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### UNDERSTANDING AND PROJECTING THE U/W CYCLE – INSURANCE AND REINSURANCE

May 6 & 7, 2010

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Munich Reinsurance America, Inc



Agenda Munich RE 

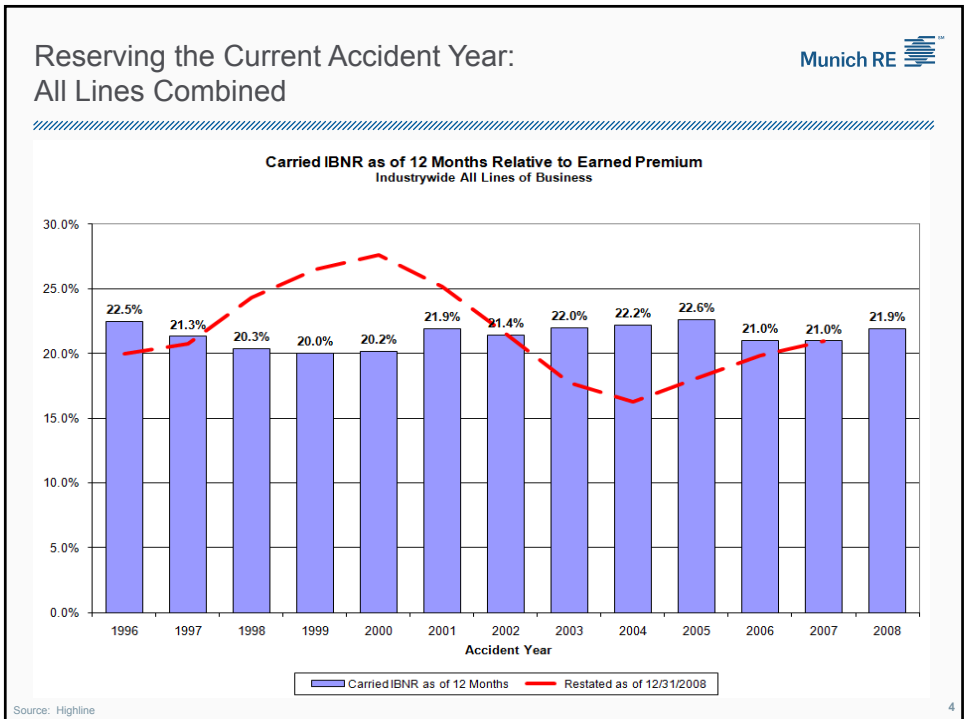
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Industry Reserving for Current Accident Year

