DFA-5: Asset/Liability Management

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CAS Committee on Valuation, Finance and Investments

July 28,2003

Agenda

- Committee work to date
- New results since last year’s session
- Next steps

Committee Work To Date

- Model companies:
  - Monoline WC (liab. dur. ~4.5)
  - Monoline HO (with cats) (liab. dur. ~2)
  - Test with treasury bond portfolios with varying durations
  - Base case insurance operations generate positive cash flow most of the time
  - Also tested alternatives where insurance consumes cash
  - Keep moving parts to a minimum
  - Level interest rates on average
- Results from three different vendors' models

Committee Work To Date

- Results reported last year:
  - Statutory basis: Longer => higher return, lower risk
  - GAAP basis: Longer => higher return, higher risk
  - Stat. masks volatility on both sides of balance sheet
  - GAAP masks volatility on one side only – makes surplus more volatile
  - Results consistent across several measures of risk:
    - VAR, TailVAR
    - Probability of % Surplus Decline, Ruin
    - Standard Deviation of Net Income
  - Results consistent across variations on model companies and two vendors' models

New Results

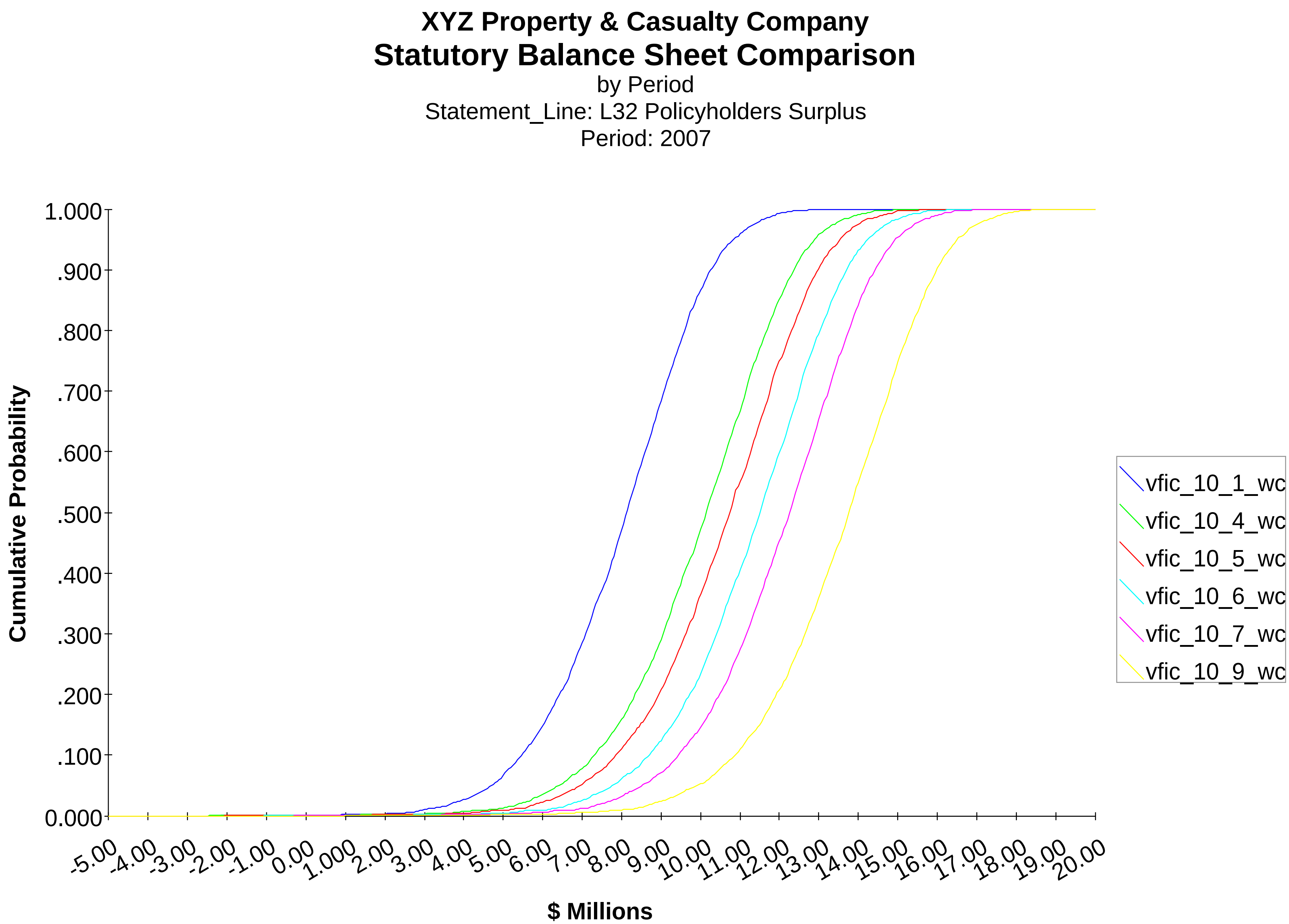
- Work since last year:
  - Used a third model to validate previous results
  - Also studied “economic basis”, i.e.,
    - Assets at market value
    - Reserves discounted (risk free rates)
  - Starting to look at unified measures – work ongoing

New Results

- “Economic Basis” results:
  - “Economic” means market value assets, discounted reserves (no risk margin) – assets and liabilities move in same direction in response to interest rates
  - Better indicator of true economic condition
  - In general:
    - longer duration always produces higher expected return
    - lowest risk is around duration match
  - Unlike statutory or GAAP results, the liabilities matter
  - The risk measure matters, too
    - some measure pure volatility
    - some measure absolute level of downside
    - both types have their uses
    - absolute measures cannot be ignored

New Results

- The original question: Does duration matching make sense for a P/C insurer?
- Answer: It depends
- What's interesting is what it depends on
  - Accounting basis
  - Risk measure


XYZ Property & Casualty Company
Statutory Balance Sheet Comparison
by Period
Statement_Line: L32 Policyholders Surplus
Period: 2007
Cumulative Probability
1.000
.900
.800
.700
.600
.500
.400
.300
.200
.100
0.000
-5.00
-4.00
-3.00
-2.00
-1.00
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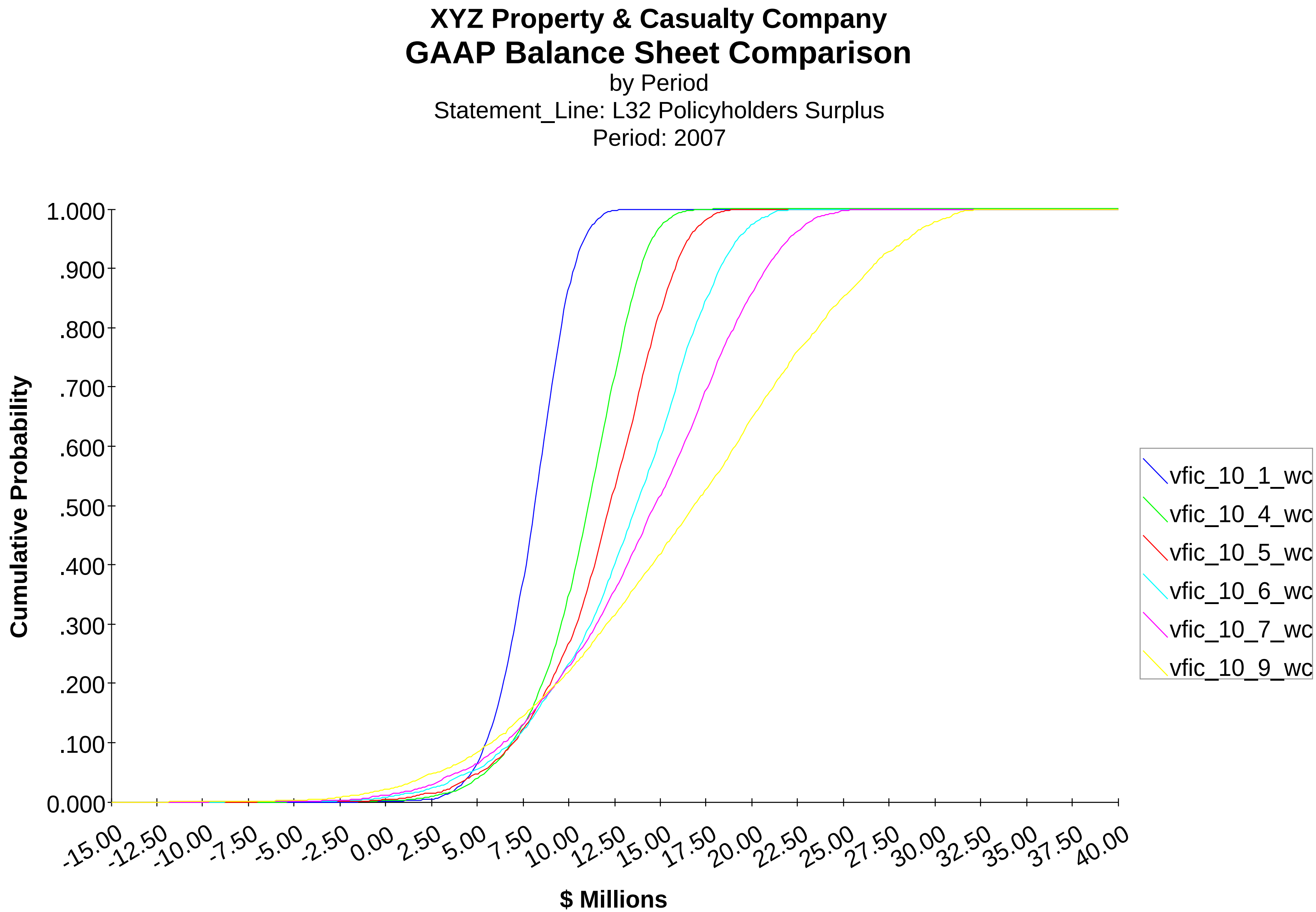
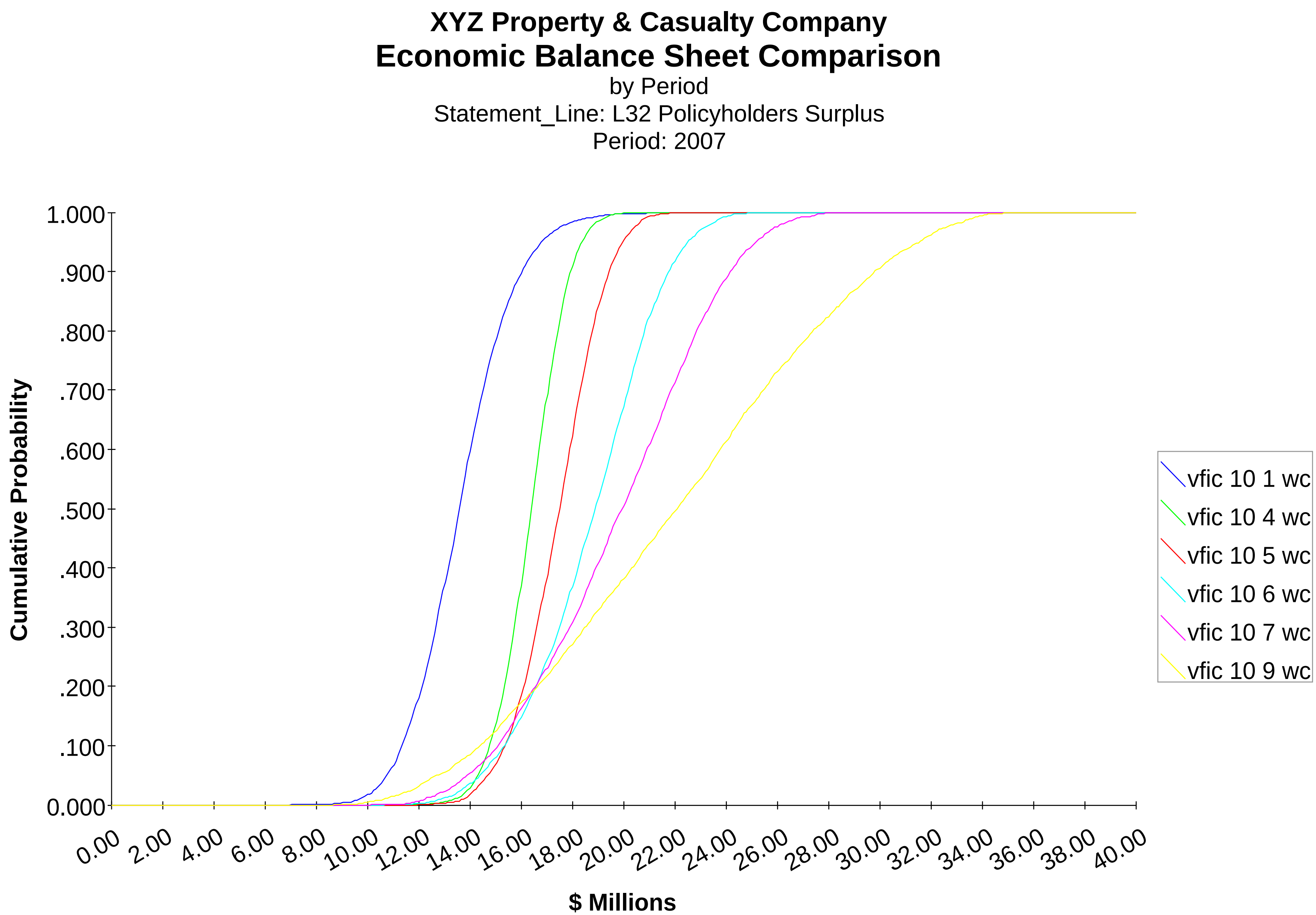
19.00
20.00
$ Millions
vfic_10_1_wc
vfic_10_4_wc
vfic_10_5_wc
vfic_10_6_wc
vfic_10_7_wc
vfic_10_9_wc

- FOSD (almost)

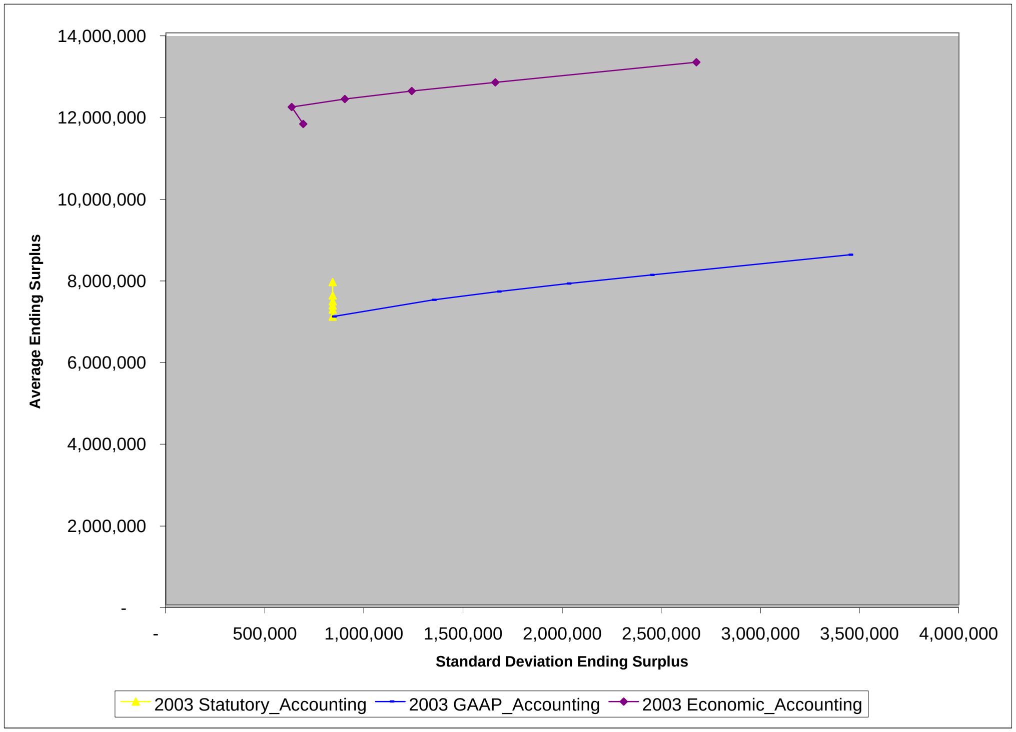


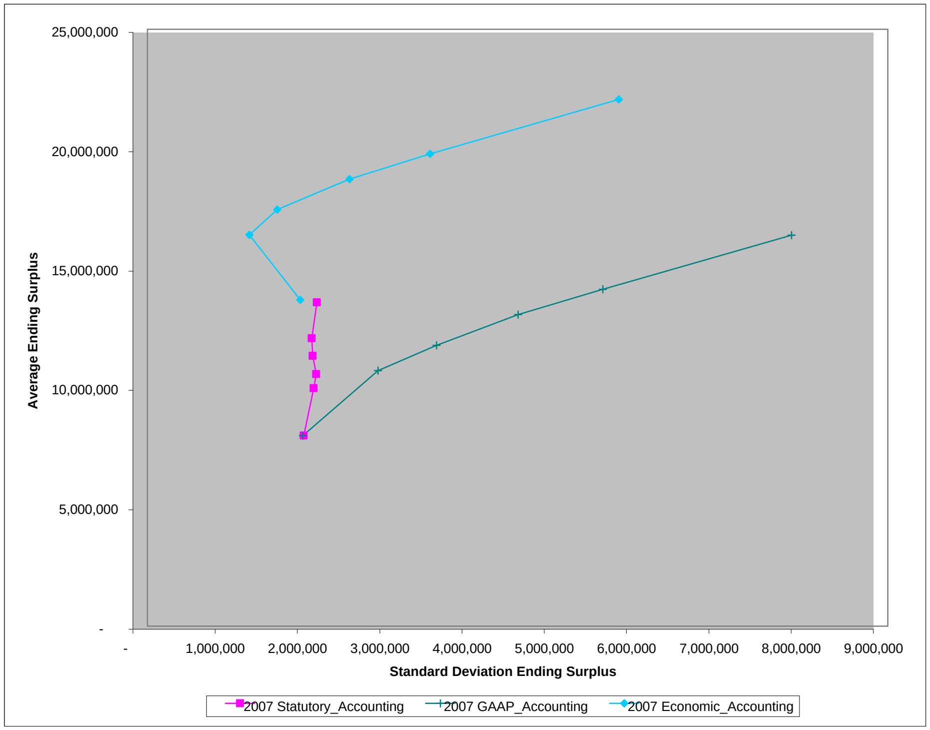
- Risk/reward tradeoff



- 4 FOSD 1
- Risk/reward tradeoff above that
- Minimum risk is neither longest nor shortest
- The liability duration matters

