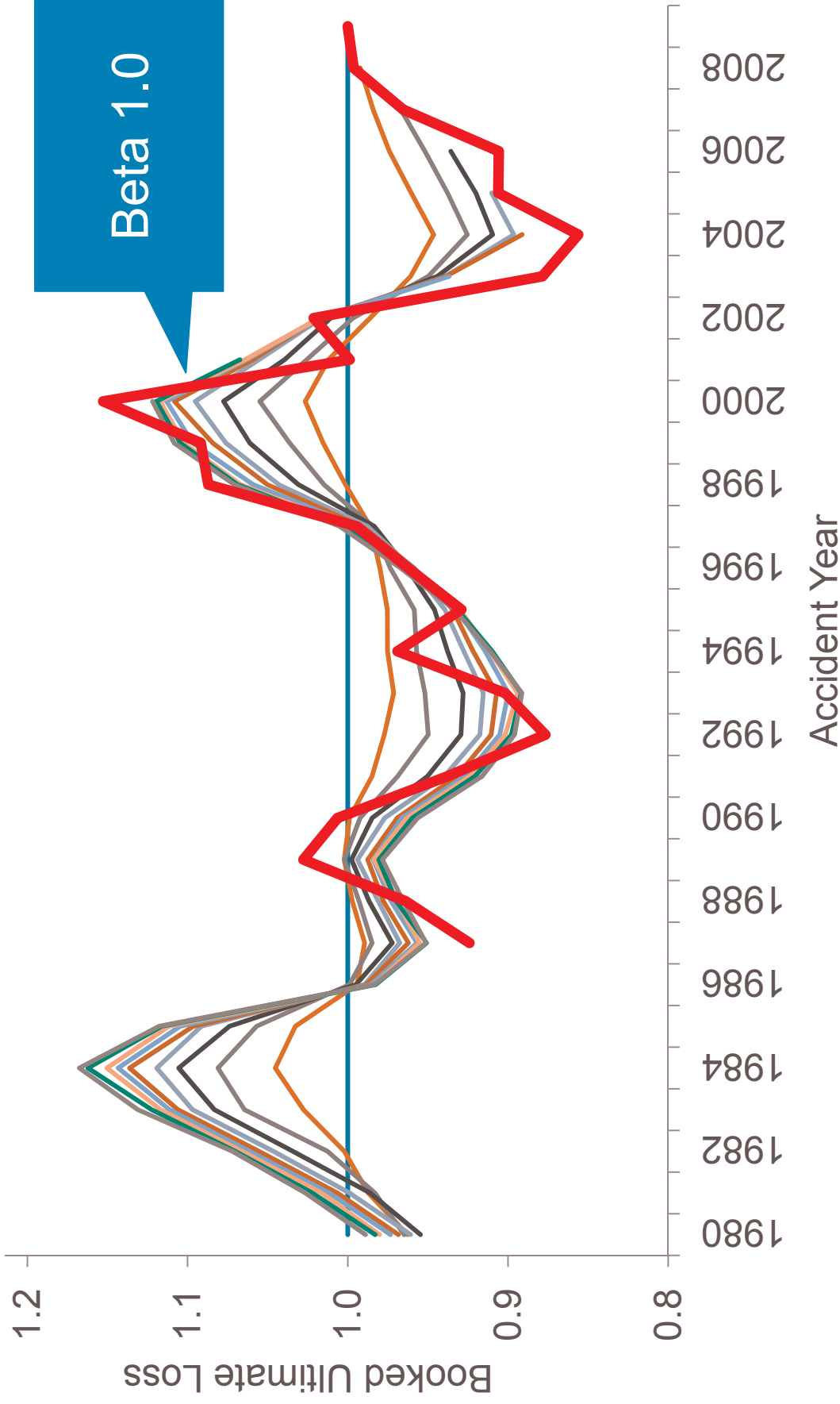


# Cycles by line of business



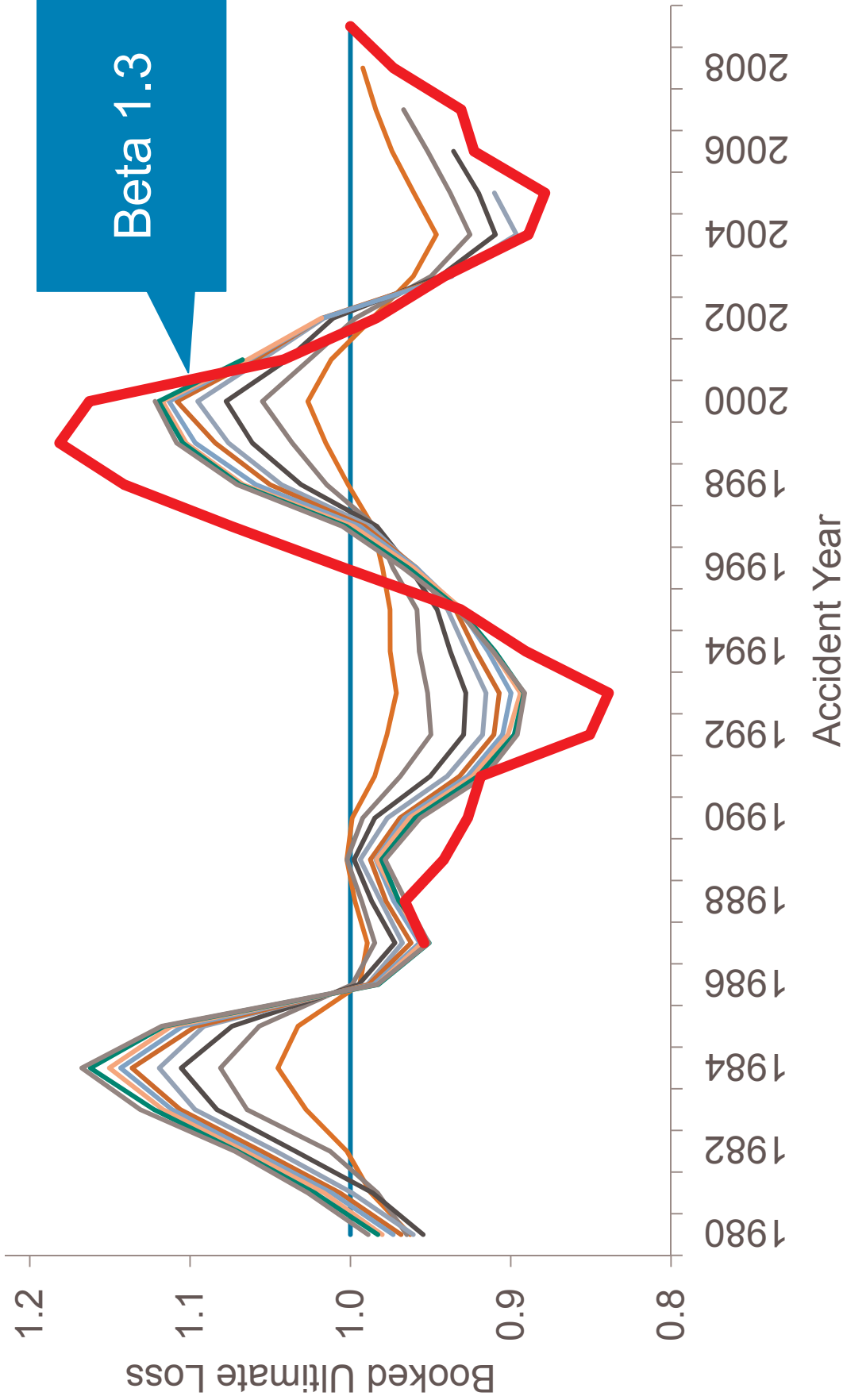


# Reserve Cycle – Company A



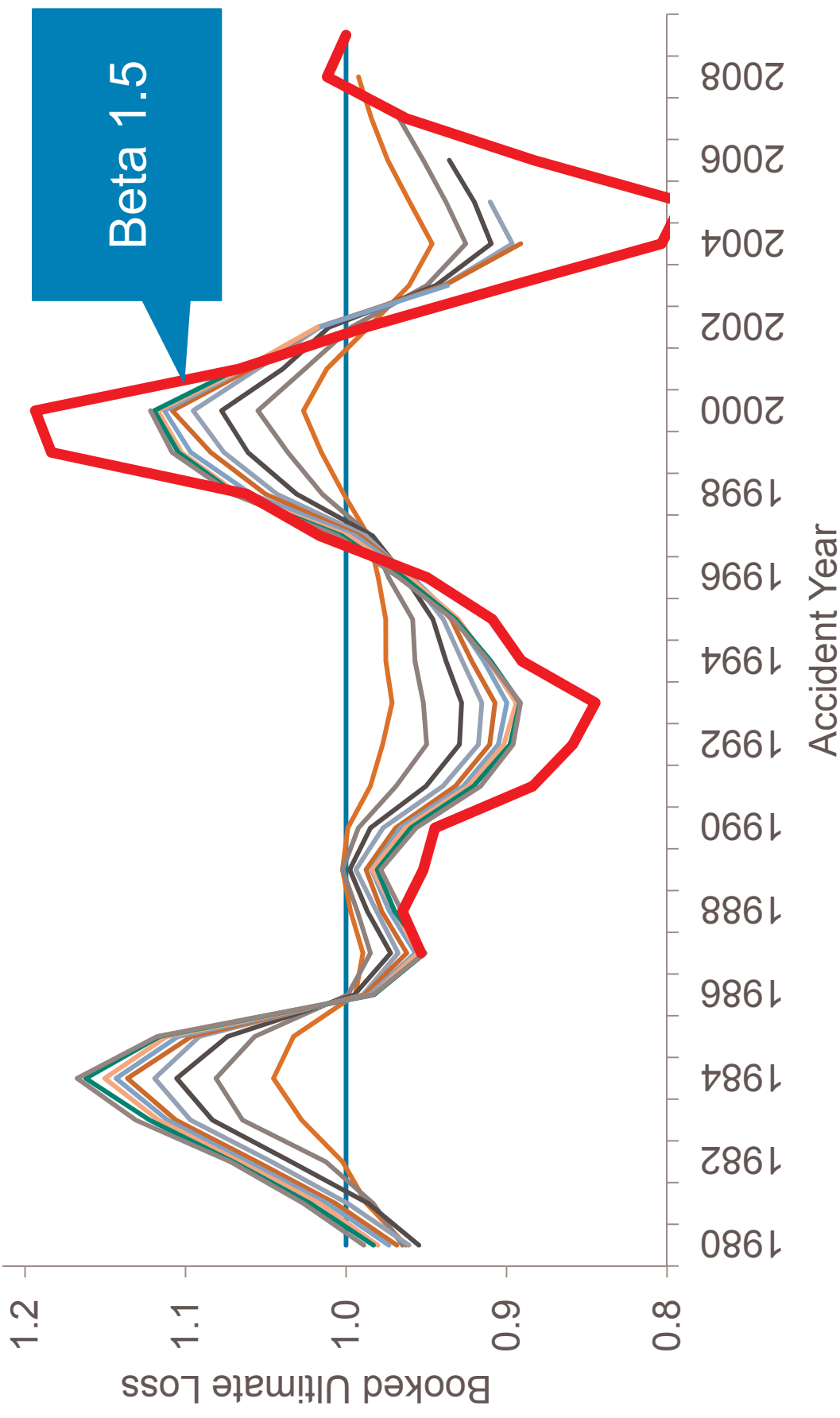
Sum of: Priv Pass Auto, Comm Auto Liab, CMP, Home, Med Prof Liab, Other Liab, Prod Liab, WC. Data to 12/2009 is from cleaned Schedule P database from Guy Carpenter & Risk Lighthouse (representing more than 95% of the industry) Red line = company's booked ultimate loss & ALAE at 120 months / at 12 months where possible.

# Reserve Cycle – Company B



Sum of: Priv Pass Auto, Comm Auto Liab, CMP, Home, Med Prof Liab, Other Liab, Prod Liab, WC. Data to 12/2009 is from cleaned Schedule P database from Guy Carpenter & Risk Lighthouse (representing more than 95% of the industry) Red line = company's booked ultimate loss & ALAE at 120 months / at 12 months where possible.

# Reserve Cycle – Company C



Sum of: Priv Pass Auto, Comm Auto Liab, CMP, Home, Med Prof Liab, Other Liab, Prod Liab, WC. Data to 12/2009 is from cleaned Schedule P database from Guy Carpenter & Risk Lighthouse (representing more than 95% of the industry) Red line = company's booked ultimate loss & ALAE at 120 months / at 12 months where possible.

