Property-Liability Insurance Loss Reserve Ranges Based on Economic Value

Stephen P. D'Arcy, Ph.D., FCAS, MAAA
Professor Emeritus of Finance, University of Illinois
Alfred Y. H. Au, Milliman FRM
Liang Zhang, Aegon America

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Overview

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

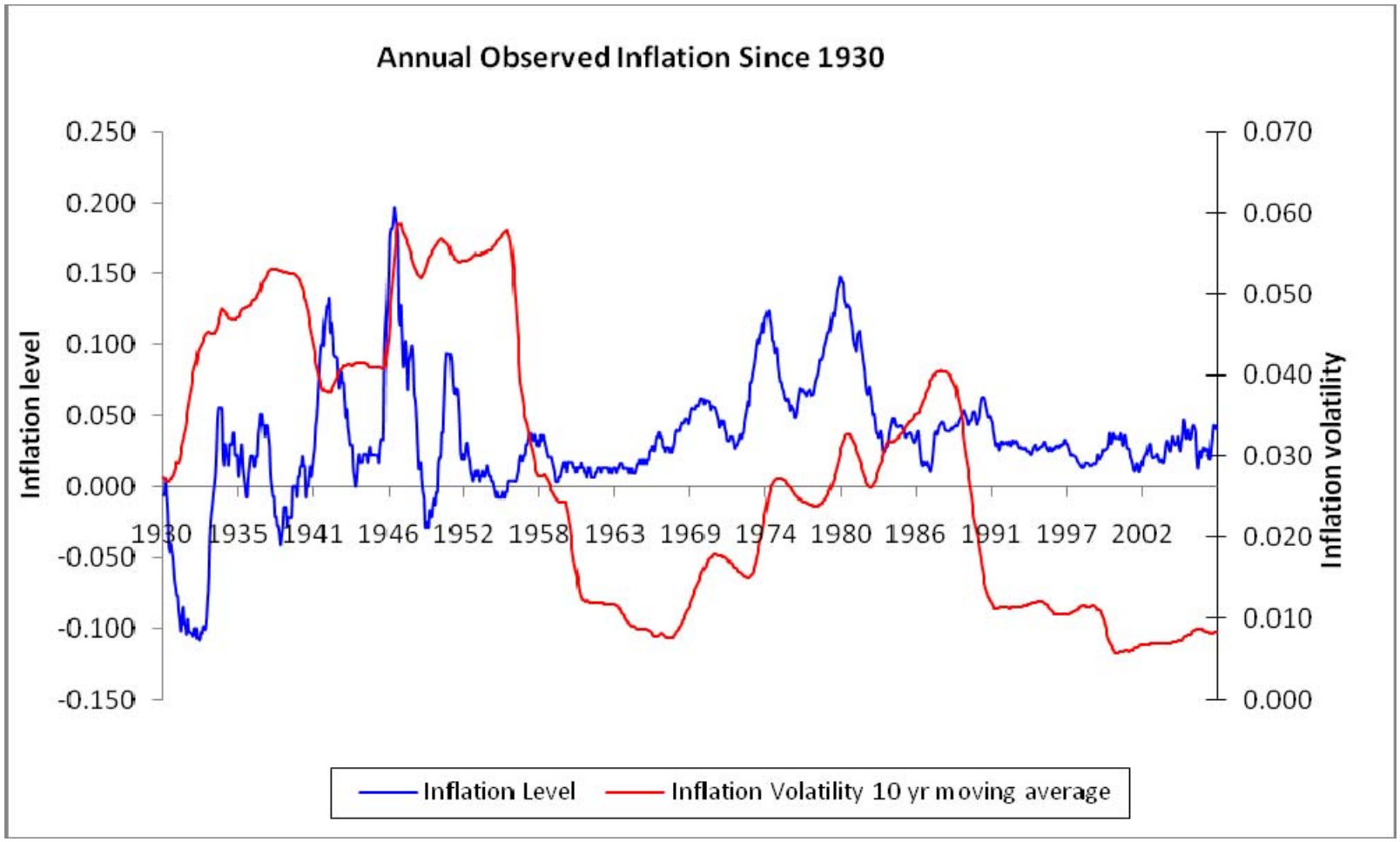
Background

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

Background

- Recent Developments
  - Asset Liability Management
  - Fair Value Accounting
    - Financial Accounting Standards Board (FASB)
    - International Accounting Standards Board (IASB)
  - CEA: Solvency II
  - Australian Regulation
  - S&P criticism of actuarial profession

