

Property-Liability Insurance Loss Reserve Ranges Based on Economic Value

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Overview

- Background
 - Loss reserve ranges
 - Economic value of loss reserves
 - Inflation
- Methodology
- Running the model
- Results
- Further research
- Conclusions

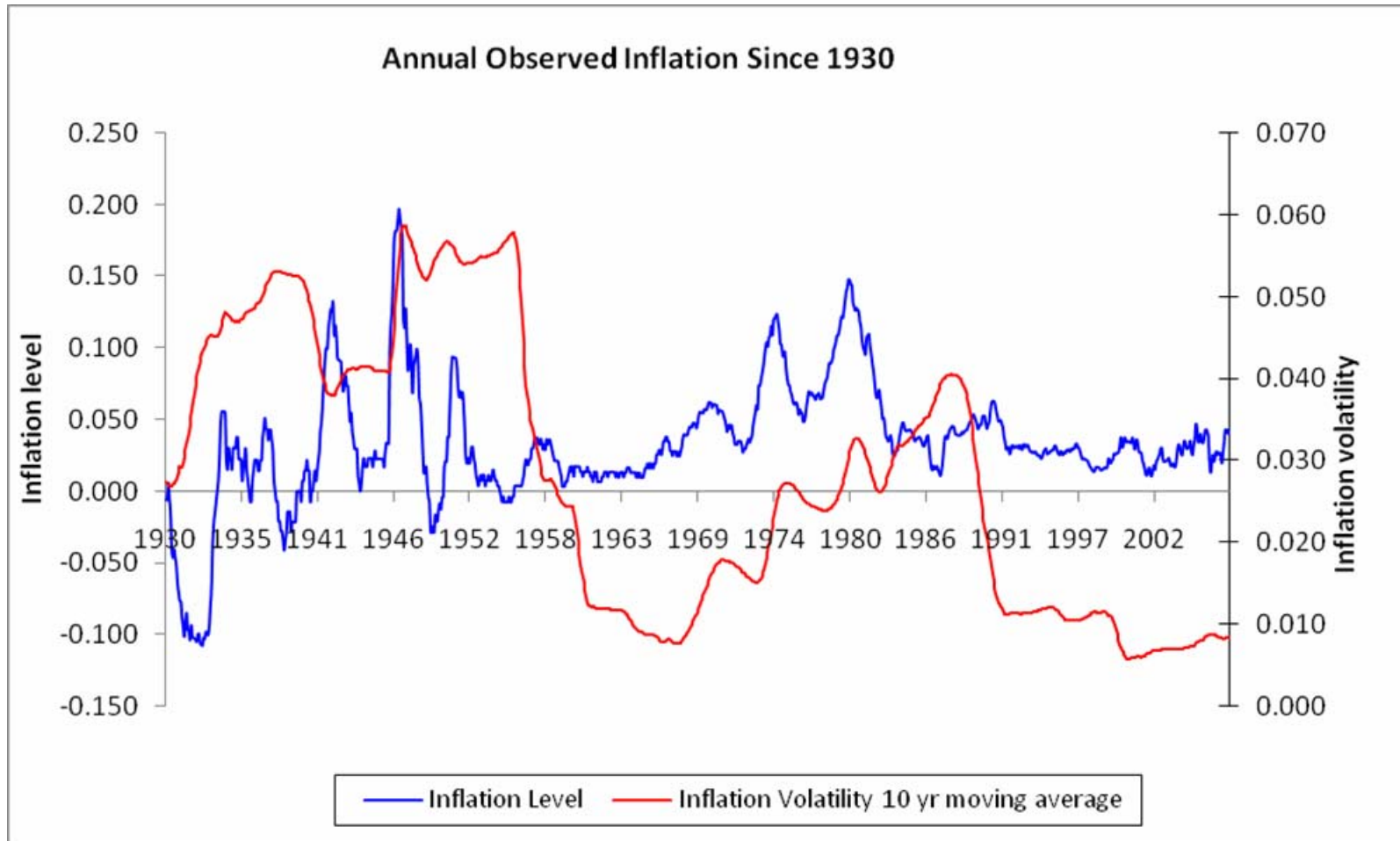
Background

- Traditional loss reserving methods
 - Nominal, undiscounted, for statutory requirements
 - Impacts of inflation on traditional methods

Background

- Recent Developments
 - ALM
 - FASB & IASC: “Fair Value”
 - CEA: Solvency II
 - S&P criticism

