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Frequency of valuation for long tail classes

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Introduction

- Long tail classes
  - Low frequency, high severity claims
    - Highly variable claims data
  - Subject to environmental influences
    - Changes in claimant behaviour
    - Changes in judicial decisions
- Challenge for actuary
  - Detect systemic changes in presence of claims volatility
- How frequently should LT classes be revalued?

Introduction

- Question about valuation frequency impacts on two practical issues:
  - For quarterly valuations
    - How much value is there is performing anything more than a simple **roll-forward** of the recent annual valuation?
  - For annual valuations
    - If an actuary prepares an annual valuation prior to the Company's reporting date (say 1 quarter early) what is the magnitude of potential prediction errors?

Overview

- Overview of Approach
- Some specific details of approach
- Results
  1. Effect of claims environment and portfolio size on prediction error of different quarterly valuation methods
  2. Annual valuation update errors
  3. Errors from preparing annual valuation 1 quarter prior to balance date

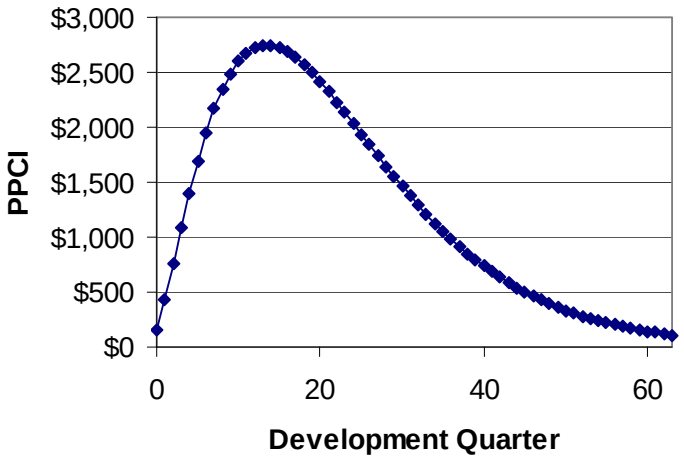
Overview of Approach

- Simulate large number of datasets containing
  - Claims variability
    - Based on realistic models of claims in a motor bodily injury portfolio
  - Systemic changes
    - Simulated using models of superimposed inflation
- Measure prediction error of different quarterly valuation strategies
  - Basic roll-forward
  - Full roll-forward
  - Moving Average
  - AvE Threshold
  - Adaptive filtering
- Measuring prediction error over course of year $\Rightarrow$ indication of value of remodelling at different time intervals

Details of Approach

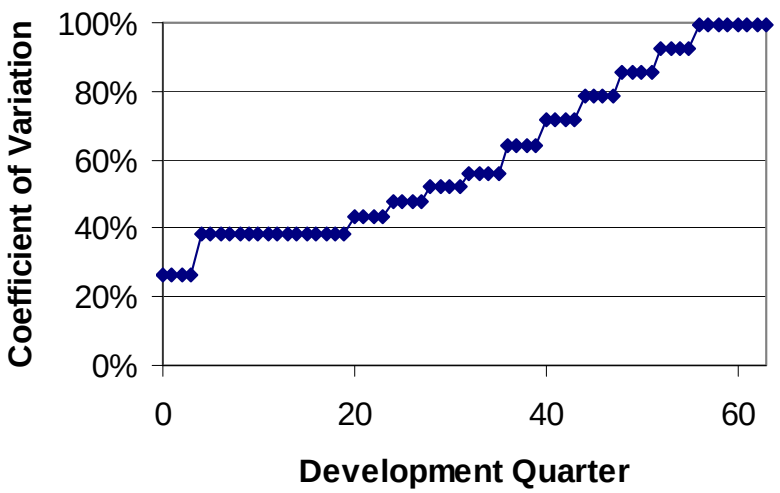
- Modelling Claims – PPCI
  - Assumed to be Log-Normally Distributed
  - PPCI modelled with Hoerl Curve

$$\log PPCI_{ij} = \beta_0 + \beta_1 \log(j+1) + \beta_2 j + \gamma(i,p) + \varepsilon(j), \qquad j = 0,1,\ldots$$



Details of Approach

- Modelling Claims – PPCI
  - Variance of PPCI modelled as:
    - function of j (development quarter)
    - And portfolio size
  - LARGE PORTFOLIO PPCI ~ 1000 claims p.a
  - SMALL PORTFOLIO PPCI ~ 250 claims p.a

