Reinsurance and Retentions Working Party
Sample Data Distribution Used in Examples
Aviation LMX
Amounts in £000s

Claim Amount	Probability Point
22	2.439%
35	4.878%
235	7.317%
236	9.756%
244	12.195%
280	14.634%
332	17.073%
332	19.512%
338	21.951%
360	24.390%
598	26.829%
666	29.268%
693	31.707%
723	34.146%
750	36.585%
766	39.024%
795	41.463%
997	43.902%
1,006	46.341%
1,035	48.780%
1,080	51.220%
1,615	53.659%
2,507	56.098%
2,635	58.537%
2,635	60.976%
3,622	63.415%
3,832	65.854%
4,042	68.293%
4,551	70.732%
4,868	73.171%
5,800	75.610%
6,247	78.049%
8,865	80.488%
15,714	82.927%
20,160	85.366%
24,670	87.805%
25,587	90.244%
49,912	92.683%
52,211	95.122%
83,445	97.561%

Severity Mean = 9175

Claim Frequency Distribution = Poisson

Mean Claims Per Year = 8.000

Reinsurance and Retentions Working Party
Sample Data Distribution Used in Examples
Liability
Amounts in £s

Claim Amount	Probability Point
46	0.16%
210	2.03%
464	3.91%
604	5.79%
726	7.67%
864	9.55%
1,005	11.42%
1,168	13.30%
1,366	15.18%
1,542	17.06%
1,689	18.94%
1,843	20.81%
1,996	22.69%
2,218	24.57%
2,342	26.45%
2,545	28.33%
2,773	30.20%
3,135	32.08%
3,423	33.96%
3,880	35.84%
4,094	37.72%
4,458	39.59%
4,922	41.47%
5,252	43.35%
5,678	45.23%
6,104	47.10%
6,268	48.98%
6,917	50.86%
7,560	52.74%
8,024	54.62%
8,685	56.49%
9,763	58.37%
10,648	60.25%
11,784	62.13%
13,018	64.01%
14,054	65.88%
15,421	67.76%
17,940	69.64%
19,019	71.52%
21,568	73.40%
23,442	75.27%
25,230	77.15%
27,479	79.03%
30,405	80.91%
34,021	82.79%
37,906	84.66%
44,741	86.54%
58,040	88.42%
71,214	90.30%
91,109	92.18%
136,713	94.05%
199,848	95.93%
282,685	97.81%
291,012	97.97%
302,705	98.12%
384,537	98.28%
386,191	98.44%
388,151	98.59%
390,770	98.75%
508,880	98.90%
818,551	99.06%
835,373	99.22%
854,870	99.37%
975,428	99.53%
1,151,688	99.69%
1,756,234	99.84%
2,275,973	99.90%