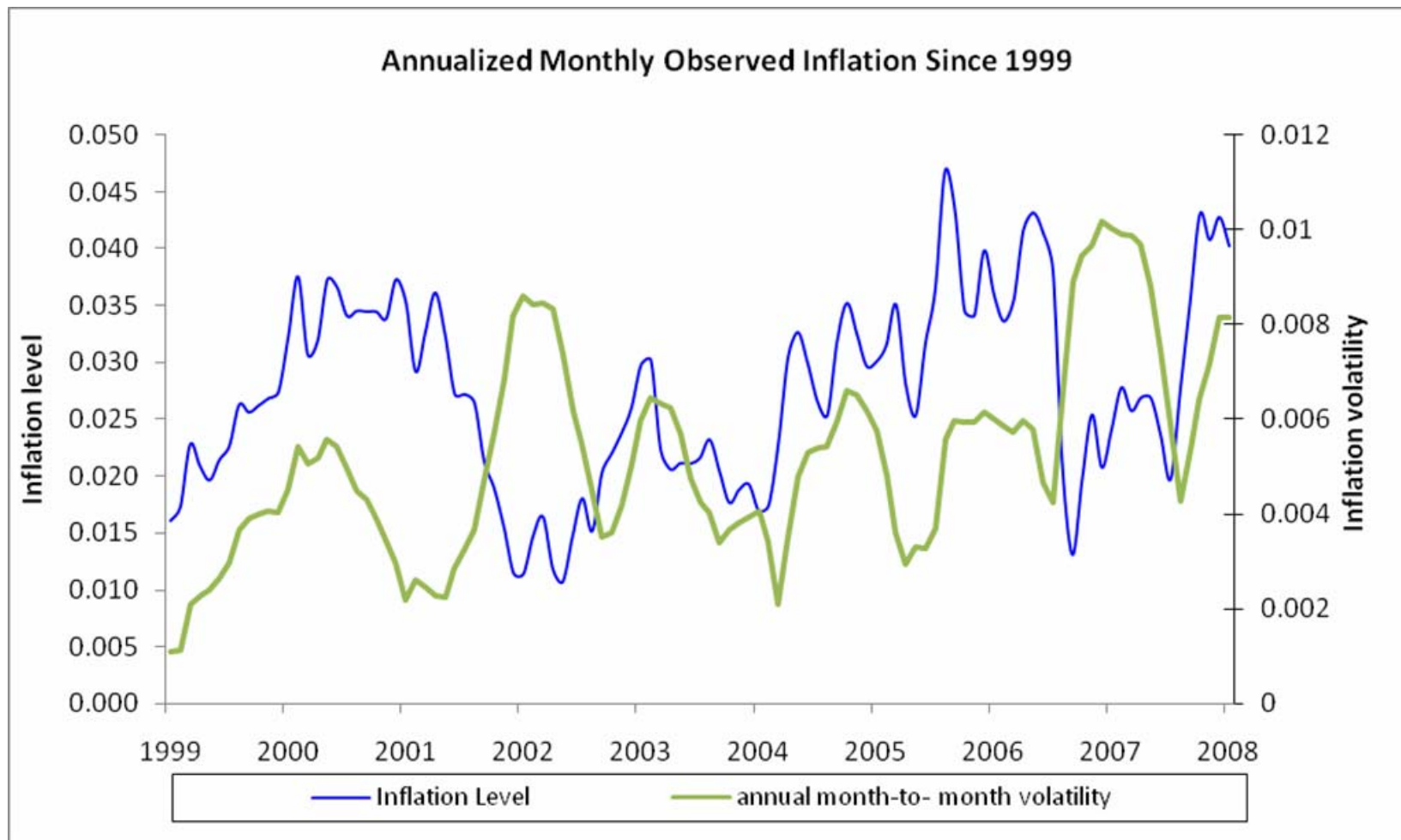
Trends in Inflation



Trends in Inflation

- Increasing oil prices
- Depreciation of the dollar
- Sub-prime mortgage, credit crunch
- Fed lowered discount rate

Trends in Inflation



Methodology

- Loss generation model
- Loss decay model (payment pattern)
- Inflation model
 - Ornstein-Uhlenbeck
 - Masterson Claim Cost Index
- Nominal interest rate model
 - 2 factor Hull-White
- Fixed claim model
 - D'Arcy & Gorvett