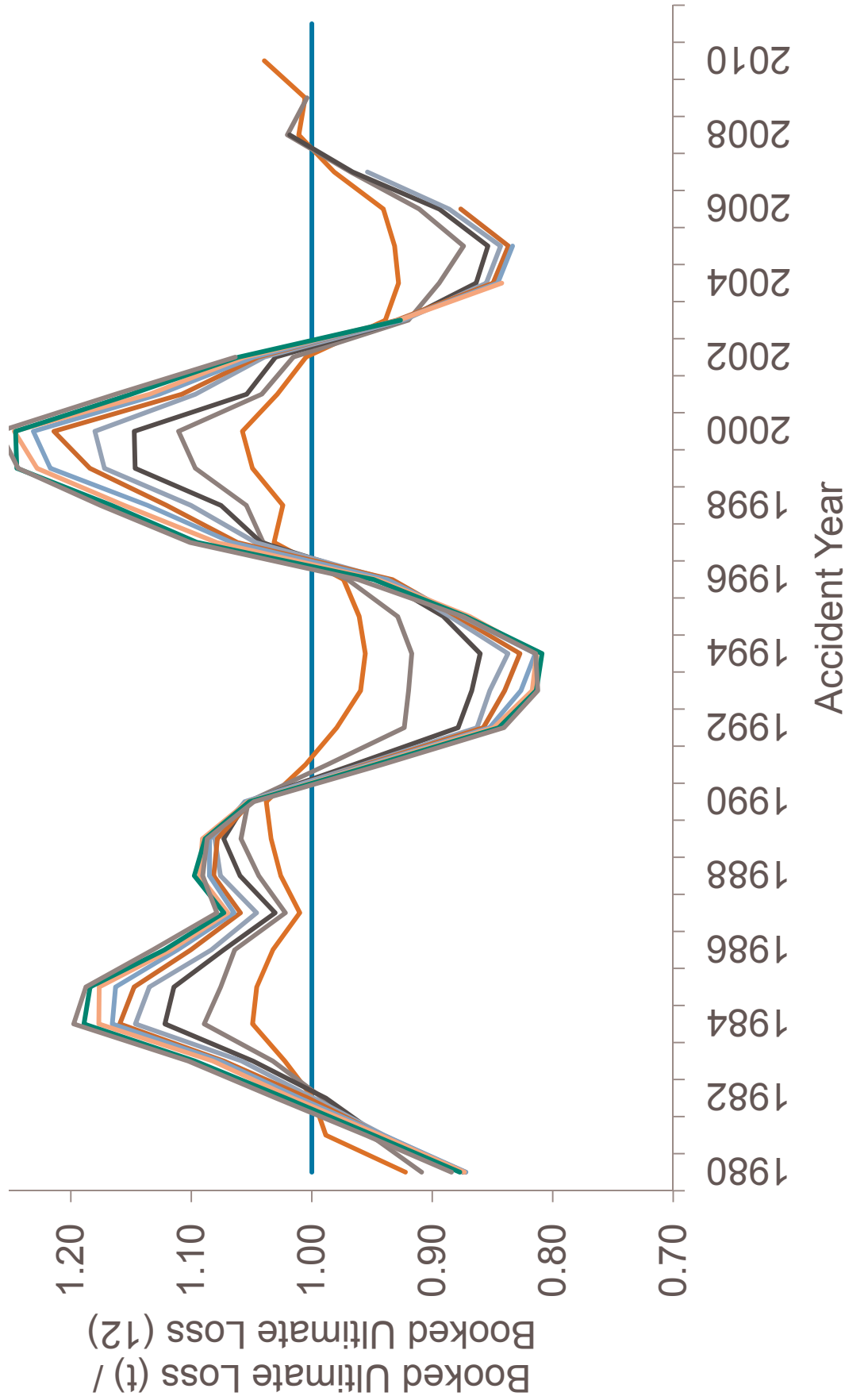
# Reserve Cycle – an analysis

1. Why do we have a cycle?
2. Do we need to break this cycle?

# Reserve Cycle – an analysis

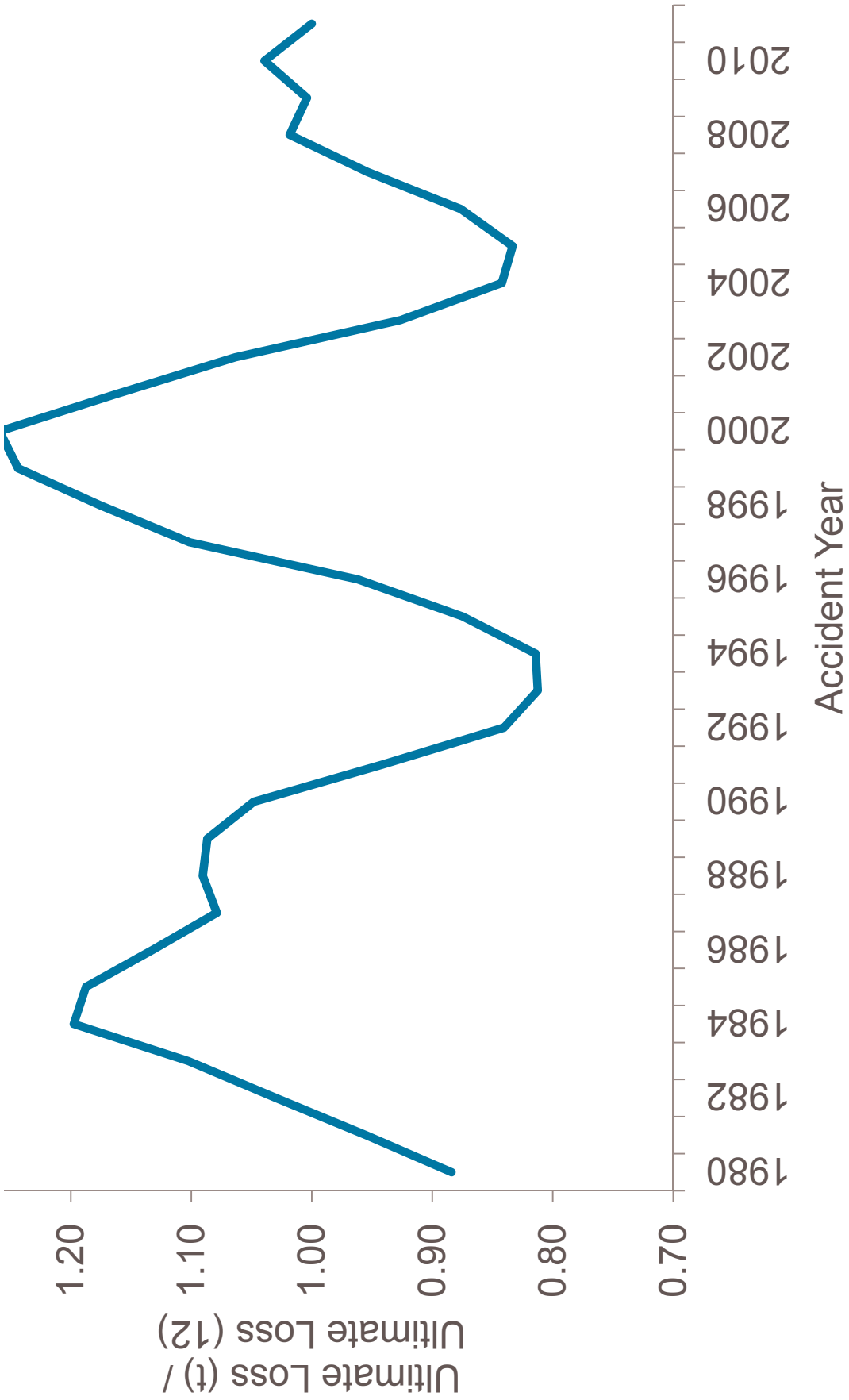
1. Why do we have a cycle?
2. Do we need to break this cycle?

# WC Cycle

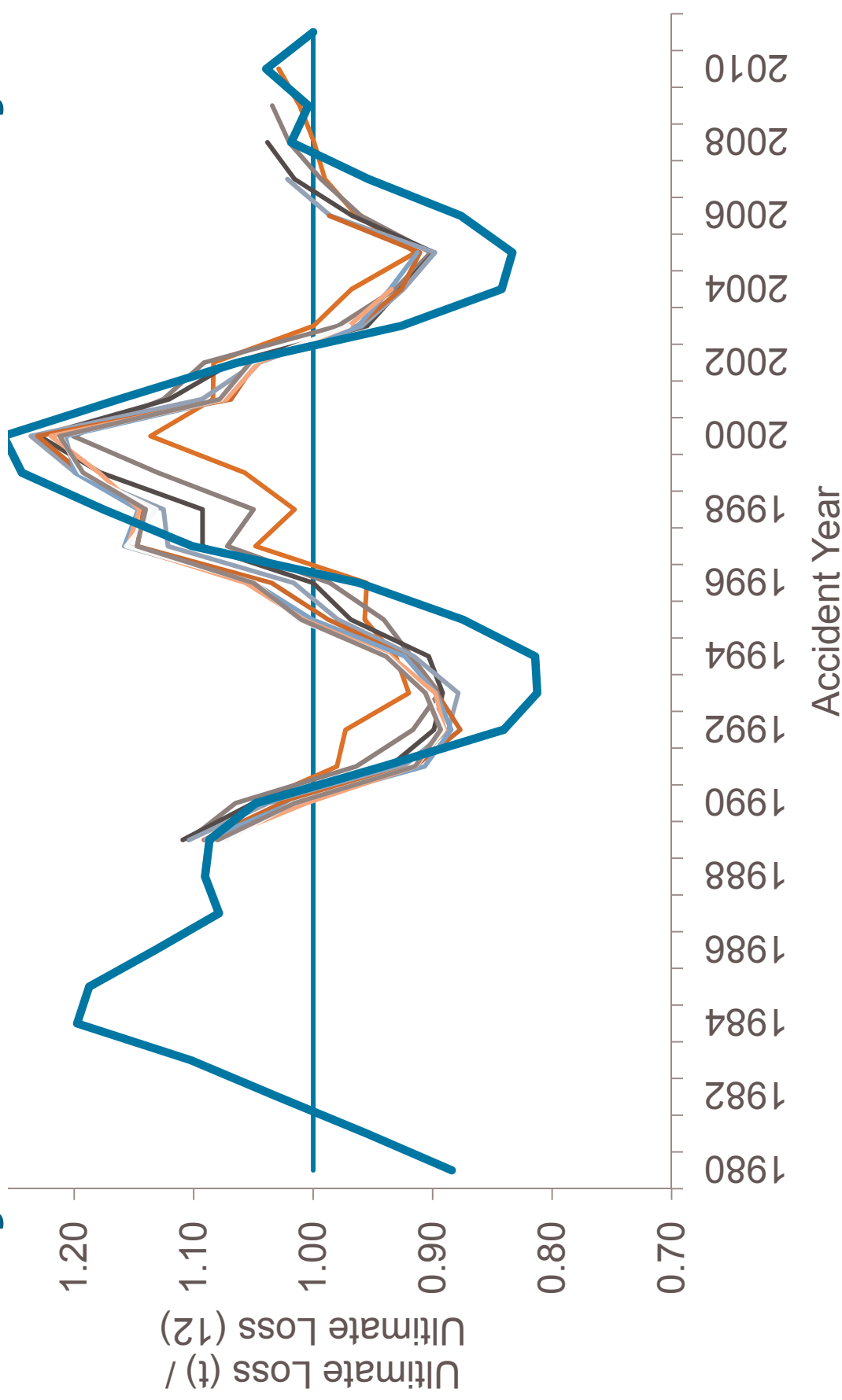


Data to 12/2009 is from cleaned Schedule P database from Risk Lighthouse, and updated for 12/2010 & 12/2011 financials using SNL and subject to change.

# WC Cycle outline



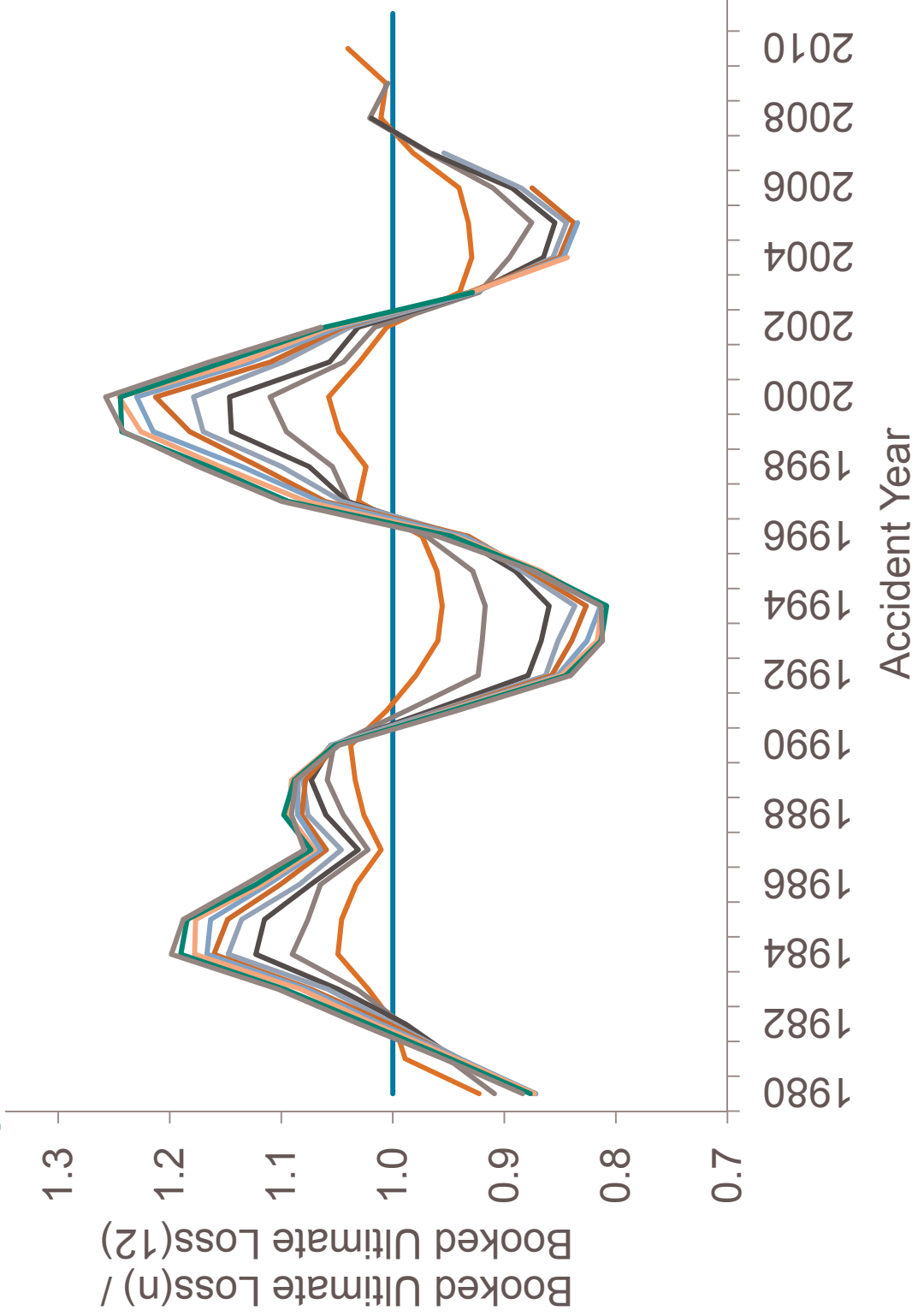
# WC Cycle outline + Incurred chain-ladder cycle



Incurred chain-ladder cycle uses an all year weighted average of 10x10 year Incurred Loss & ALAE triangles (paid + case reserve). Data to 12/2009 is from cleaned Schedule P database from Risk Lighthouse, and updated for 12/2010 & 12/2011 financials using SNL and subject to change.



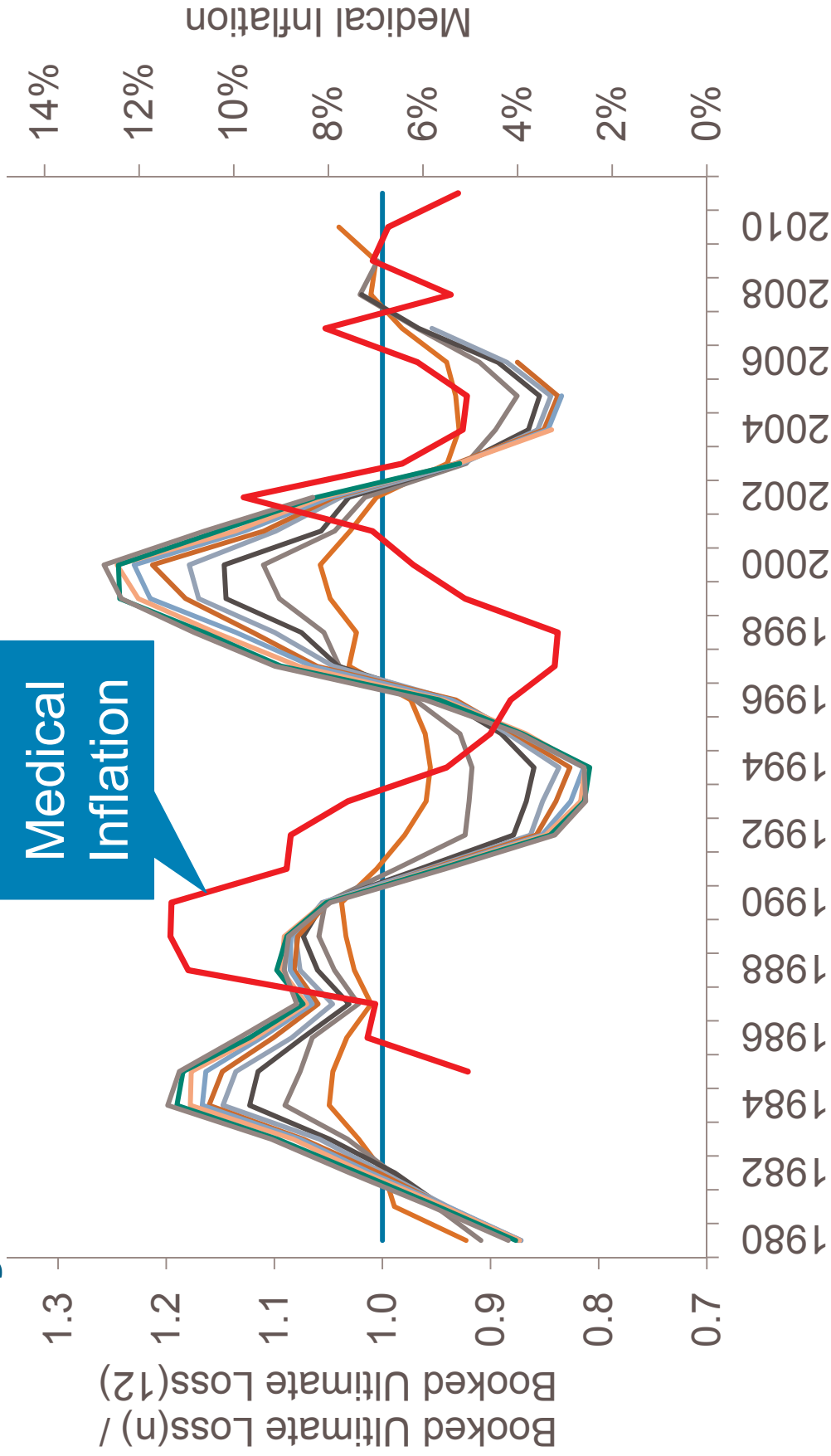
# WC Cycle + Medical Inflation



Cycle data is from cleaned Schedule P database from the Guy Carpenter and Risk Lighthouse risk benchmarks database.

Medical CPI is the US CPI Urban Consumers Hospital & Related Services NSA

# WC Cycle + Medical Inflation



Cycle data is from cleaned Schedule P database from the Guy Carpenter and Risk Lighthouse risk benchmarks database.

Medical inflation is the US CPI Urban Consumers Hospital & Related Services NSA

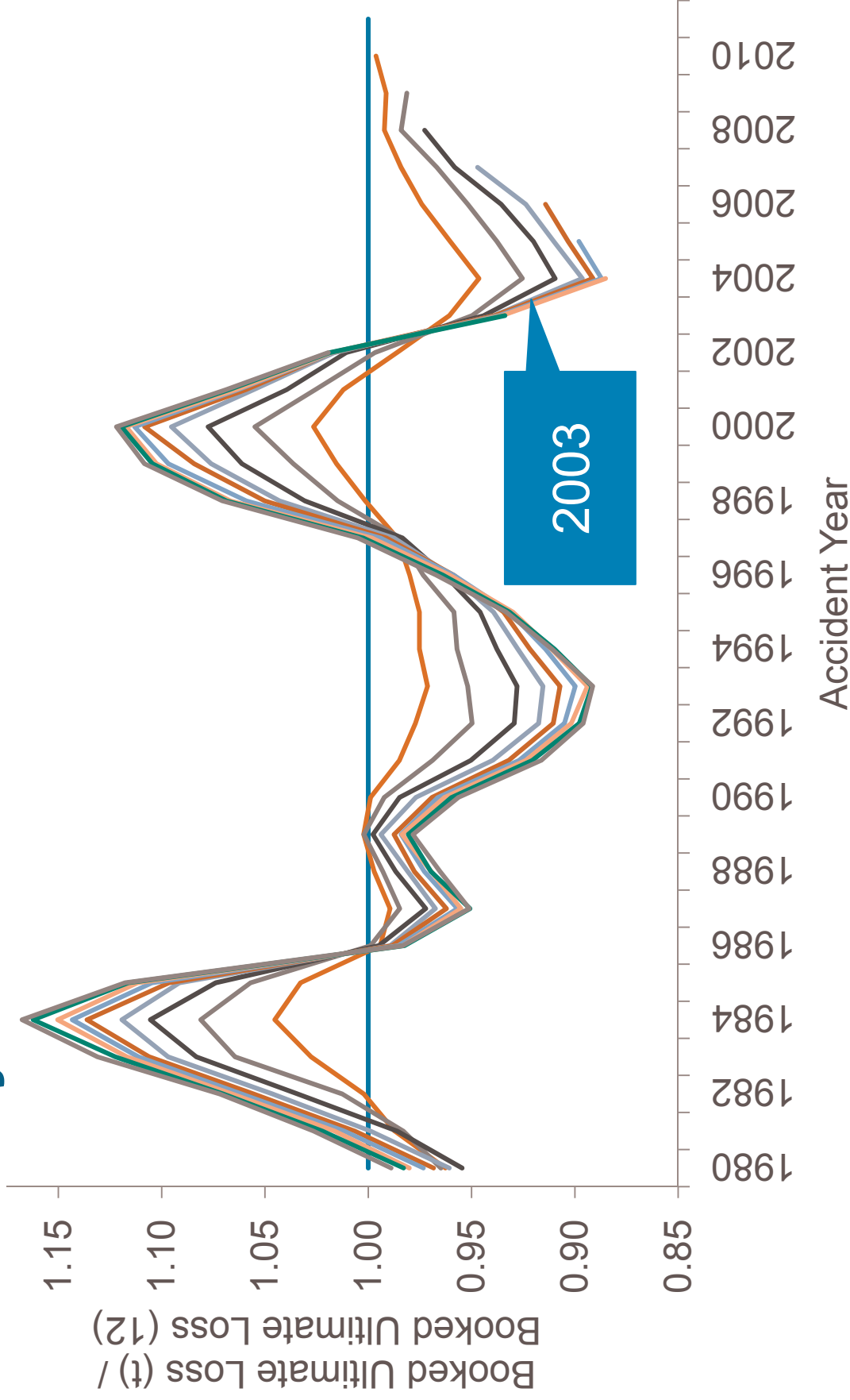
# Reserve Cycle – an analysis

1. Why do we have a cycle?
2. Do we need to break this cycle?

# Reserve Cycle – an analysis

1. Why do we have a cycle?
2. Do we need to break this cycle?

# Reserve Cycle



Sum of: Private Passenger Auto, Comm Auto Liab, CMP, Homeowners, Med Prof Liab, Other Liab, Products Liab, WC. Data to 12/2009 is from cleaned Schedule P database from Guy Carpenter & Risk Lighthouse (representing more than 95% of the industry), and updated for 12/2010 & 12/2011 financials using SNL and subject to change.