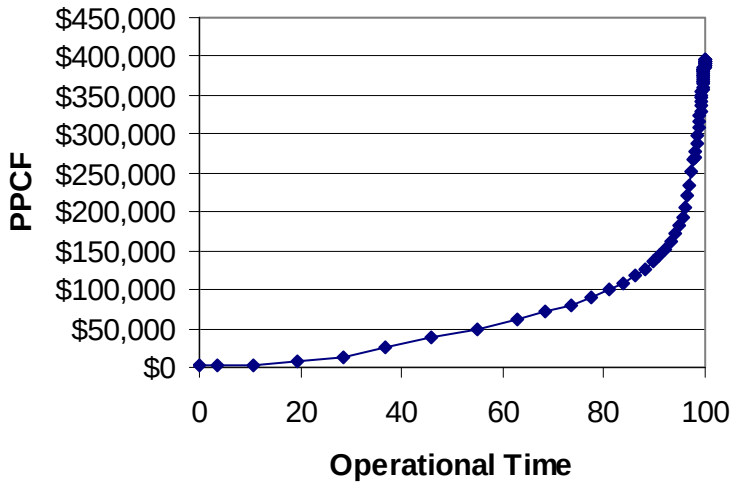


Variation of aggregate PPCI for large portfolio

Details of Approach

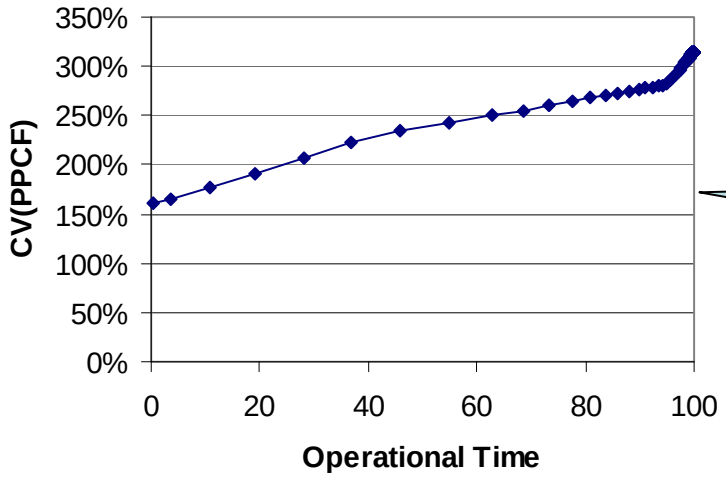
- Modelling Claims – PPCF
  - Assumed to be Log-Normally Distributed
  - PPCF modelled as:

$$\log PPCF_{it} = \beta_0 + \beta_1 t + \beta_2 \max(t-40,0) + \beta_3 \max(t-95,0) + \gamma(i,p) + \varepsilon(t)$$



Details of Approach

- Modelling Claims – PPCF
  - Variance of PPCF modelled as:
    - function of *t* (operational time)
    - And portfolio size
  - LARGE PORTFOLIO PPCF ~ 2 million vehicles
  - SMALL PORTFOLIO PPCF ~ 0.5 million vehicles



Variation of Individual PPCF

Details of Approach

- Superimposed inflation models
  - $\gamma(i, p)$, for superimposed inflation in accident quarter i and experience quarter $p(= i + j)$
  - Modelled as random walk

$$\gamma_{k+1} = \gamma_k + \mu + \sigma Z$$

  - where $k = i$ or p:

$k = i \Rightarrow$ **Accident Quarter SI**

$k = p \Rightarrow$ **Payment Quarter SI**

Details of Approach

- Superimposed inflation models
  - **3 SCENARIOS** $\Leftarrow$ 3 sets of parameters
  - **STABLE**
    - $\mu = 0$, $\sigma = 0.016$
    - 2/3 chance that SI will not change by more than 3% in a year
  - **VARIABLE**
    - $\mu = 0$, $\sigma = 0.032$
    - 2/3 chance that SI will not change by more than 6% in a year
  - T**REND**
    - $\mu = 0.0125$, $\sigma = 0.032$
    - 5% p.a. trend has been added to the variable environment.