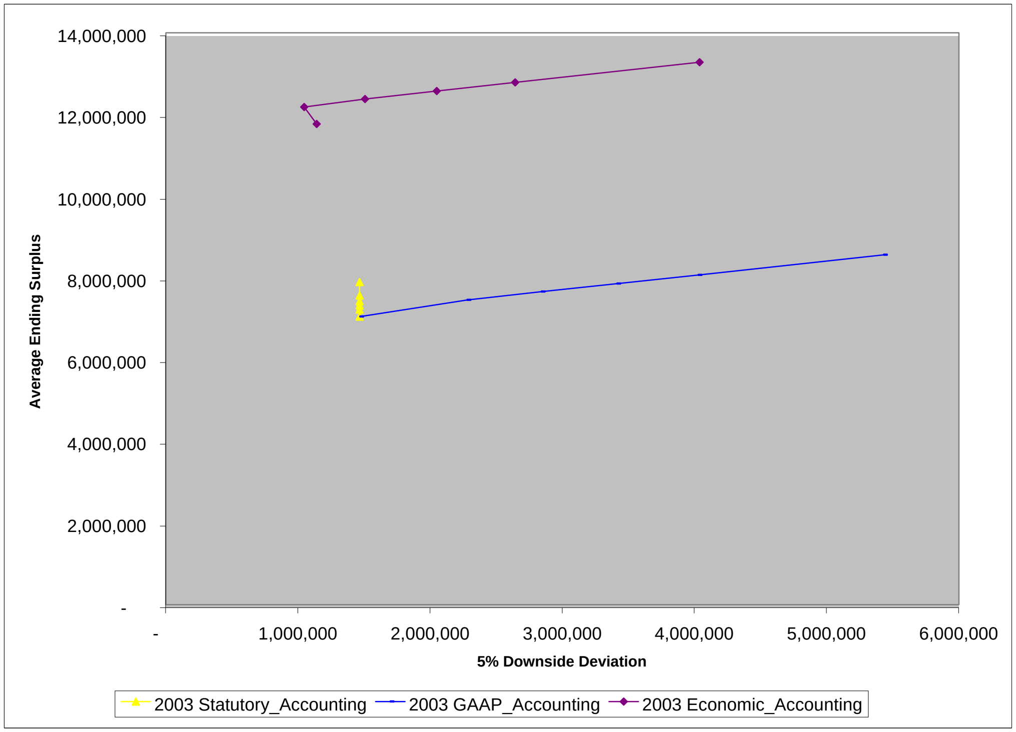
RISK/REWARD - BASED ON ENDING SURPLUS
WORKERS COMPENSATION BASE CASE
Risk Measure: Standard Deviation

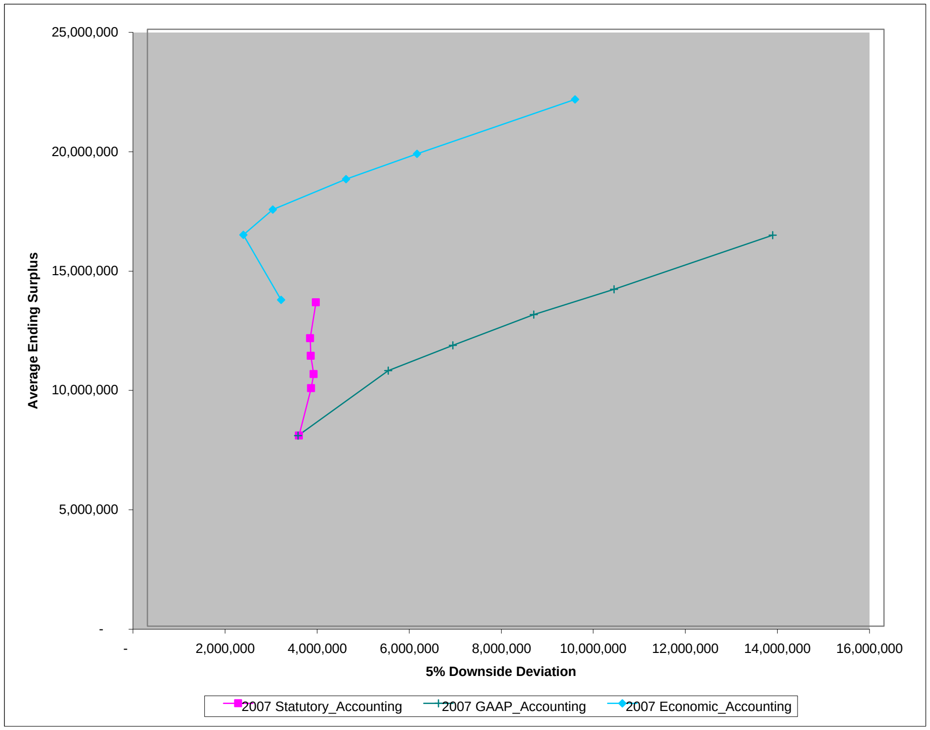




Frontier view (based on ending surplus):
- Longer duration always has higher average result
- Risk measure = standard deviation (two-sided, pure volatility)
- Statutory: risk is ~constant
- GAAP: risk increases with duration
- Economic: shortest duration is not lowest risk

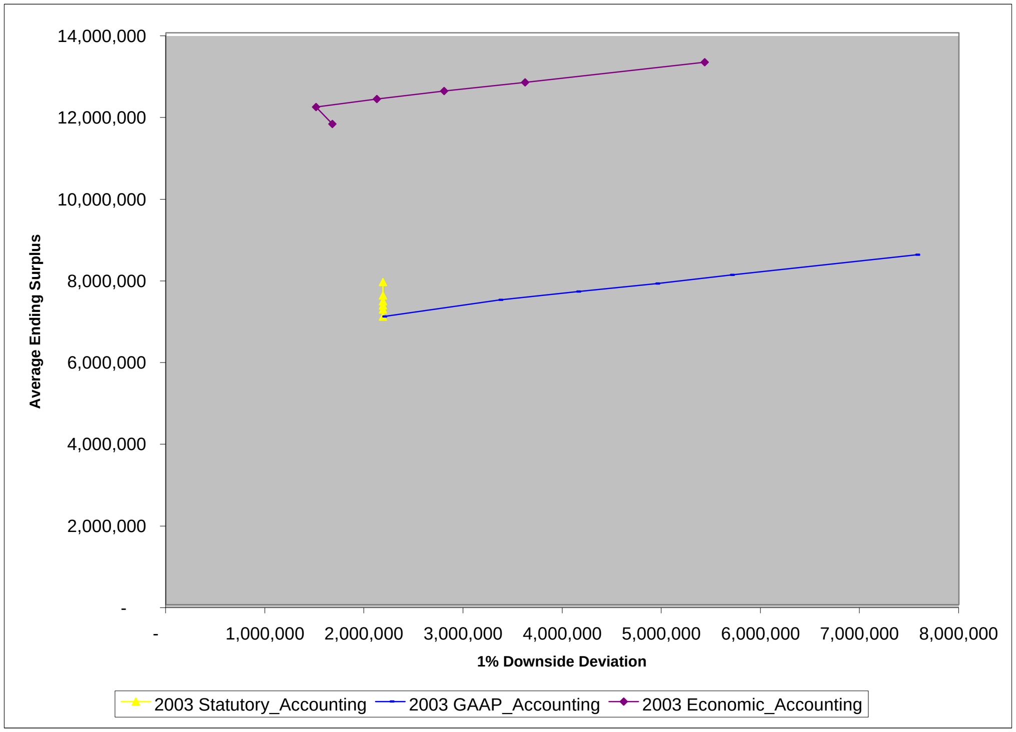
RISK/REWARD - BASED ON ENDING SURPLUS
WORKERS COMPENSATION BASE CASE
Risk Measure: 5% Downside Deviation Relative to Average Ending Surplus

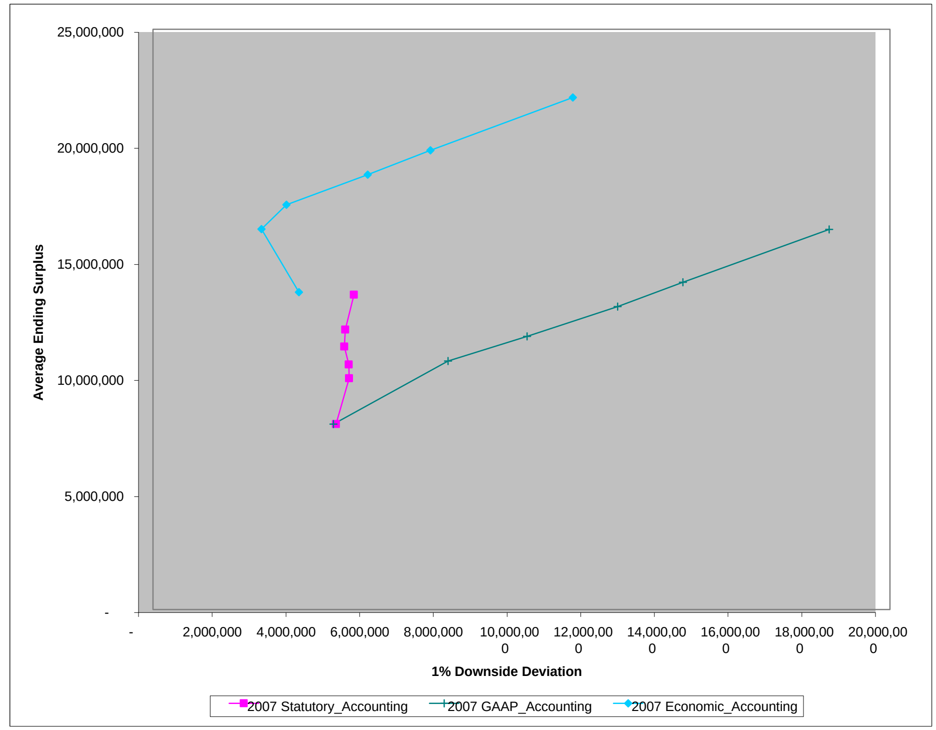




- Risk measure is percentile of ending surplus distribution
- Risk measure is relative to mean of distribution, i.e., measures pure volatility - penalizes volability even if absolute results are better
- One sided only
- Same result as standard deviation

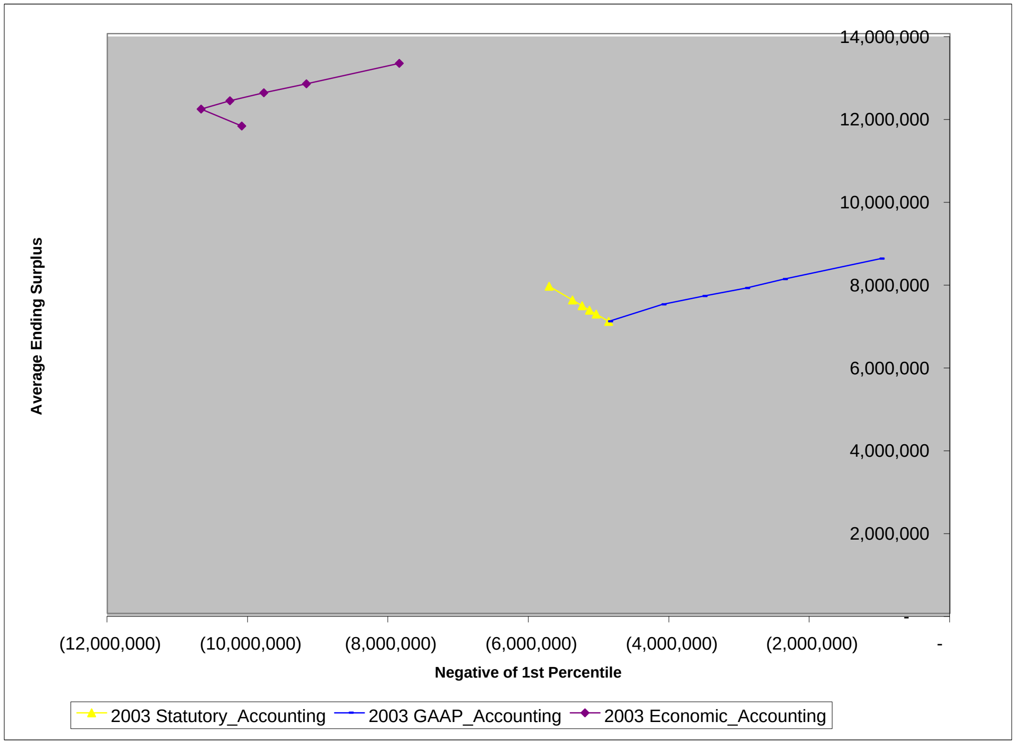
RISK/REWARD - BASED ON ENDING SURPLUS
WORKERS COMPENSATION BASE CASE
Risk Measure: 1% Downside Deviation Relative to Average Ending Surplus

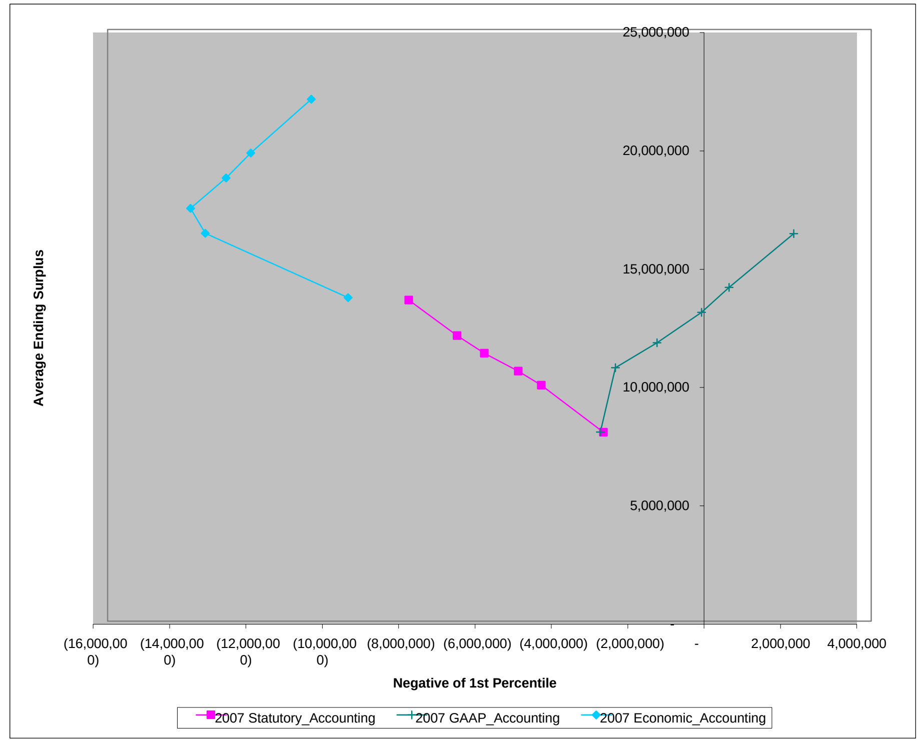




- Same as previous except at 1% level

RISK/REWARD - BASED ON ENDING SURPLUS
WORKERS COMPENSATION BASE CASE
Risk Measure: Negative of 1st Percentile of Ending Surplus