Loss Generation Model

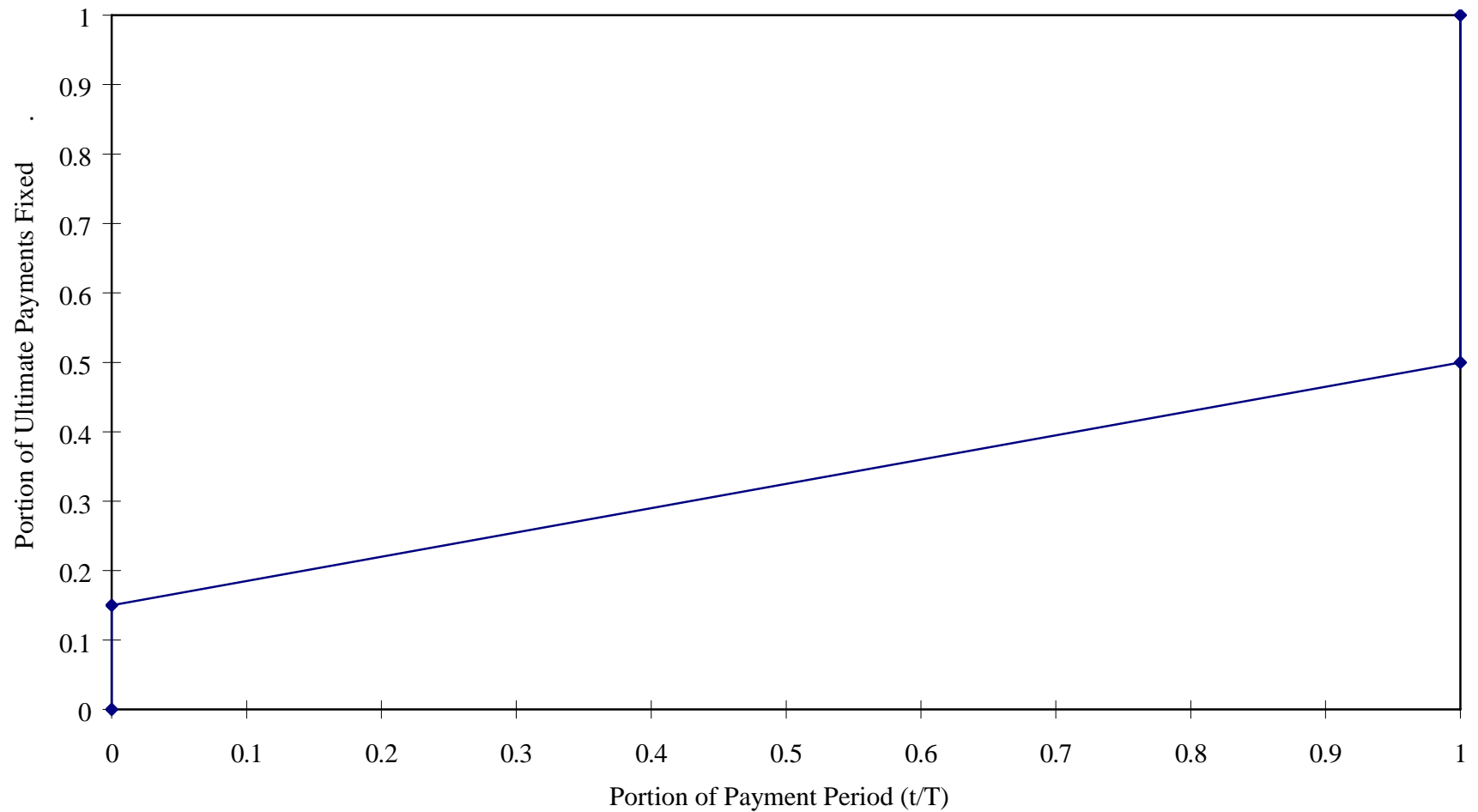
- Nominal values:
 - Normally generated losses compounded by the nominal interest rate
- Economic values:
 - Nominal losses discounted by the inflation rate

Fixed Claim Model

FIXED CLAIM MODEL
FORMULA FOR "FIXED" COSTS

$$f(x) = k + (1-k-m)(t/T)^n$$

$$k = 0.15, m = 0.5, n = 1$$



Fixed Claim Model

- Discrete approximation of continuous function
- Impact of inflation on fixed claim model

Running the Model

<http://www.business.uiuc.edu/~s-darcy/papers/LossReserveRangeModelv2.xls>

- Input Sheet
- Loss Generator
- Nominal Interest Rate
- Inflation
- Inflation under Fixed Claim
- Fixed Claim Model
- Summary
- Masterson Claim Cost Index

Input Sheet

Loss Model Parameters	
No. of Claims	1000
Loss Distribution	Lognormal
Mean	1000
Standard Deviation	500
Settlement type	Decay Model
Settlement (years)	10
Hull-White 2-Factor Nominal Interest Rate Model Parameters	
Short-Term Mean-Reversion Speed	0.06
Current Short-Term Rate	2.12%
Short-Term Volatility	1.55%
Long-Term Mean-Reversion Speed	0.07
Long-Term Mean	6.69%
Long-Term Volatility	0.96%
Ornstein-Uhlenbeck Inflation Rate Model Parameters	
Mean-Reversion Speed	0.23
Long-Term Mean	4.12%
Current Short-Term Rate	3.54%
Volatility	1.90%
Correlation between Nominal Interest Rate and Inflation	45%
Claim Cost Regression Slope	1.60
Claim Cost Regression Intercept	0.00
Simulation	
No. of Simulation Iterations	10000
Time Step	0.083
Decay Model: $z(t+1) = (1-a)z(t)$	
Annual Decay Factor	0.5
Fixed Claim Model: $f(t) = k + (1-k-m)(t/T)^n$	
Fixed Portion at time 0 (k)	0.15
Portion unknown until settlement (m)	0.5
Speed of fixed settlement (n)	1
Generate Histogram	<input checked="" type="checkbox"/>
<input type="button" value="Run Simulation"/>	