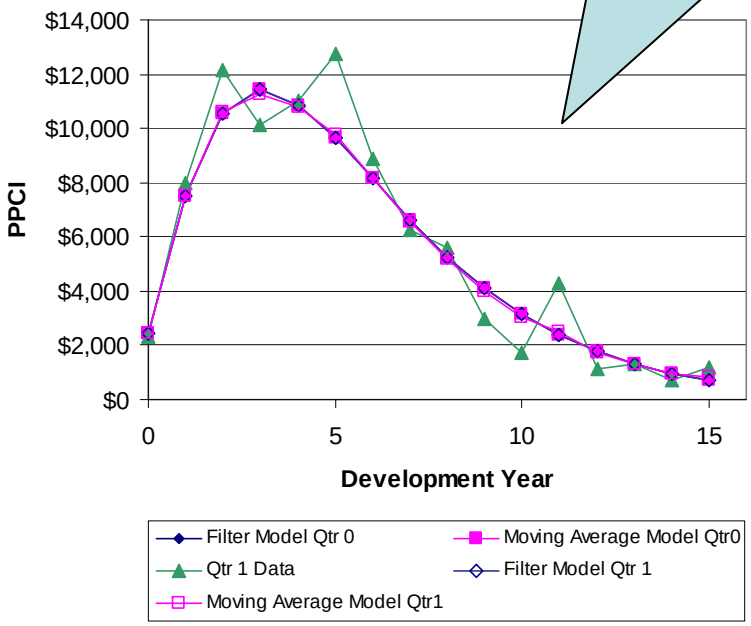
Details of Approach

- Simulation of datasets
  - Combine claim models with SI models $\Rightarrow$ simulate large number of datasets
  - Apply different quarterly valuation strategies to simulated datasets to see how well they pick up the systematic changes amongst the noise
    - Basic roll-forward
    - Full roll-forward
    - Moving Average
    - AvE Threshold
    - Adaptive filtering

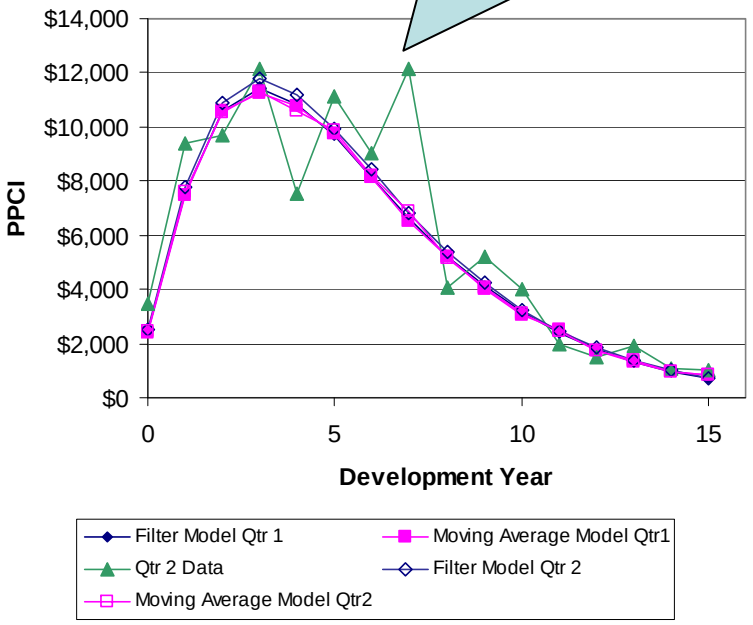
Details of Approach

- Example – PPCI model with trend SI

Refinement of annual valuation model after 1 qtr of data



Refinement of annual valuation model after 2 qtr of data



Details of Approach

- Prediction Error
  - Used to evaluate performance of each valuation method
  - Prediction Error = True Liability – Estimated Liability
  - Is measured at each quarter over the course of the year
  - To keep things consistent – always measured in relation to payments after the end of the year
  - Measure on many datasets -> Distribution of Prediction Error

Details of Approach

- Annual valuation update error
  - **Update error** – size of movement in liabilities between a 3rd quarter valuation and the 4th quarter "full" valuation
  - Measures likely impact if quarterly method doesn't pick up systemic changes as well as the annual valuation method