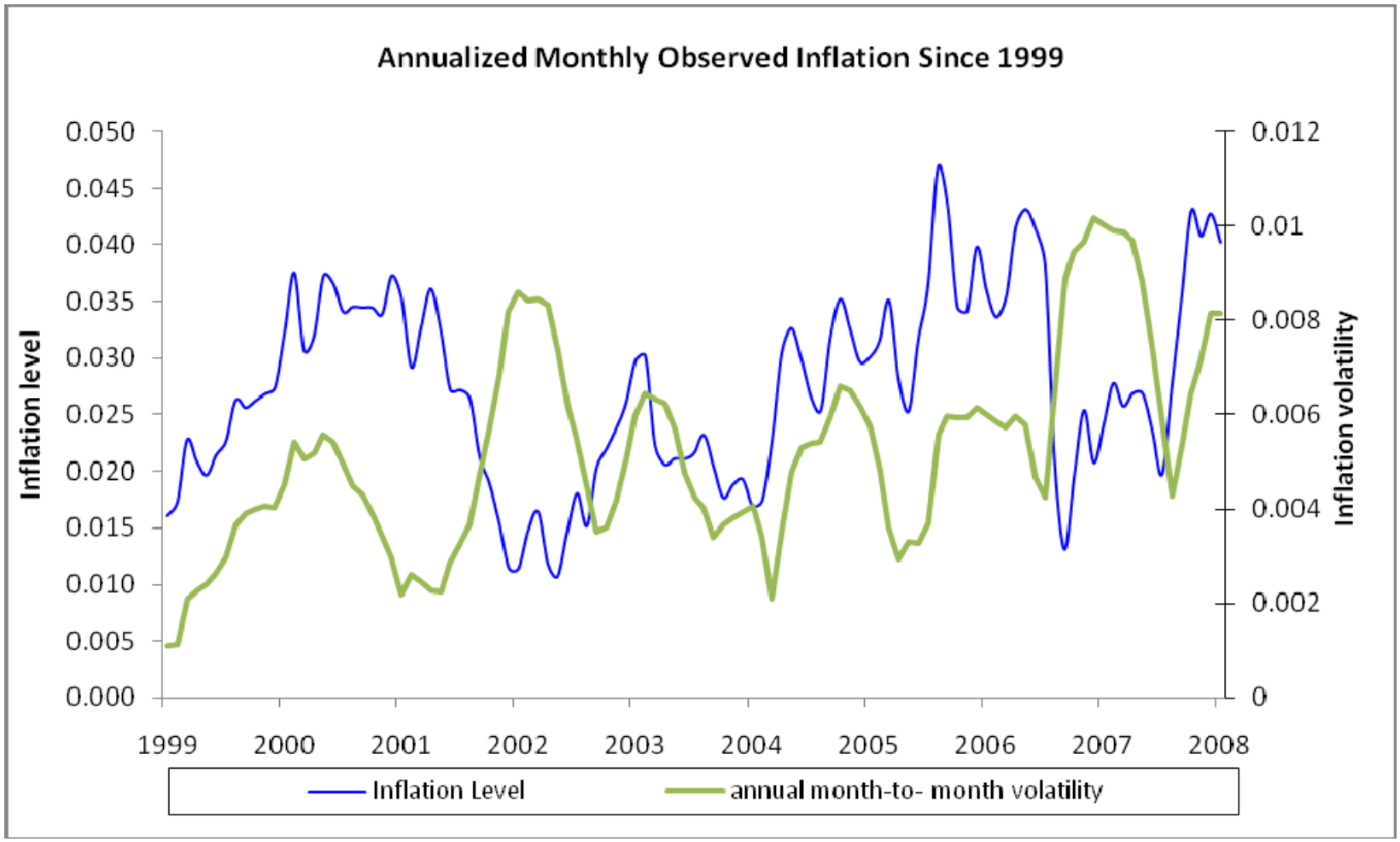
Trends in Inflation



Factors Impacting Inflation

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

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

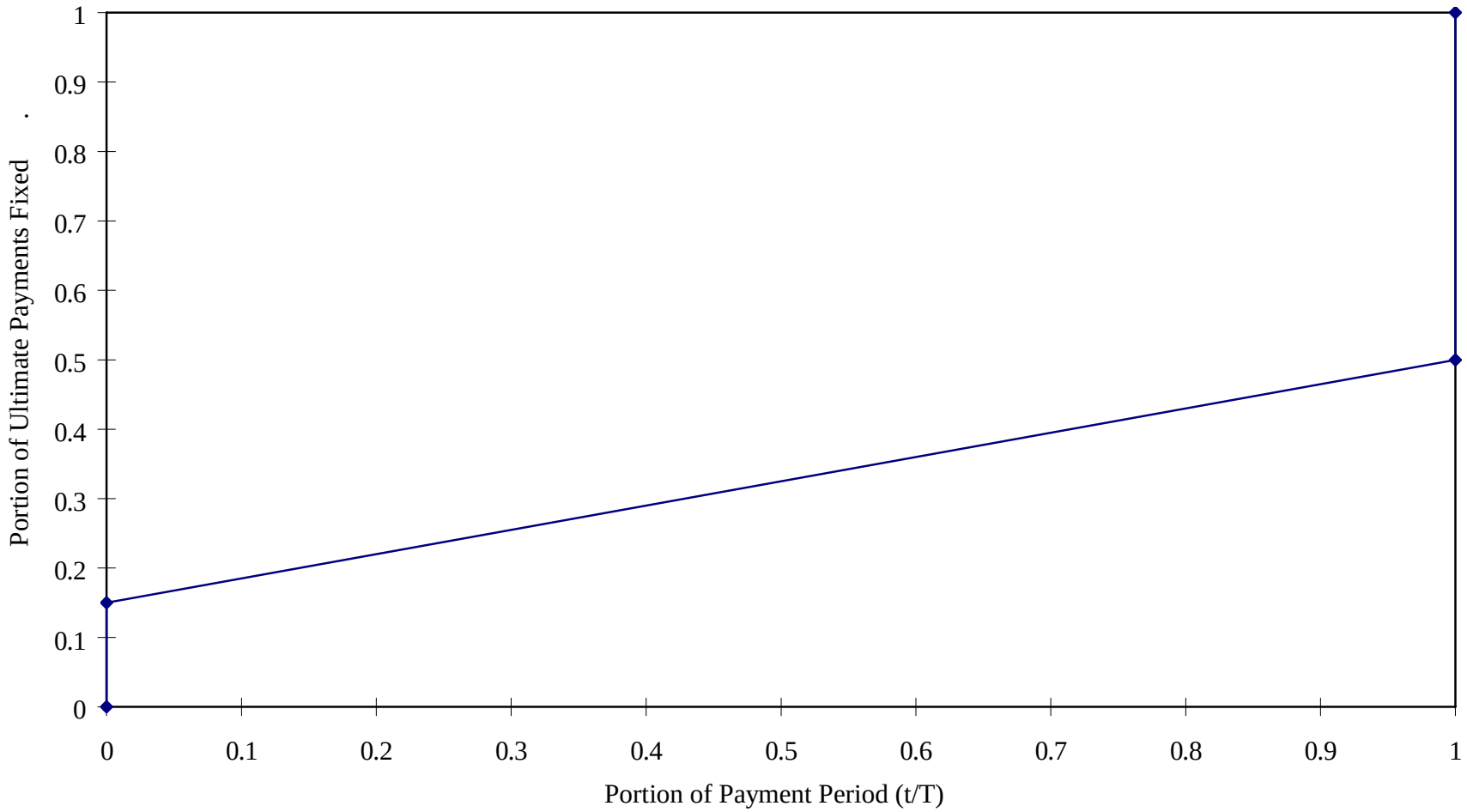
- Nominal values:
  - Nominal losses generated by
    - Loss frequency distribution
    - Loss severity distribution
    - Aggregate claims increased by the inflation rate
- Economic values:
  - Nominal losses discounted by the interest rate

Impact of Inflation on Loss Reserves

- Taylor separation model
  - All unpaid claims subject to full inflation impact
- Fixed claim model – D'Arcy & Gorvett
  - Two portions of unpaid claims
  - One part is fixed in value and not subject to future inflation
  - The remaining portion of the claim is subject to future inflation