# ■ Top stories for CAS actuaries 2003:

# Top stories for CAS actuaries 2003:

1. **Actuaries Come Under ...Criticism for ..Poor Performance in Projecting Loss Reserves**
  - Standard & Poor's published an article in November (2003) stating that "actuaries are signing off on reserves that turn out to be wildly inaccurate. It's an abysmal track record."

# Top stories for CAS actuaries 2003:

- 1. Actuaries Come Under ...Criticism for ..Poor Performance in Projecting Loss Reserves**
  - Standard & Poor's published an article in November (2003) stating that "actuaries are signing off on reserves that turn out to be wildly inaccurate. It's an abysmal track record."
- 2. [L]evel of Reserve Deficiency...**
  - Despite substantial reserve increases by ...insurers, during 2003 rating agencies estimate that the non-asbestos reserve shortfall ...is between \$30 billion and \$60 billion.



# ■ Top stories for CAS actuaries 2004:

# ■ Top stories for CAS actuaries 2004:

## 9. Actuarial Organizations Respond to ... Criticism of Loss Reserving

[T]he CAS Board is working with a task force to prioritize a series of action plans relating to loss reserving.

# Top stories for CAS actuaries 2004:

## 9. Actuarial Organizations Respond to ... Criticism of Loss Reserving

[T]he CAS Board is working with a task force to prioritize a series of action plans relating to loss reserving.

[O]ur survey respondents ...opined that, as long as there is a public question regarding our effectiveness in ...the basic core function of loss reserving, all other issues... should be considered secondary.

# Top stories for CAS actuaries 2004:

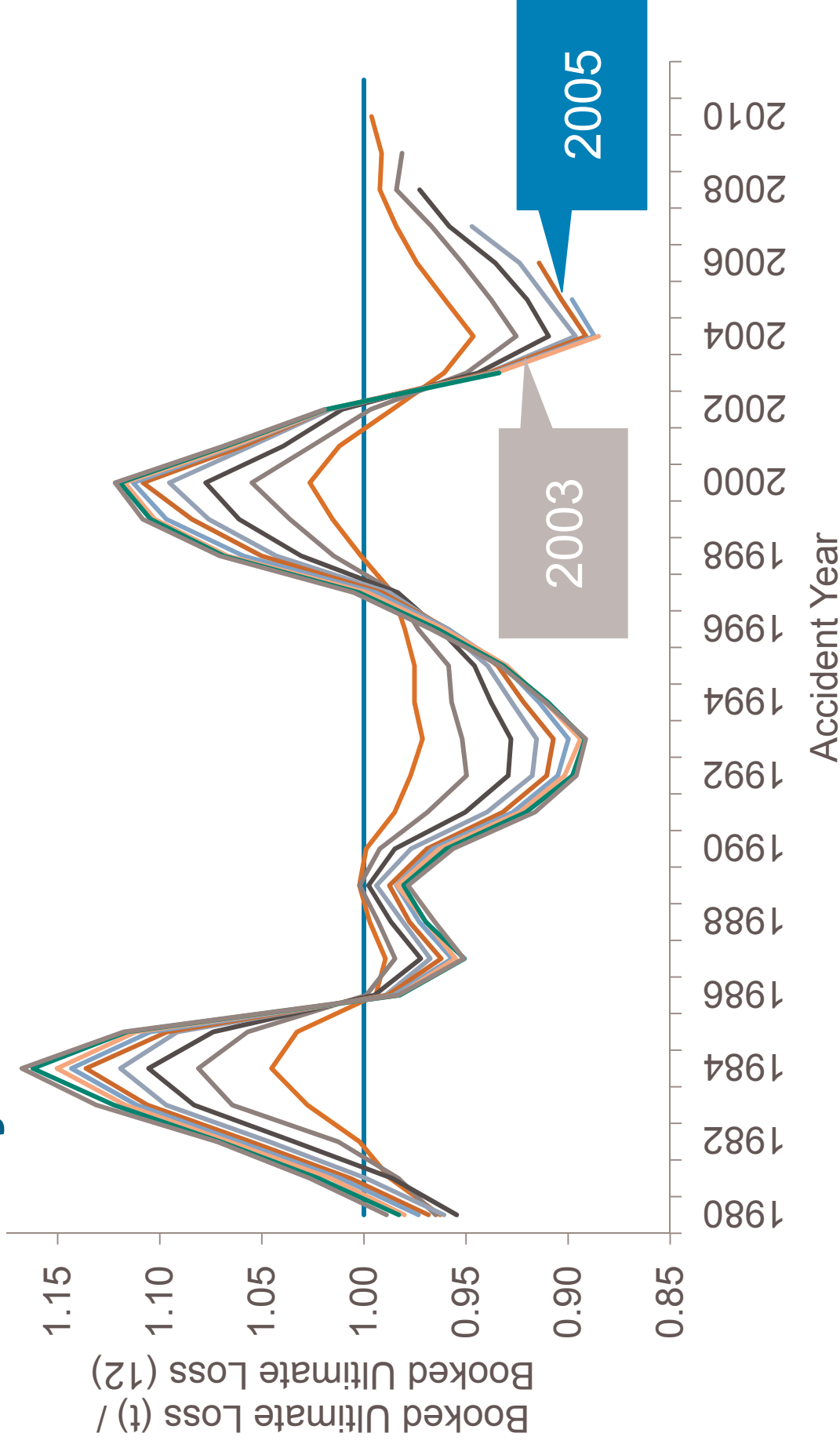
## 9. Actuarial Organizations Respond to ... Criticism of Loss Reserving

[T]he CAS Board is working with a task force to prioritize a series of action plans relating to loss reserving.

[O]ur survey respondents ...opined that, as long as there is a public question regarding our effectiveness in ...the basic core function of loss reserving, all other issues... should be considered secondary.

The profession must continue... its self-review, as these issues will not go away on their own.

# Reserve Cycle



Sum of: Private Passenger Auto, Comm Auto Liab, CMP, Homeowners, Med Prof Liab, Other Liab, Products Liab, WC. Data to 12/2009 is from cleaned Schedule P database from Guy Carpenter & Risk Lighthouse (representing more than 95% of the industry), and updated for 12/2010 & 12/2011 financials using SNL and subject to change.

# ■ Top stories for CAS actuaries 2005:

# ■ Top stories for CAS actuaries 2005:

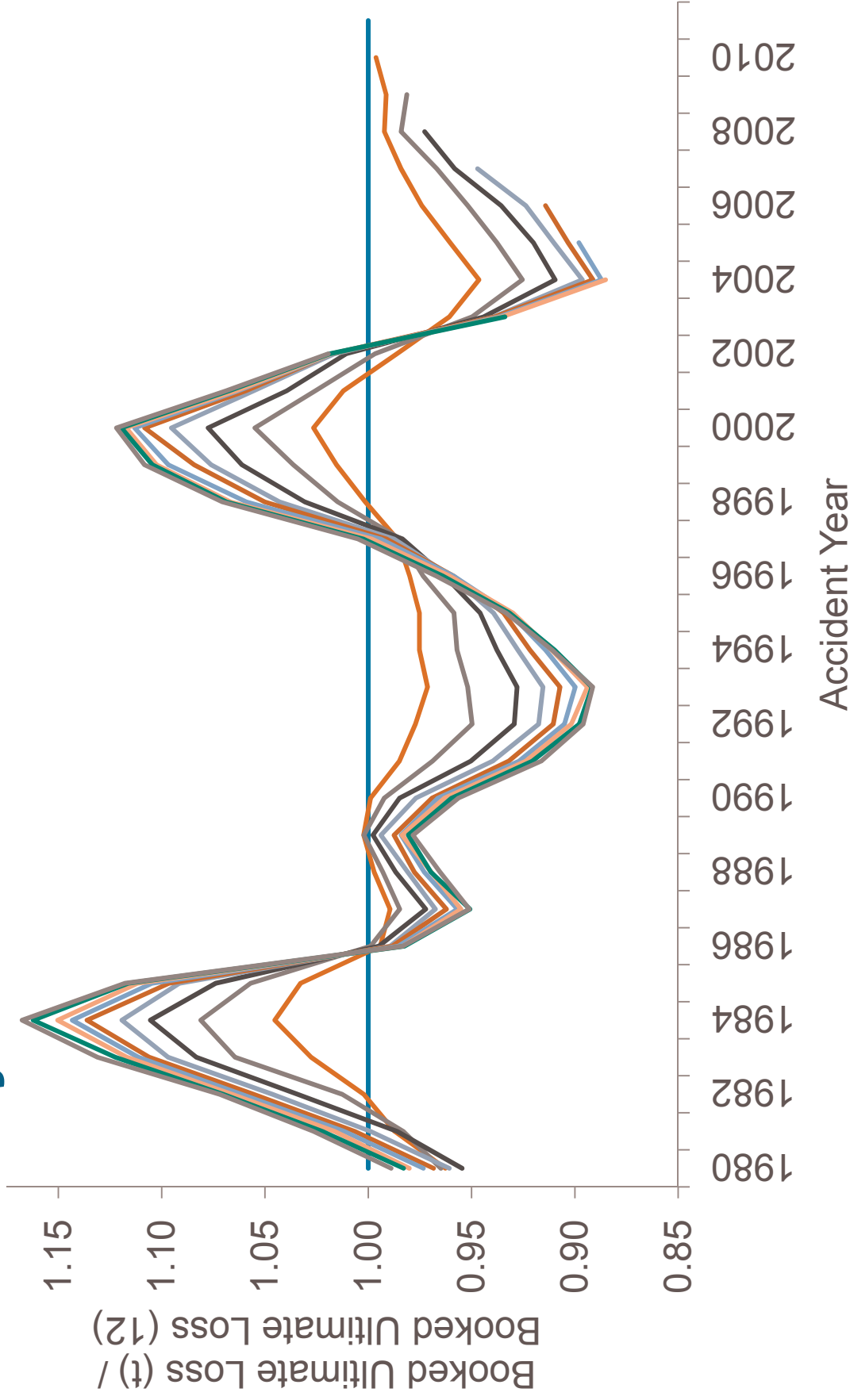
- ?

# ■ Top stories for CAS actuaries 2005:

- ? What reserving problem ?



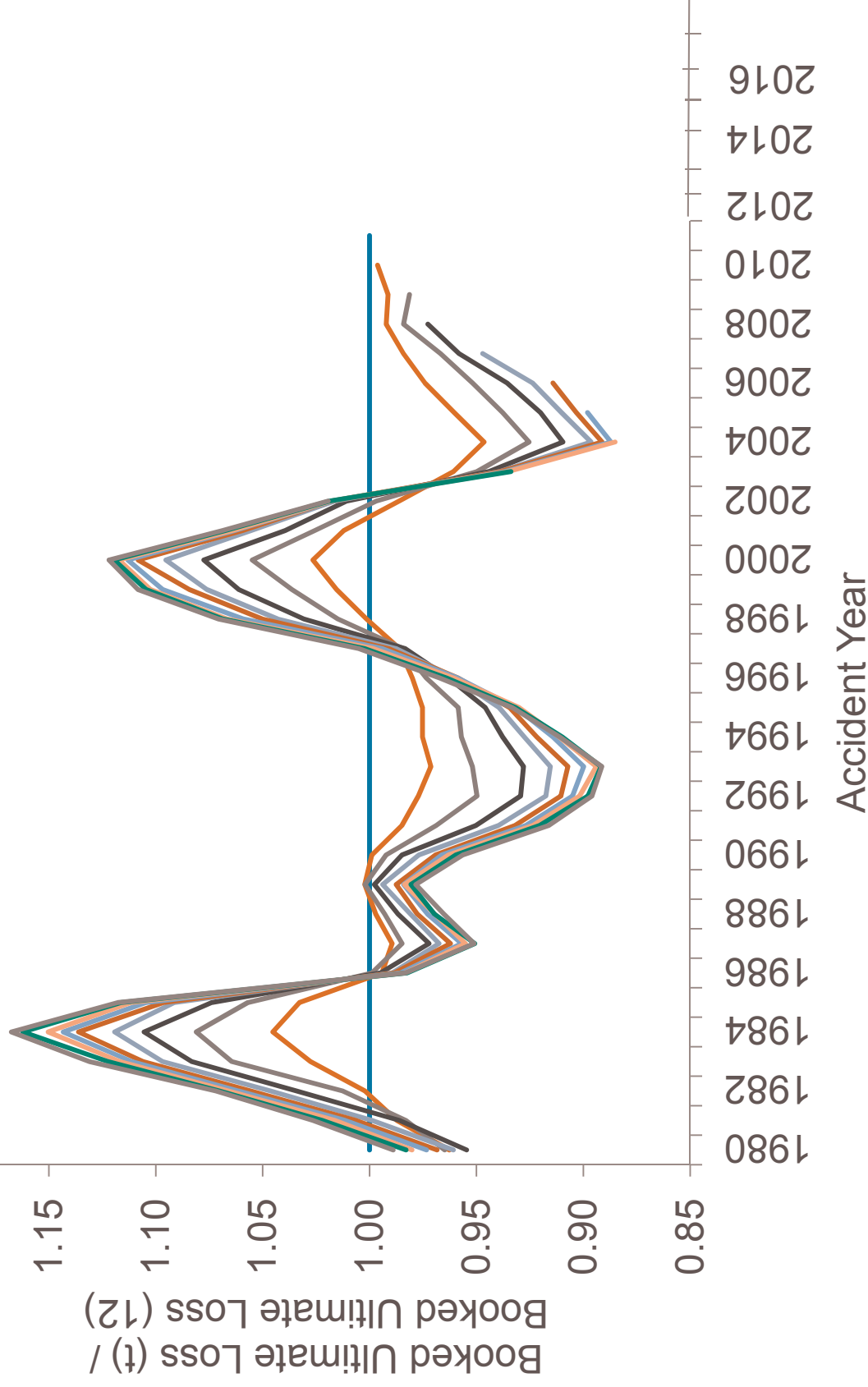
# Reserve Cycle



Sum of: Private Passenger Auto, Comm Auto Liab, CMP, Homeowners, Med Prof Liab, Other Liab, Products Liab, WC. Data to 12/2009 is from cleaned Schedule P database from Guy Carpenter & Risk Lighthouse (representing more than 95% of the industry), and updated for 12/2010 & 12/2011 financials using SNL and subject to change.