- Risk measure is percentile of ending surplus distribution, but now in absolute dollars (sign is reversed so higher risk is to the right)
- Higher volatility not penalized if absolute returns are good enough
- Stat. risk decreases as duration increases
- Econ. minimum risk point has shifted from 4 to 5

- Key point: the risk measure matters
    - relative to mean vs. absolute

XYZ Property & Casualty Company

Statistical Balance Sheet Comparison

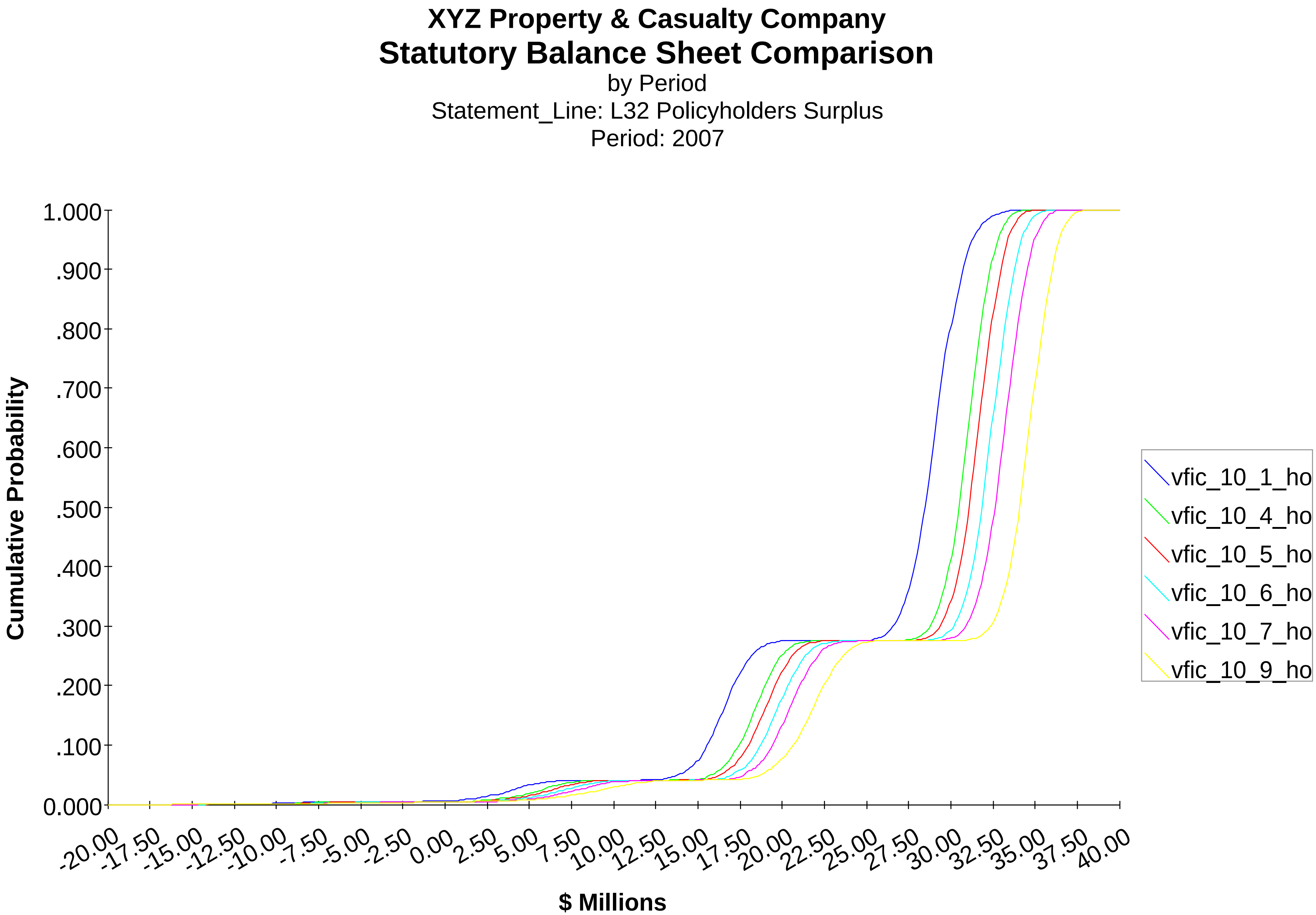
by Period

Statement_Line: L32 Policyholders Surplus

Period: 2007

	Simulation					
Statistics	**vfic 10 1 wc**	**vfic 10 4 wc**	**vfic 10 5 wc**	**vfic 10 6 wc**	**vfic 10 7 wc**	**vfic 10 9 wc**
avg	7,983,622	9,961,937	10,557,199	11,322,031	12,061,809	13,563,350
std	1,899,638	2,020,456	2,051,755	2,011,391	1,999,100	2,061,356
min	-2,180,895	-2,492,074	-2,089,870	-1,055,705	-302,029	977,137
0.1%	149,376	406,824	868,503	1,870,505	2,595,170	3,924,691
0.2%	1,038,151	1,823,325	2,279,337	3,137,426	3,948,056	5,384,065
0.4%	2,425,255	3,459,435	3,925,655	4,865,777	5,604,860	6,685,530
1.0%	3,014,063	4,640,142	5,239,820	6,130,719	6,845,124	8,110,734
2.5%	3,941,034	5,684,661	6,108,095	6,996,326	7,739,446	9,046,677
5.0%	4,693,100	6,406,180	6,945,404	7,771,306	8,526,206	9,903,651
10.0%	5,458,312	7,315,576	7,853,523	8,688,534	9,440,659	10,883,145
25.0%	6,784,470	8,725,799	9,301,121	10,098,074	10,853,434	12,305,258
50.0%	8,132,551	10,138,844	10,751,693	11,507,469	12,253,166	13,758,892
75.0%	9,335,826	11,390,350	12,005,642	12,728,799	13,466,586	15,010,221
90.0%	10,266,877	12,365,715	12,982,781	13,698,626	14,417,900	15,986,378
95.0%	10,856,561	12,889,772	13,520,786	14,233,983	14,939,970	16,528,041
97.5%	11,365,557	13,383,775	14,023,548	14,701,911	15,428,564	17,000,093
99.0%	11,899,091	13,925,299	14,573,732	15,281,897	15,991,816	17,603,658
99.6%	12,229,376	14,313,836	14,975,422	15,658,798	16,397,391	17,987,246
99.8%	12,696,252	14,825,212	15,438,931	16,164,574	16,806,303	18,356,675
99.9%	12,798,587	15,081,673	15,754,729	16,429,581	16,894,940	18,486,612
max	13,664,321	15,728,566	16,274,520	17,086,803	17,646,381	19,350,644

- Statutory surplus distribution tabular format
- Increases with duration at every percentile - FOSD



- HO - note steps due to 1, 2, etc. cats
- almost FOSD, but not quite ...

XYZ Property & Casualty Company

Statutory Balance Sheet Comparison

by Period

Statement_Line: L32 Policyholders Surplus

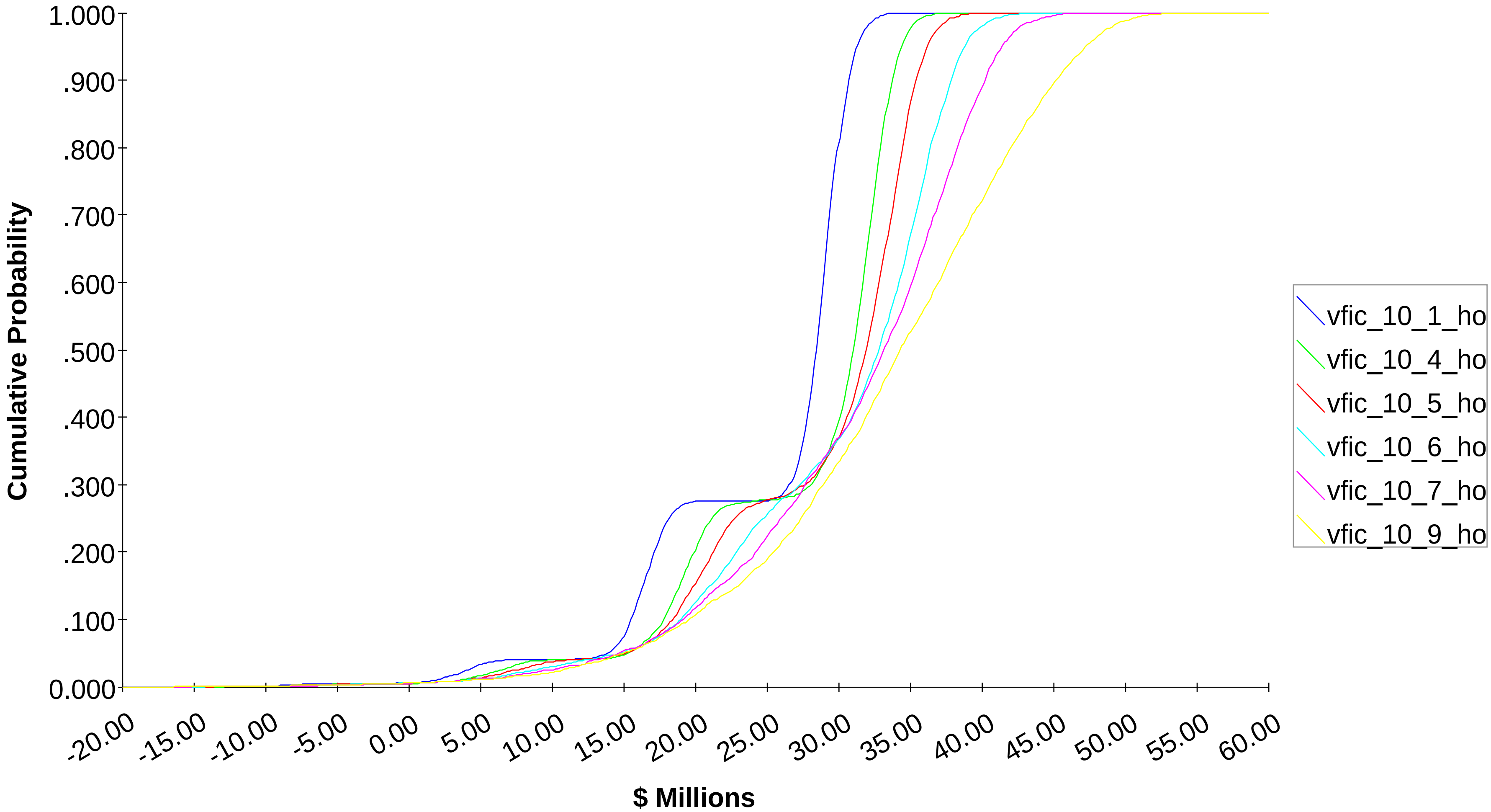
Period: 2007

	Simulation					
Statistics	**vfic 10 1 ho**	**vfic 10 4 ho**	**vfic 10 5 ho**	**vfic 10 6 ho**	**vfic 10 7 ho**	**vfic 10 9 ho**
avg	25,079,510	26,942,767	27,544,893	28,325,221	29,071,673	30,491,365
std	7,338,486	7,342,898	7,355,668	7,377,564	7,399,387	7,505,665
min	-14,221,352	-14,042,020	-14,029,900	-14,162,213	-14,636,150	-16,217,736
0.1%	-10,876,161	-9,300,467	-9,118,968	-8,434,738	-8,739,952	-10,320,499
0.2%	-9,645,503	-8,633,583	-8,280,860	-7,644,993	-7,049,768	-6,464,403
0.4%	-7,954,078	-5,354,969	-4,617,347	-4,124,706	-2,600,410	38,624
1.0%	1,914,026	3,221,667	3,857,883	4,706,551	5,386,261	6,120,158
2.5%	4,133,188	5,814,389	6,364,931	7,194,622	7,880,775	9,378,826
5.0%	13,859,244	15,745,445	16,302,344	17,035,310	17,726,505	18,758,845
10.0%	15,532,734	17,453,845	17,998,733	18,727,660	19,454,821	20,647,482
25.0%	18,150,814	19,937,994	20,599,394	21,337,006	22,137,947	23,642,829
50.0%	28,475,911	30,488,828	31,086,429	31,877,795	32,608,695	34,097,937
75.0%	29,645,974	31,543,835	32,153,016	32,957,942	33,701,774	35,181,863
90.0%	30,708,773	32,355,210	32,964,809	33,794,329	34,560,774	36,028,457
95.0%	31,288,156	32,778,996	33,365,126	34,180,458	34,966,344	36,436,599
97.5%	31,845,531	33,166,947	33,783,979	34,627,347	35,367,768	36,806,797
99.0%	32,489,882	33,535,459	34,127,203	34,979,890	35,777,241	37,169,026
99.6%	33,110,086	33,877,103	34,416,437	35,311,552	36,099,697	37,509,688
99.8%	33,367,116	34,127,145	34,684,480	35,542,278	36,199,466	37,676,642
99.9%	33,638,706	34,205,791	34,873,907	35,676,788	36,442,709	37,821,055
max	34,113,948	34,727,334	35,336,605	36,352,938	37,150,022	38,386,345

- Not quite FOSD - higher duration has higher risk below 1% level

- Key point: the percentile (often) matters

XYZ Property & Casualty Company
GAAP Balance Sheet Comparison
by Period
Statement_Line: L32 Policyholders Surplus
Period: 2007



- HO GAAP basis
- Note steps are smoothed at longer durations - cat risk diversifies against interest rate risk