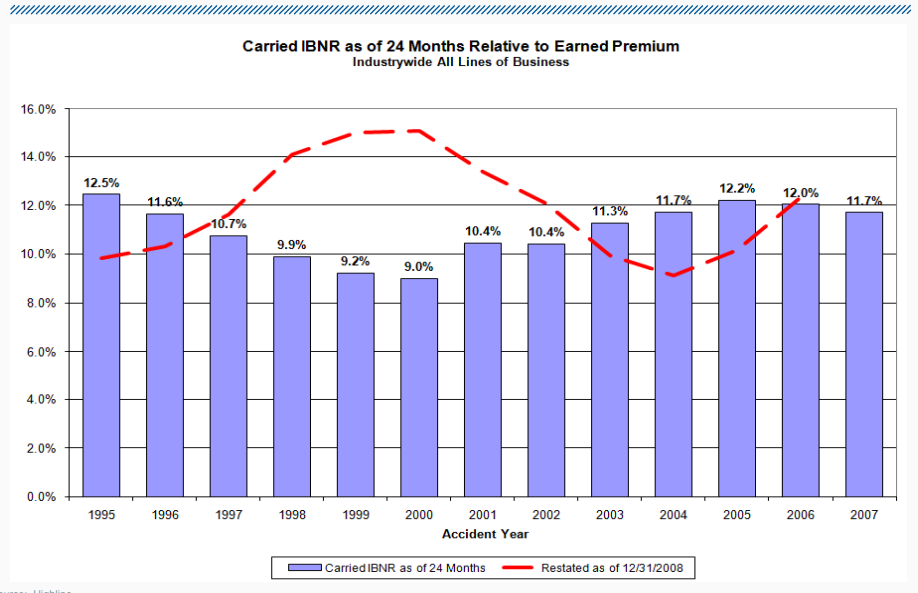
Implications on Calendar Year Results

A Mathematical Model for the Cycle

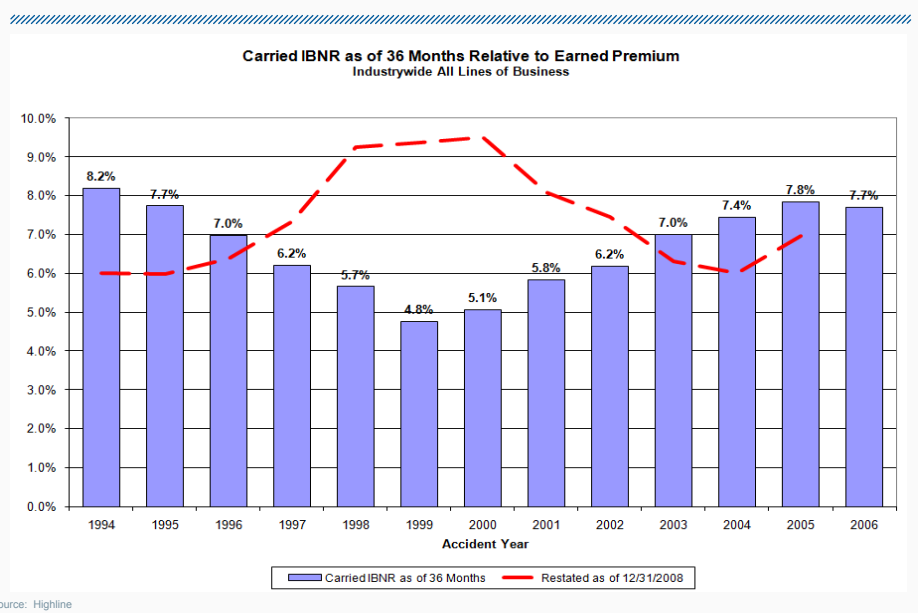
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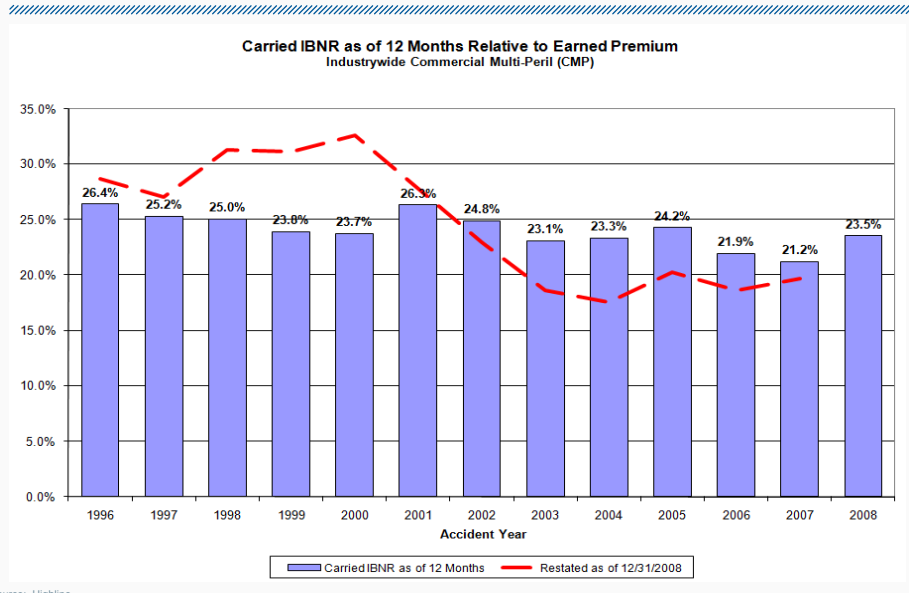
### Reserving the Current Accident Year: All Lines Combined