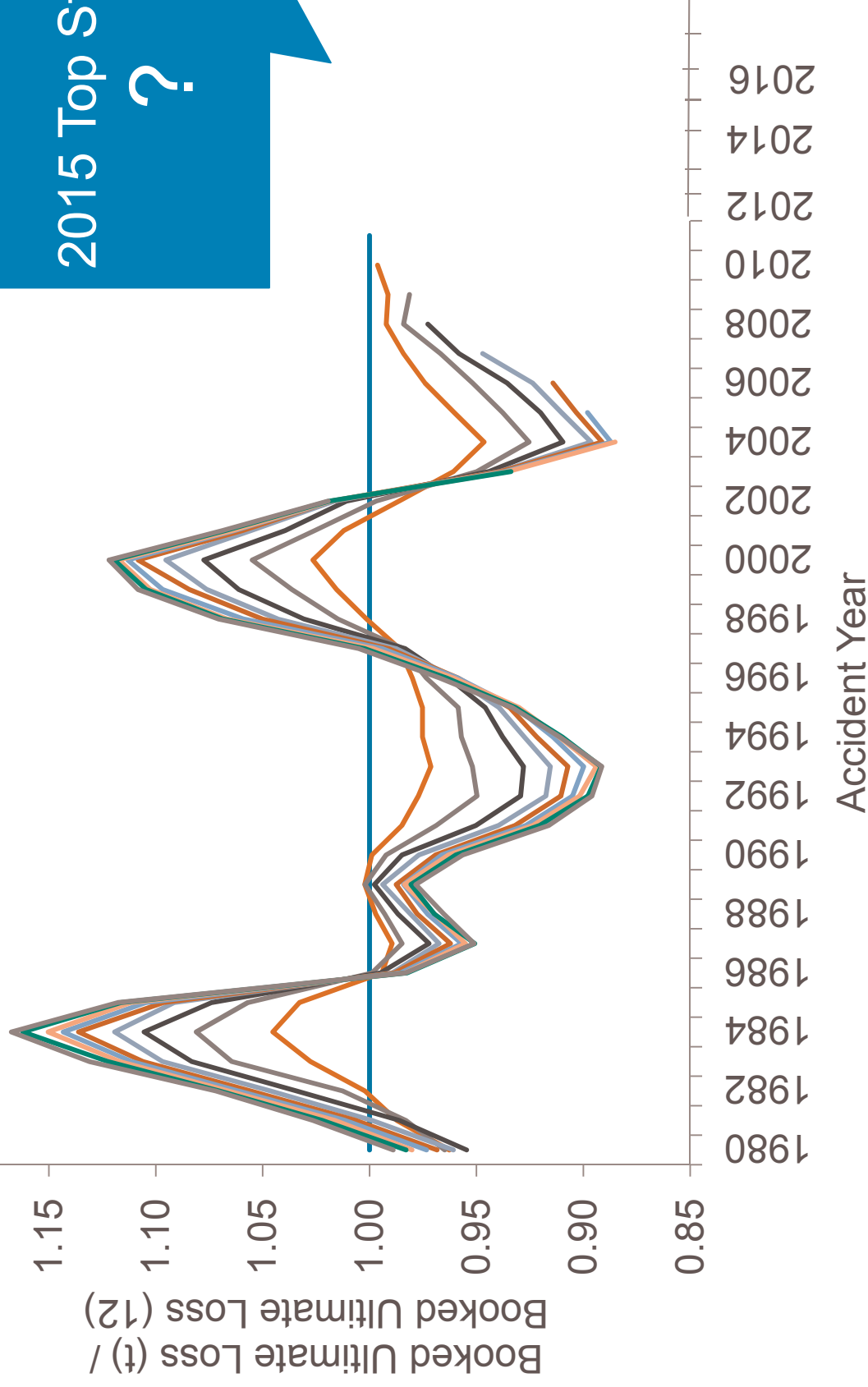
# Reserving Cycle

120



# Reserving Cycle

120



2015 Top Story:  
?

# Model risk in the best estimate model

1. Why do we have a cycle?
2. Do we need to break this cycle?

# GUY CARPENTER

Can we get it right??

1. Reserving
2. Reserve risk

# What is a Reserve Distribution?

## What is a Reserve Distribution?

- A. A distribution of all possible reserve outcomes

## What is a Reserve Distribution?

- A. A distribution of all possible reserve outcomes
- B. How wrong your reserve estimate could be



# What is a Reserve Distribution?

- A. A distribution of all possible reserve outcomes
- B. How wrong your reserve estimate could be
  - Best estimate, then the distribution around it

# What is a Reserve Distribution?

- A. A distribution of all possible reserve outcomes
- B. How wrong your reserve estimate could be
  - Best estimate, then the distribution around it
  - It's how we model reserve risk

# What is a Reserve Distribution?

- A. A distribution of all possible reserve outcomes
- B. How wrong your reserve estimate could be
  - Best estimate, then the distribution around it
  - It's how we model reserve risk
  - Allows for uncertainty

# Components of a reserve distribution

- Process risk: \_\_\_\_\_
- Systemic risk: \_\_\_\_\_
- Uncertainty: \_\_\_\_\_

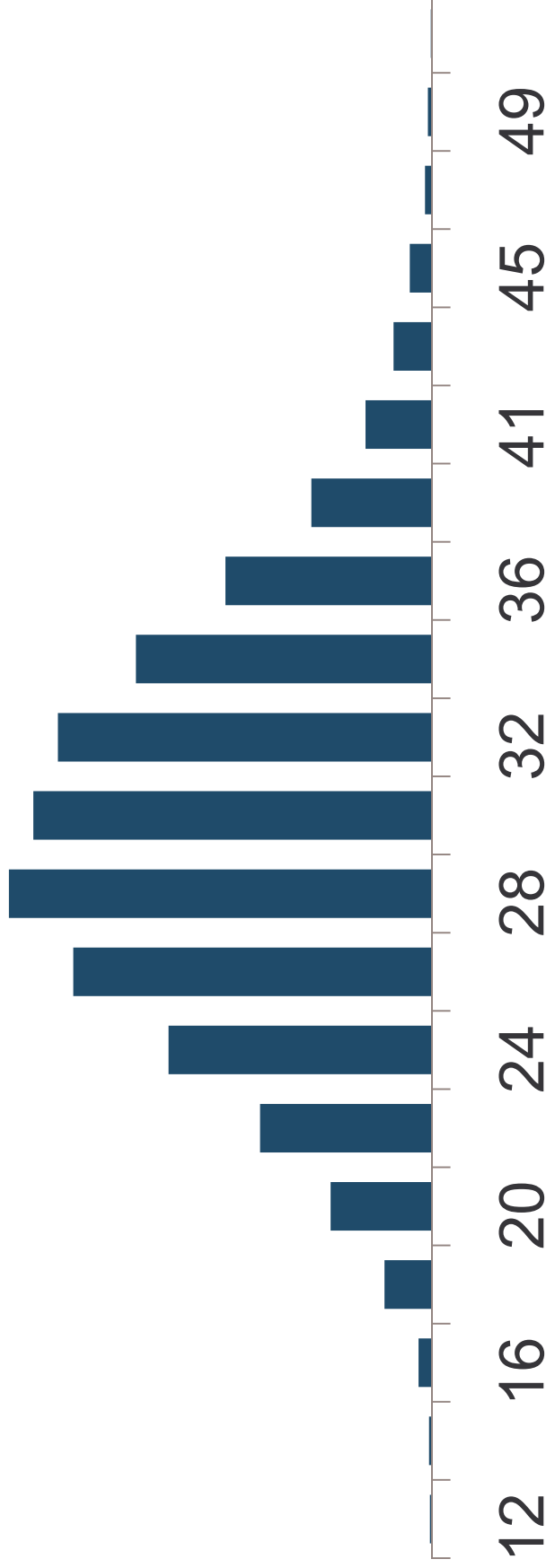
# Components of a reserve distribution

- Process risk: Bootstrap model
- Systemic risk: \_\_\_\_\_
- Uncertainty: \_\_\_\_\_



Company A

# Distribution of Homeowners Unpaid as of 12/2000

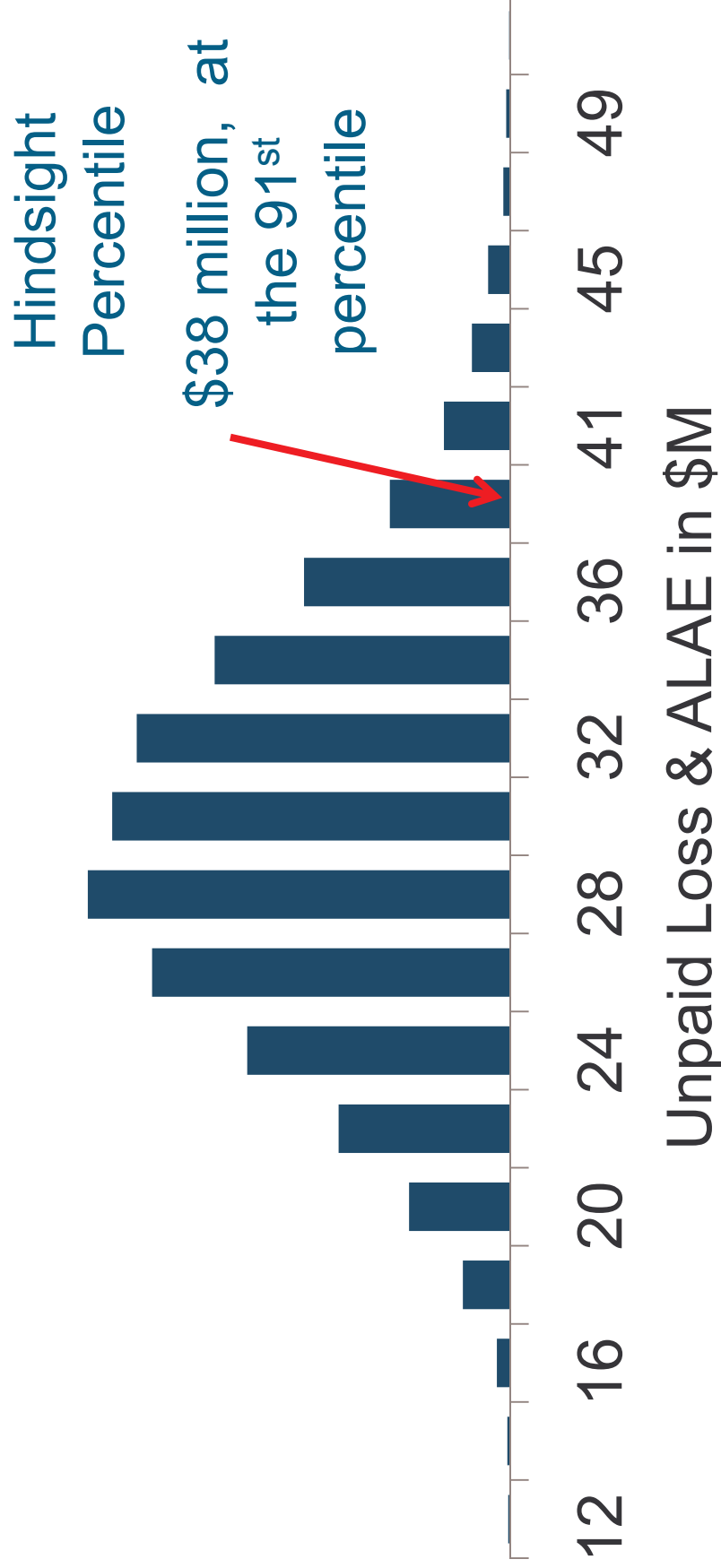


Unpaid Loss & ALAE in \$M



Company A

# Distribution of Homeowners Unpaid as of 12/2000





## 51 Companies

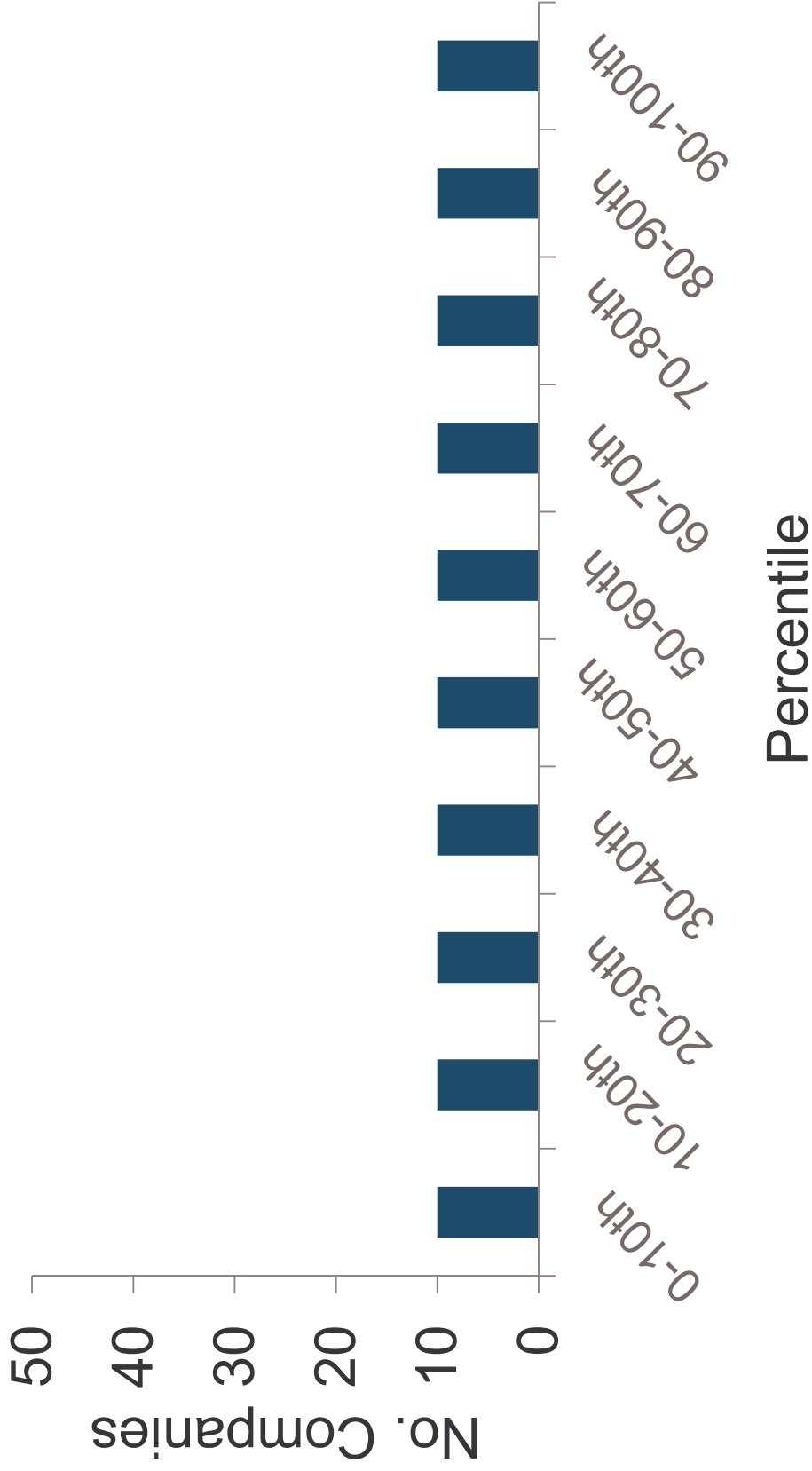
## Hindsight Percentile

---

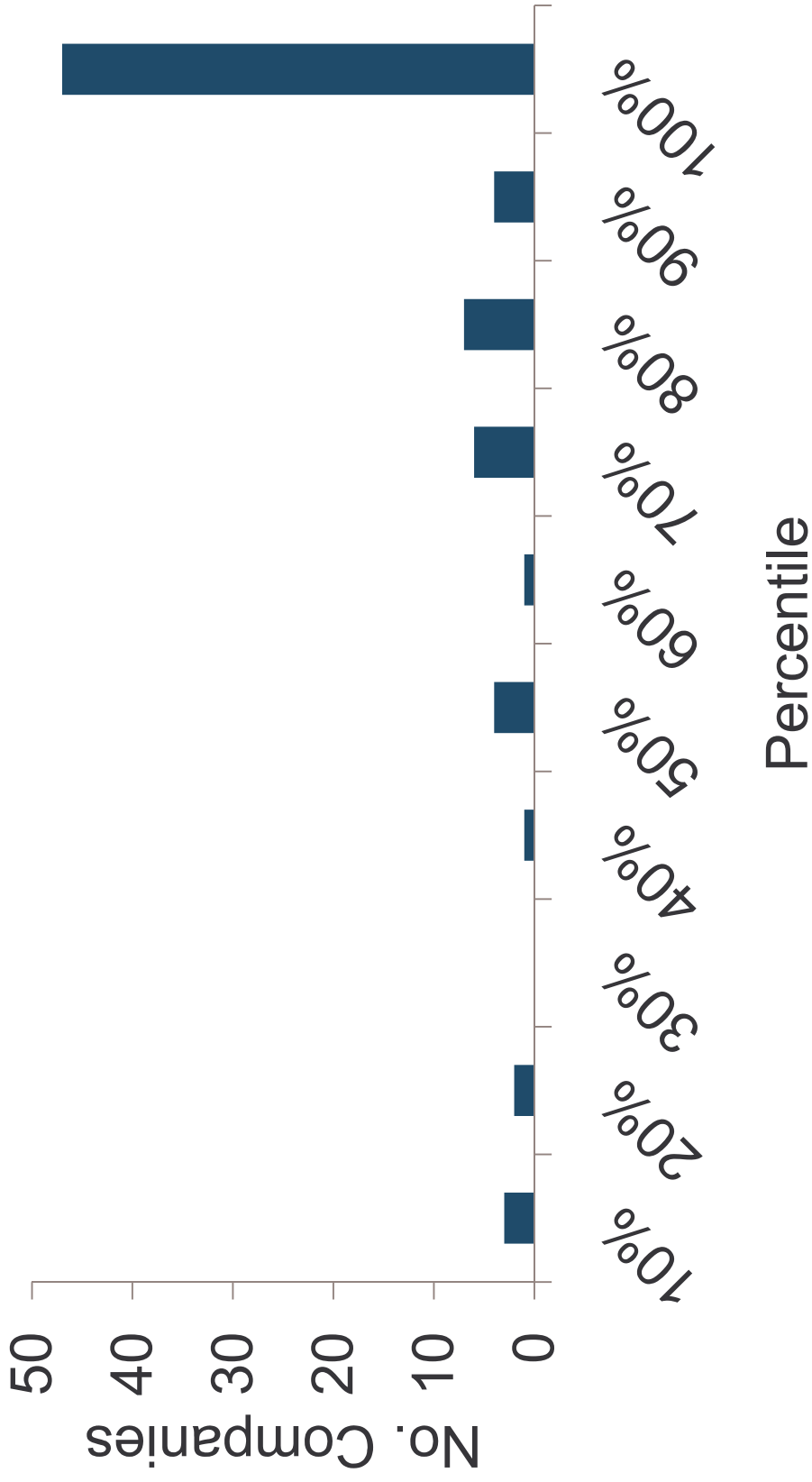
Company A	91%
Company B	51%
Company C	6%
....	....
....	....
Company AA	85%
Company AB	37%