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



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 - 1

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%

Input Sheet - 2

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 ☑

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
1	0.4381	830.9586	3.6667	1.2703	0.9365	1055.5872	988.5301		1061252	1032696
2	0.8897	1595.4998	1.0000	1.0381	0.9755	1656.2912	1615.7112			
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			
5	0.2763	675.6815	3.0833	1.2025	0.9464	812.5386	768.9883			
6	0.0818	463.2301	1.6667	1.0747	0.9667	497.8462	481.2892			
7	0.8442	1442.4336	0.7500	1.0282	0.9815	1483.1201	1455.6399			
8	0.5448	943.2253	0.7500	1.0282	0.9815	969.8307	951.8611			
9	0.2735	672.9734	0.6667	1.0249	0.9840	689.7287	678.7073			
10	0.4702	863.4188	1.6667	1.0747	0.9667	927.9400	897.0793			
11	0.1937	594.6111	0.9167	1.0348	0.9773	615.3101	601.3587			
12	0.1593	558.3649	4.5833	1.3948	0.9258	778.8077	721.0074			
13	0.1226	516.5451	3.9167	1.3023	0.9326	672.7219	627.3883			
14	0.3887	792.6413	0.6667	1.0249	0.9840	812.1271	799.3097			

Nominal Interest Rate

Nominal Interest Rate Generator

Time	Short-Term Random Z	Long-Term Random Z	Hull-White Short-Term Nominal Interest Rate	Hull-White Long-Term Nominal Interest Rate	Discount Factor	Cumulative Discount Factor	Correlated Random Z
0			0.0212	0.0669			
0.0833	0.1359	-1.9551	0.0244	0.0615	0.9980	0.9980	1.1829
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

Inflation Rate Generator					Increase in
				Cumulative	Cumulative
			Claim Cost	Claim Cost	Claim Cost
	Random	Inflation	Inflation	Inflation	Inflation
Time	Z	Rate	Factor	Factor	Factor
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

Impact of Inflation on Claims

k	0.15											
m	0.5											
n	1											
	1.0028	1.0064	1.0100	1.0134	1.0164	1.0194	1.0222	1.0249	1.0282	1.0313	1.0348	1.0381
t / T	0.0833	0.1667	0.2500	0.3333	0.4167	0.5000	0.5833	0.6667	0.7500	0.8333	0.9167	1.0000
0.0833	0.3501	0.1750	0.1167	0.0875	0.0700	0.0583	0.0500	0.0438	0.0389	0.0350	0.0318	0.0292
0.1667		0.1760	0.1173	0.0880	0.0704	0.0587	0.0503	0.0440	0.0391	0.0352	0.0320	0.0293
0.2500			0.1179	0.0885	0.0708	0.0590	0.0505	0.0442	0.0393	0.0354	0.0322	0.0295
0.3333				0.0889	0.0711	0.0593	0.0508	0.0445	0.0395	0.0356	0.0323	0.0296
0.4167					0.0715	0.0596	0.0511	0.0447	0.0397	0.0357	0.0325	0.0298
0.5000						0.0598	0.0513	0.0449	0.0399	0.0359	0.0326	0.0299
0.5833							0.0515	0.0450	0.0400	0.0360	0.0328	0.0300
0.6667								0.0452	0.0402	0.0362	0.0329	0.0301
0.7500									0.0403	0.0363	0.0330	0.0303
0.8333										0.0365	0.0332	0.0304
0.9167											0.0333	0.0305
1.0000												0.0307

Fixed Claim Model

Fixed Claim Model: f(t) = k + (1-k-m)(t/T)^n

k	0.15
m	0.5
n	1

Fixed Portion of Claim at time t

t / T	0.0833	0.1667	0.2500	0.3333	0.4167	0.5000	0.5833	0.6667	0.7500	0.8333	0.9167	1.0000
0.0000	0.1500	0.1500	0.1500	0.1500	0.1500	0.1500	0.1500	0.1500	0.1500	0.1500	0.1500	0.1500
0.0833	0.5000	0.3250	0.2667	0.2375	0.2200	0.2083	0.2000	0.1938	0.1889	0.1850	0.1818	0.1792
0.1667		0.5000	0.3833	0.3250	0.2900	0.2667	0.2500	0.2375	0.2278	0.2200	0.2136	0.2083
0.2500			0.5000	0.4125	0.3600	0.3250	0.3000	0.2813	0.2667	0.2550	0.2455	0.2375
0.3333				0.5000	0.4300	0.3833	0.3500	0.3250	0.3056	0.2900	0.2773	0.2667
0.4167					0.5000	0.4417	0.4000	0.3688	0.3444	0.3250	0.3091	0.2958
0.5000						0.5000	0.4500	0.4125	0.3833	0.3600	0.3409	0.3250
0.5833							0.5000	0.4563	0.4222	0.3950	0.3727	0.3542
0.6667								0.5000	0.4611	0.4300	0.4045	0.3833
0.7500									0.5000	0.4650	0.4364	0.4125
0.8333										0.5000	0.4682	0.4417
0.9167											0.5000	0.4708
1.0000												0.5000