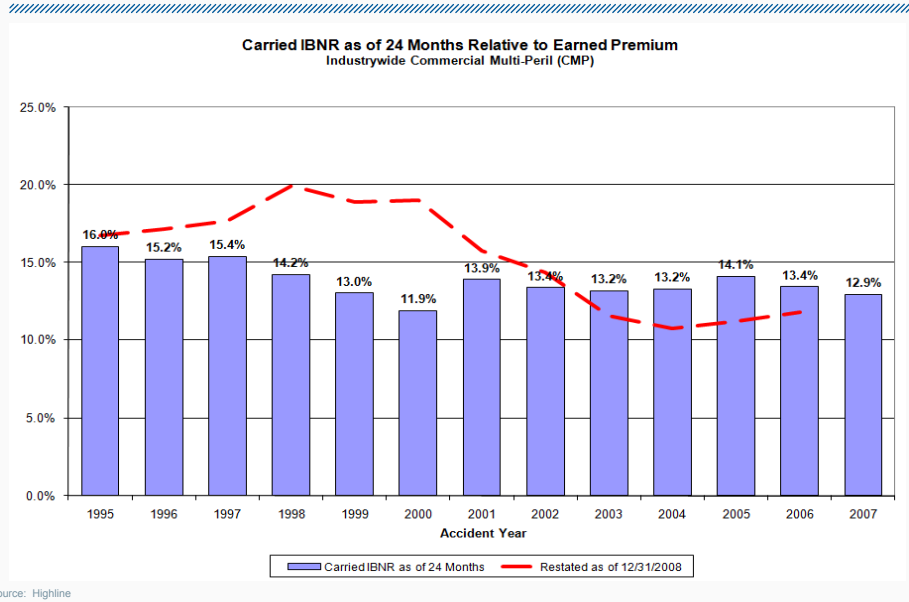
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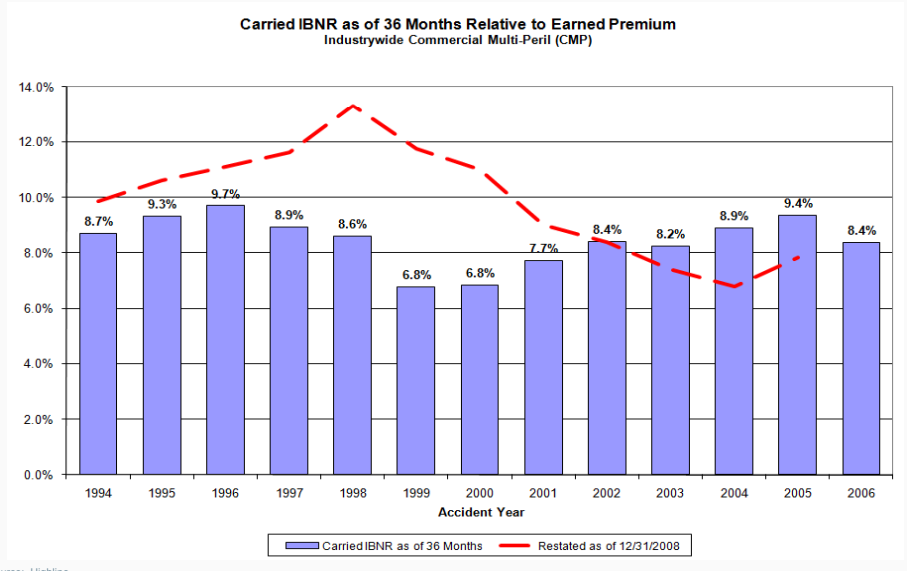
### Reserving the Current Accident Year: Commercial Multiple Peril (CMP)