Severity Mean = 38,134

Claim Frequency Distribution = Poisson

Mean Claims Per Year = 262.233

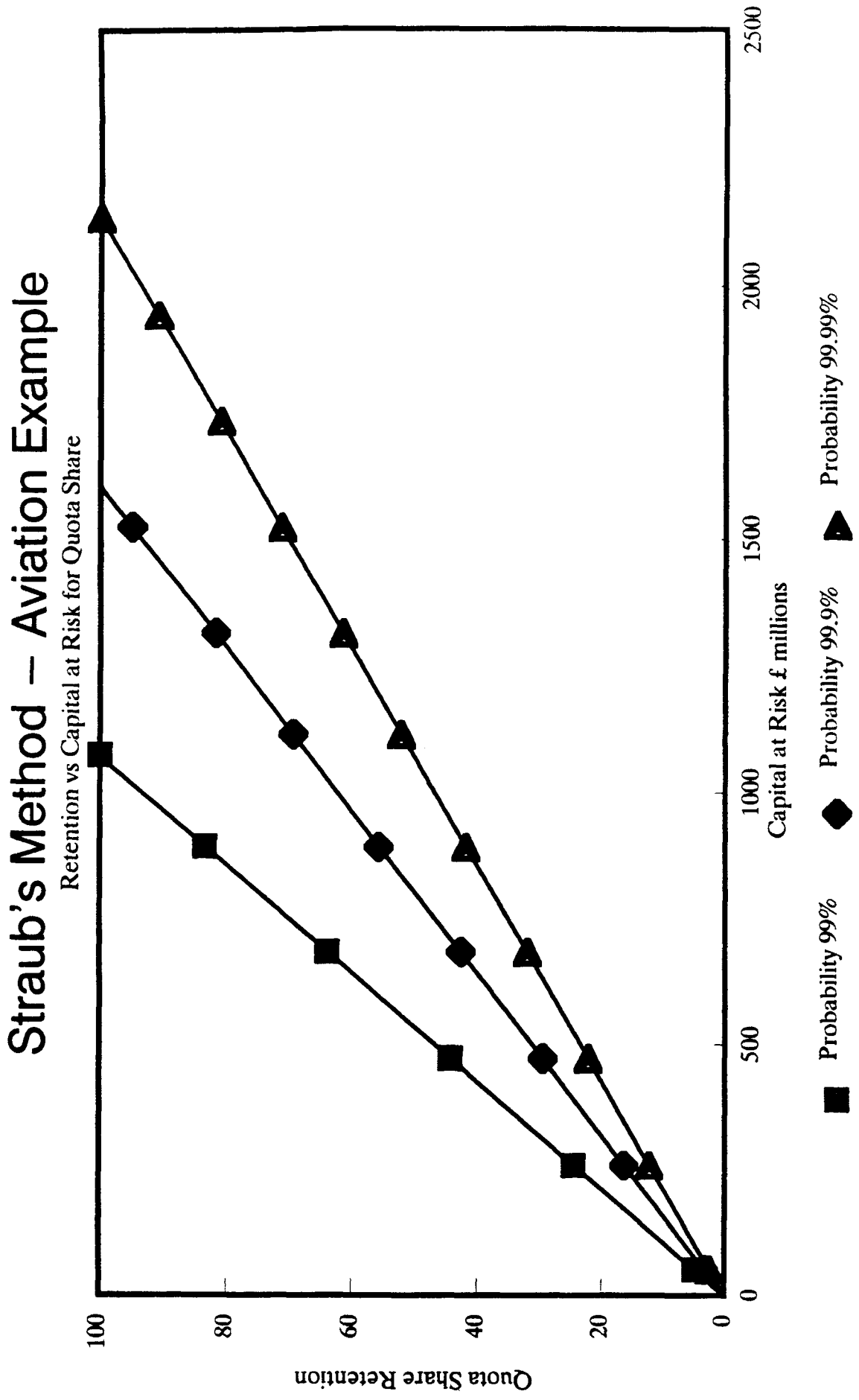
Reinsurance and Retentions Working Party
Sample Data Distribution Used in Examples
Property
Amounts in £s