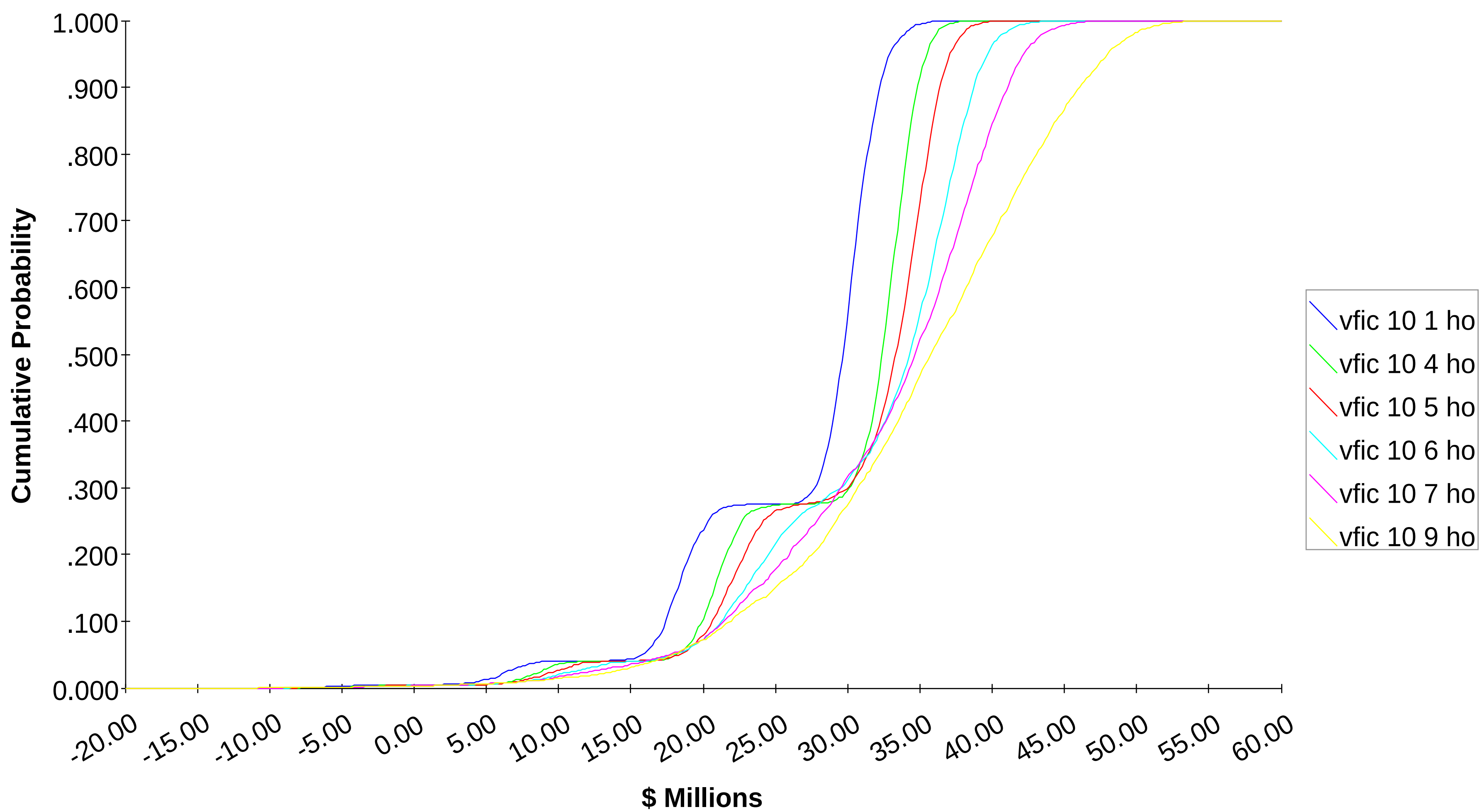
XYZ Property & Casualty Company

Economic Balance Sheet Comparison

by Period

Statement_Line: L32 Policyholders Surplus

Period: 2007



- HO economic basis

XYZ Property & Casualty Company

Economic Balance Sheet Comparison

by Period

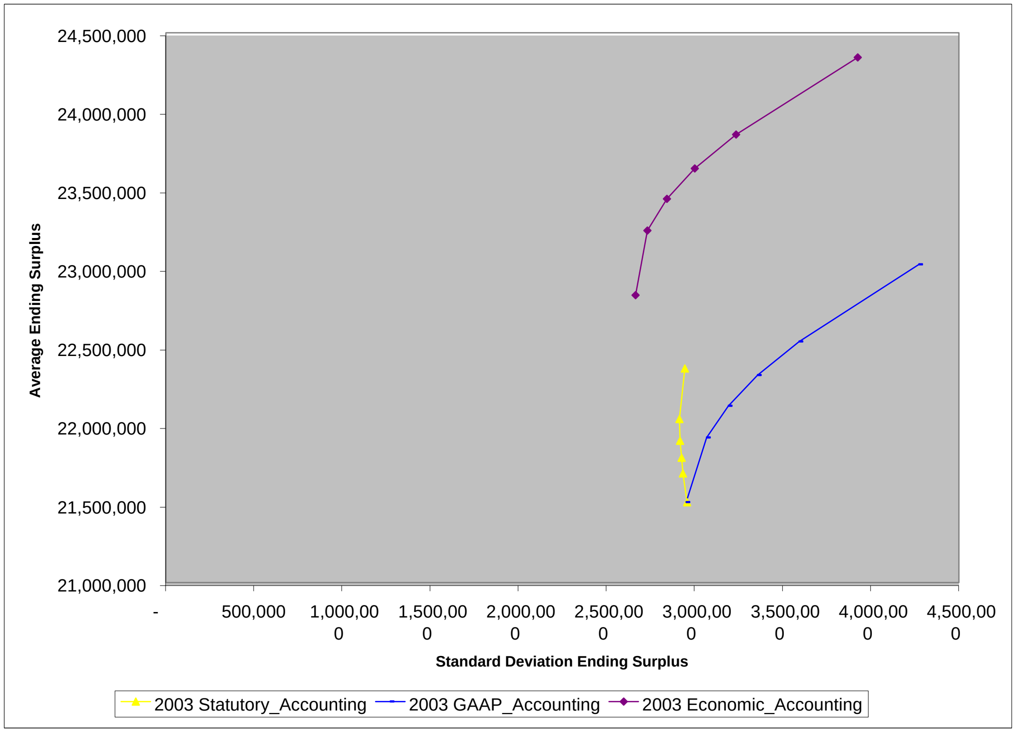
Statement_Line: L32 Policyholders Surplus

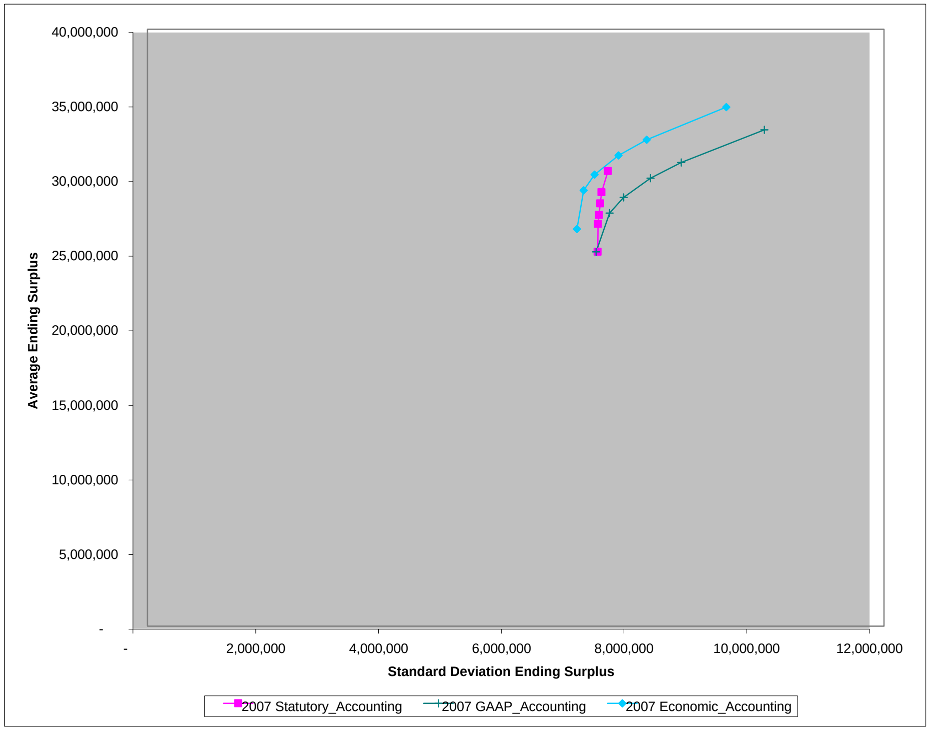
Period: 2007

	Simulation					
Statistics	**vfic 10 1 ho**	**vfic 10 4 ho**	**vfic 10 5 ho**	**vfic 10 6 ho**	**vfic 10 7 ho**	**vfic 10 9 ho**
avg	26,614,083	29,204,203	30,256,890	31,544,456	32,592,408	34,784,656
std	6,996,899	7,107,589	7,285,881	7,674,468	8,131,562	9,430,762
min	-7,903,653	-7,872,695	-8,079,794	-8,546,105	-9,032,604	-10,830,991
0.1%	-6,536,637	-4,846,855	-4,319,315	-3,671,855	-3,880,841	-5,688,190
0.2%	-5,797,248	-3,629,120	-3,326,017	-3,238,564	-2,786,543	-1,238,711
0.4%	-2,520,894	-1,273,099	-460,974	1,111,160	2,418,257	2,681,259
1.0%	4,594,606	6,767,877	7,295,557	7,690,793	7,680,105	7,722,598
2.5%	6,479,539	8,838,931	9,826,635	11,116,274	12,283,361	14,008,361
5.0%	15,854,156	18,132,330	18,401,571	17,888,941	17,677,952	17,892,524
10.0%	17,420,073	19,920,153	20,623,196	21,284,588	21,477,271	21,848,063
25.0%	20,315,272	22,682,675	24,151,269	26,351,060	27,852,727	29,230,567
50.0%	29,664,511	32,387,050	33,344,058	34,282,358	34,706,617	35,731,195
75.0%	31,024,497	33,797,989	35,186,335	37,024,563	38,593,327	41,740,622
90.0%	32,219,764	34,853,967	36,380,508	38,753,823	41,069,012	46,047,793
95.0%	32,899,272	35,435,781	37,102,045	39,672,975	42,187,480	47,997,633
97.5%	33,697,630	35,980,820	37,754,276	40,428,090	43,201,668	49,429,314
99.0%	34,463,958	36,559,264	38,406,784	41,554,896	44,639,460	50,904,124
99.6%	35,261,194	37,060,833	39,209,900	42,419,272	45,614,062	52,104,642
99.8%	35,676,696	37,544,330	39,779,273	43,254,666	45,959,380	52,641,348
99.9%	35,893,523	38,142,795	39,900,930	43,835,989	47,242,404	53,548,783
max	36,714,989	41,835,132	44,929,712	46,401,346	48,197,356	54,558,462

- HO economic basis
- As duration increases:
    - Worst case outcome gets worse
    - 1%ile outcome improves
    - 1%ile outcome gets worse relative to average
- Again, the risk metric matters

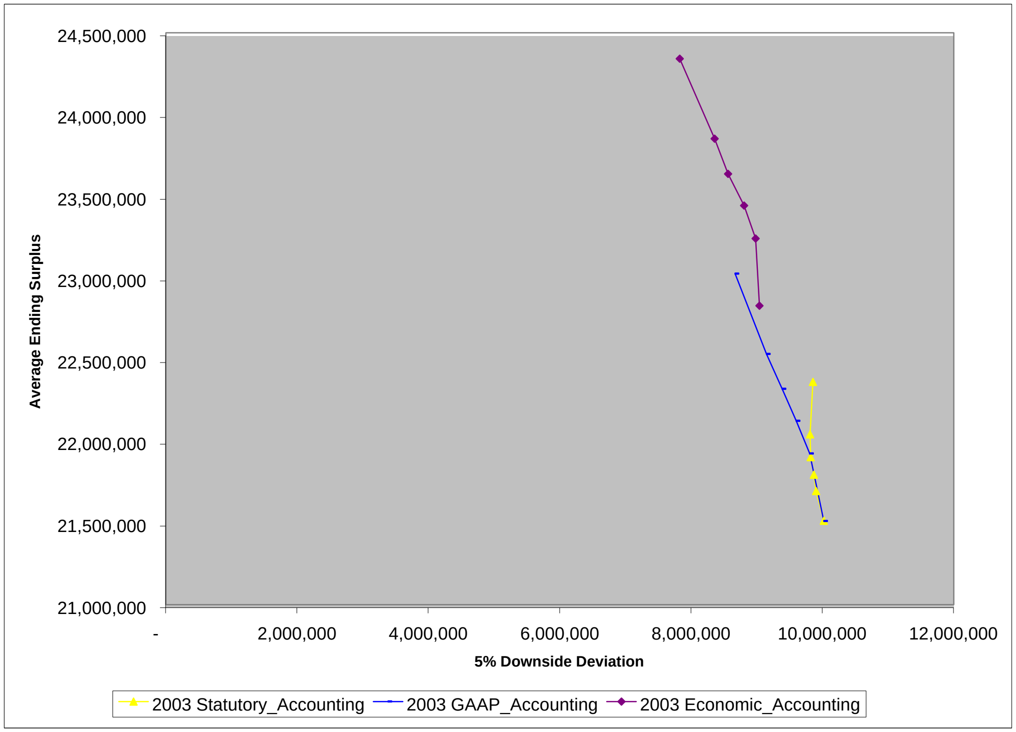
RISK/REWARD - BASED ON ENDING SURPLUS
HOMEOWNERS BASE CASE
Risk Measure: Standard Deviation

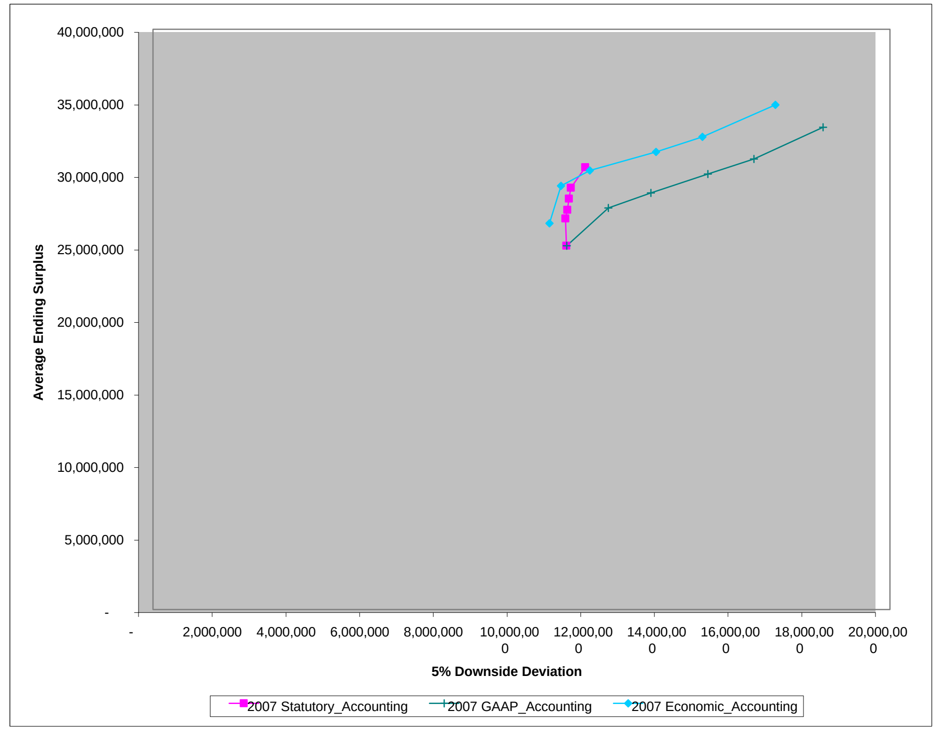




Frontiers:
- Standard deviation - similar to WC

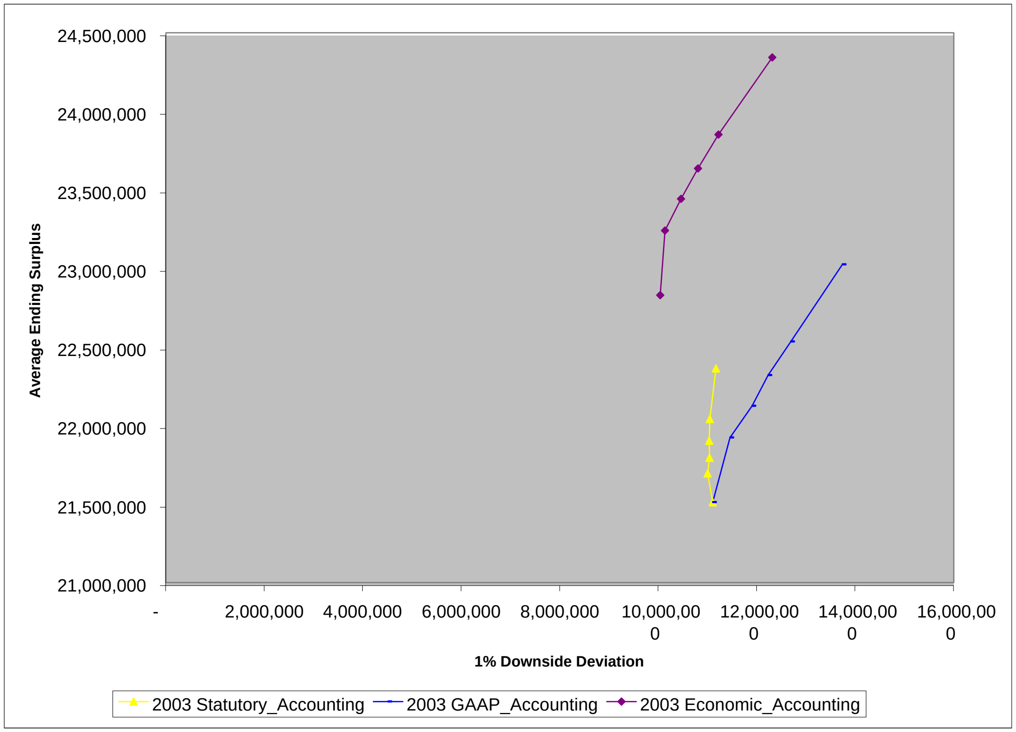
RISK/REWARD - BASED ON ENDING SURPLUS
HOMEOWNERS BASE CASE
Risk Measure: 5% Downside Deviation Relative to Average Ending Surplus