Loss Generator

Loss Generator								Nominal	Economic			
			Time to	Inflation	Discount	Nominal	Economic	Value	Value			
Claim	Random No.	Severity	Settlement	Factor	Factor	Value	Value	Mean	Mean	Claim Settlement Distribution		
1	0.4381	830.9586	3.6667	1.2703	0.9365	1055.5872	988.5301	1061252	1032696	Decay Model: $x(t+1) = (1-a)x(t)$, $x(0) =$ No. of Claims		
2	0.8897	1595.4998	1.0000	1.0381	0.9755	1656.2912	1615.7112			a	0.5	
3	0.0269	359.7058	1.5833	1.0682	0.9679	384.2538	371.9190					
4	0.2730	672.5134	0.4167	1.0164	0.9904	683.5443	676.9713			Cumulative Pr	Time	Count
5	0.2763	675.6815	3.0833	1.2025	0.9464	812.5386	768.9883			0.0000	0.0833	54
6	0.0818	463.2301	1.6667	1.0747	0.9667	497.8462	481.2892			0.0561	0.1667	54
7	0.8442	1442.4336	0.7500	1.0282	0.9815	1483.1201	1455.6399			0.1091	0.2500	56
8	0.5448	943.2253	0.7500	1.0282	0.9815	969.8307	951.8611			0.1591	0.3333	55
9	0.2735	672.9734	0.6667	1.0249	0.9840	689.7287	678.7073			0.2063	0.4167	59
10	0.4702	863.4188	1.6667	1.0747	0.9667	927.9400	897.0793			0.2508	0.5000	39
11	0.1937	594.6111	0.9167	1.0348	0.9773	615.3101	601.3587			0.2929	0.5833	42
12	0.1593	558.3649	4.5833	1.3948	0.9258	778.8077	721.0074			0.3326	0.6667	43
13	0.1226	516.5451	3.9167	1.3023	0.9326	672.7219	627.3883			0.3700	0.7500	45
14	0.3887	782.6413	0.6667	1.0249	0.9840	802.1271	789.3097			0.4054	0.8333	38

Nominal Interest Rate

Nominal Interest Rate Generator									
	Short-Term	Long-Term	Hull-White	Hull-White		Cumulative			Correlation Weights
	Random	Random	Short-Term	Long-Term	Discount	Discount		Correlated	Correlated
Time	Z	Z	Nominal Interest Rate	Nominal Interest Rate	Factor	Factor		Random Z	Independent
0			0.0212	0.0669					0.45
0.0833	0.1359	-1.9551	0.0244	0.0615	0.9980	0.9980		1.1829	0.89302855
0.1667	-0.1162	-0.1944	0.0271	0.0610	0.9977	0.9957		1.5057	
0.2500	-1.2944	-0.2926	0.0210	0.0602	0.9982	0.9940		-0.5297	
0.3333	1.0519	-0.9875	0.0234	0.0575	0.9981	0.9921		-1.0350	
0.4167	-0.2128	0.0147	0.0202	0.0576	0.9983	0.9904		-1.2206	
0.5000	1.1043	-1.3444	0.0251	0.0539	0.9979	0.9883		0.1589	
0.5833	-0.0566	-1.4798	0.0244	0.0499	0.9980	0.9863		-0.3366	
0.6667	0.8381	-0.6815	0.0279	0.0481	0.9977	0.9840		0.0357	
0.7500	0.4038	-0.0661	0.0312	0.0480	0.9974	0.9815		0.7613	
0.8333	-0.3806	1.3761	0.0275	0.0520	0.9977	0.9792		-1.0885	
0.9167	-1.4776	-0.4073	0.0233	0.0509	0.9981	0.9773		0.7657	
1.0000	0.1953	-0.7562	0.0225	0.0489	0.9981	0.9755		-0.8689	
1.0833	-2.1182	-1.1637	0.0177	0.0458	0.9985	0.9741		1.7445	
1.1667	0.1006	-0.3456	0.0197	0.0450	0.9984	0.9725		0.7249	