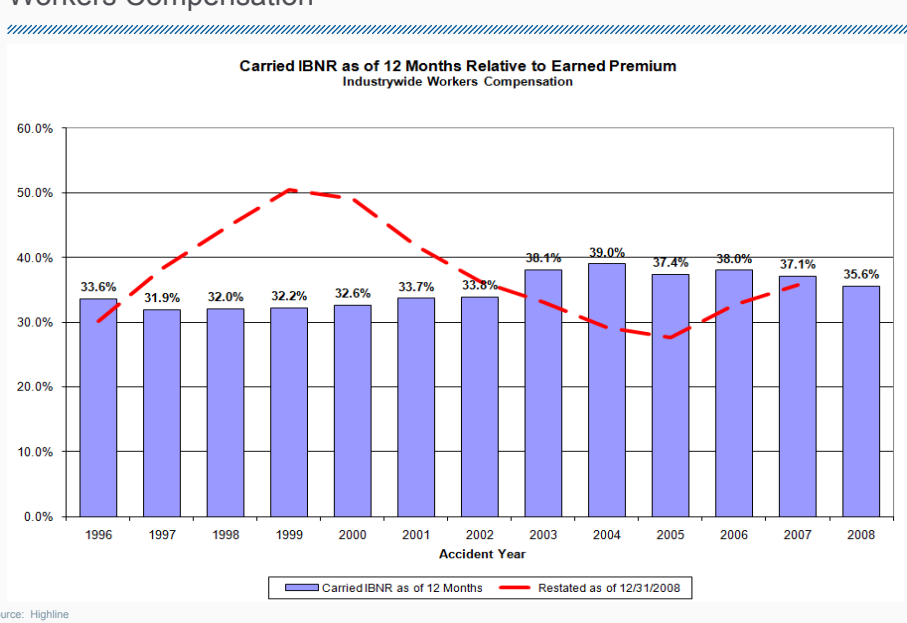
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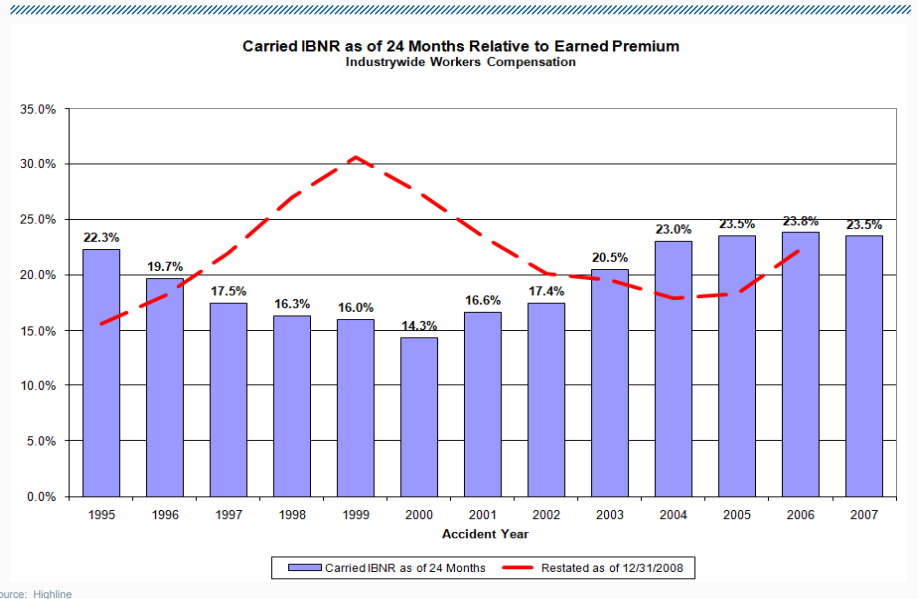
### Reserving the Current Accident Year: Commercial Multiple Peril (CMP)