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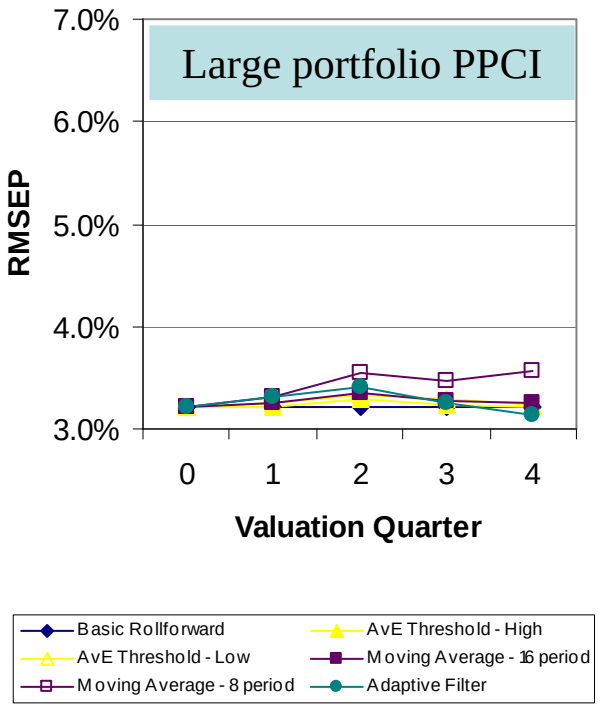
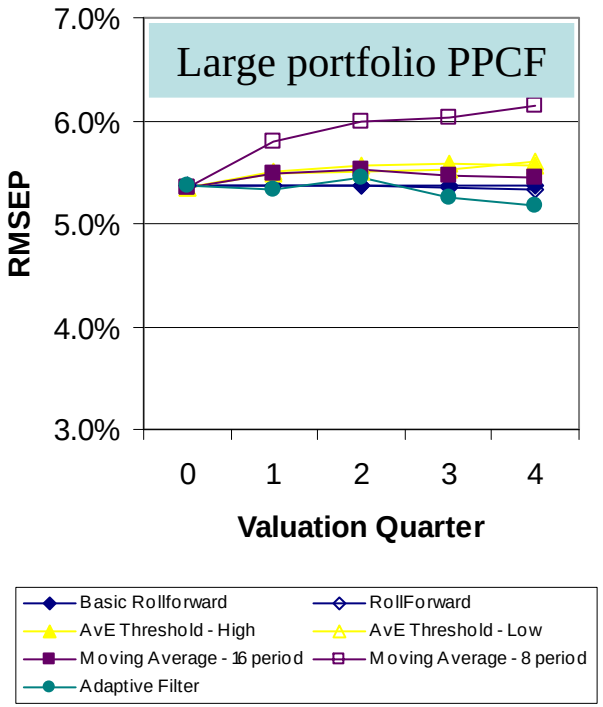
Prediction errors throughout the year

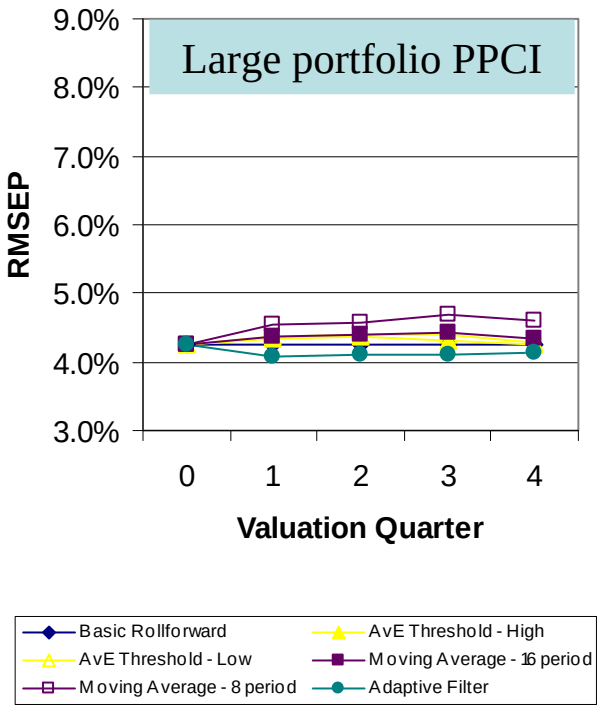
- In a **relatively stable SI environment** remodelling did not improve prediction error
  - Payment Quarter SI