Inflation

<u>Inflation Rate Generator</u>					Increase in
			Claim Cost	Cumulative Claim Cost	Cumulative Claim Cost
	Random	Inflation	Inflation	Inflation	Inflation
<u>Time</u>	<u>Z</u>	<u>Rate</u>	<u>Factor</u>	<u>Factor</u>	<u>Factor</u>
0.0000		0.0354		1	
0.0833	0.4988	0.0409	1.0054	1.0054	0.0054
0.1667	-1.0937	0.0392	1.0052	1.0107	0.0053
0.2500	0.4863	0.0404	1.0054	1.0161	0.0054
0.3333	-0.3208	0.0362	1.0048	1.0211	0.0049
0.4167	-0.6122	0.0303	1.0040	1.0252	0.0041
0.5000	0.1730	0.0318	1.0042	1.0295	0.0043
0.5833	-0.3752	0.0293	1.0039	1.0336	0.0040
0.6667	-0.5383	0.0270	1.0036	1.0373	0.0037
0.7500	1.5781	0.0368	1.0049	1.0424	0.0051
0.8333	-0.1838	0.0333	1.0044	1.0470	0.0046
0.9167	0.6971	0.0388	1.0052	1.0524	0.0054
1.0000	-0.2964	0.0352	1.0047	1.0574	0.0049

Summary

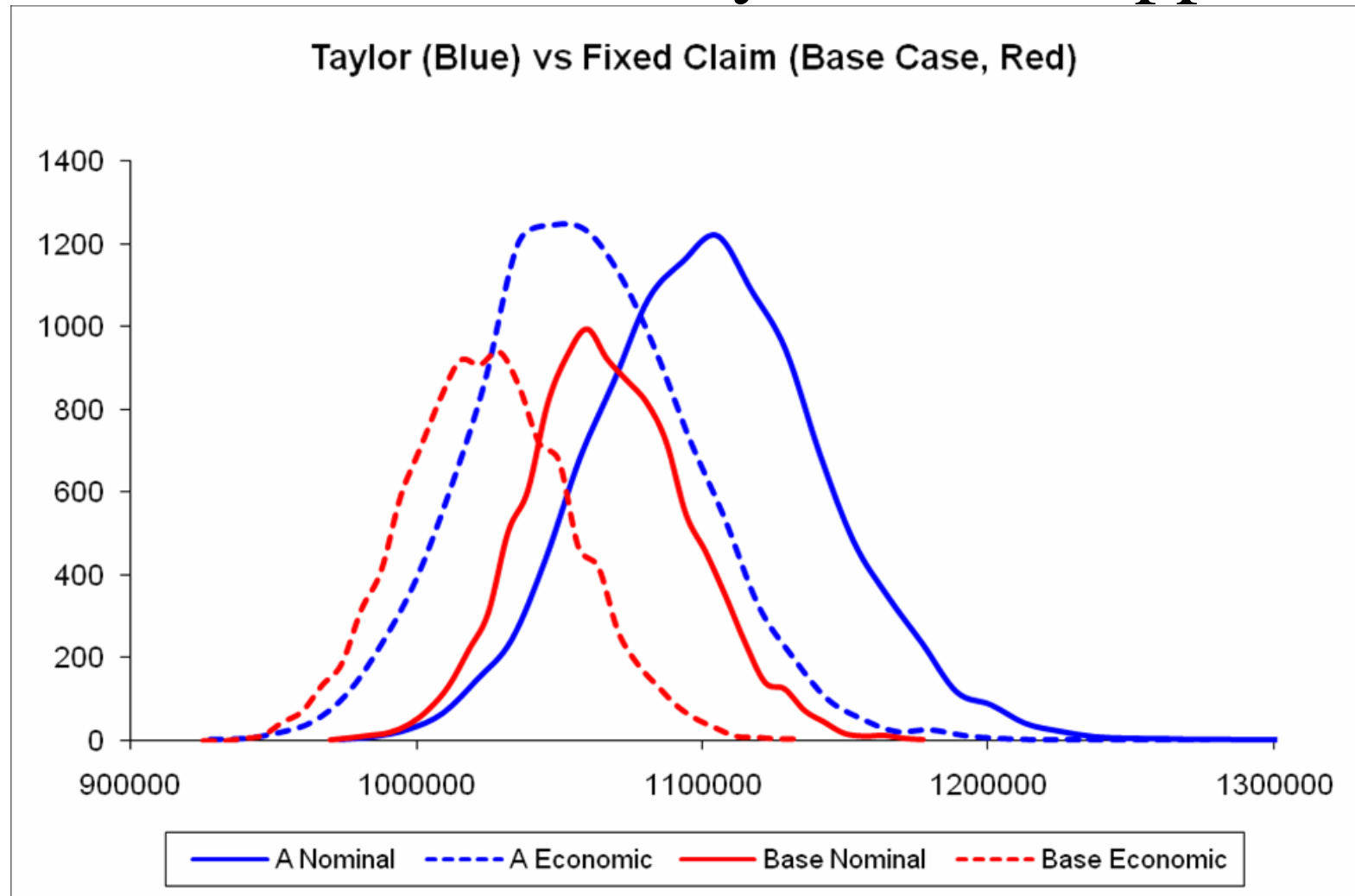
Summary		
	Delete Run	
Run	1	2
Nominal Value		
Mean	1051975.894	1063793.761
SD	24747.6774	28823.52596
Min	969136.51	955976.76
5%	1012563.39	1018224.14
25%	1035024.77	1044242.94
75%	1068167.85	1082153.27
95%	1093894.54	1113307.5
Max	1144274.58	1191628.65
50% CI Range	33143.08	37910.33
90% CI Range	81331.15	95083.36
Economic Value		
Mean	1011037.946	1021737.452
SD	25424.31721	29024.89057
Min	914064.1	899359.65
5%	970082.28	974414.89
25%	993713.91	1001955.87
75%	1027731.83	1040576.3
95%	1053385.3	1069878.12
Max	1103185.18	1139477.87
50% CI Range	34017.92	38620.43
90% CI Range	83303.02	95463.23
50% CI Range Ratio	102.64%	101.87%
90% CI Range Ratio	102.42%	100.40%