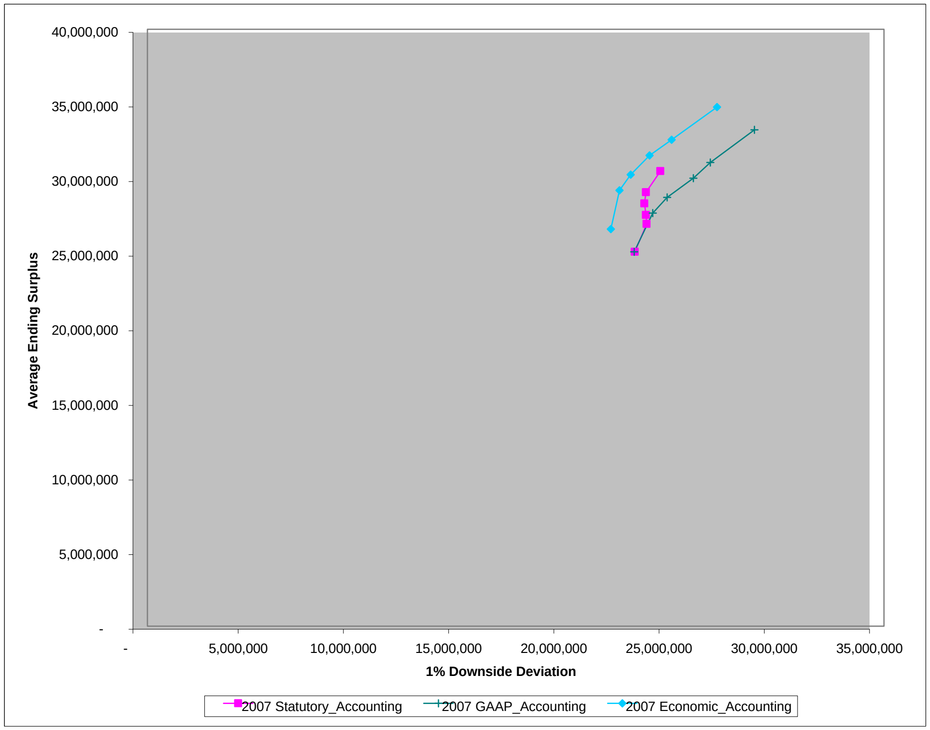




Downside 5th percentile relative to mean - duration lowers risk at 1 year horizon, raises it at 5 years

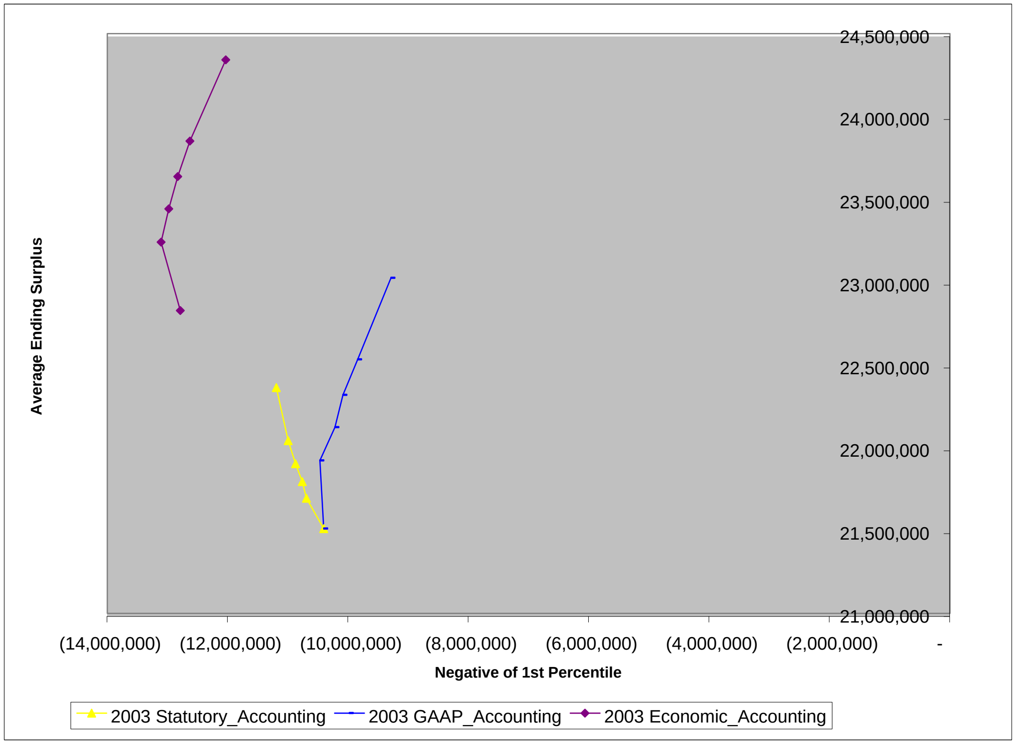
RISK/REWARD - BASED ON ENDING SURPLUS
HOMEOWNERS BASE CASE
Risk Measure: 1% Downside Deviation Relative to Average Ending Surplus

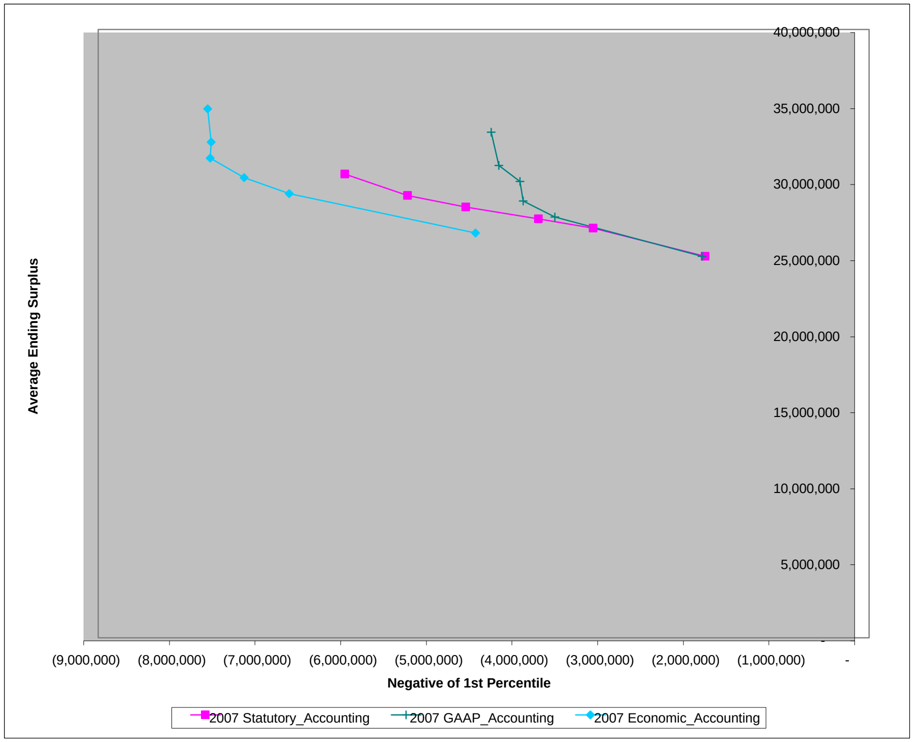




Downside 1st percentile relative to mean - duration raises risk at 1 and 5 years

RISK/REWARD - BASED ON ENDING SURPLUS
HOMEOWNERS BASE CASE
Risk Measure: Negative of 1st Percentile of Ending Surplus





1st percentile of absolute ending surplus (sign reversed) - higher duration leads to lower risk

(but not at lower percentiles)

New Results

- “Economic Basis” results:
  - “Economic” means market value assets, discounted reserves (no risk margin)
  - Better indicator of true economic performance
  - In general:
    - longer duration always produces higher expected return
    - lowest risk is around duration match
  - Unlike statutory or GAAP results, the liabilities matter
  - The risk measure matters, too
    - some measure pure volatility
    - some measure absolute level of downside

New Results

- The original question: Does duration matching make sense for a P/C insurer?
- Answer: It depends
- What's interesting is what it depends on
  - Accounting basis
  - Risk measure

New Results

- Next: Unified risk return measures
  - Aim is to rank results on the risk/reward frontier
- Plan to examine Wang transforms under range of risk-aversion parameters

Duration 4

										-1						
			Expectations:						Expectations:					Expectations:		
			unweighted	wt weighted					unweighted	wt weighted				unweighted	wt weighted	
			9,961,937	7,740,811					10,705,790	7,576,504				16,386,541	15,125,865	
	Modul	Statutory_Accounting				GAAP_Accounting					Economic_Accounting					
	Time	2007	cdf	wt cdf	wt pdf	2007	cdf	wt cdf	wt pdf		2007	cdf	wt cdf	wt pdf		
Path																
0		(2,492,074)	0.00025	0.00655	0.00655	(5,330,441)	0.00025	0.00655	0.00655		11,486,709	0.00025	0.00655	0.00655		
1		(144,755)	0.0005	0.01099	0.00444	(2,919,340)	0.0005	0.01099	0.00444		11,792,586	0.0005	0.01099	0.00444		
2		(57,994)	0.00075	0.01483	0.00383	(2,598,630)	0.00075	0.01483	0.00383		11,906,343	0.00075	0.01483	0.00383		
3		53,058	0.001	0.01830	0.00347	(1,643,793)	0.001	0.01830	0.00347		12,095,643	0.001	0.01830	0.00347		
4		407,178	0.00125	0.02152	0.00322	(1,056,190)	0.00125	0.02152	0.00322		12,202,633	0.00125	0.02152	0.00322		
5		865,639	0.0015	0.02455	0.00303	(555,383)	0.0015	0.02455	0.00303		12,347,140	0.0015	0.02455	0.00303		
6		1,370,521	0.00175	0.02743	0.00288	(404,055)	0.00175	0.02743	0.00288		12,402,048	0.00175	0.02743	0.00288		
7		1,515,210	0.002	0.03018	0.00275	66,842	0.002	0.03018	0.00275		12,572,090	0.002	0.03018	0.00275		
3,987		14,399,253	0.997	0.99991	0.00001	16,386,703	0.997	0.99991	0.00001		19,624,602	0.997	0.99991	0.00001		
3,988		14,443,173	0.99725	0.99992	0.00001	16,387,867	0.99725	0.99992	0.00001		19,701,774	0.99725	0.99992	0.00001		
3,989		14,452,437	0.9975	0.99993	0.00001	16,600,404	0.9975	0.99993	0.00001		19,702,098	0.9975	0.99993	0.00001		
3,990		14,818,203	0.99775	0.99994	0.00001	16,679,873	0.99775	0.99994	0.00001		19,708,122	0.99775	0.99994	0.00001		
3,991		14,825,203	0.998	0.99995	0.00001	16,727,577	0.998	0.99995	0.00001		19,747,479	0.998	0.99995	0.00001		
3,992		14,829,622	0.99825	0.99996	0.00001	16,871,494	0.99825	0.99996	0.00001		19,823,433	0.99825	0.99996	0.00001		
3,993		14,884,224	0.9985	0.99996	0.00001	16,890,216	0.9985	0.99996	0.00001		19,978,238	0.9985	0.99996	0.00001		
3,994		14,953,266	0.99875	0.99997	0.00001	16,992,209	0.99875	0.99997	0.00001		19,991,194	0.99875	0.99997	0.00001		
3,995		15,081,617	0.999	0.99998	0.00001	17,096,430	0.999	0.99998	0.00001		20,079,379	0.999	0.99998	0.00001		
3,996		15,137,651	0.99925	0.99999	0.00001	17,104,901	0.99925	0.99999	0.00001		20,154,695	0.99925	0.99999	0.00001		
3,997		15,223,820	0.9995	0.99999	0.00001	17,212,077	0.9995	0.99999	0.00001		20,202,013	0.9995	0.99999	0.00001		
3,998		15,622,930	0.99975	1.00000	0.00001	17,263,261	0.99975	1.00000	0.00001		20,374,314	0.99975	1.00000	0.00001		
3,999		15,728,566	1	1.00000	0.00000	17,791,489	1	1.00000	0.00000		20,814,093	1	1.00000	0.00000		

WORKERS COMPENSATION BASE CASE

Wang Transformed Surplus at 5 Year Horizon

WT lambda: 0.0

duration	stat	gaap	econ
	accounting basis		
1	7,983,622	7,985,684	13,666,435
4	9,961,937	10,705,790	16,386,541
5	10,557,199	11,764,940	17,445,691
6	11,322,031	13,048,671	18,729,422
7	12,061,809	14,103,093	19,783,844
9	13,563,350	16,378,281	22,059,032

WT lambda: -1.0

duration	stat	gaap	econ
	accounting basis		
1	5,941,708	5,964,867	11,897,004
4	7,740,811	7,576,504	15,125,865
5	8,297,397	7,850,579	15,842,571
6	9,109,207	8,099,539	16,230,408
7	9,856,847	8,205,822	16,402,977
9	11,283,536	8,395,823	16,639,915

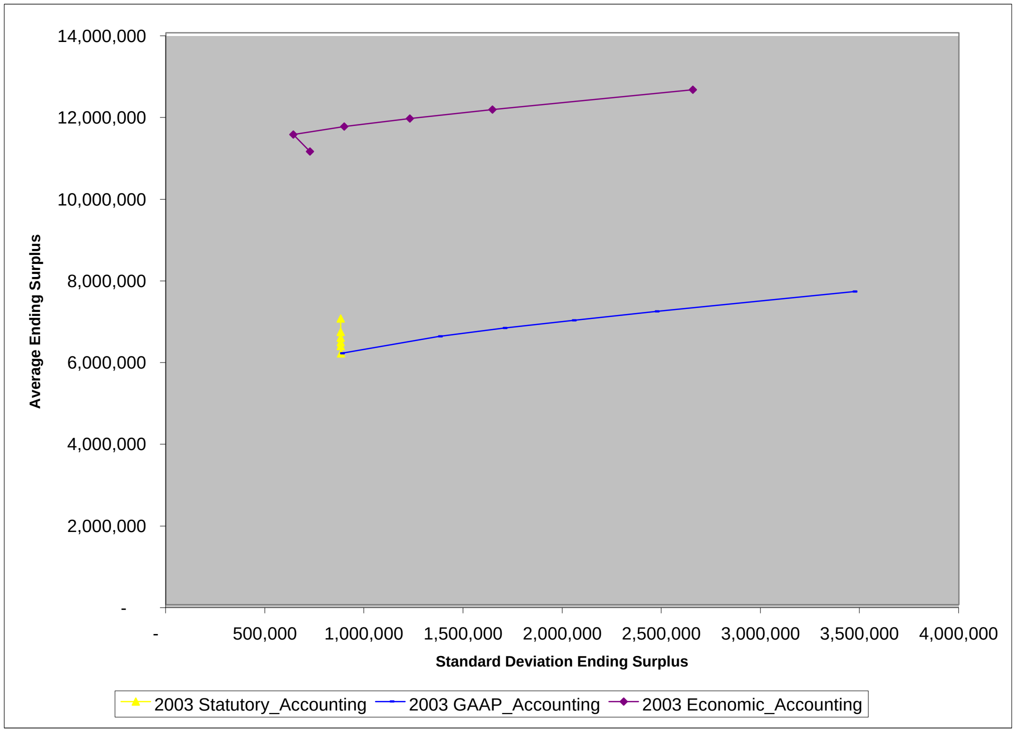
WT lambda: -0.5

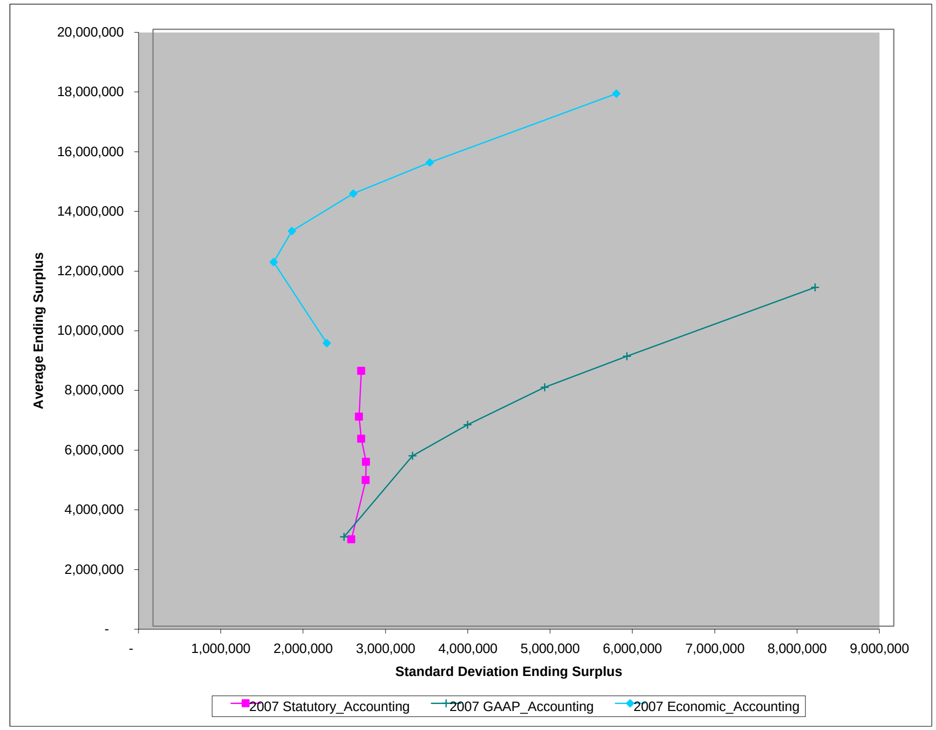
duration	stat	gaap	econ
	accounting basis		
1	7,003,175	7,011,749	12,764,402
4	8,911,367	9,236,036	15,762,205
5	9,489,384	9,922,756	16,648,345
6	10,275,778	10,696,383	17,484,693
7	11,020,955	11,245,344	18,067,005
9	12,488,807	12,409,656	19,251,740