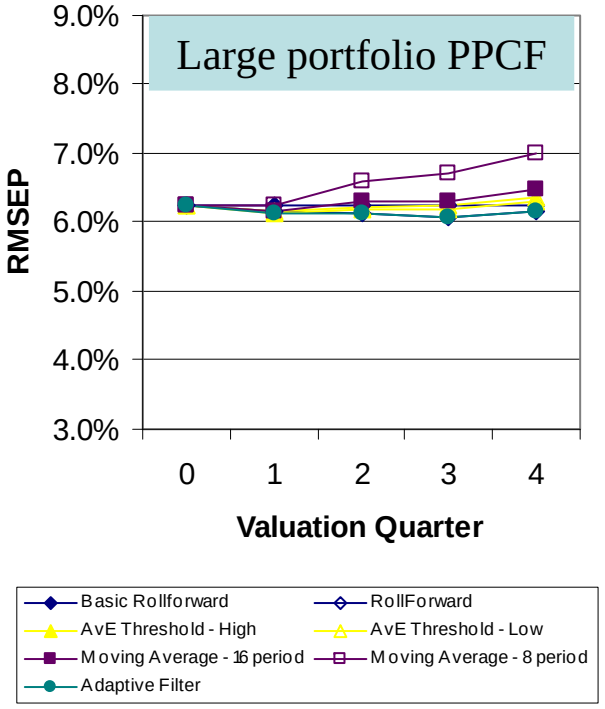




Prediction errors throughout the year

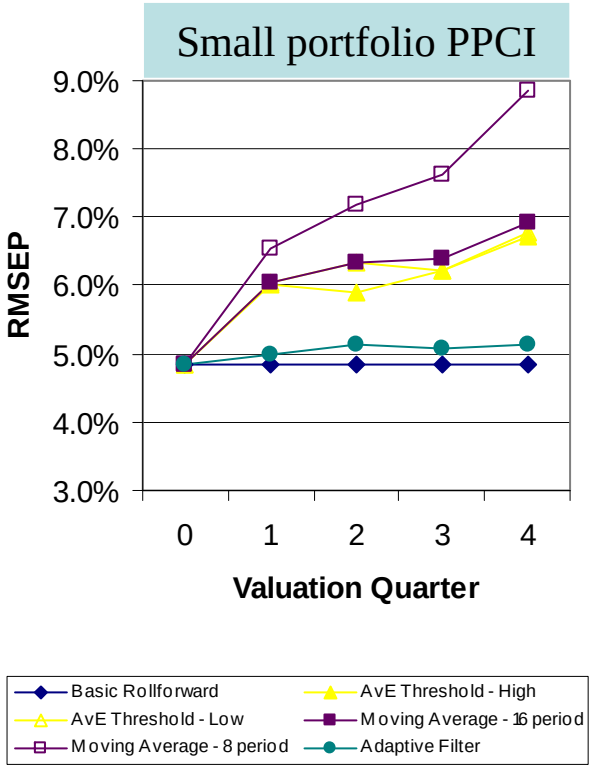
- In a **relatively stable SI environment** remodelling did not improve prediction error
  - Accident Quarter SI

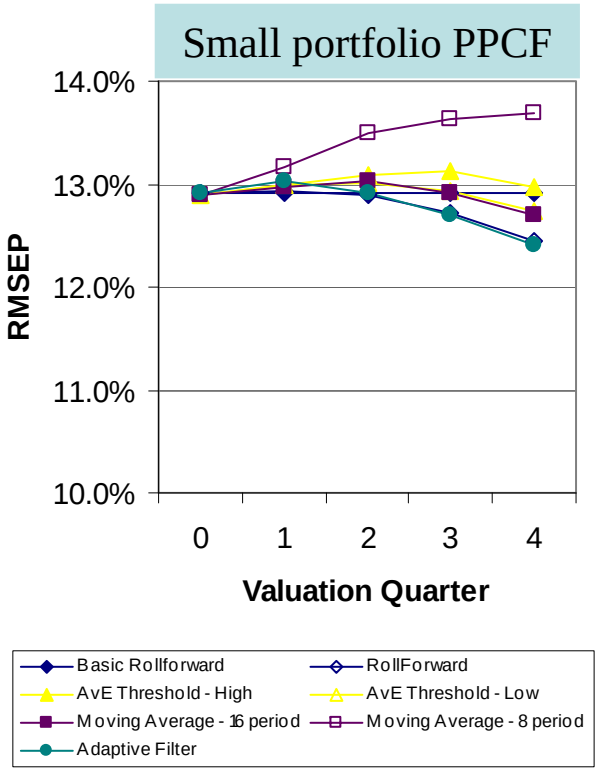




Prediction errors throughout the year

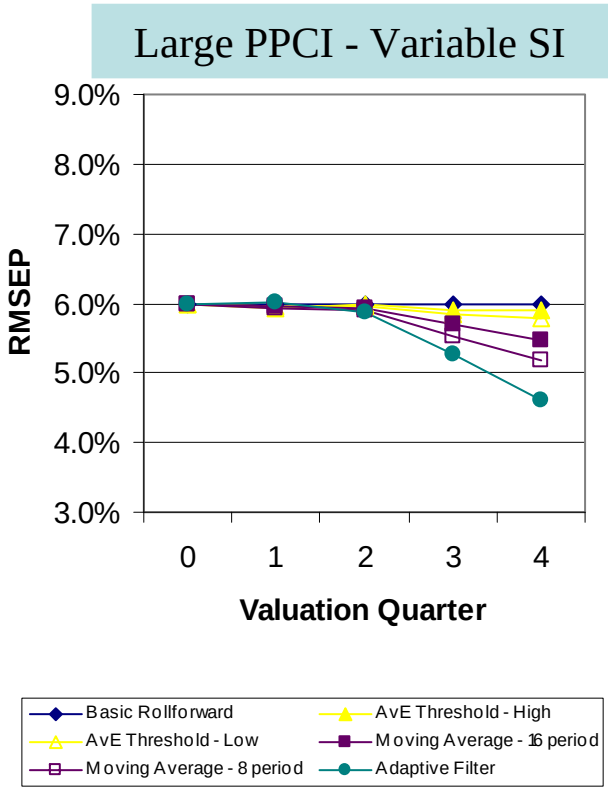
- If portfolio small, or valuation method particularly sensitive to claims volatility, then remodelling ⇒ worse prediction error