Summary - 1

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

Summary - 2

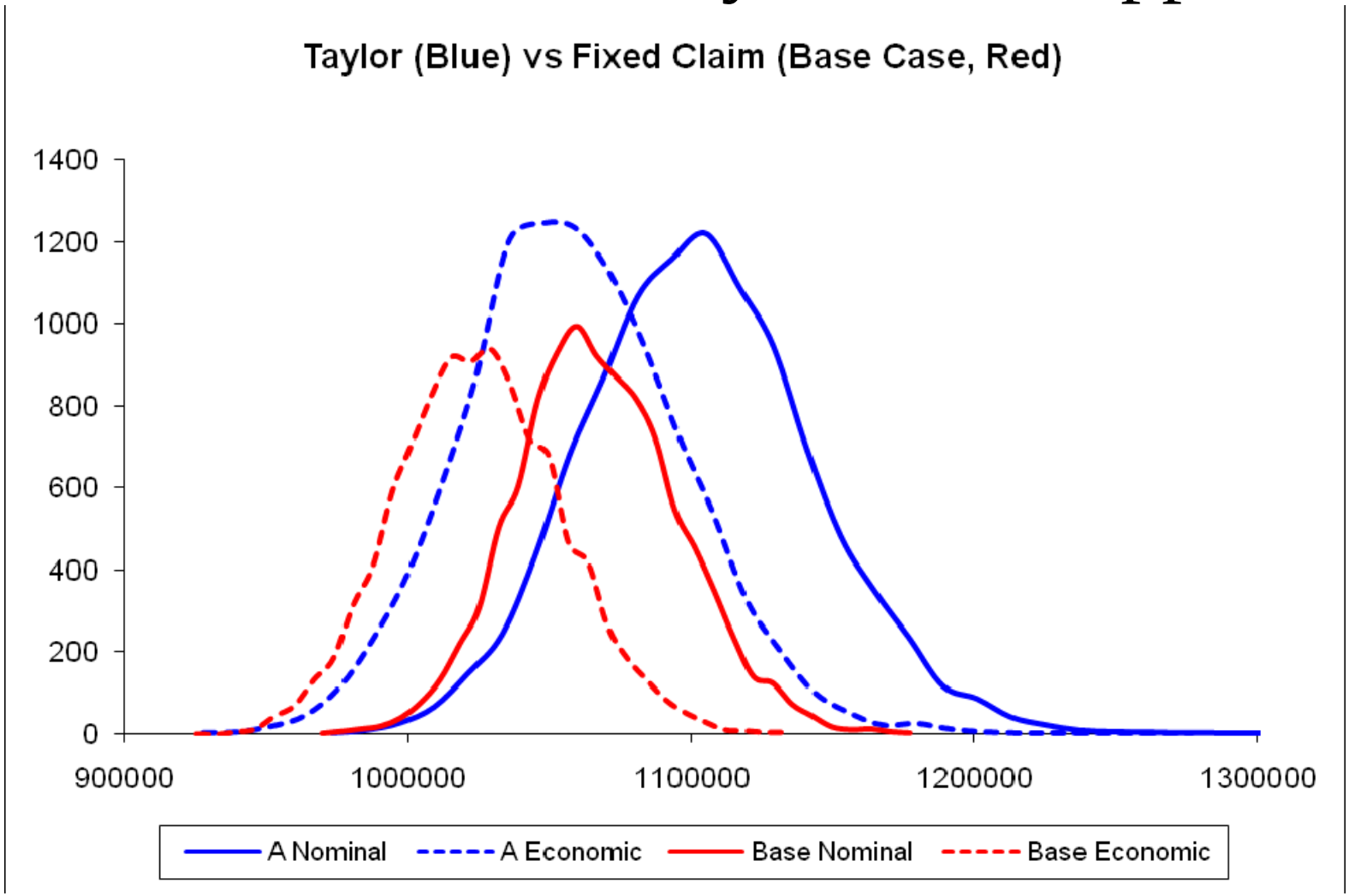
90% CI Range	81331.19	95063.36
Economic Value		
Mean	1011037.946	1021737.452
SD	25424.31721	29024.89057
Min	914064.1	899359.65
5%	970082.28	974414.89
25%	993713.91	1001955.87
75%	1027731.83	1040576.3
95%	1053385.3	1069878.12
Max	1103185.18	1139477.87
50% CI Range	34017.92	38620.43
90% CI Range	83303.02	95463.23
50% CI Range Ratio	102.64%	101.87%
90% CI Range Ratio	102.42%	100.40%