Masterson Claim Cost Index

Masterson Claim Cost Index Inflation 1936-2004		
Year/Coverage	CPI All Items	Auto BI
1995	2.73%	4.84%
1996	3.04%	3.89%
1997	1.57%	3.96%
1998	1.67%	3.90%
1999	2.74%	4.48%
2000	3.73%	5.60%
2001	1.14%	4.43%
2002	2.60%	5.16%
2003	1.93%	4.36%
2004	2.97%	4.11%

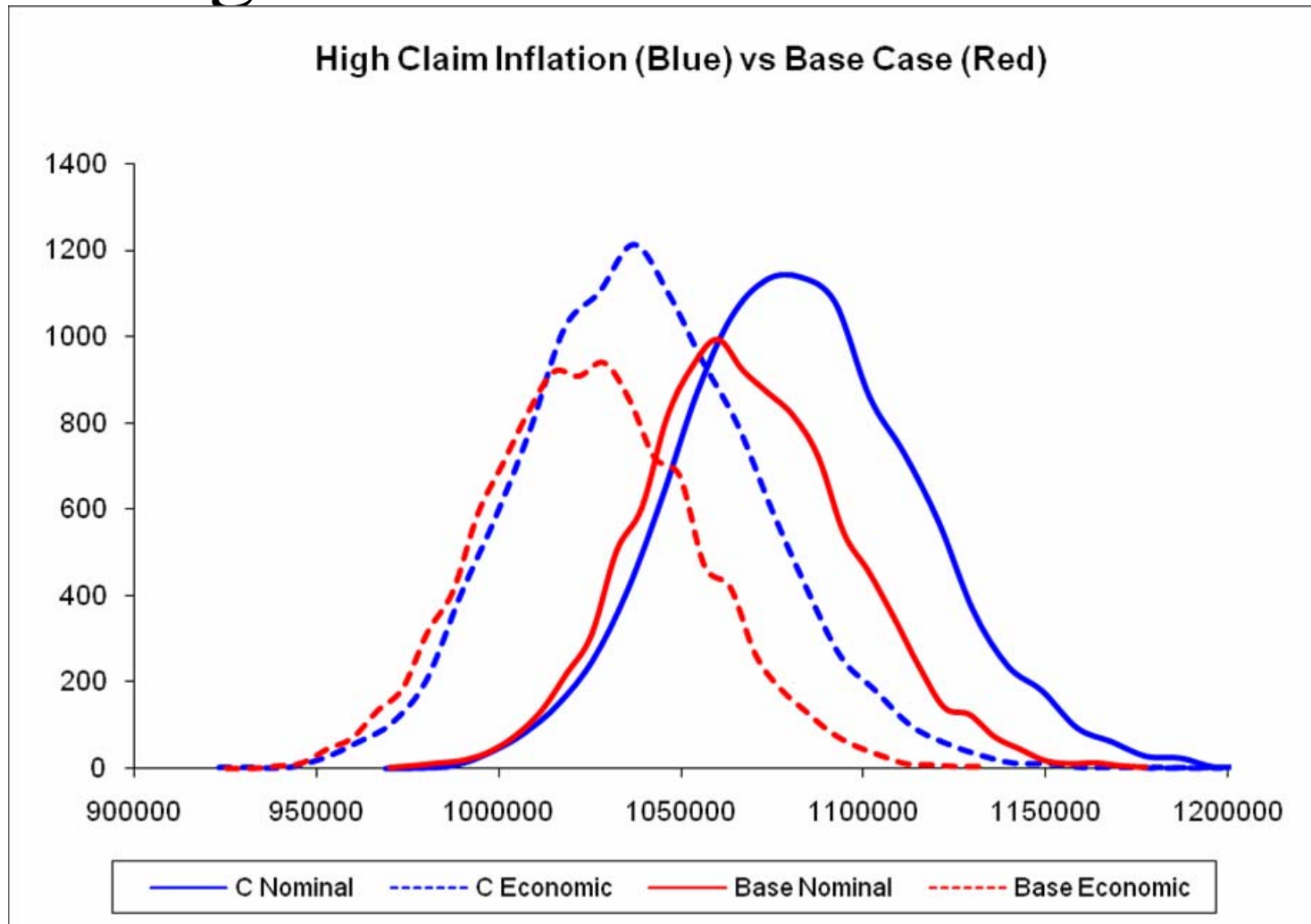
Results

Taylor Method vs. D'Arcy-Gorvett Approach



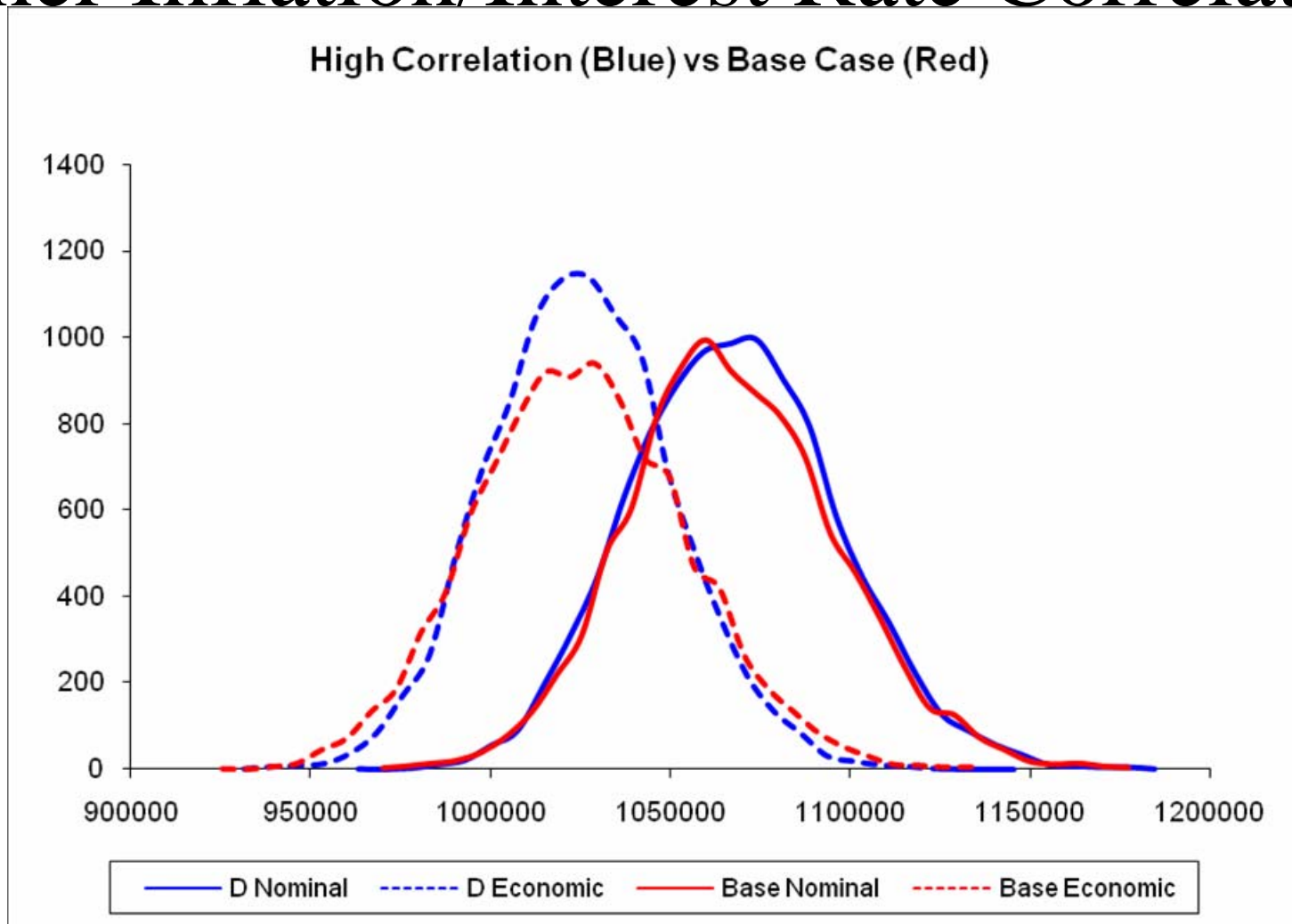