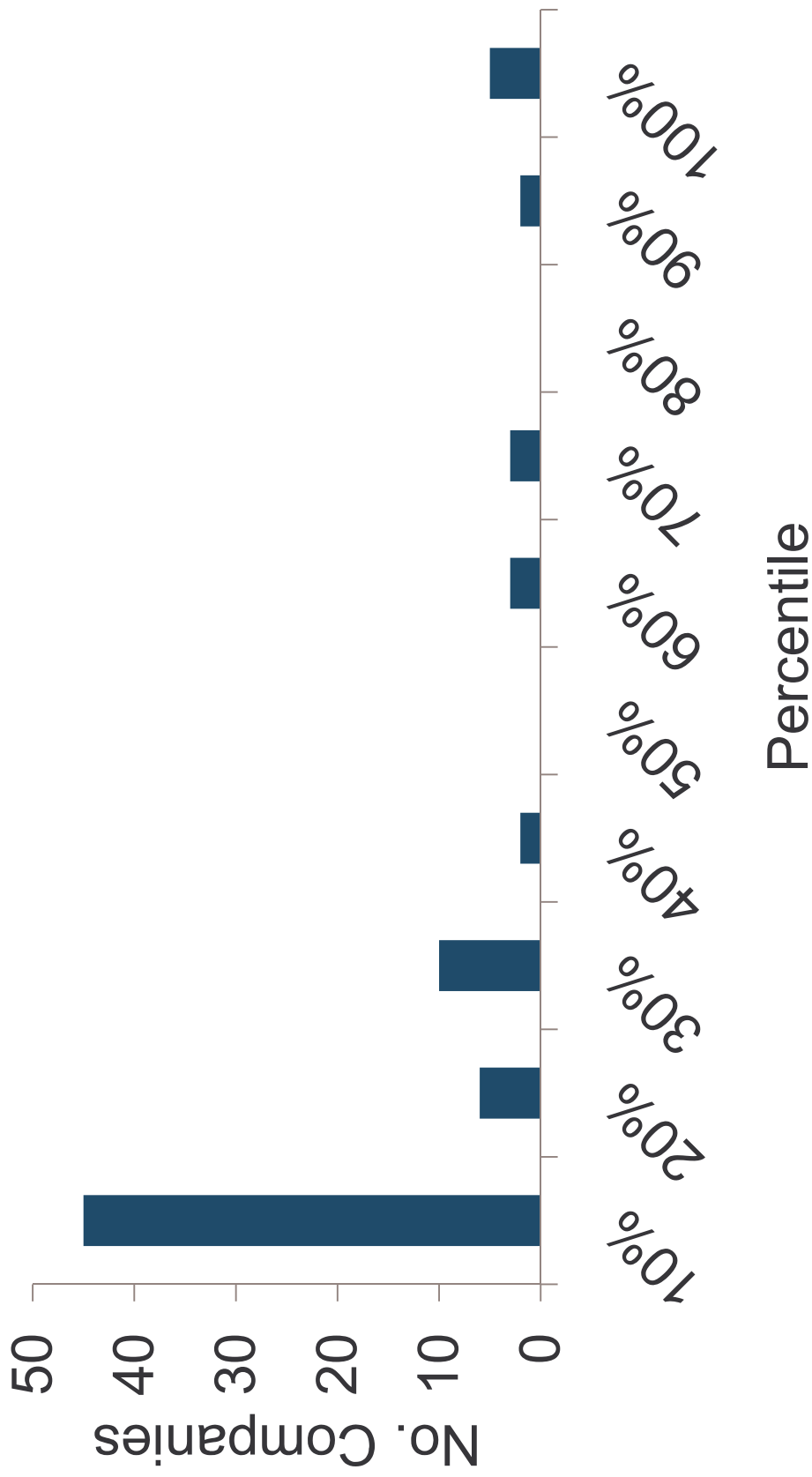
# Ideal histogram of percentiles



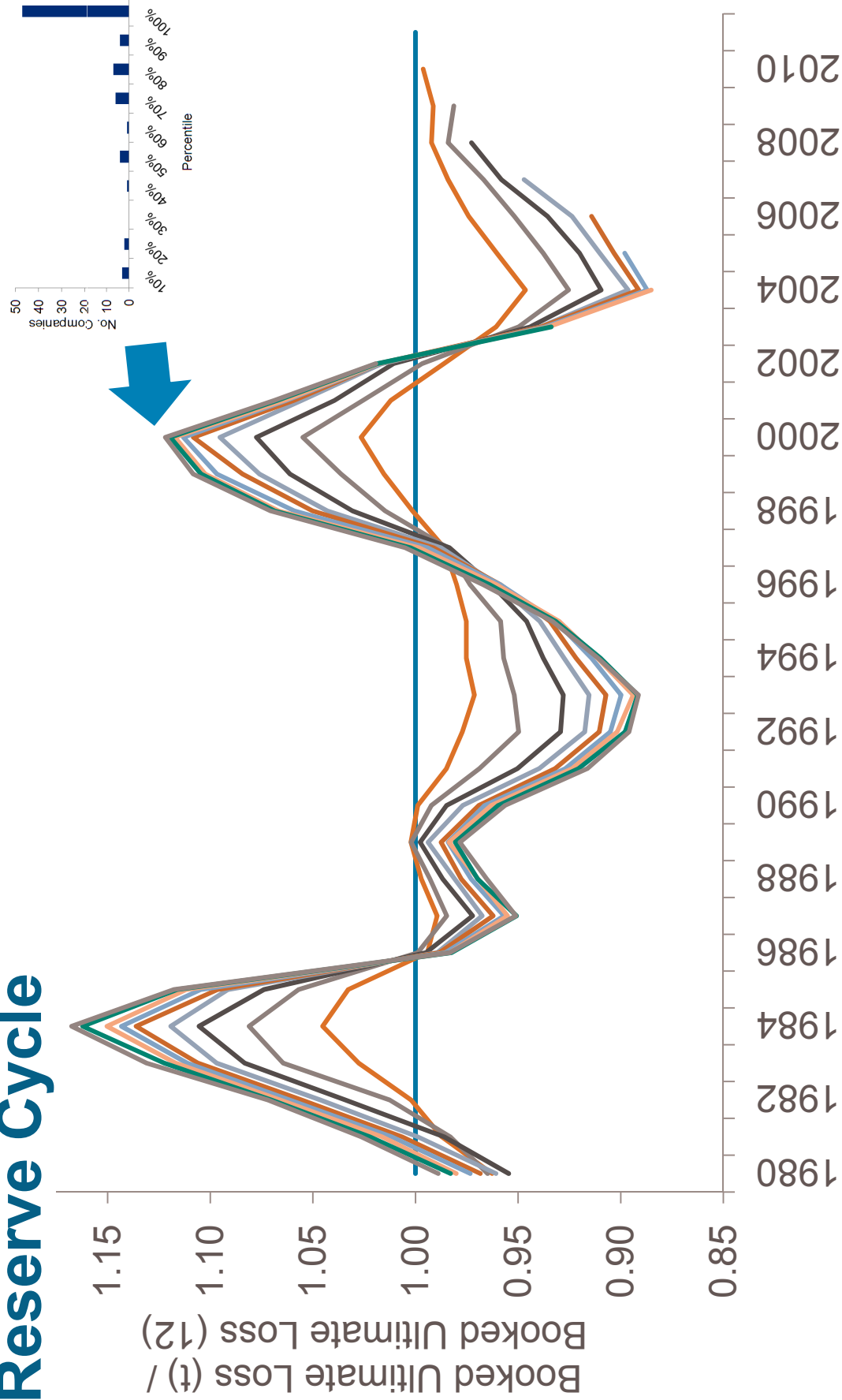
# Homeowners as of 12/2000



# Homeowners as of 12/1996

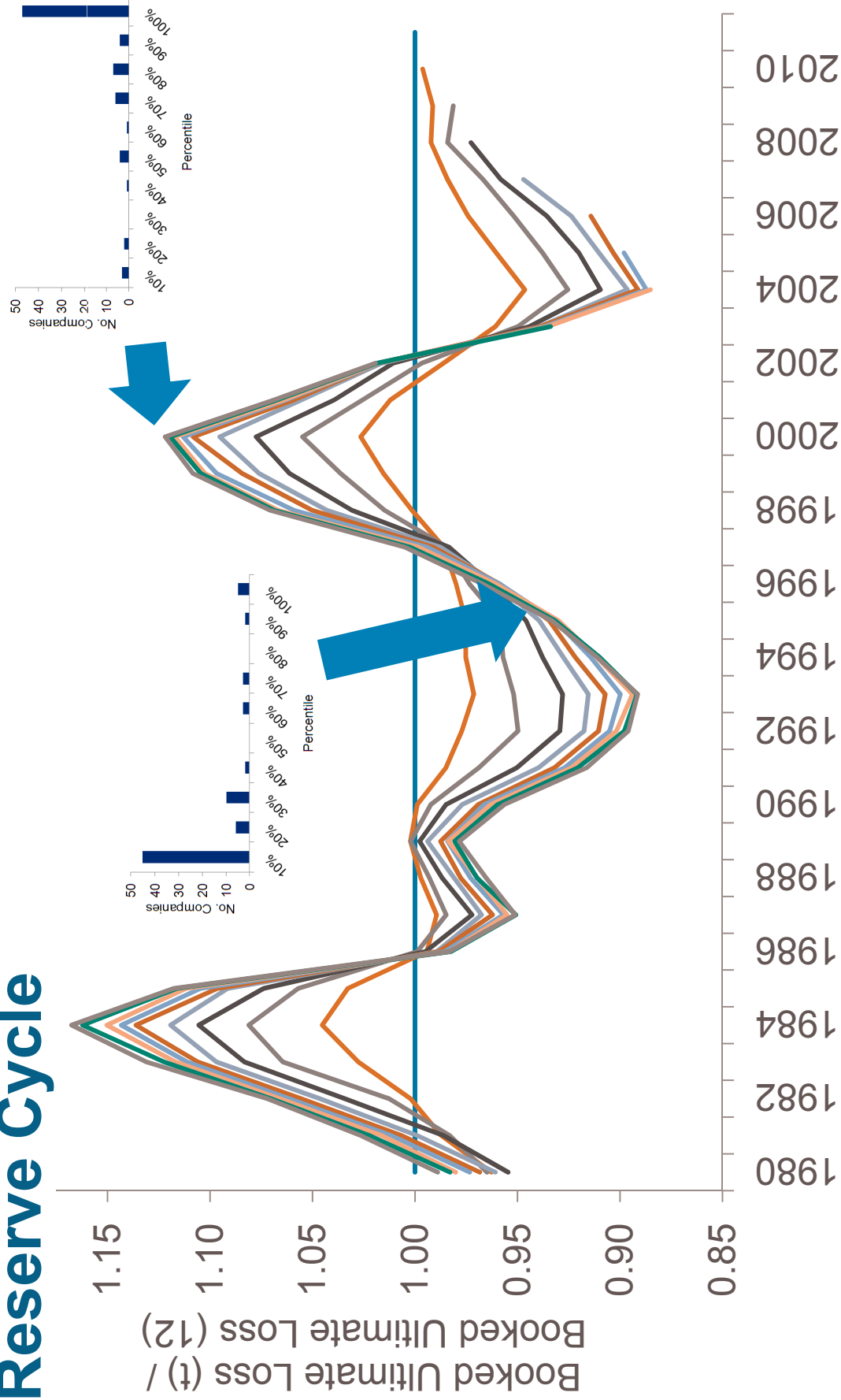


# Reserve Cycle



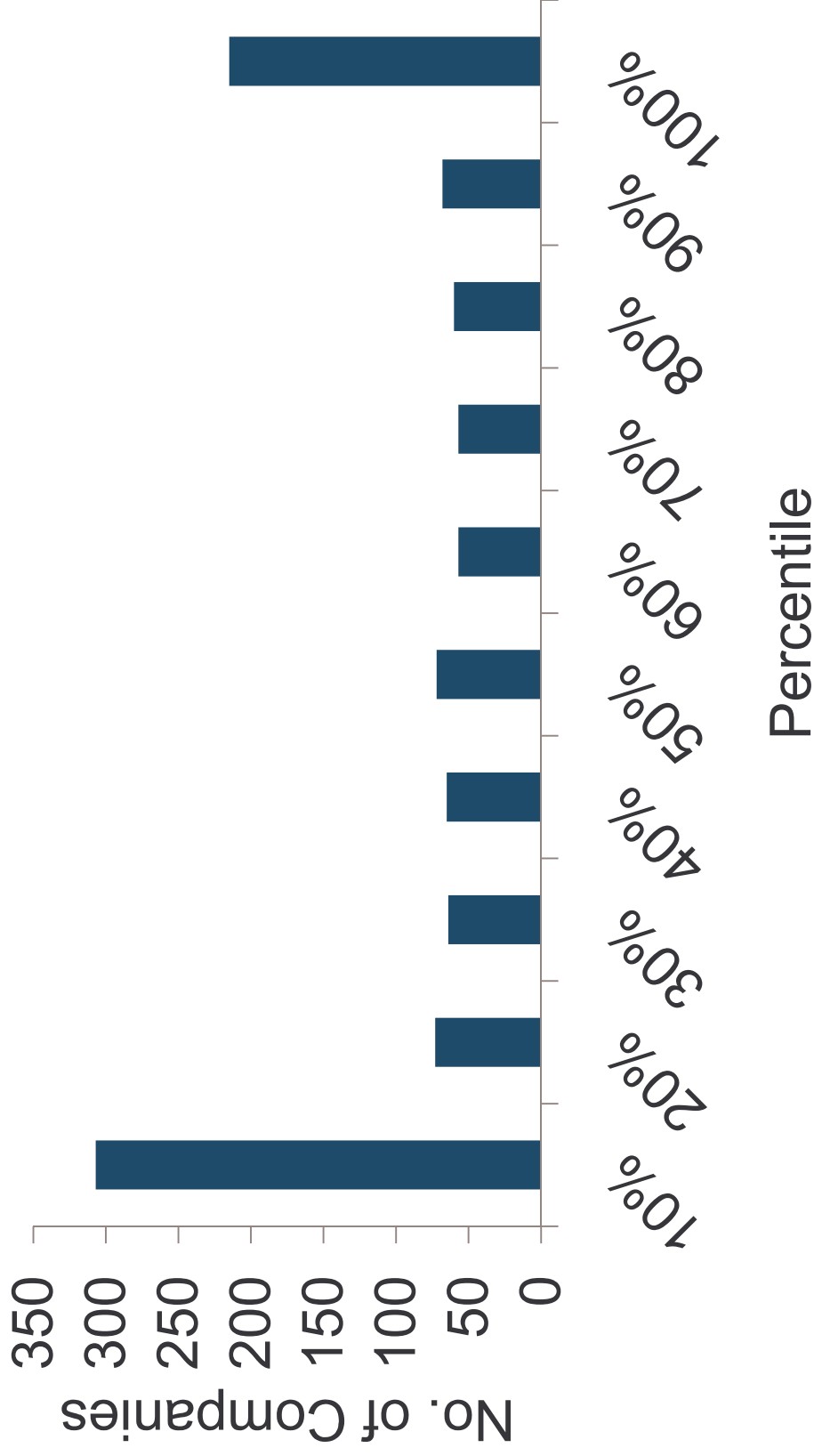
Sum of: Private Passenger Auto, Comm Auto Liab, CMP, Homeowners, Med Prof Liab, Other Liab, Products Liab, WC. Data to 12/2009 is from cleaned Schedule P database from Guy Carpenter & Risk Lighthouse (representing more than 95% of the industry), and updated for 12/2010 & 12/2011 financials using SNL and subject to change.

# Reserve Cycle



Sum of: Private Passenger Auto, Comm Auto Liab, CMP, Homeowners, Med Prof Liab, Other Liab, Products Liab, WC. Data to 12/2009 is from cleaned Schedule P database from Guy Carpenter & Risk Lighthouse (representing more than 95% of the industry), and updated for 12/2010 & 12/2011 financials using SNL and subject to change.