Masterson Claim Cost Index

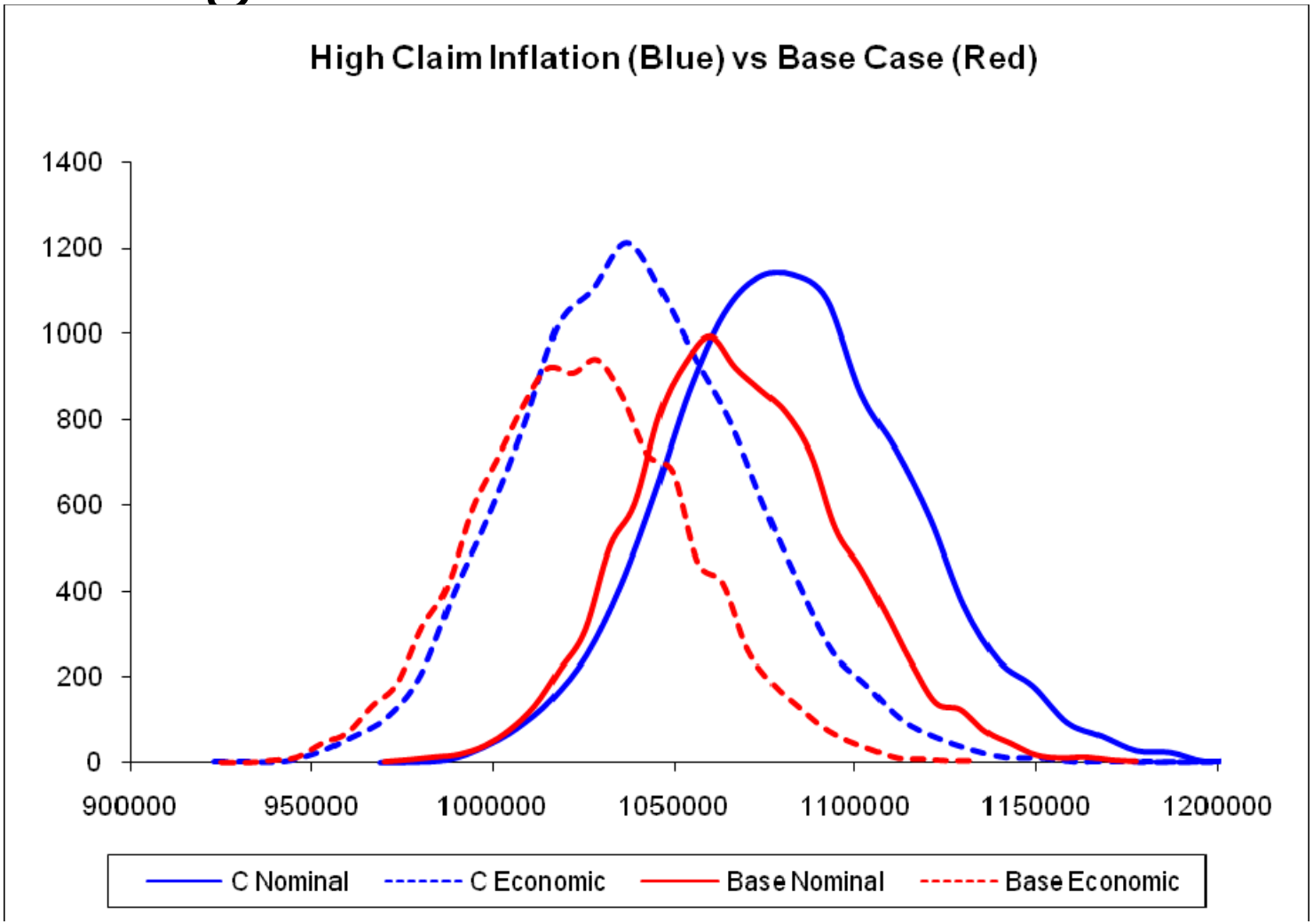
Masterson Claim Cost Index Inflation 1936-2004		
Year\Coverage	CPI All Items	Auto BI
1995	2.73%	4.84%
1996	3.04%	3.89%
1997	1.57%	3.96%
1998	1.67%	3.90%
1999	2.74%	4.48%
2000	3.73%	5.60%
2001	1.14%	4.43%
2002	2.60%	5.16%
2003	1.93%	4.36%
2004	2.97%	4.11%