WT lambda: -1.5

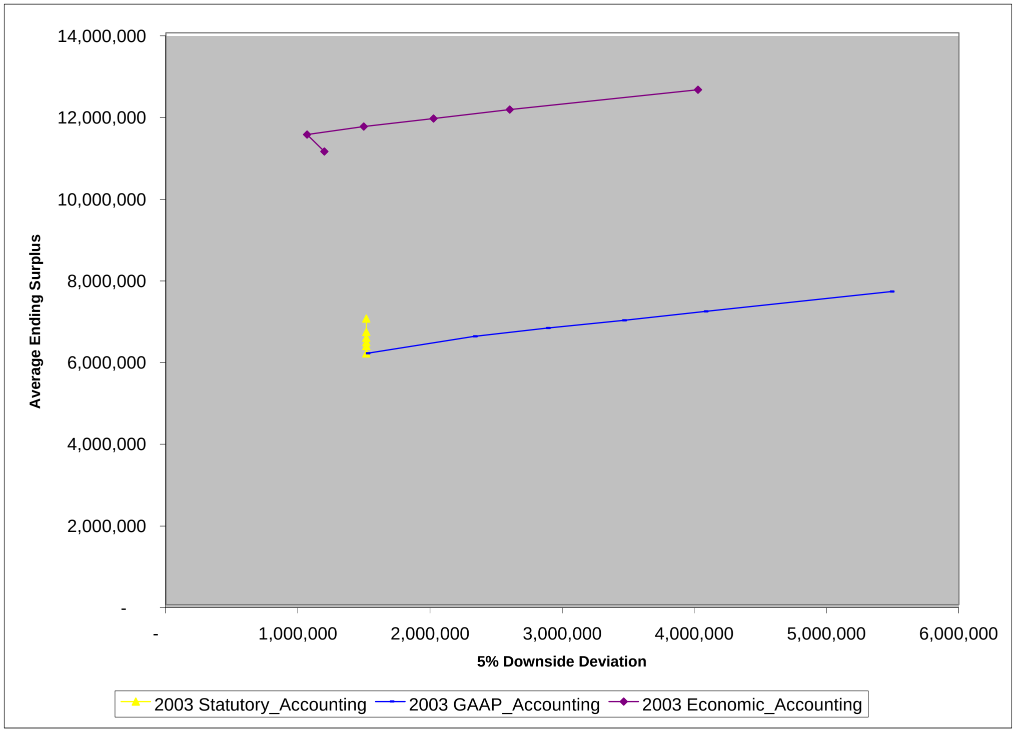
duration	stat	gaap	econ
	accounting basis		
1	4,781,645	4,833,546	11,054,254
4	6,411,709	5,724,967	14,476,827
5	6,943,892	5,568,187	15,044,221
6	7,785,025	5,315,484	15,020,345
7	8,532,055	5,073,771	14,881,053
9	9,911,523	4,467,315	14,363,487

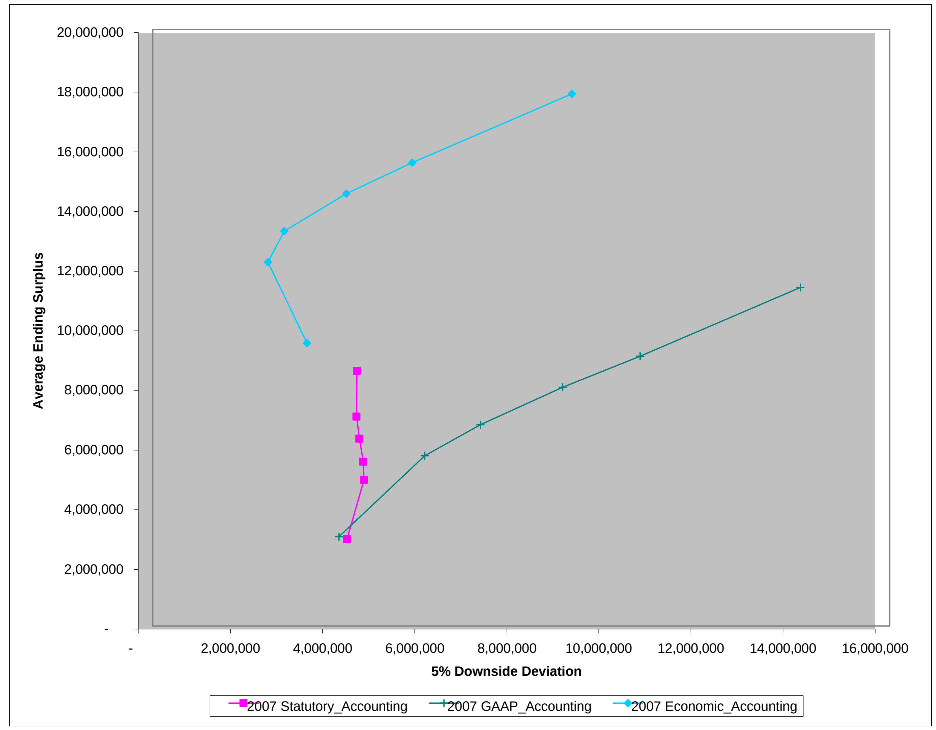
RISK/REWARD - BASED ON ENDING SURPLUS
WORKERS COMPENSATION ADVERSE LOSS RATIO
Risk Measure: Standard Deviation



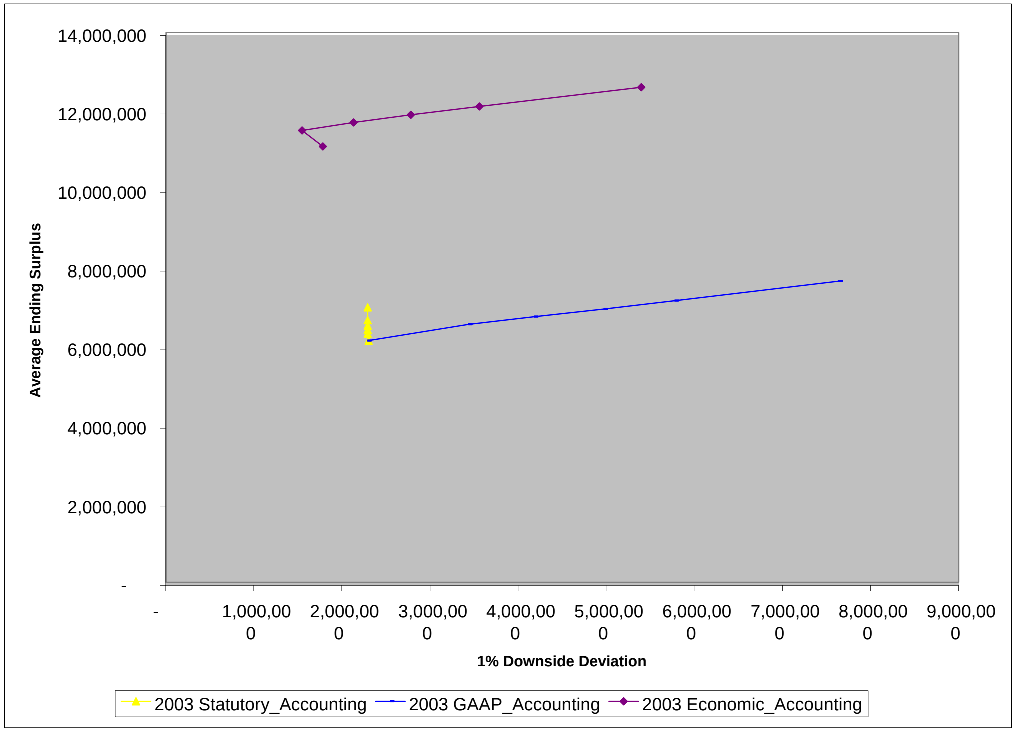


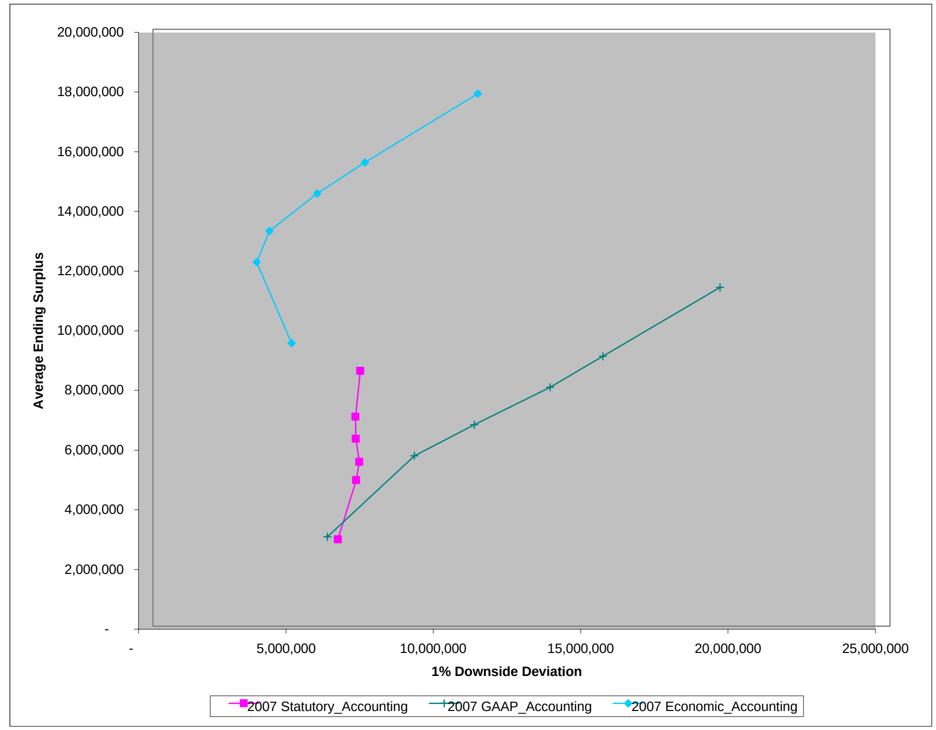
RISK/REWARD - BASED ON ENDING SURPLUS
WORKERS COMPENSATION ADVERSE LOSS RATIO
Risk Measure: 5% Downside Deviation Relative to Average Ending Surplus



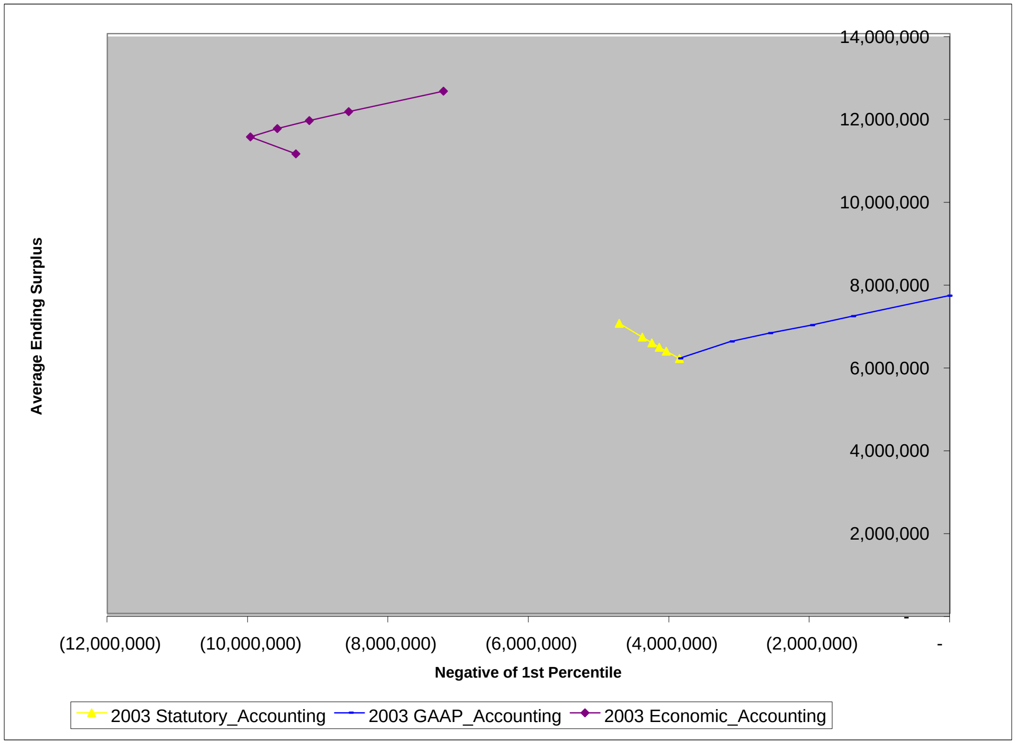


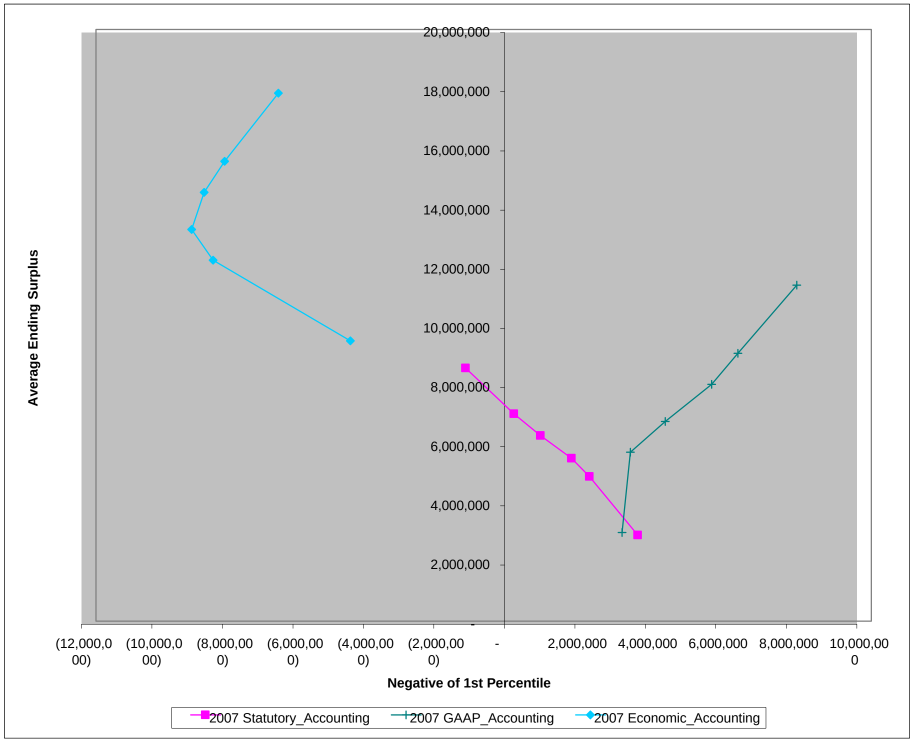
RISK/REWARD - BASED ON ENDING SURPLUS
WORKERS COMPENSATION ADVERSE LOSS RATIO
Risk Measure: 1% Downside Deviation Relative to Average Ending Surplus