Results

Higher Claim Cost Inflation



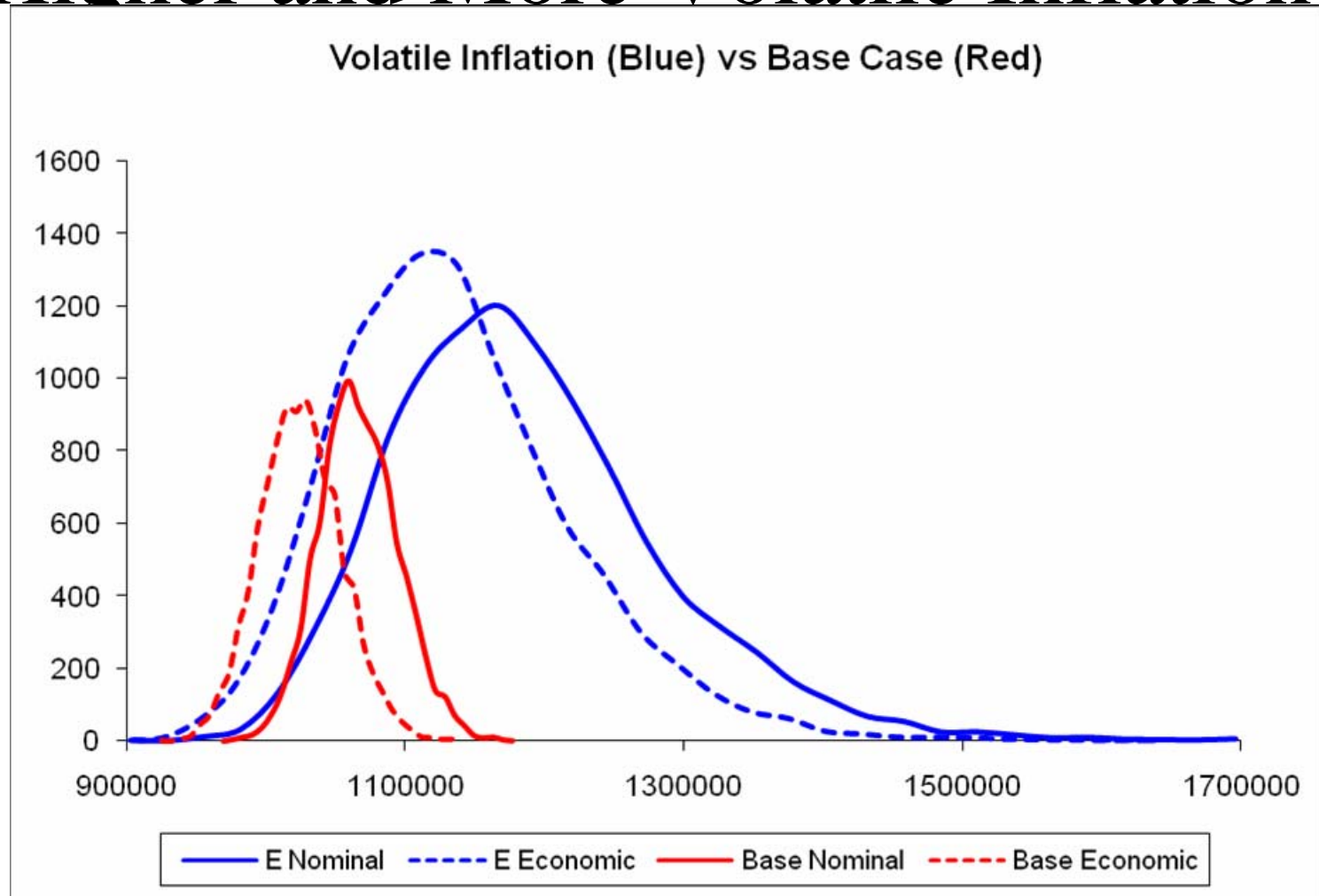
Results

Higher Inflation/Interest Rate Correlation



Results

Higher and More Volatile Inflation



Further Research

- Two factor approach to loss reserving
 - Deflate loss triangle
 - Generate reserve ranges on deflated losses
 - Incorporate inflation variability separately
 - Useful when inflation rate or variability changes
- ALM issues
 - Some companies intentionally mismatch assets and liabilities to pick up yield
 - Mismatching would increase the risk of an increase in inflation

Summary

- Traditional loss reserving methods do not reflect the economic value of loss reserves
- Economic value ranges can be smaller than the nominal value ranges
- Results are more significant during periods of high inflation rates and increased inflation volatility