Results

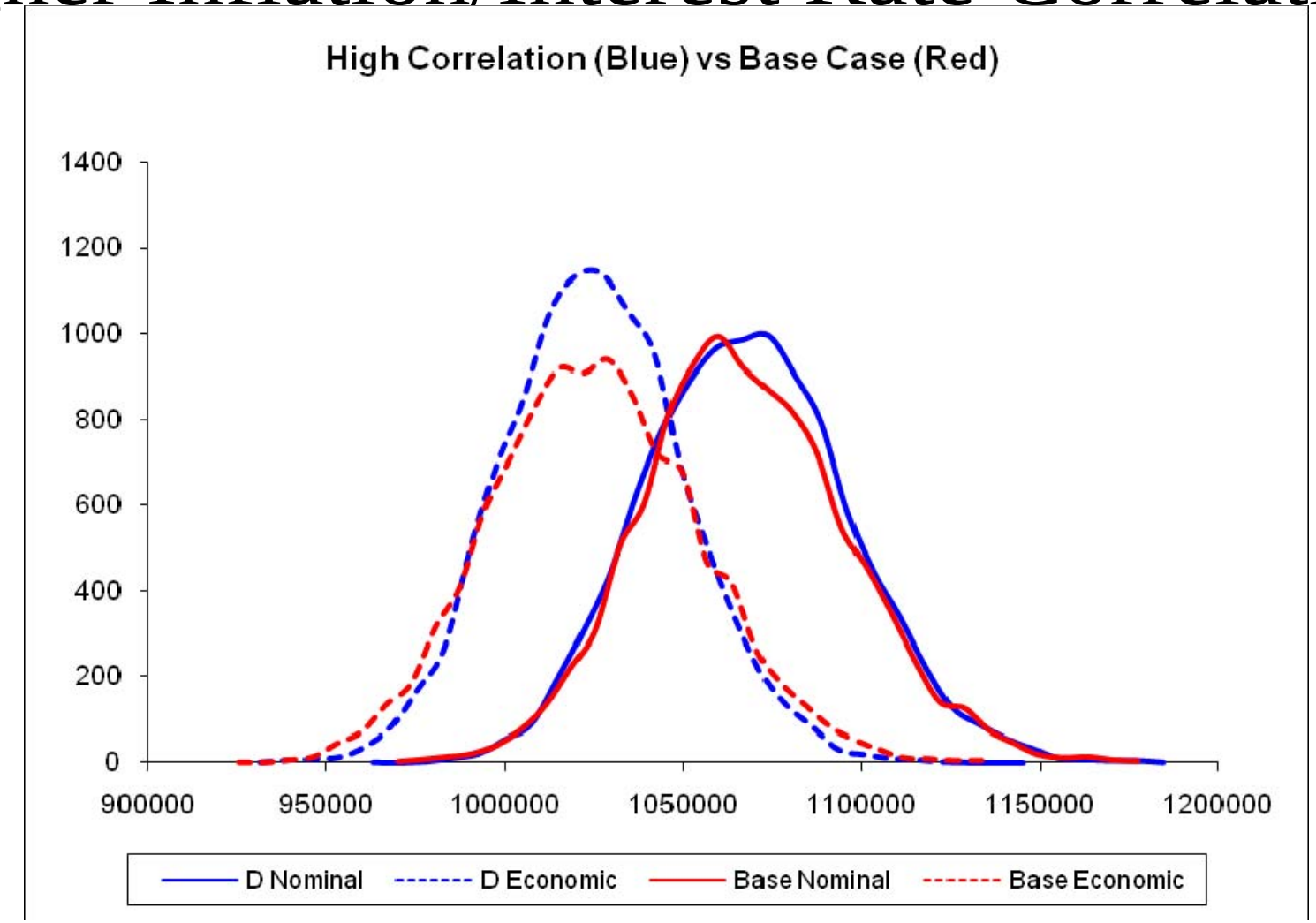
Taylor Method vs. D'Arcy-Gorvett Approach