### Reserving the Current Accident Year: Workers Compensation

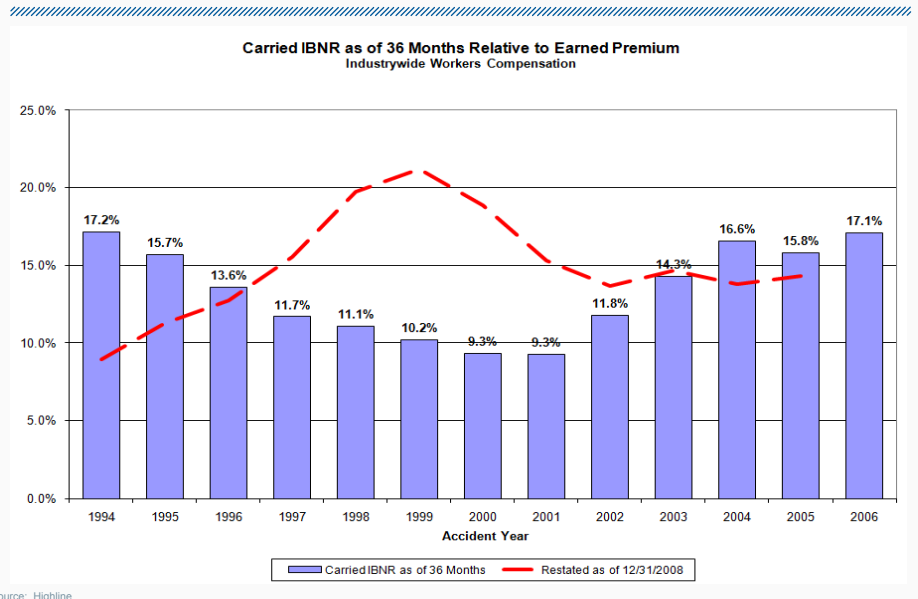


### Reserving the Current Accident Year: Workers Compensation

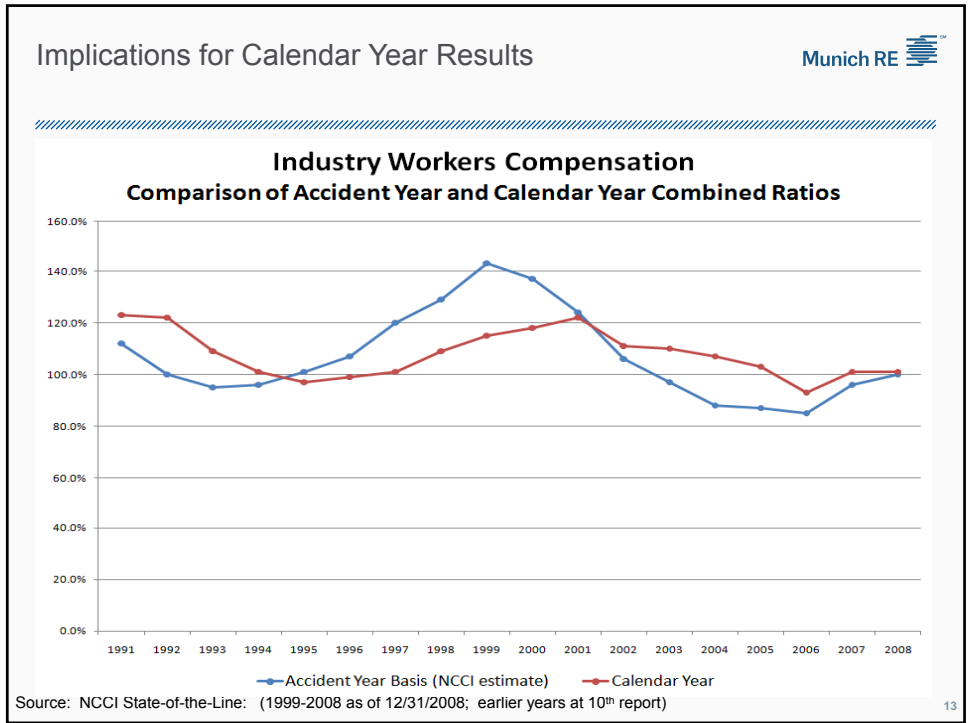


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### Reserving the Current Accident Year: Workers Compensation