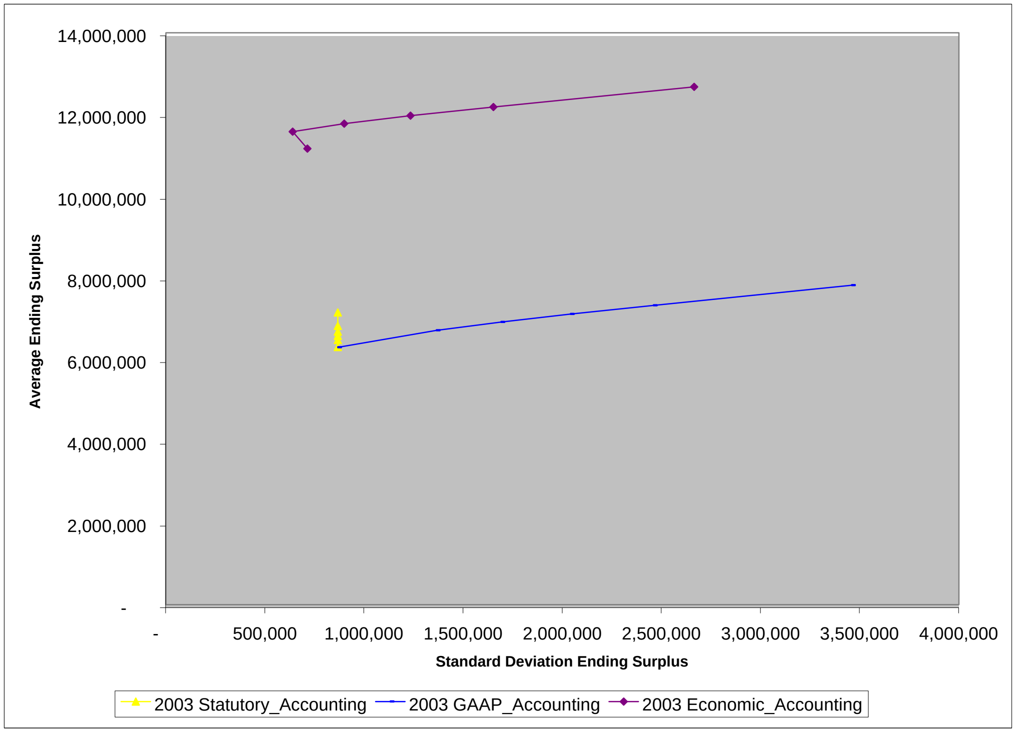


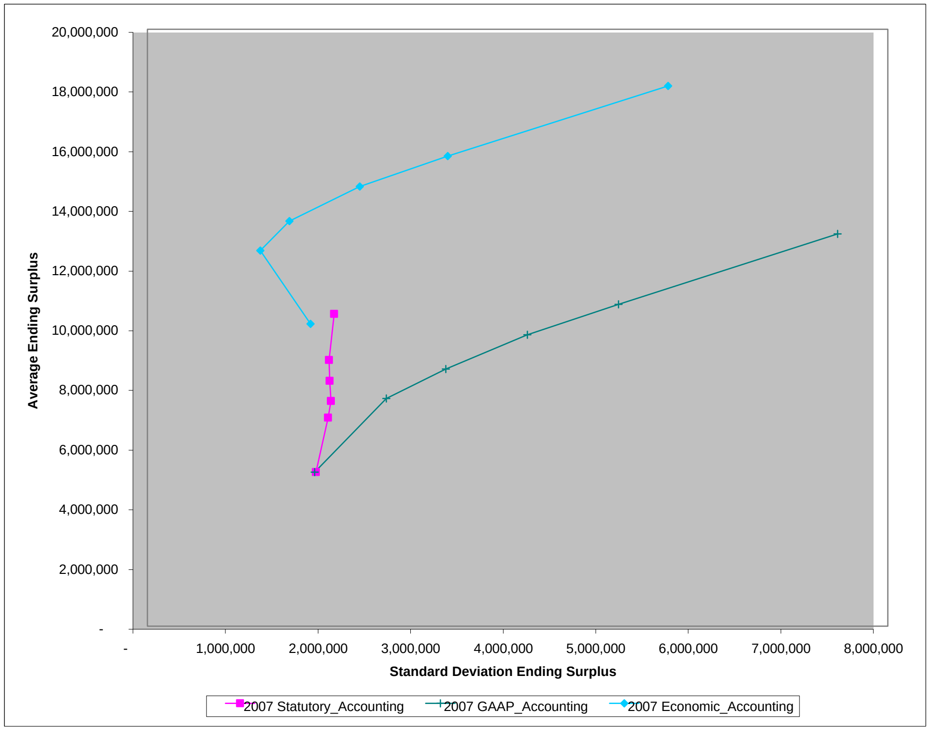
RISK/REWARD - BASED ON ENDING SURPLUS
WORKERS COMPENSATION ADVERSE LOSS RATIO
Risk Measure: Negative of 1st Percentile of Ending Surplus



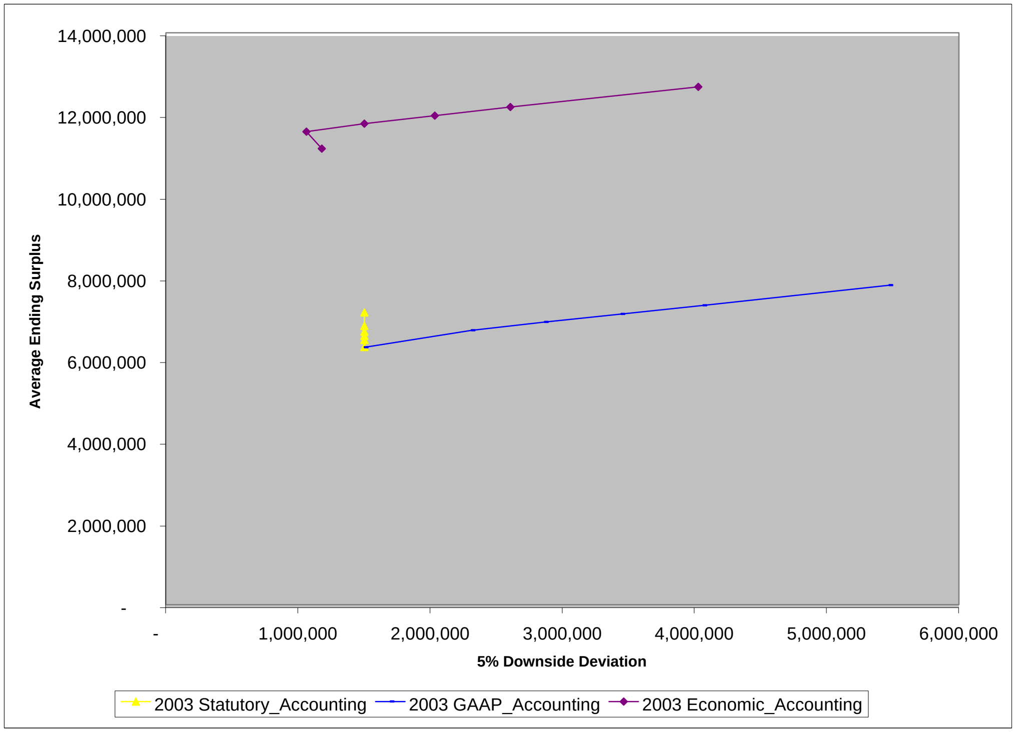


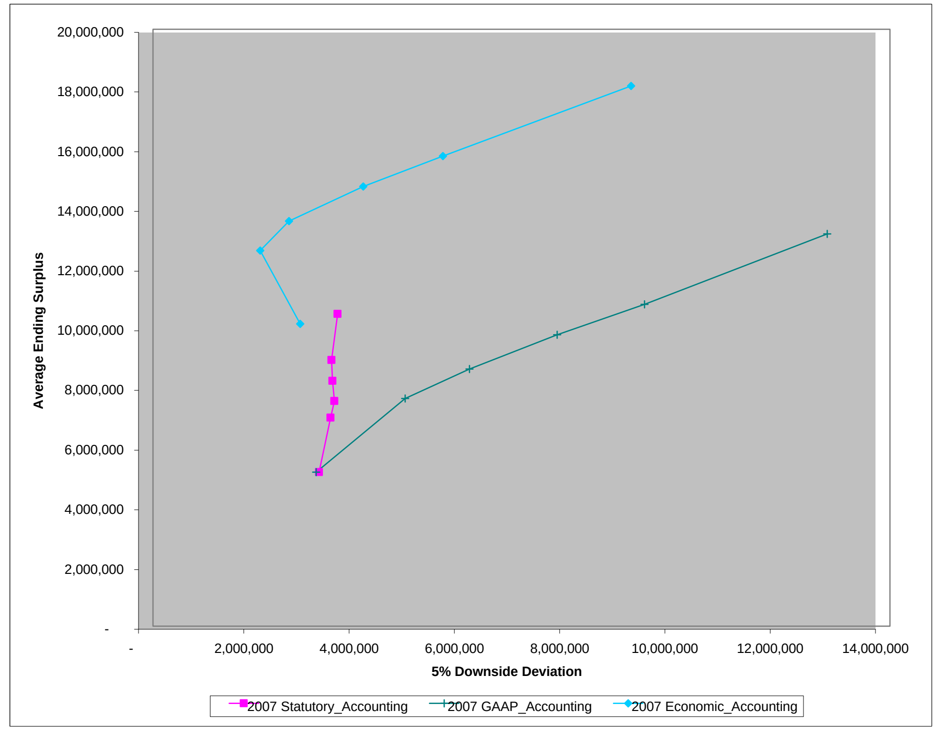
RISK/REWARD - BASED ON ENDING SURPLUS
WORKERS COMPENSATION ADVERSE LOSS RATIO DECLINING VOLUME
Risk Measure: Standard Deviation



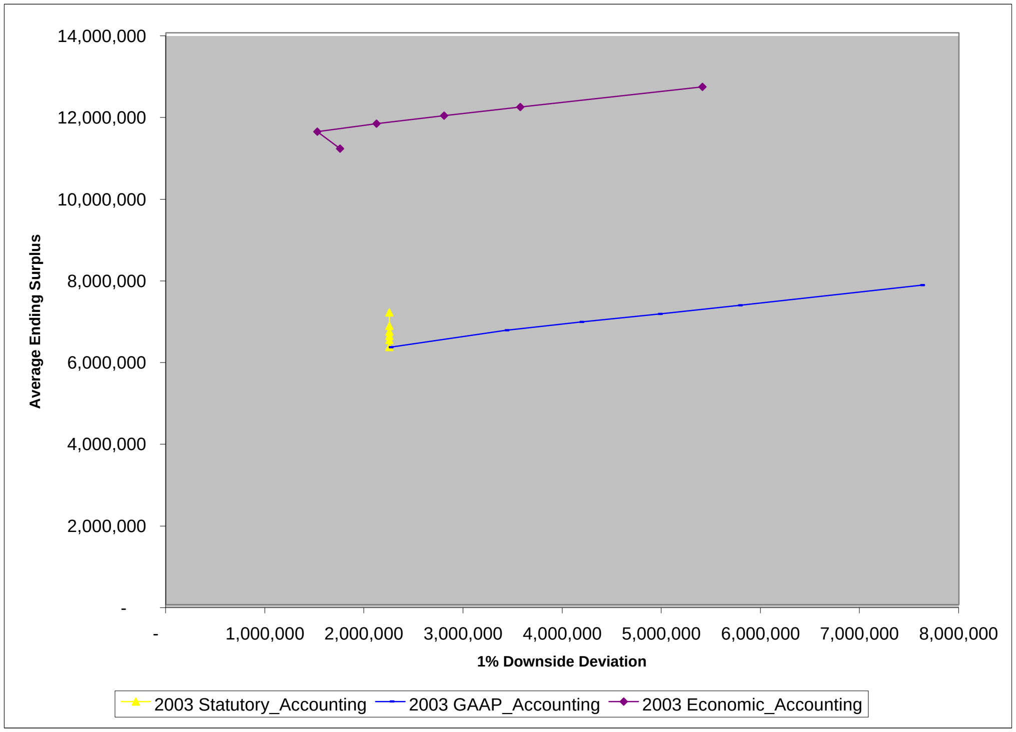


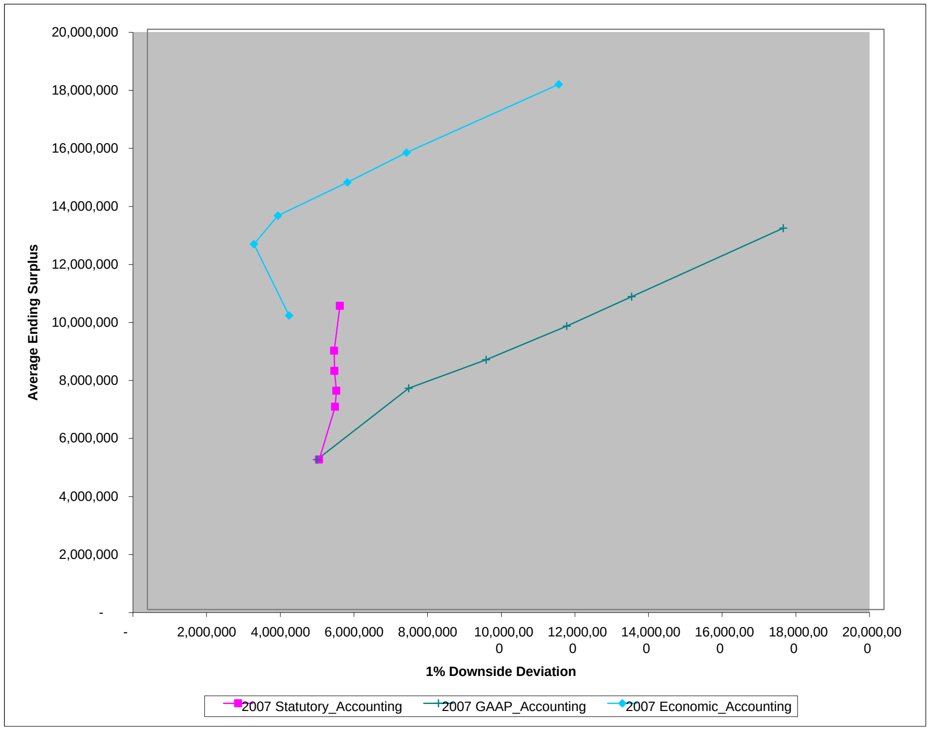
RISK/REWARD - BASED ON ENDING SURPLUS
WORKERS COMPENSATION ADVERSE LOSS RATIO DECLINING VOLUME
Risk Measure: 5% Downside Deviation Relative to Average Ending Surplus



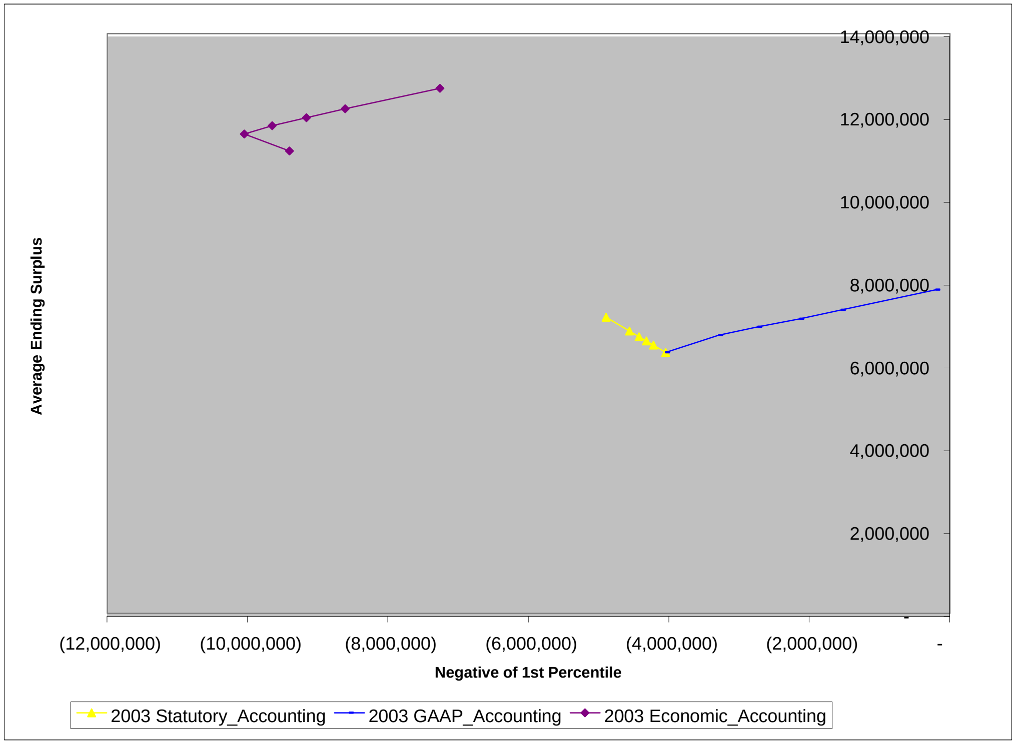


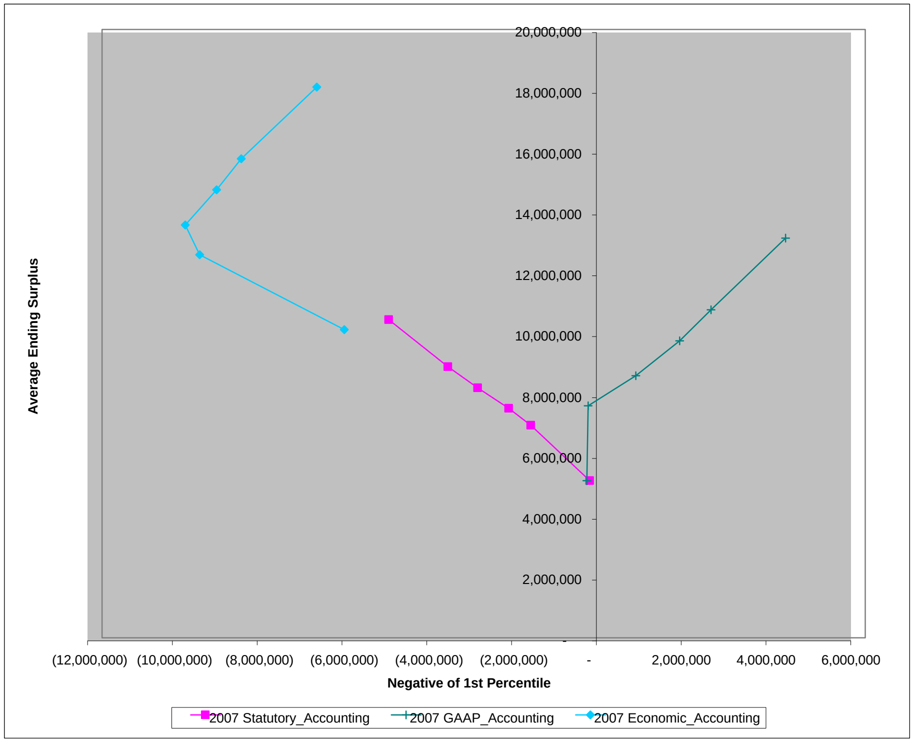
RISK/REWARD - BASED ON ENDING SURPLUS
WORKERS COMPENSATION ADVERSE LOSS RATIO DECLINING VOLUME
Risk Measure: 1% Downside Deviation Relative to Average Ending Surplus