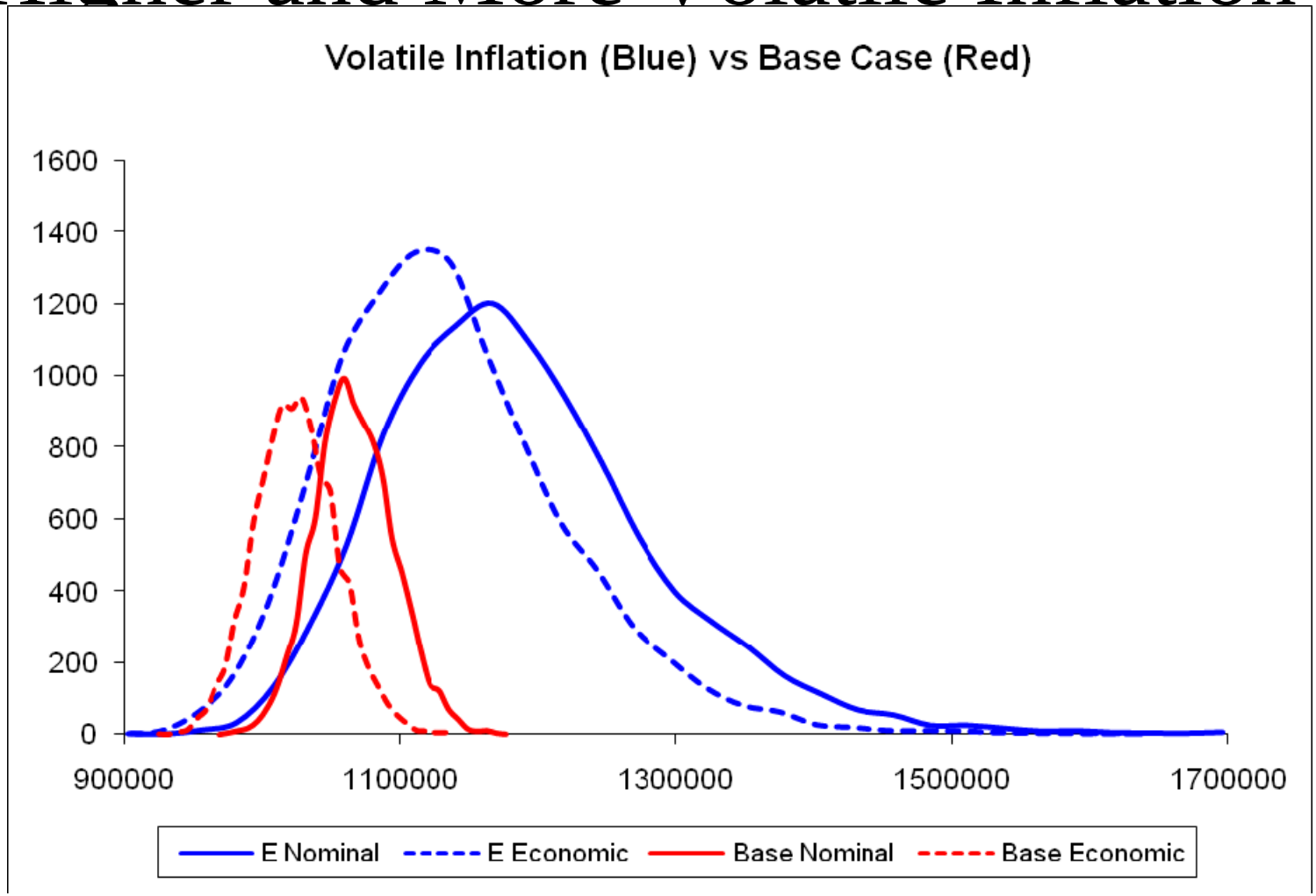
Results
Higher Claim Cost Inflation



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
  - Available at: http://www.business.uiuc.edu/~s-darcy/
- ALM issues
  - Some companies intentionally mismatch assets and liabilities to pick up yield
  - Mismatching will create losses if interest rates rise rapidly

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
- Economic value ranges are smaller during periods of high inflation rates and increased inflation volatility