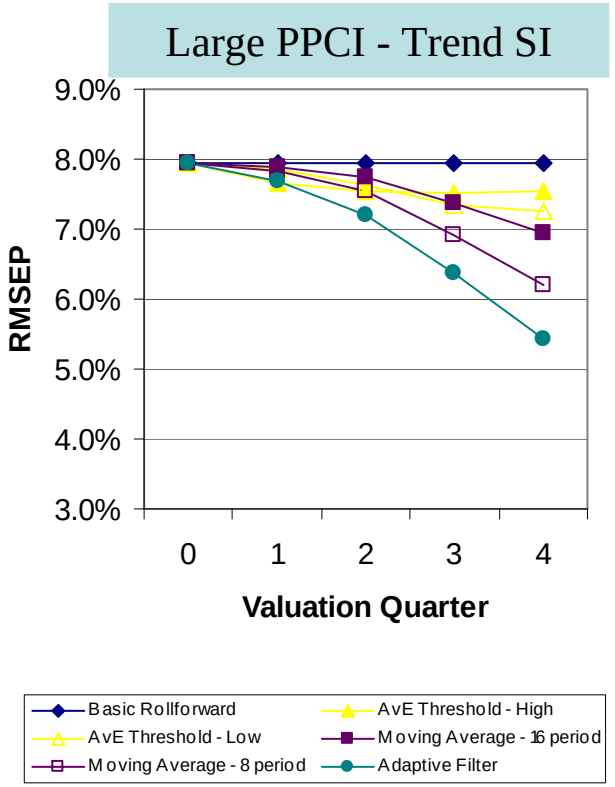




Prediction errors throughout the year

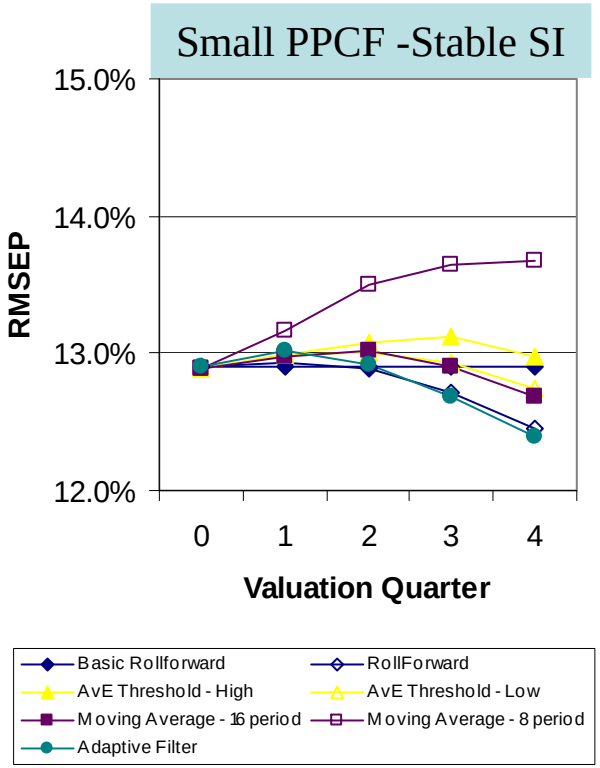
- In **less stable SI** environments, remodelling ⇒ decrease prediction error