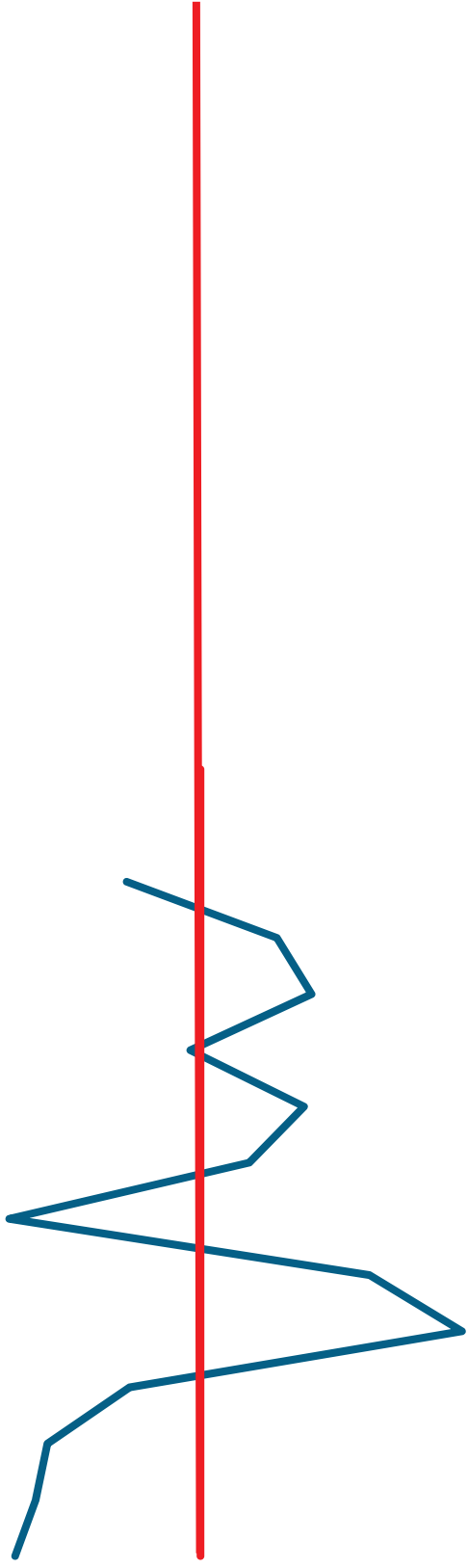
# Homeowners: Percentiles 1989-2002



# ■ Why does the bootstrap model fail?

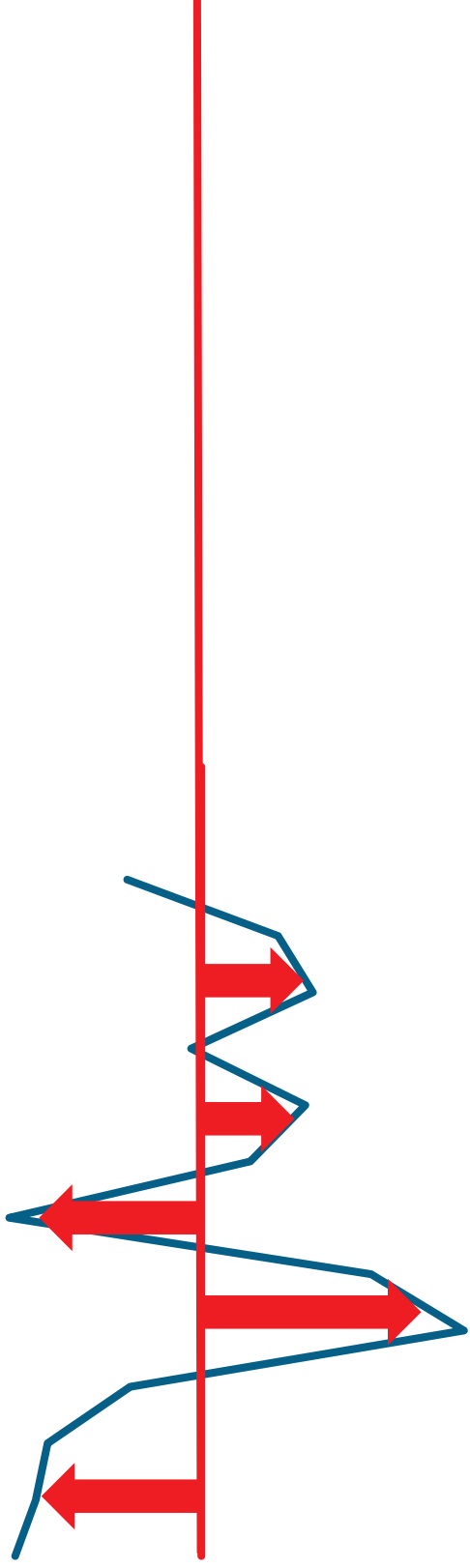
1. Process risk
2. Systemic risk

# How the bootstrap model works

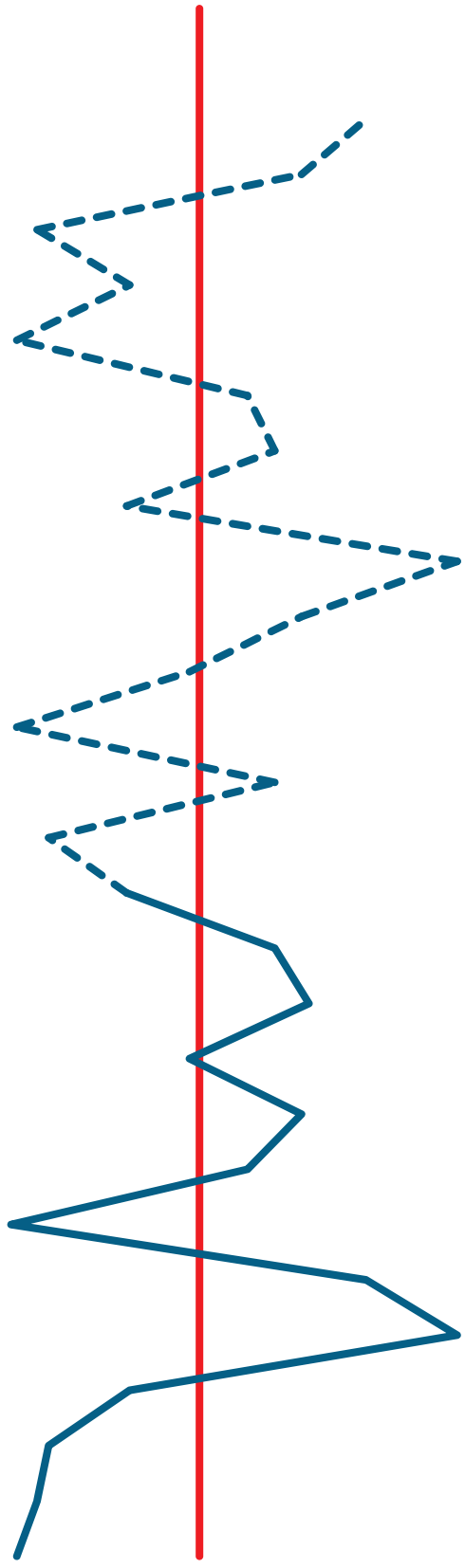




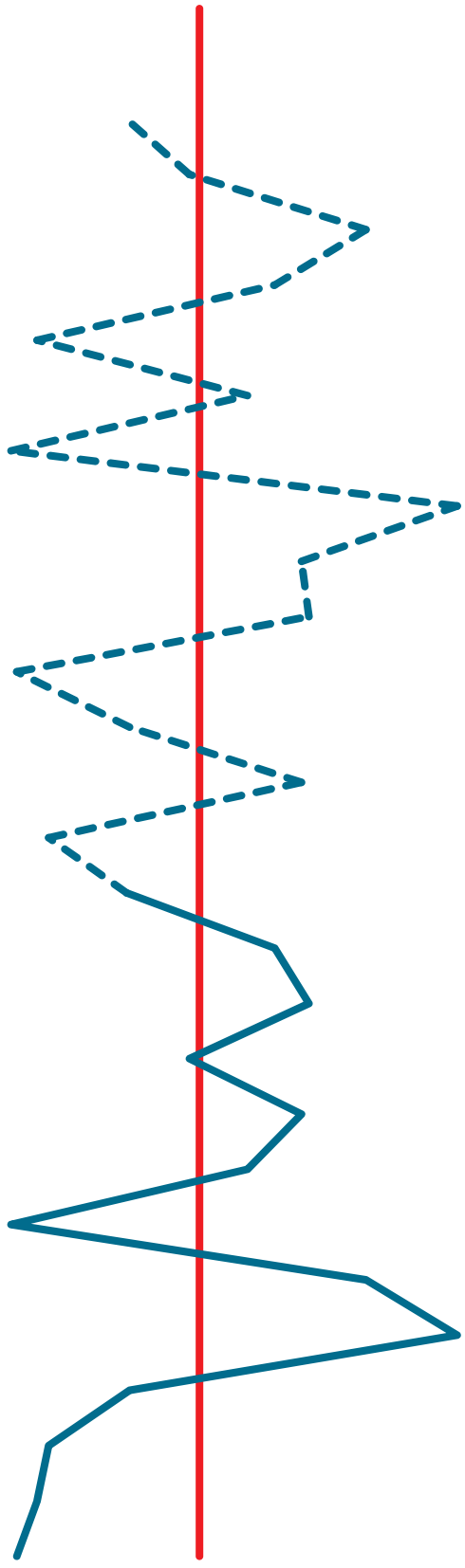
# How the bootstrap model works



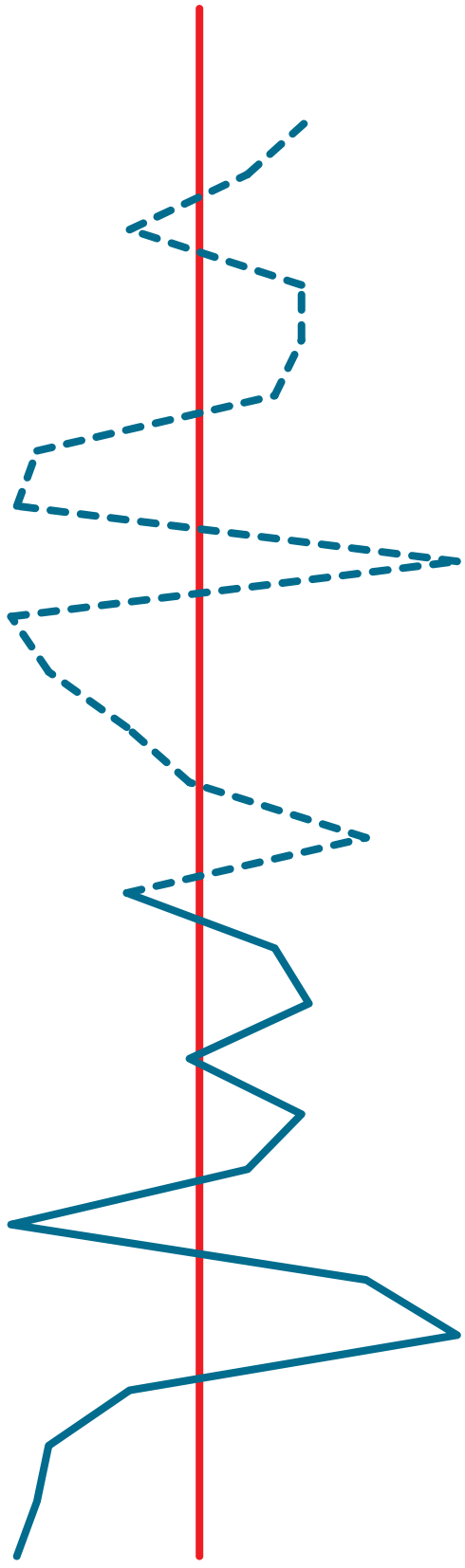
# How the bootstrap model works



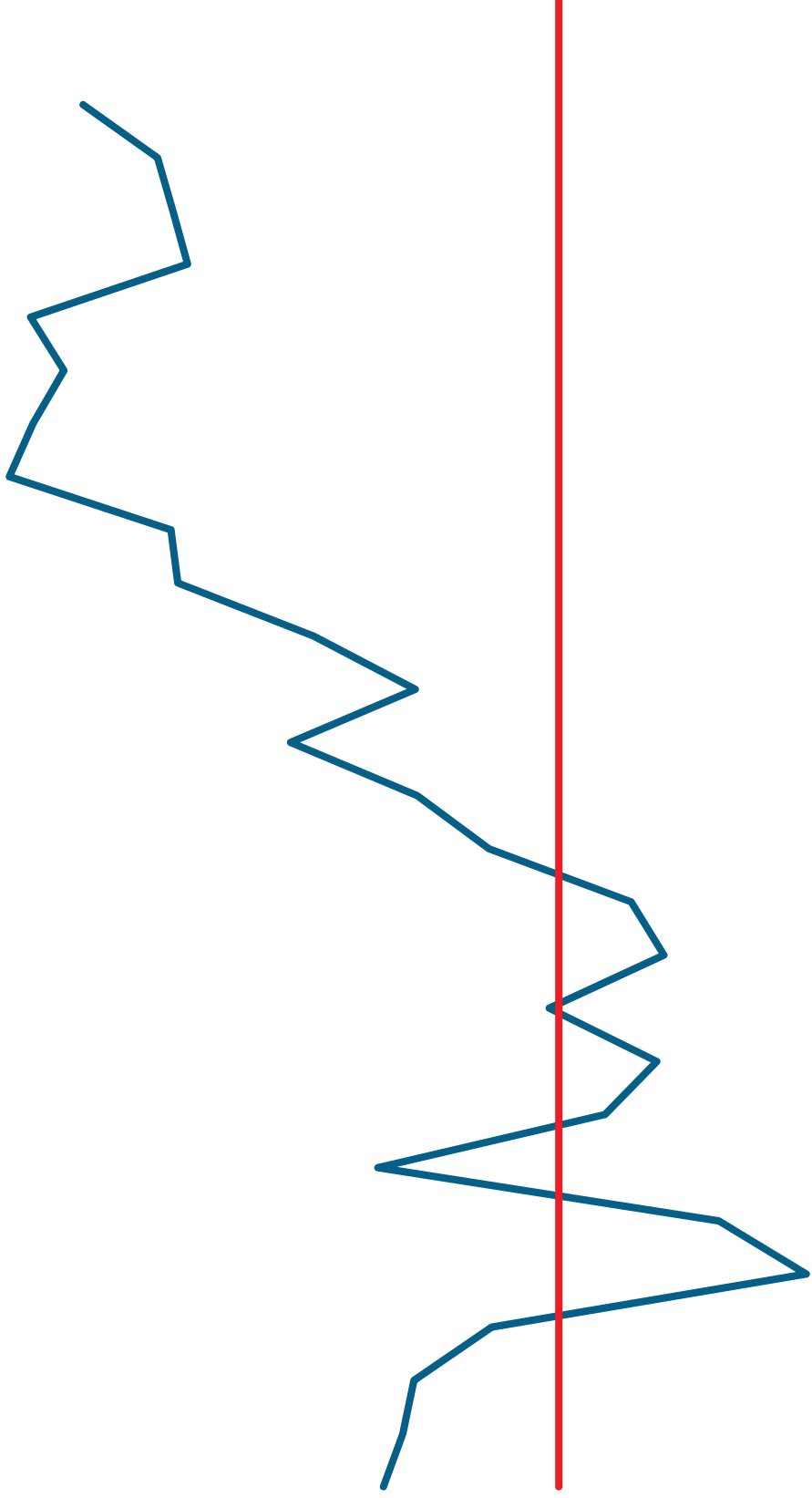