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### A Mathematical Model of the U/W Cycle

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#### Assumptions

- Begin with deterministic steady-state for losses:
  - Each year's expected loss is  $(1+g)$  times the prior year
  - Value is unknown, but not a random variable
- Reserving is always done with a Bornhuetter-Ferguson method using the same permissible loss ratio, say,  $PLR=65\%$
- Pricing is done assuming reserving is done correctly
  - Pricing is an average of last three CY losses (adjusted for growth)

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## A Mathematical Model of the U/W Cycle



## Basic Notation:

$L_j$  = expected loss for accident year  $j$

$CYIL_j$  = Booked calendar year  $j$  incurred loss

$g$  = constant growth rate, such that  $L_j = L_{j-1} \cdot (1 + g) \quad \forall j$

$PLR$  = Permissible Loss Ratio

$\{\beta_i\}_{i=1}^{\infty} = \beta_1, \beta_2, \dots, \beta_n, \dots$  = Incremental payment pattern by development period  $i$

Such that  $1 = \sum_{i=1}^{\infty} \beta_i$ ; and also desirable that  $\beta_i > 0 \quad \forall i$

Bornhuetter-Ferguson Estimate for Current Accident Year:

$$L_j \cdot \beta_1 + Premium_j \cdot PLR \cdot (1 - \beta_1)$$

New working paper: "How to Create a Market Cycle"  
<http://www.casact.org/research/wp/>

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## A Mathematical Model of the U/W Cycle



The Premium for a given year is based on the average of the "n" most recent calendar year incurred losses (CYIL).

This definition immediately creates a relationship of calendar year (CY) results as a rolling average of accident year (AY) results.

$$Prem_j = \frac{1}{n} \cdot \sum_{k=1}^n \frac{CYIL_{j-k} \cdot (1+g)^k}{PLR}$$

$$ProfitAY_j = PLR \cdot Prem_j - L_j$$

$$ProfitCY_j = PLR \cdot Prem_j - CYIL_j = \sum_{i=1}^{\infty} ProfitAY_{j+1-i} \cdot \beta_i$$

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## A Mathematical Model of the U/W Cycle



The Calendar Year Incurred Loss (CYIL) can be written in a recursive form as a weighted average of prior calendar year losses. Technically this is known as a **linear difference equation** (discrete analogy to a linear differential equation).

Simplified versions of the cycle can also be generated:

$$CYIL_j - L_j = \frac{1}{n} \cdot \sum_{k=1}^n \left\{ (CYIL_{j-k} - L_{j-k}) - \sum_{i=1}^{\infty} (CYIL_{j+1-i-k} - L_{j+1-i-k}) \cdot \beta_i \right\} \cdot (1+g)^k$$

If  $n=1$  and  $\beta_2 = 1$  and  $\beta_k = 0$  for  $k > 2$  (all loss paid in 2<sup>nd</sup> year):