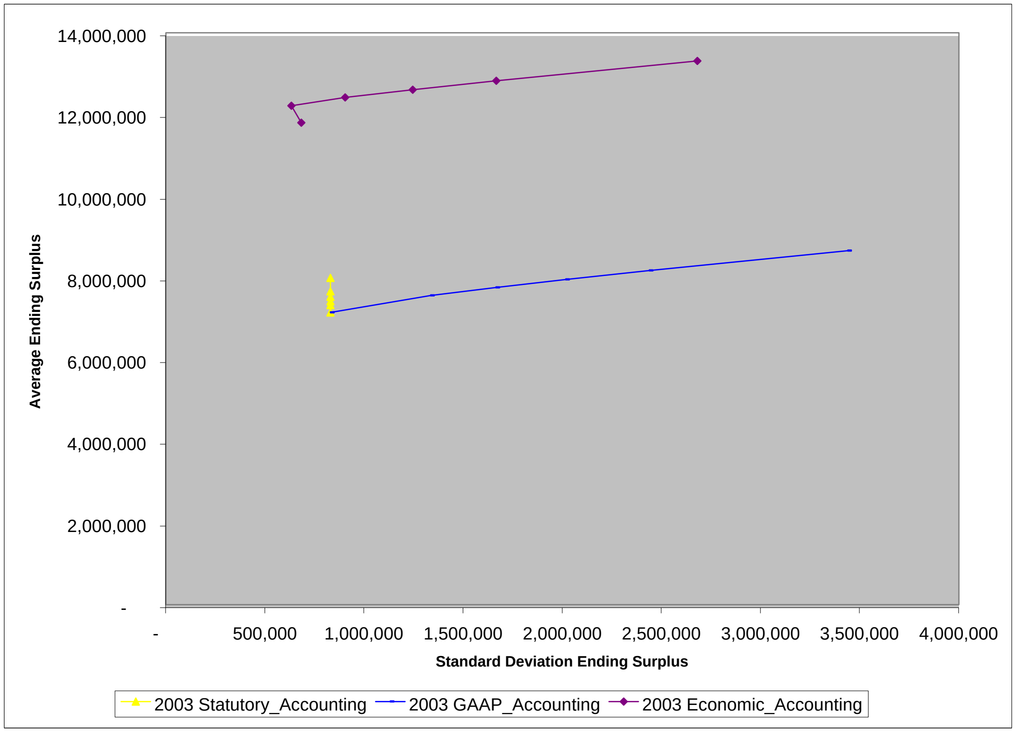


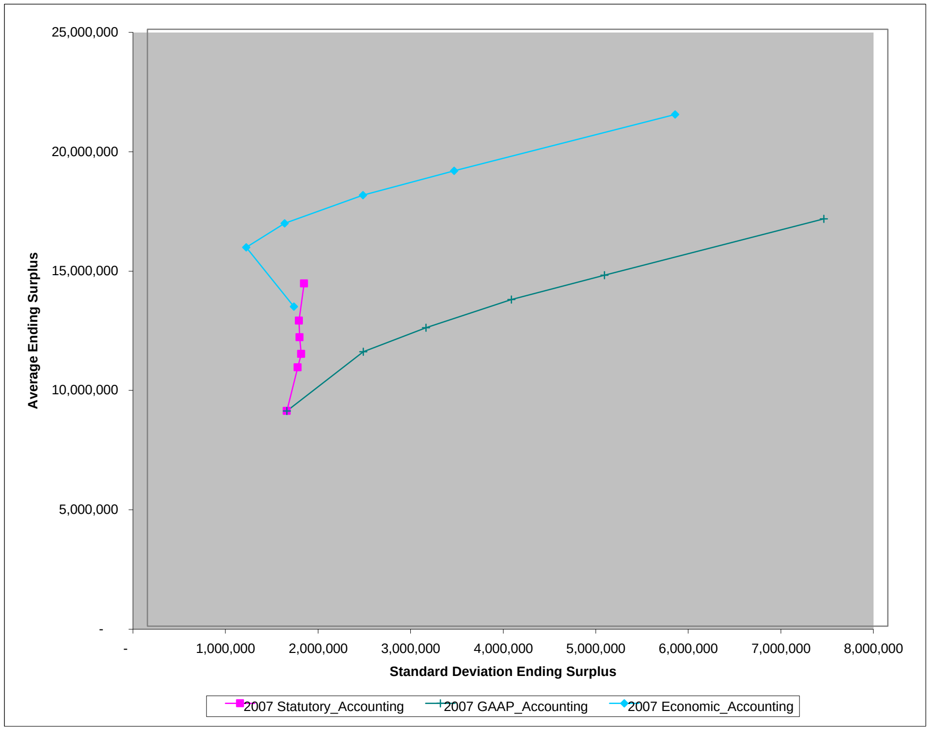
RISK/REWARD - BASED ON ENDING SURPLUS
WORKERS COMPENSATION ADVERSE LOSS RATIO DECLINING VOLUME
Risk Measure: Negative of 1st Percentile of Ending Surplus



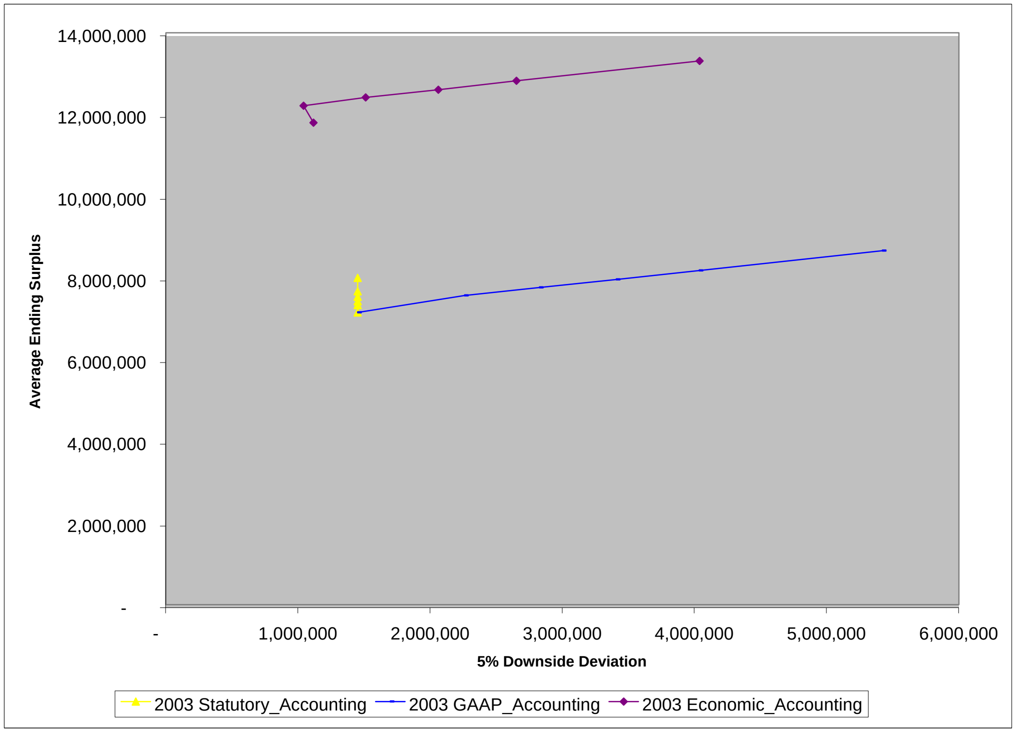


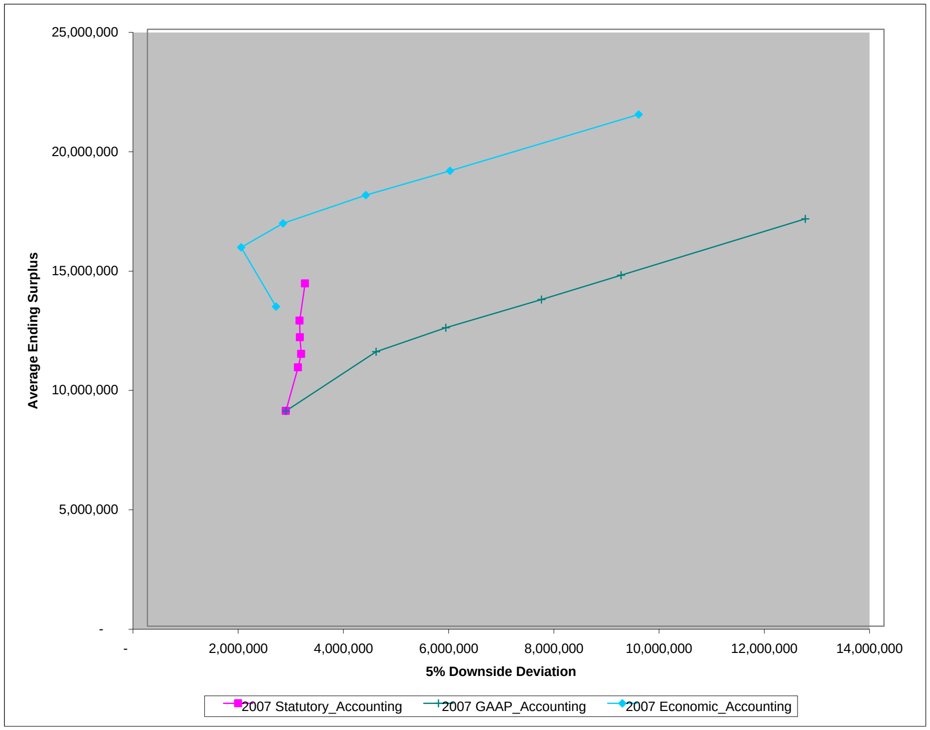
RISK/REWARD - BASED ON ENDING SURPLUS
WORKERS COMPENSATION DECLINING VOLUME
Risk Measure: Standard Deviation



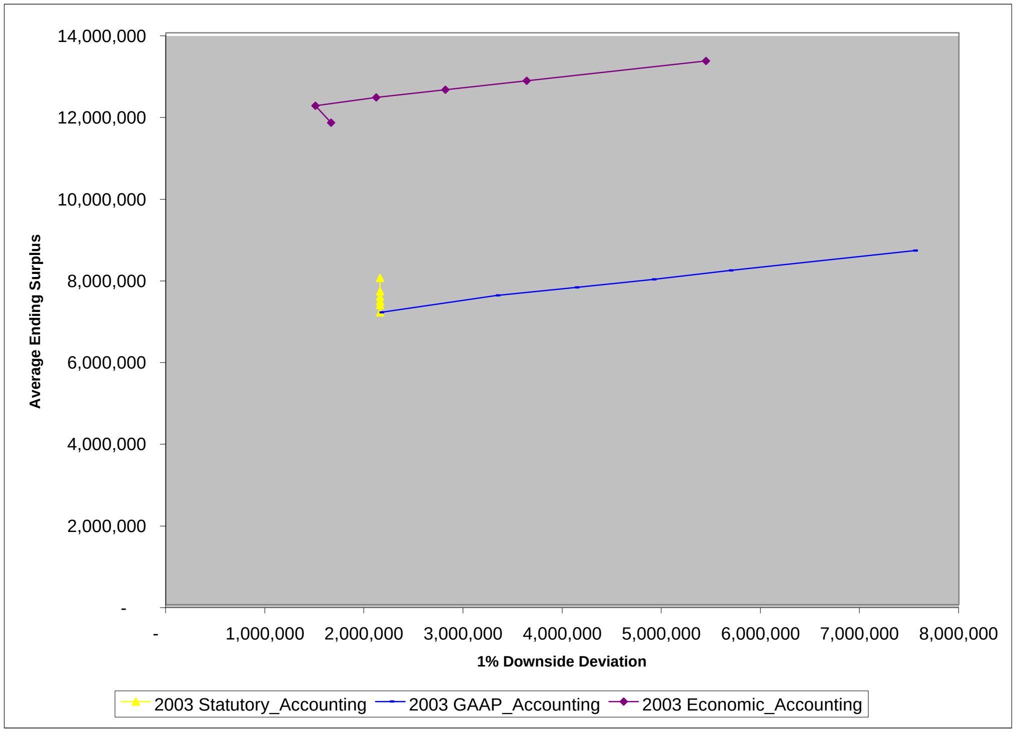


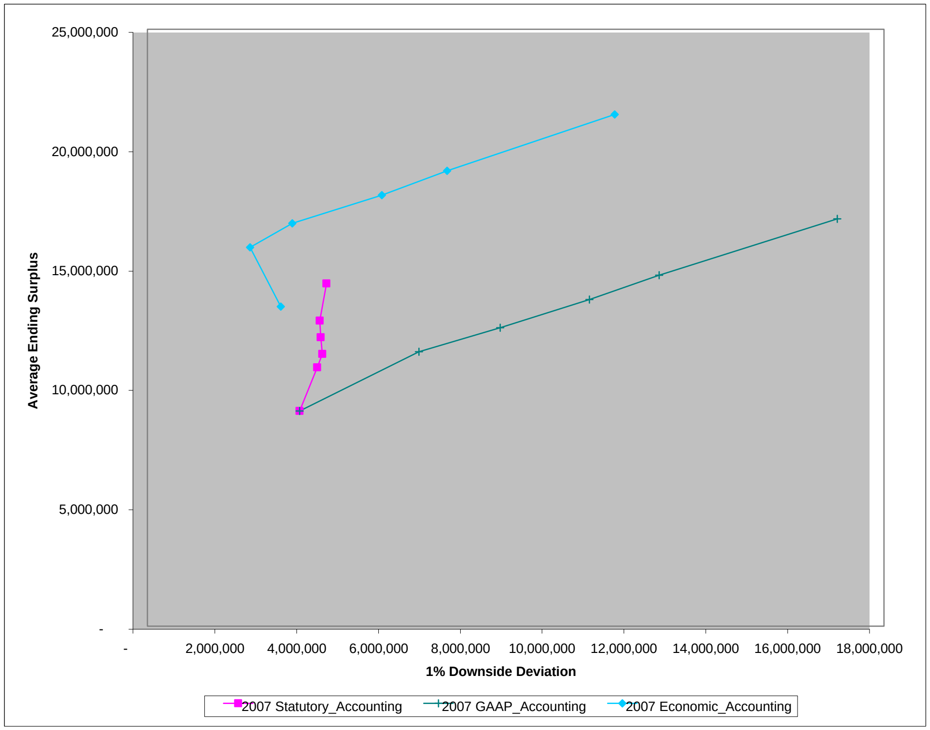
RISK/REWARD - BASED ON ENDING SURPLUS
WORKERS COMPENSATION DECLINING VOLUME
Risk Measure: 5% Downside Deviation Relative to Average Ending Surplus





RISK/REWARD - BASED ON ENDING SURPLUS
WORKERS COMPENSATION DECLINING VOLUME
Risk Measure: 1% Downside Deviation Relative to Average Ending Surplus





RISK/REWARD - BASED ON ENDING SURPLUS
WORKERS COMPENSATION DECLINING VOLUME
Risk Measure: Negative of 1st Percentile of Ending Surplus