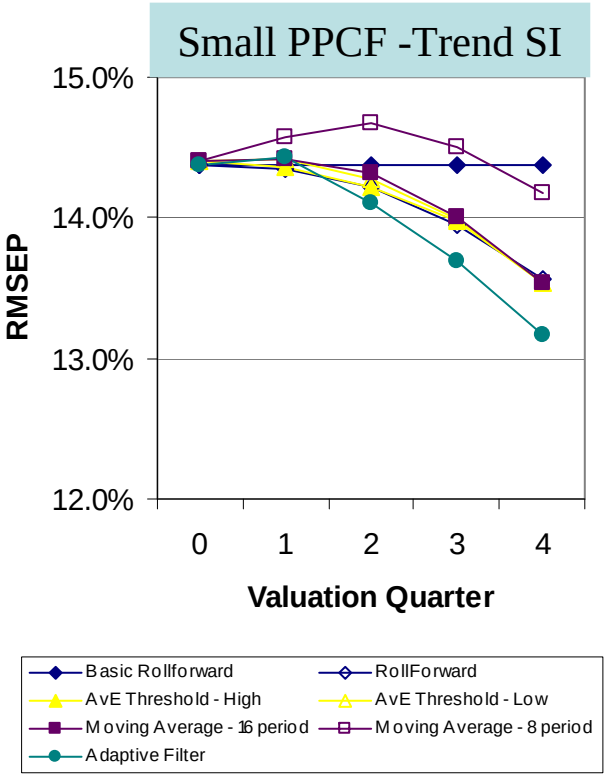




Prediction errors throughout the year

- Full roll-forward gave superior results to basic roll-forward particularly when the portfolio was small





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Annual valuation update errors

- In a relatively **stable SI environment**:

  an appropriate roll-forward procedure did not give appreciably worse update errors

Large Portfolio PPCI – distribution of update error

Valuation Method	Mean			
	Stable - rw	Stable - jump	Variable	Trend
Basic Rollforward	0%	0%	0%	3%
AvE Threshold - High	0%	0%	0%	2%
AvE Threshold - Low	0%	0%	0%	2%
Moving Average - 16 period	0%	0%	0%	2%
Moving Average - 8 period	0%	0%	0%	1%
Adaptive Filter	0%	0%	0%	1%
	Standard Deviation			
	Stable - rw	Stable - jump	Variable	Trend
Basic Rollforward	1%	3%	3%	3%
AvE Threshold - High	1%	2%	3%	3%
AvE Threshold - Low	1%	2%	3%	3%
Moving Average - 16 period	1%	2%	2%	2%
Moving Average - 8 period	1%	2%	2%	2%
Adaptive Filter	1%	2%	2%	2%
	P75			
	Stable - rw	Stable - jump	Variable	Trend
Basic Rollforward	1%	2%	3%	5%
AvE Threshold - High	1%	1%	2%	4%
AvE Threshold - Low	1%	1%	2%	4%
Moving Average - 16 period	1%	1%	2%	4%
Moving Average - 8 period	1%	1%	2%	3%
Adaptive Filter	1%	1%	1%	2%
	P90			
	Stable - rw	Stable - jump	Variable	Trend
Basic Rollforward	2%	3%	5%	8%
AvE Threshold - High	1%	2%	4%	6%
AvE Threshold - Low	1%	2%	4%	6%
Moving Average - 16 period	1%	2%	4%	5%
Moving Average - 8 period	2%	2%	3%	4%
Adaptive Filter	1%	2%	2%	3%

Annual valuation update errors

- Inappropriate quarterly remodelling ⇒

  worse update errors compared to not remodelling at all

Small Portfolio PPCI – distribution of update error

Valuation Method	Mean			
	Stable - rw	Stable - jump	Variable	Trend
Basic Rollforward	0%	0%	0%	2%
AvE Threshold - High	-1%	-1%	-1%	0%
AvE Threshold - Low	0%	0%	0%	1%
Moving Average - 16 period	0%	0%	1%	1%
Moving Average - 8 period	0%	0%	0%	1%
Adaptive Filter	0%	0%	0%	0%
	Standard Deviation			
	Stable - rw	Stable - jump	Variable	Trend
Basic Rollforward	1%	3%	3%	3%
AvE Threshold - High	3%	3%	4%	4%
AvE Threshold - Low	3%	4%	4%	4%
Moving Average - 16 period	3%	4%	4%	4%
Moving Average - 8 period	5%	5%	5%	5%
Adaptive Filter	1%	2%	1%	1%
	P75			
	Stable - rw	Stable - jump	Variable	Trend
Basic Rollforward	1%	2%	2%	4%
AvE Threshold - High	1%	2%	2%	3%
AvE Threshold - Low	2%	3%	3%	4%
Moving Average - 16 period	3%	3%	3%	4%
Moving Average - 8 period	4%	4%	4%	4%
Adaptive Filter	0%	1%	1%	2%
	P90			
	Stable - rw	Stable - jump	Variable	Trend
Basic Rollforward	2%	4%	4%	5%
AvE Threshold - High	3%	4%	4%	5%
AvE Threshold - Low	4%	4%	5%	5%
Moving Average - 16 period	4%	4%	5%	6%
Moving Average - 8 period	6%	6%	7%	7%
Adaptive Filter	1%	2%	2%	2%