# How the bootstrap model works



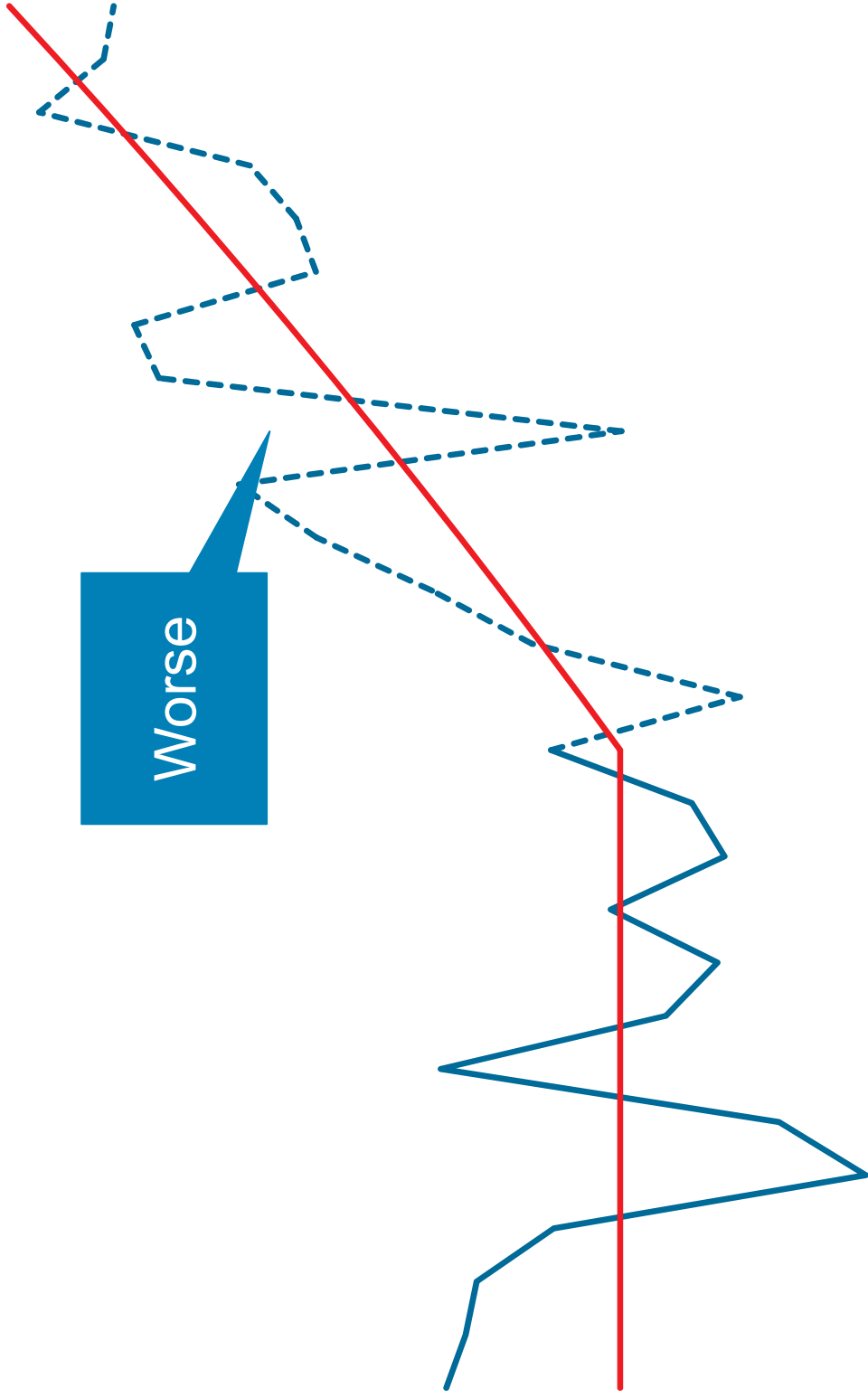
# How the bootstrap model works



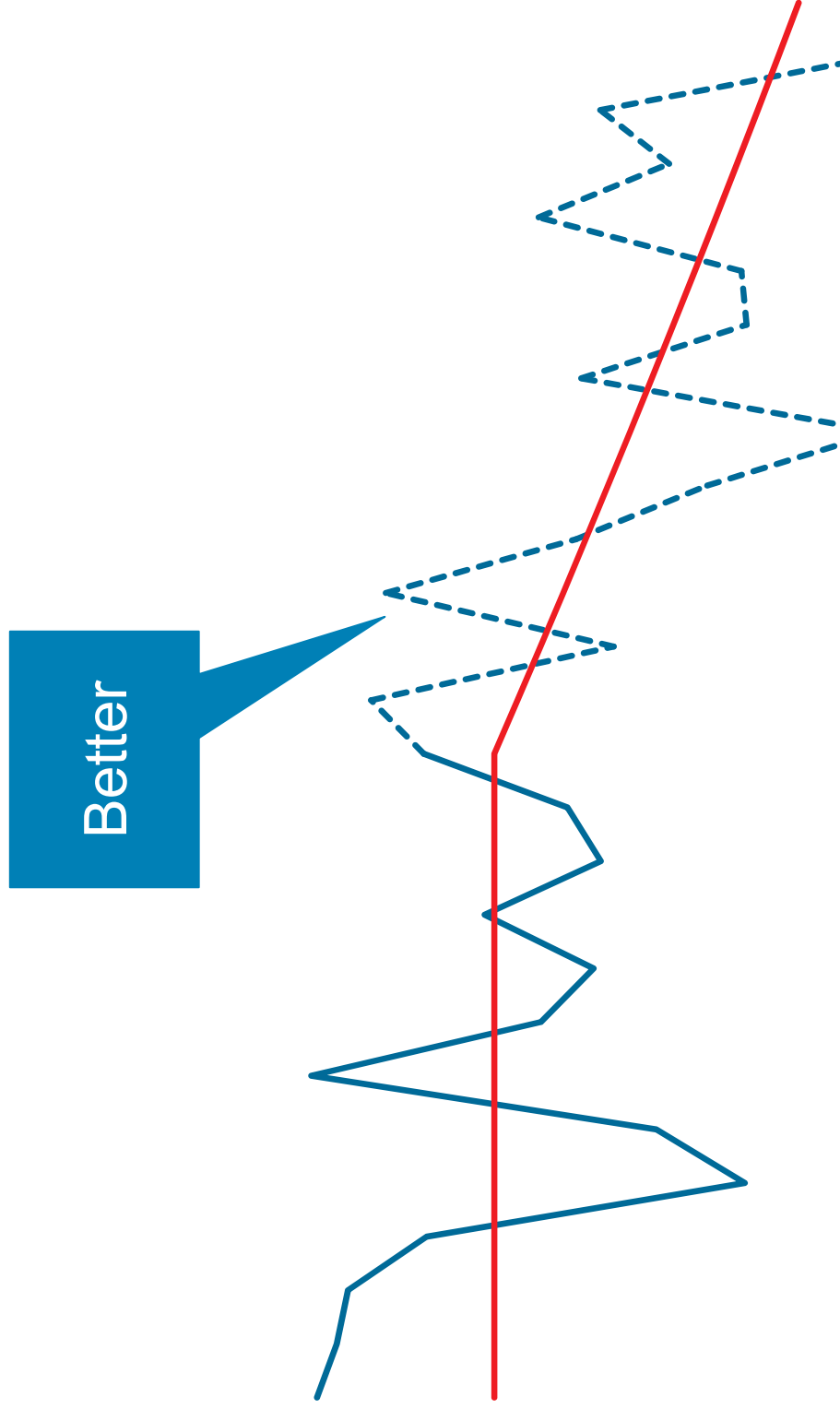
# ...systemic risk!



# Make it wiggle!

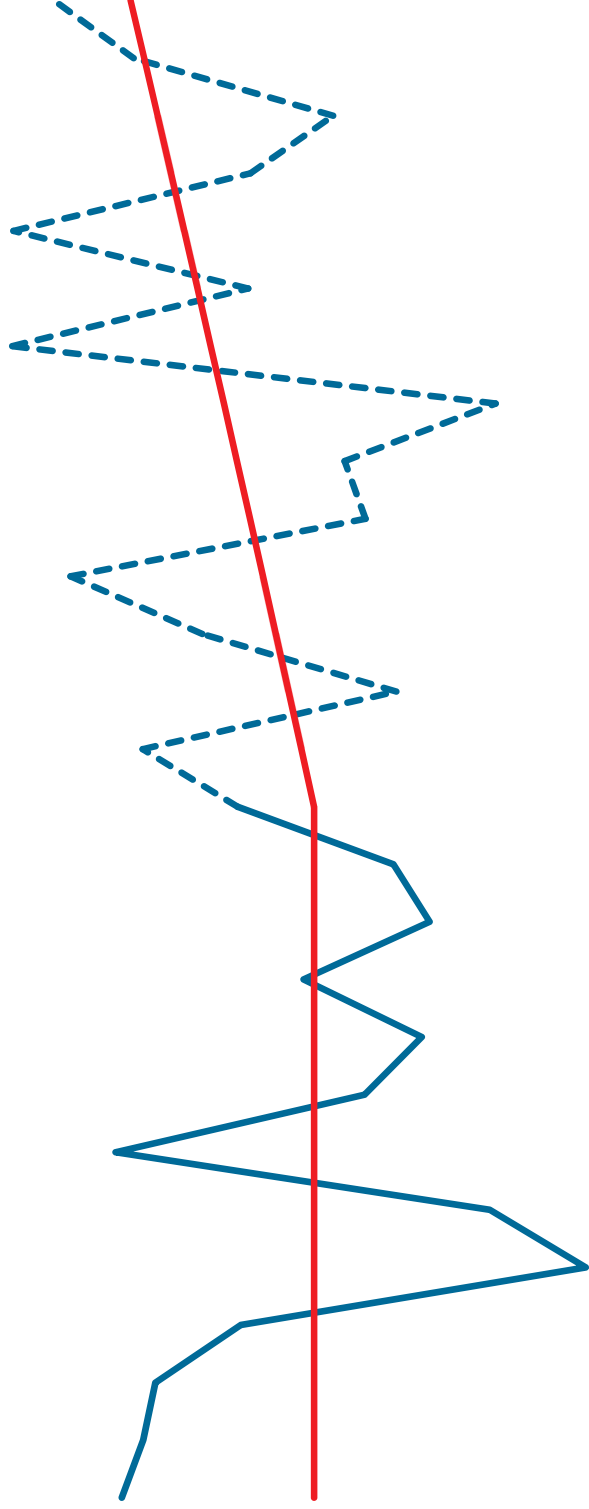


# Make it wiggle!



# Make it wiggle!

A little worse

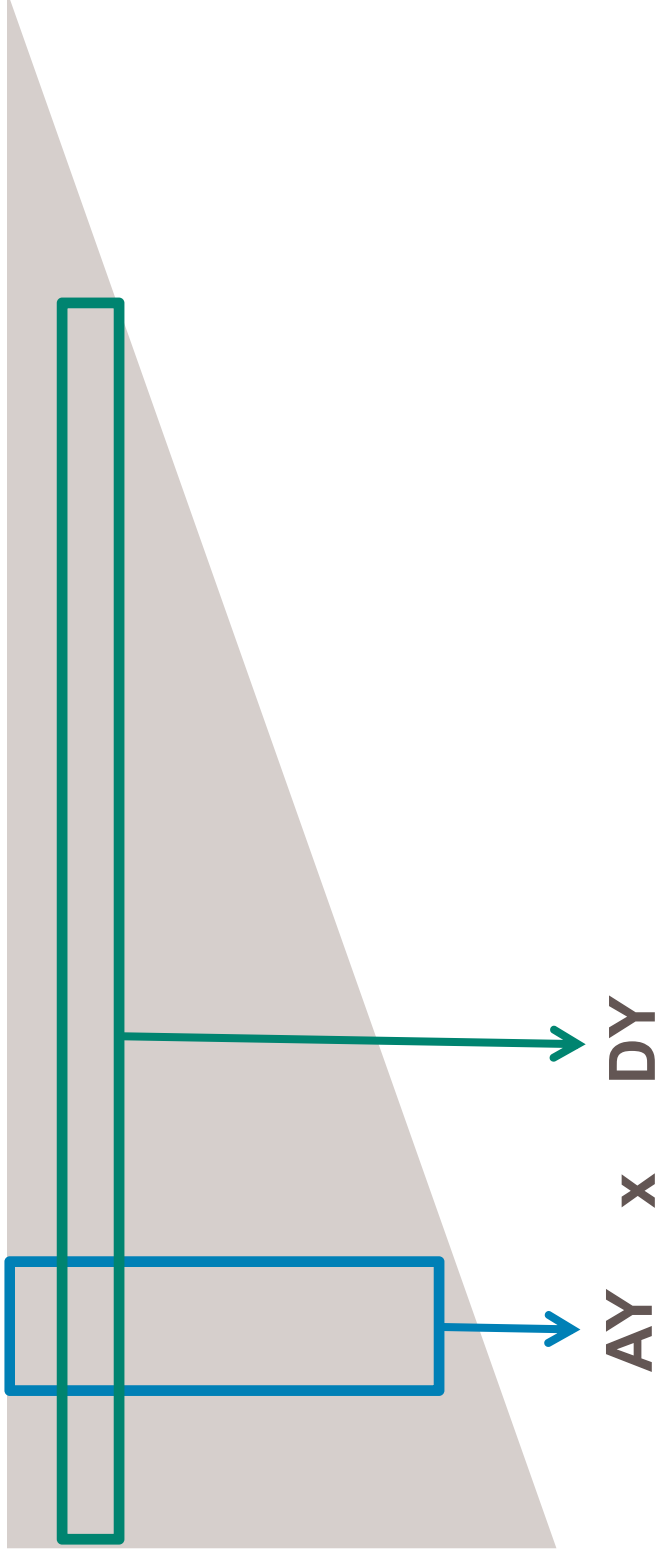




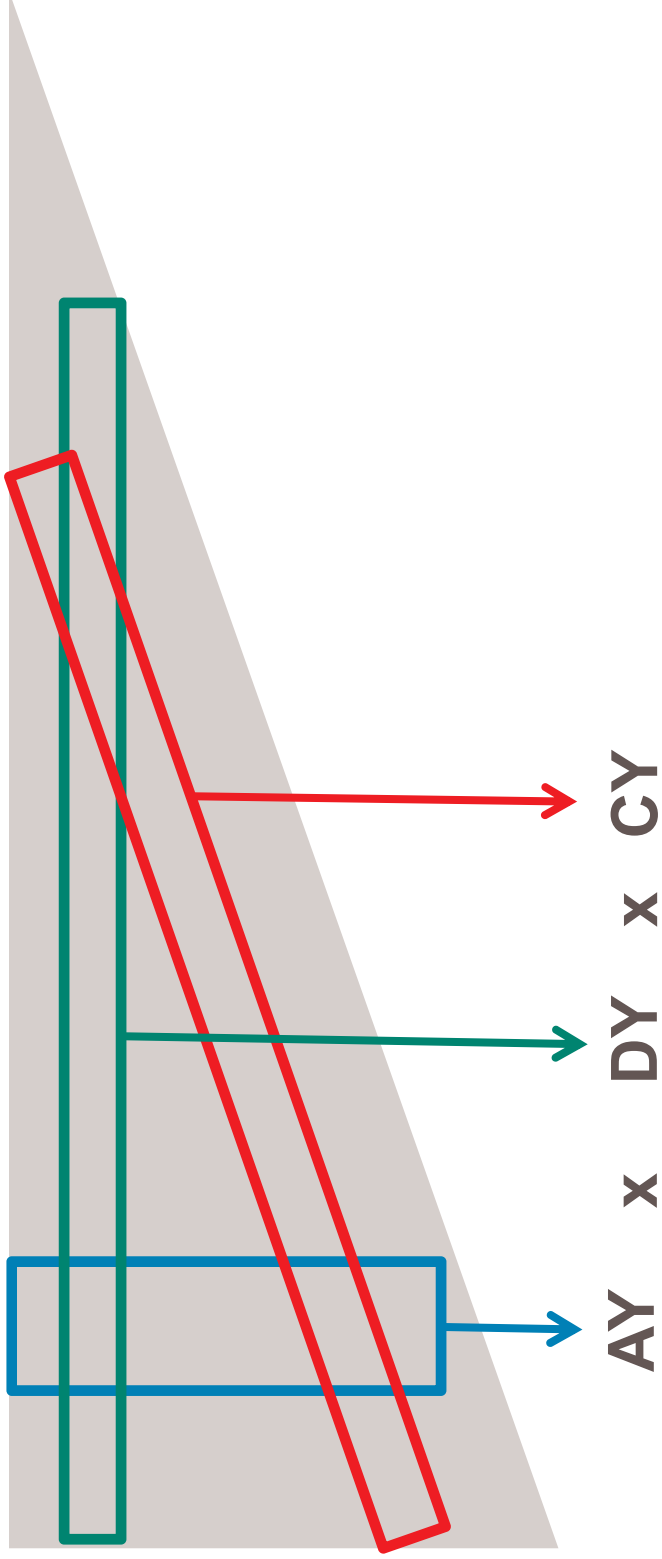
# Components of a reserve distribution

- Process risk: Bootstrap model
- Systemic risk: CY trend model
- Uncertainty:

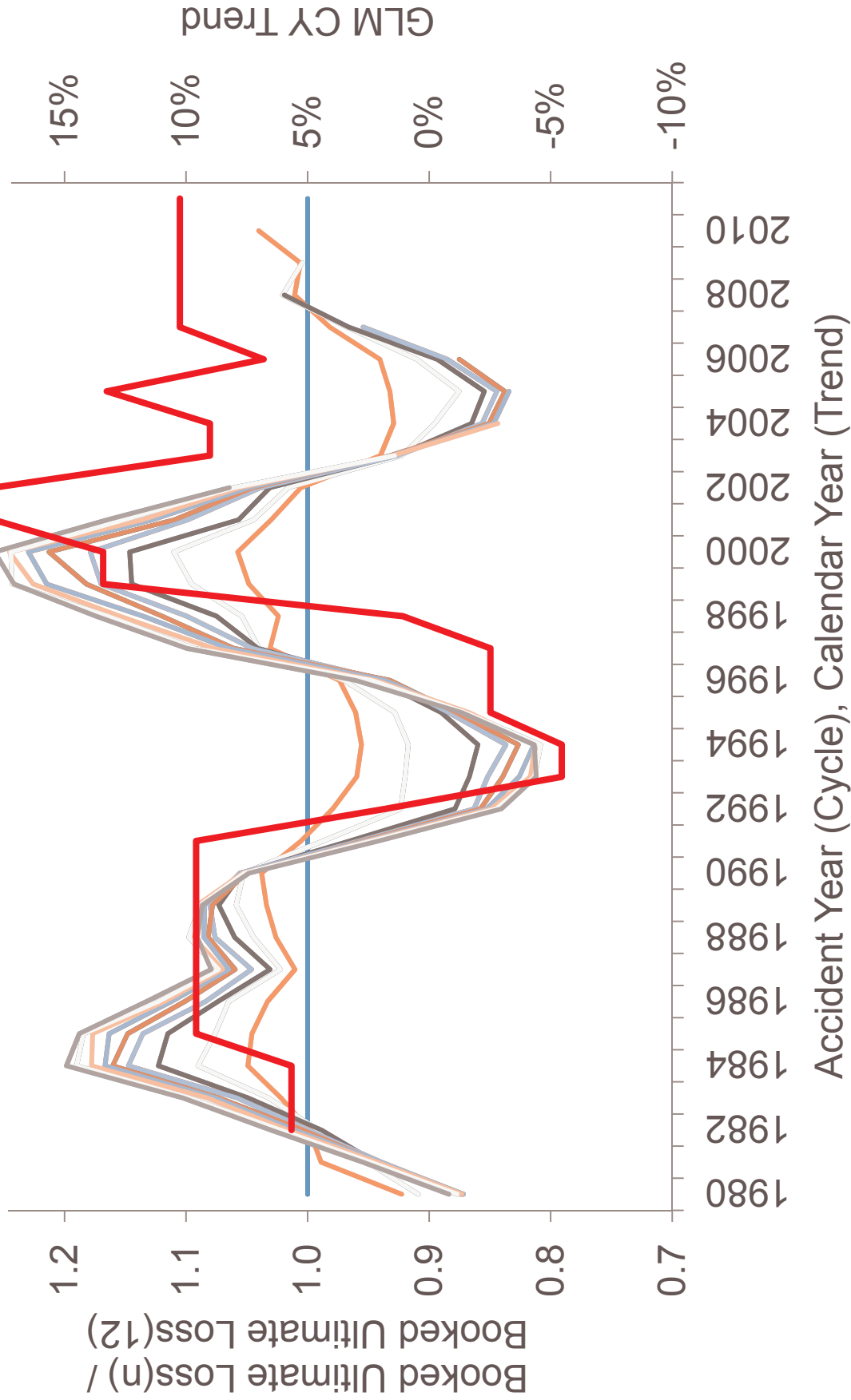
# Measuring CY Trend using a GLM



# Measuring CY Trend using a GLM

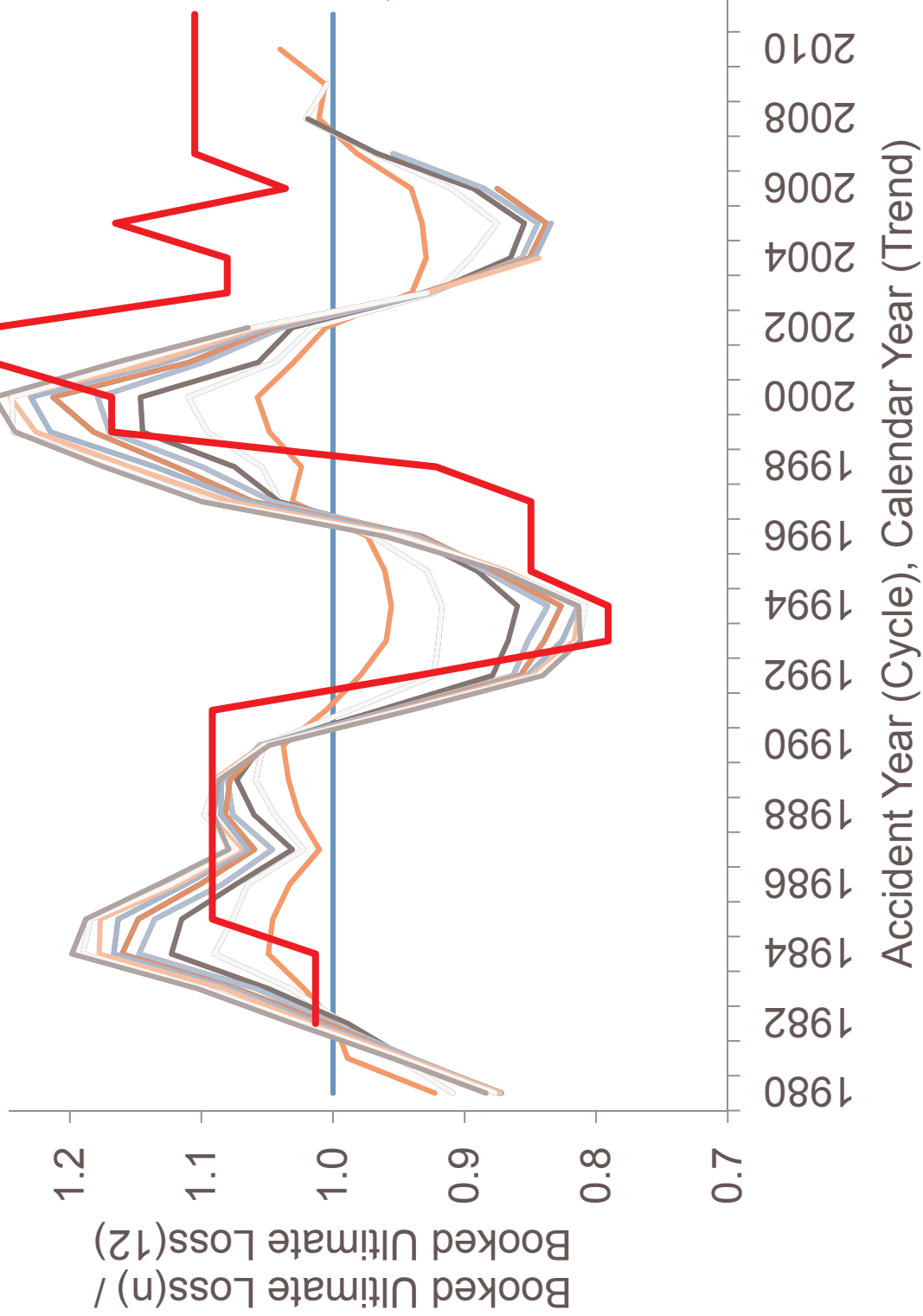


# Workers Compensation and GLM CY trend



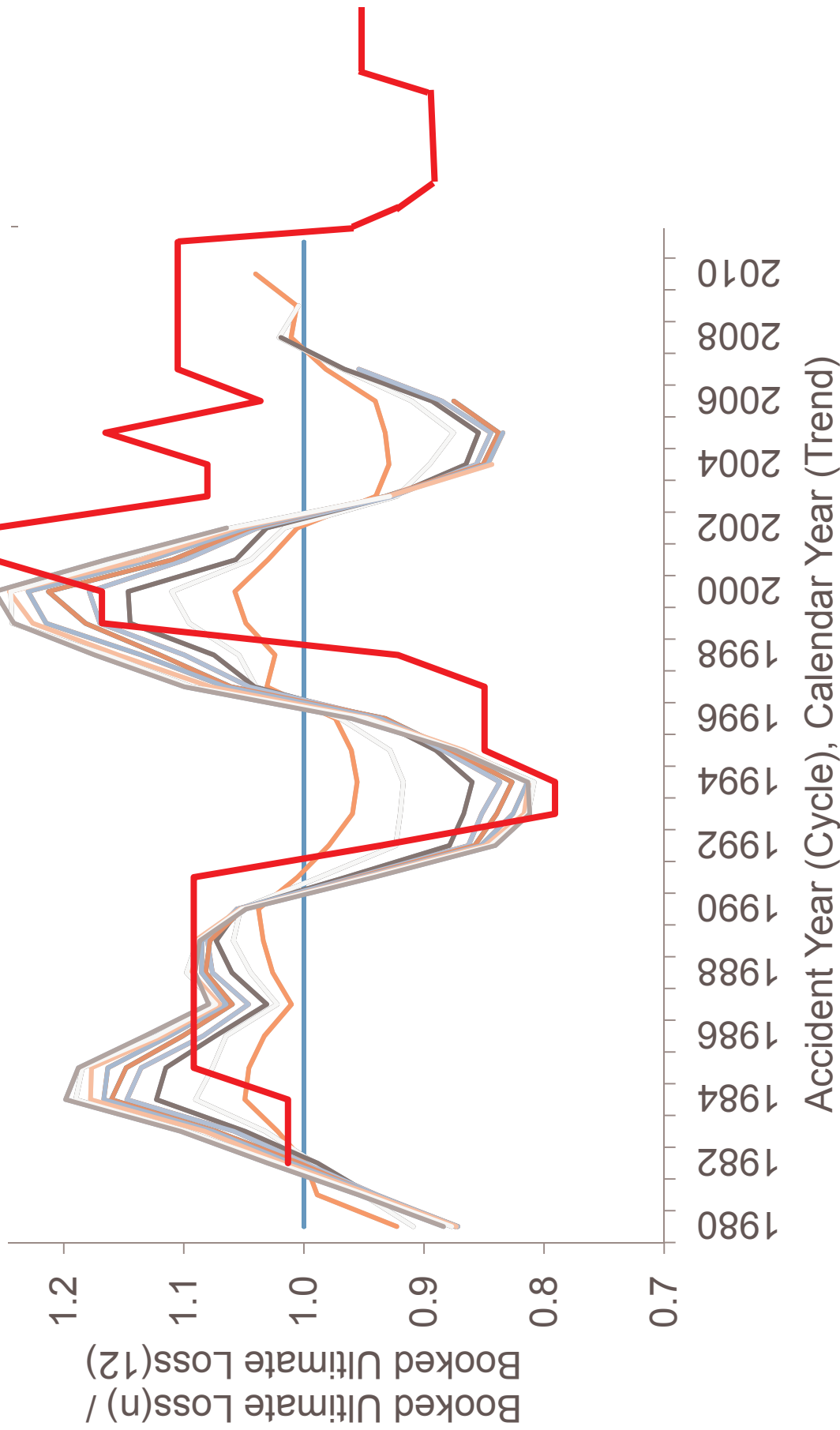
WC cycle is from Guy Carpenter and Risk Lighthouse risk benchmark database  
 GLM CY Trend is a simple average of the GLM calendar year trends from a few large workers compensation writers

# Workers Compensation and GLM CY trend



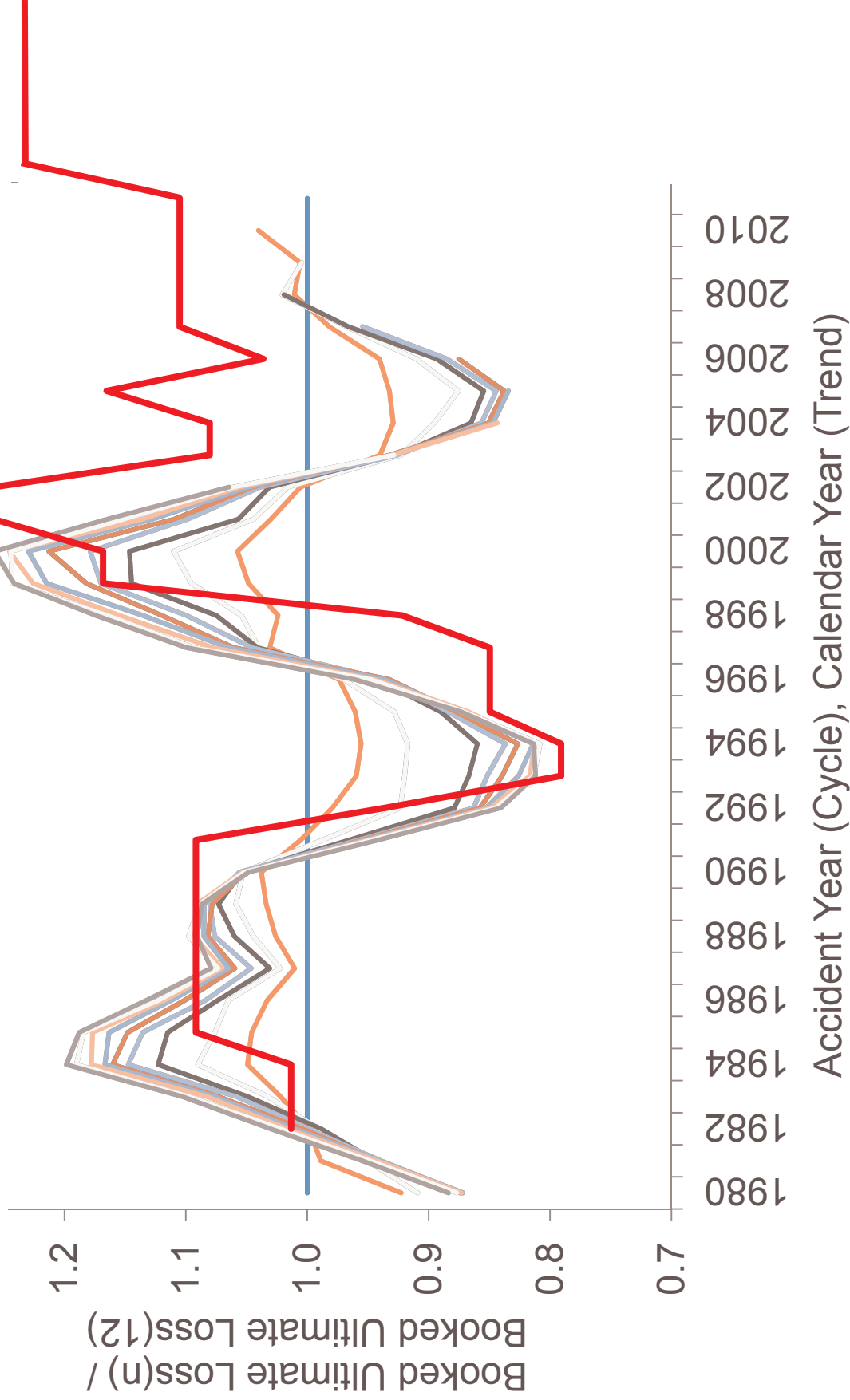
WC cycle is from Guy Carpenter and Risk Lighthouse risk benchmark database  
 GLM CY Trend is a simple average of the GLM calendar year trends from a few large workers compensation writers

# Workers Compensation and GLM CY trend



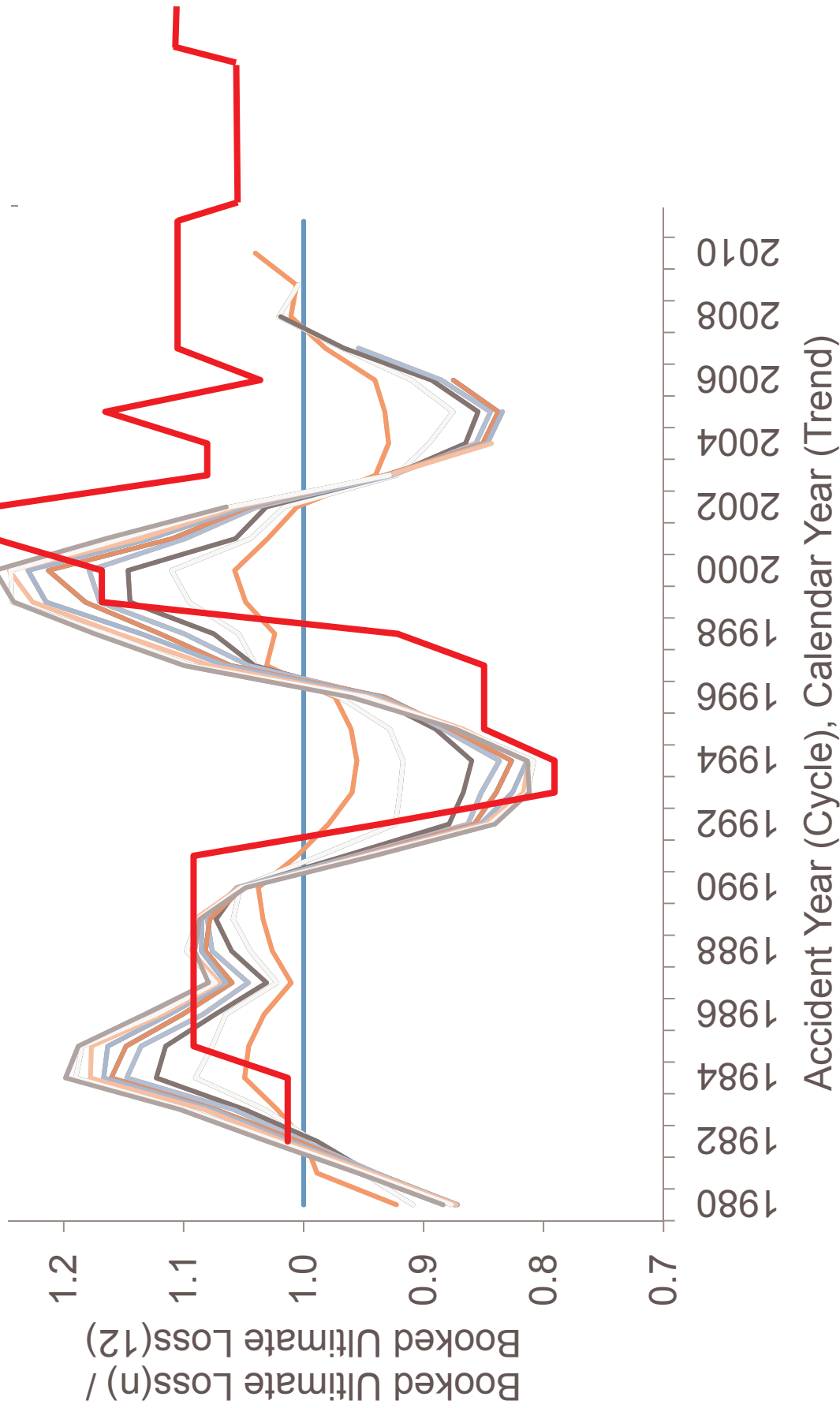
WC cycle is from Guy Carpenter and Risk Lighthouse risk benchmark database  
 GLM CY Trend is a simple average of the GLM calendar year trends from a few large workers compensation writers

# Workers Compensation and GLM CY trend



WC cycle is from Guy Carpenter and Risk Lighthouse risk benchmark database  
 GLM CY Trend is a simple average of the GLM calendar year trends from a few large workers compensation writers

# Workers Compensation and GLM CY trend



WC cycle is from Guy Carpenter and Risk Lighthouse risk benchmark database  
 GLM CY Trend is a simple average of the GLM calendar year trends from a few large workers compensation writers



# Components of a reserve distribution

- Process risk: Bootstrap model
- Systemic risk: CY trend model
- Uncertainty: Qualitative framework

# ■ Uncertainty

- Started writing higher limits in 2012

# ■ Uncertainty

- Started writing higher limits in 2012
- Start up – only started writing 3 years ago

# ■ Uncertainty

- Started writing higher limits in 2012
- Start up – only started writing 3 years ago
- Poor data quality – changes yearly

# Qualitative assessment of risk

Question	Score	Weight
Changes in underwriting	2	30%
Data quality	4	10%
Data quantity	4	30%
<b>Total</b>	<b>3</b>	

# Components of a reserve distribution

- Process risk: Bootstrap model
- Systemic risk: CY trend-based model
- Uncertainty: Framework for judgment

# GUY CARPENTER

Can we get it right??

1. Reserving
2. Reserve risk



“Difficult to see. Always in motion is the future.”





“Difficult to see. Always in motion is the future.”

Yoda

Grand Master of the Jedi Order  
& member of the Jedi High Council of the Galactic Republic

Source: Wookieepedia