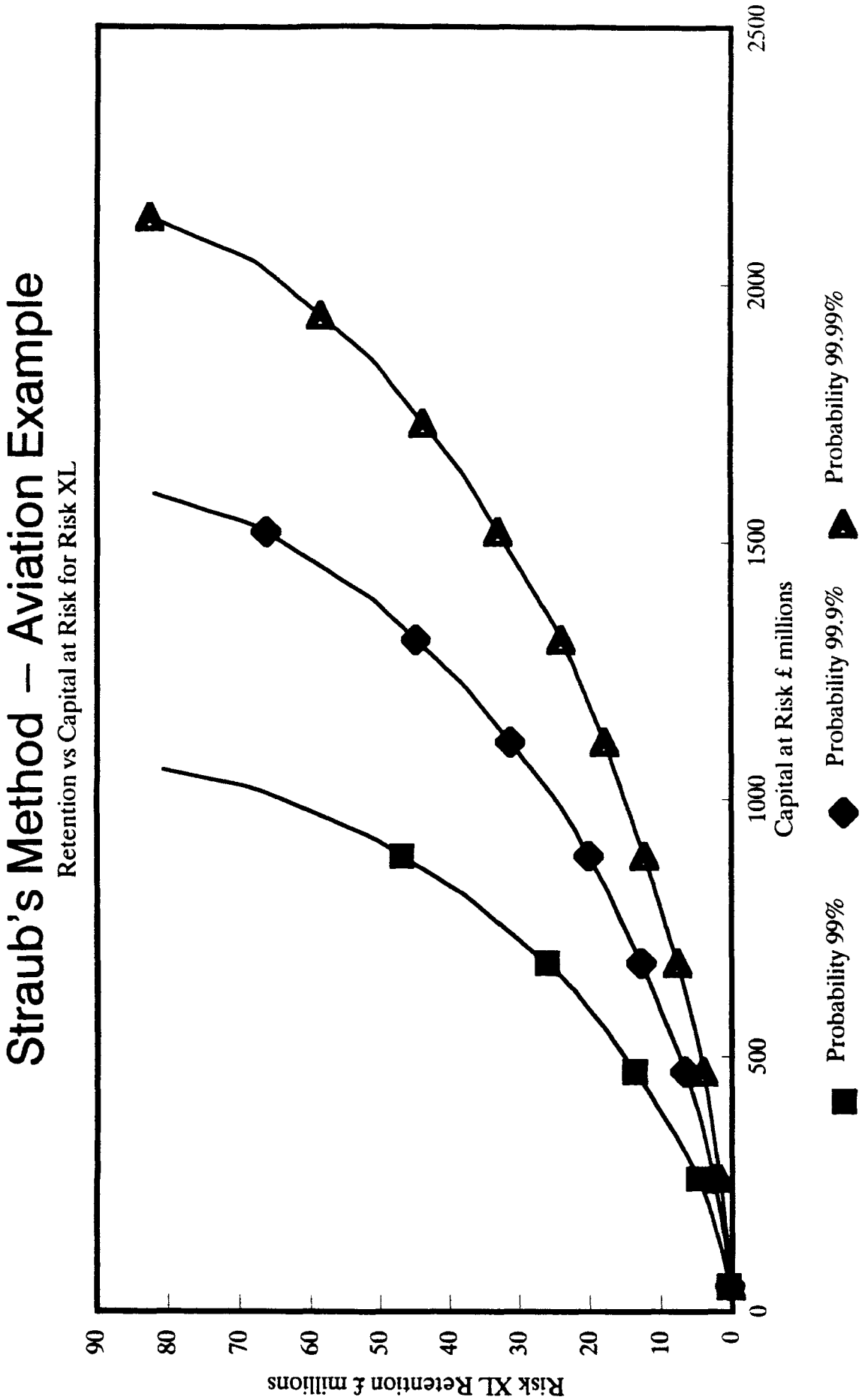
Claim Amount	Probability Point	Claim Amount	Probability Point
0	0.01%	32,390	98.87%
20	6.59%	32,930	98.91%
30	13.18%	34,130	98.95%
50	19.77%	36,630	99.00%
70	26.36%	38,530	99.04%
90	32.95%	39,740	99.09%
120	39.53%	42,920	99.13%
170	46.12%	45,000	99.17%
220	52.71%	46,660	99.22%
270	59.30%	48,480	99.26%
370	65.88%	50,080	99.30%
510	72.47%	51,540	99.35%
760	79.06%	53,840	99.39%
830	80.16%	56,250	99.44%
900	81.25%	60,150	99.48%
980	82.35%	67,290	99.52%
1,070	83.45%	72,370	99.57%
1,200	84.55%	77,400	99.61%
1,330	85.65%	93,070	99.66%
1,500	86.74%	117,940	99.70%
1,710	87.84%	122,760	99.71%
1,990	88.94%	131,250	99.71%
2,290	90.04%	132,210	99.72%
2,700	91.14%	134,780	99.73%
3,140	92.23%	143,440	99.74%
3,750	93.33%	144,740	99.74%
4,590	94.43%	148,820	99.75%
6,130	95.53%	149,540	99.76%
8,540	96.63%	150,000	99.77%
11,090	97.37%	153,600	99.78%
11,250	97.42%	153,940	99.79%
11,420	97.46%	165,000	99.80%
11,530	97.50%	168,750	99.80%
11,720	97.55%	186,880	99.81%
12,070	97.59%	187,500	99.82%
12,440	97.64%	192,450	99.82%
12,620	97.68%	194,580	99.83%
12,850	97.72%	214,990	99.84%
13,080	97.77%	222,240	99.85%
13,360	97.81%	225,000	99.85%
13,820	97.86%	234,250	99.86%
14,210	97.90%	234,800	99.87%
14,490	97.94%	247,220	99.88%
14,780	97.99%	248,000	99.88%
15,000	98.03%	305,650	99.89%
15,480	98.07%	313,440	99.90%
15,750	98.12%	326,630	99.90%
16,160	98.16%	334,860	99.91%
16,490	98.21%	375,000	99.92%
16,960	98.25%	381,080	99.93%
17,670	98.29%	427,500	99.93%
18,730	98.34%	450,000	99.94%
19,650	98.38%	549,600	99.95%
20,270	98.43%	601,230	99.96%
21,170	98.47%	626,700	99.96%
22,030	98.51%	1,117,730	99.97%
22,760	98.56%	1,261,060	99.98%
24,290	98.60%	3,753,050	99.99%
25,110	98.65%	4,305,000	99.99%
26,250	98.69%		
26,580	98.73%		
28,130	98.78%		
30,180	98.82%		