Annual valuation update errors

Valuation Method	Mean			
	Stable - rw	Stable - jump	Variable	Trend
Basic Rollforward	0%	0%	0%	3%
AvE Threshold - High	0%	0%	0%	2%
AvE Threshold - Low	0%	0%	0%	2%
Moving Average - 16 period	0%	0%	0%	2%
Moving Average - 8 period	0%	0%	0%	1%
Adaptive Filter	0%	0%	0%	1%
	Standard Deviation			
	Stable - rw	Stable - jump	Variable	Trend
Basic Rollforward	1%	3%	3%	3%
AvE Threshold - High	1%	2%	3%	3%
AvE Threshold - Low	1%	2%	3%	3%
Moving Average - 16 period	1%	2%	2%	2%
Moving Average - 8 period	1%	2%	2%	2%
Adaptive Filter	1%	2%	2%	2%
	P75			
	Stable - rw	Stable - jump	Variable	Trend
Basic Rollforward	1%	2%	3%	5%
AvE Threshold - High	1%	1%	2%	4%
AvE Threshold - Low	1%	1%	2%	4%
Moving Average - 16 period	1%	1%	2%	4%
Moving Average - 8 period	1%	1%	2%	3%
Adaptive Filter	1%	1%	1%	2%
	P90			
	Stable - rw	Stable - jump	Variable	Trend
Basic Rollforward	2%	3%	5%	8%
AvE Threshold - High	1%	2%	4%	6%
AvE Threshold - Low	1%	2%	4%	6%
Moving Average - 16 period	1%	2%	4%	5%
Moving Average - 8 period	2%	2%	3%	4%
Adaptive Filter	1%	2%	2%	3%

- **Unstable SI environment**: a roll-forward strategy gave larger update errors

Large Portfolio PPCI – distribution of update error

Difference in update errors:
3% at P75
5% at P90

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Early preparation of annual valuation

- Remodelling with only one extra quarter of data at best leads to a marginal improvement in prediction error
  - At most 1-2% at 75th percentile

Small Portfolio PPCI – distribution of prediction error 1 quarter after full valuation

Valuation Method	Mean			
	Stable - rw	Stable - jump	Variable	Trend
Basic Rollforward	0%	0%	0%	5%
AvE Threshold - High	0%	0%	0%	5%
AvE Threshold - Low	0%	0%	0%	6%
Moving Average - 16 period	0%	0%	1%	6%
Moving Average - 8 period	0%	0%	1%	6%
Adaptive Filter	0%	0%	0%	5%
	Standard Deviation			
	Stable - rw	Stable - jump	Variable	Trend
Basic Rollforward	5%	6%	6%	6%
AvE Threshold - High	6%	6%	7%	7%
AvE Threshold - Low	6%	6%	7%	7%
Moving Average - 16 period	6%	6%	7%	7%
Moving Average - 8 period	6%	7%	7%	7%
Adaptive Filter	5%	6%	7%	7%
	P75			
	Stable - rw	Stable - jump	Variable	Trend
Basic Rollforward	4%	3%	4%	10%
AvE Threshold - High	4%	4%	6%	11%
AvE Threshold - Low	4%	5%	6%	12%
Moving Average - 16 period	5%	5%	6%	12%
Moving Average - 8 period	5%	5%	6%	12%
Adaptive Filter	4%	4%	6%	11%
	P90			
	Stable - rw	Stable - jump	Variable	Trend
Basic Rollforward	7%	9%	9%	15%
AvE Threshold - High	8%	9%	10%	16%
AvE Threshold - Low	8%	9%	10%	17%
Moving Average - 16 period	8%	9%	11%	17%
Moving Average - 8 period	9%	10%	12%	18%
Adaptive Filter	7%	9%	10%	16%

Conclusions

- In many circumstances, remodelling at quarterly intervals will not improve prediction error
  - Larger portfolio and systemic changes ⇒ more value from frequent valuation
  - Framework and approach used in this paper can be used to assess the reasonableness of a particular quarterly valuation approach

- For the models and SI scenarios tested in this paper:
  - The difference in update errors between a roll-forward strategy and a full remodelling strategy were at most 5% at the 90th percentile
    - Magnitude of errors needs to be considered in light of
      - other uncertainties (e.g. how future SI will continue to evolve)
      - objectives of stakeholders
  - prediction error is not significantly increased by performing the valuation one quarter early