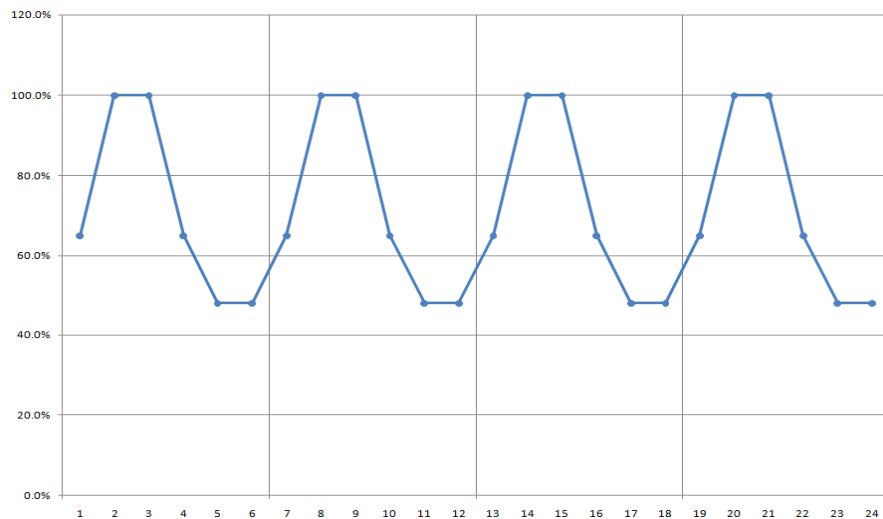
$$CYIL_j - L_j = CYIL_{j-1} - CYIL_{j-2}$$

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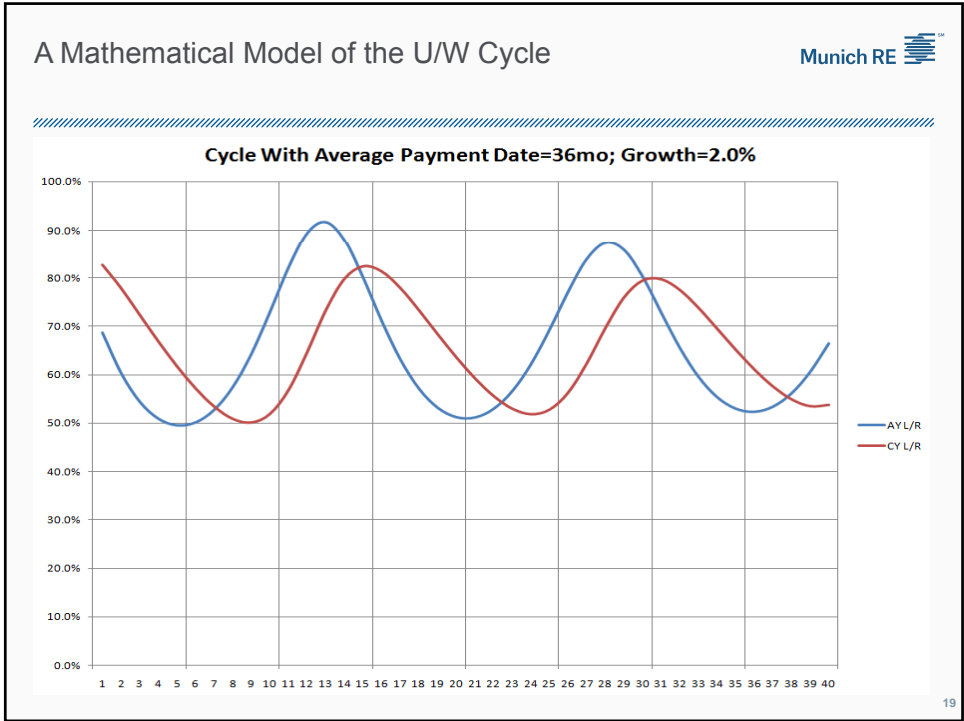
## A Mathematical Model of the U/W Cycle




AY Loss Ratios - All Loss Paid in Second Year



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**Underwriting Cycle involves both pricing and reserving**

- Use of Bornhuetter-Ferguson without changing PLR will perpetuate the cycle

**Impact of the cycle means that reinsurance pricing actuary should:**

- Select your own Loss Development Factors (LDFs) and ultimate losses by historical period
- Do not assume that recent Calendar Year results reflect current level of rate adequacy
- Compare company rate monitors versus other benchmarks

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