Severity Mean = 2956.1

Claim Frequency Distribution = Poisson

Mean Claims Per Year = 13661


Straub's Method – Aviation Example
Retention vs Capital at Risk for Quota Share
Quota Share Retention
100
80
60
40
20
0
0
500
1000
1500
2000
2500
Capital at Risk £ millions
Probability 99%
Probability 99.9%
Probability 99.99%


Straub's Method – Aviation Example
Retention vs Capital at Risk for Risk XL
Risk XL Retention £ millions
0
10
20
30
40
50
60
70
80
90
0
500
1000
1500
2000
2500
Capital at Risk £ millions
Probability 99%
Probability 99.9%
Probability 99.99%

Straub's Method - Aviation Example

Assumptions

Reference.....Aviation example
Claim amount dist'n.....User Defined
Claim number dist'n.....Poisson
Total Gross Premiums(M).....104.9
Capital at risk(M).....62.9
Total Loading in prems(%).....30
Profit Loading(%).....10
Probability (1 in ...).....1000
Reinsurance type.....Quota Share

Summary statistics

Claim amount Average.....9174719
Claim amount CV.....2.01
Number of claims.....8
Aggregate claim average.....73430000
Aggregate claim CV.....0.79

Results

The above assumptions imply Retention = 3%

For different Probabilities:-

Probability (1 in ...)	Retention
1,000	Retention = 3%
100,000	Retention = 2%
1,000,000	Retention = 1%
100,000,000	Retention = 1%
1,000,000,000	Retention = 1%

For different Capital at risk:-

Capital at risk As % prem	Amount(M)	Retention
5%	5.25	Retention = 0%
18%	18.88	Retention = 1%
100%	104.90	Retention = 6%
500%	524.50	Retention = 32%
1000%	1049.00	Retention = 65%

Straub's Method - Aviation Example

Assumptions

Reference.....Aviation example
Claim amount dist'n.....User Defined
Claim number dist'n.....Poisson
Total Gross Premiums(M).....104.9
Capital at risk(M).....62.9
Total Loading in prems(%).....30
Profit Loading(%).....10
Probability (1 in ...).....1000
Reinsurance type.....Risk XL

Summary statistics

Claim amount Average.....9174719
Claim amount CV.....2.01
Number of claims.....8
Aggregate claim average.....73430000
Aggregate claim CV.....0.79

Results

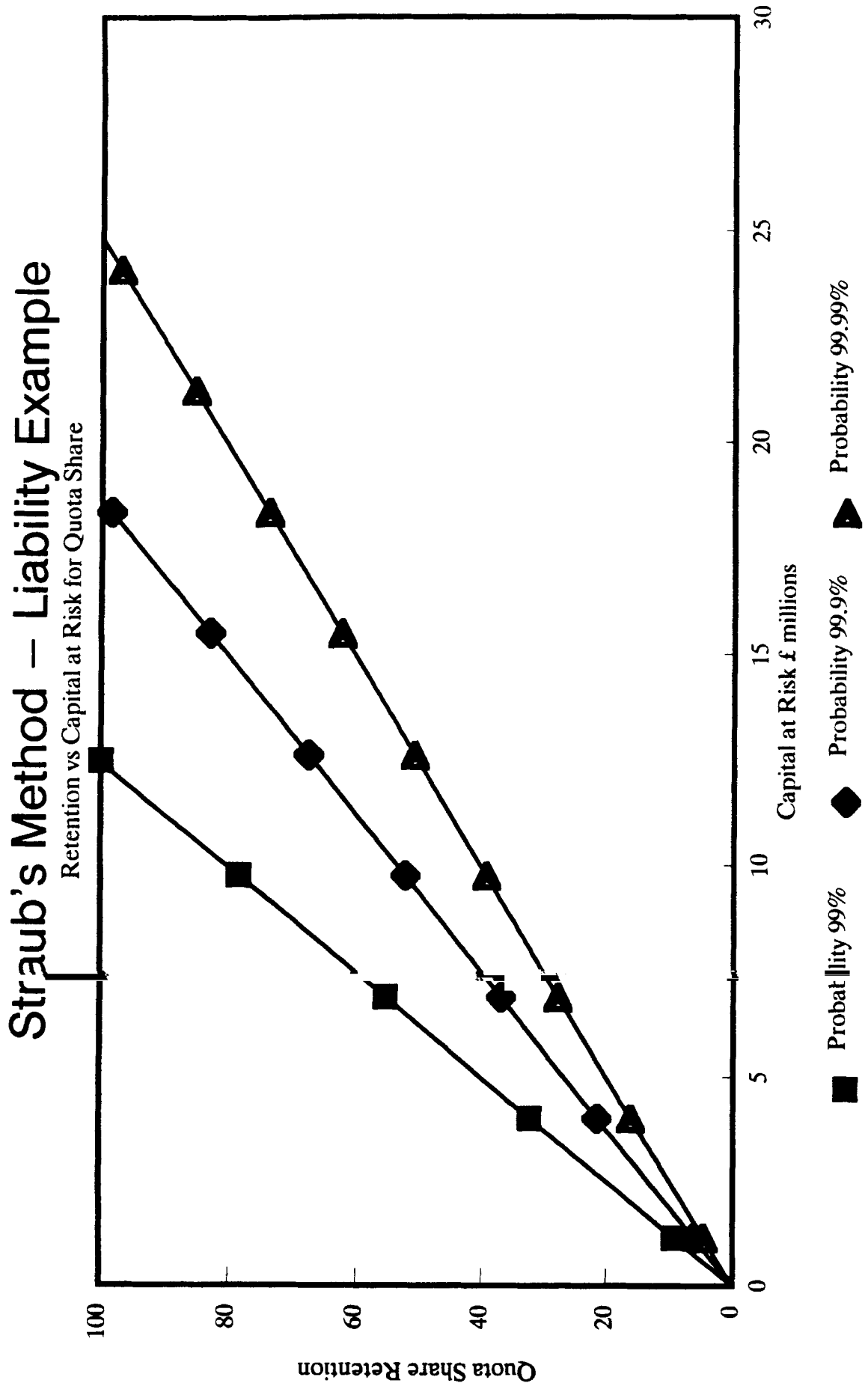
The above assumptions imply Retention = 404796

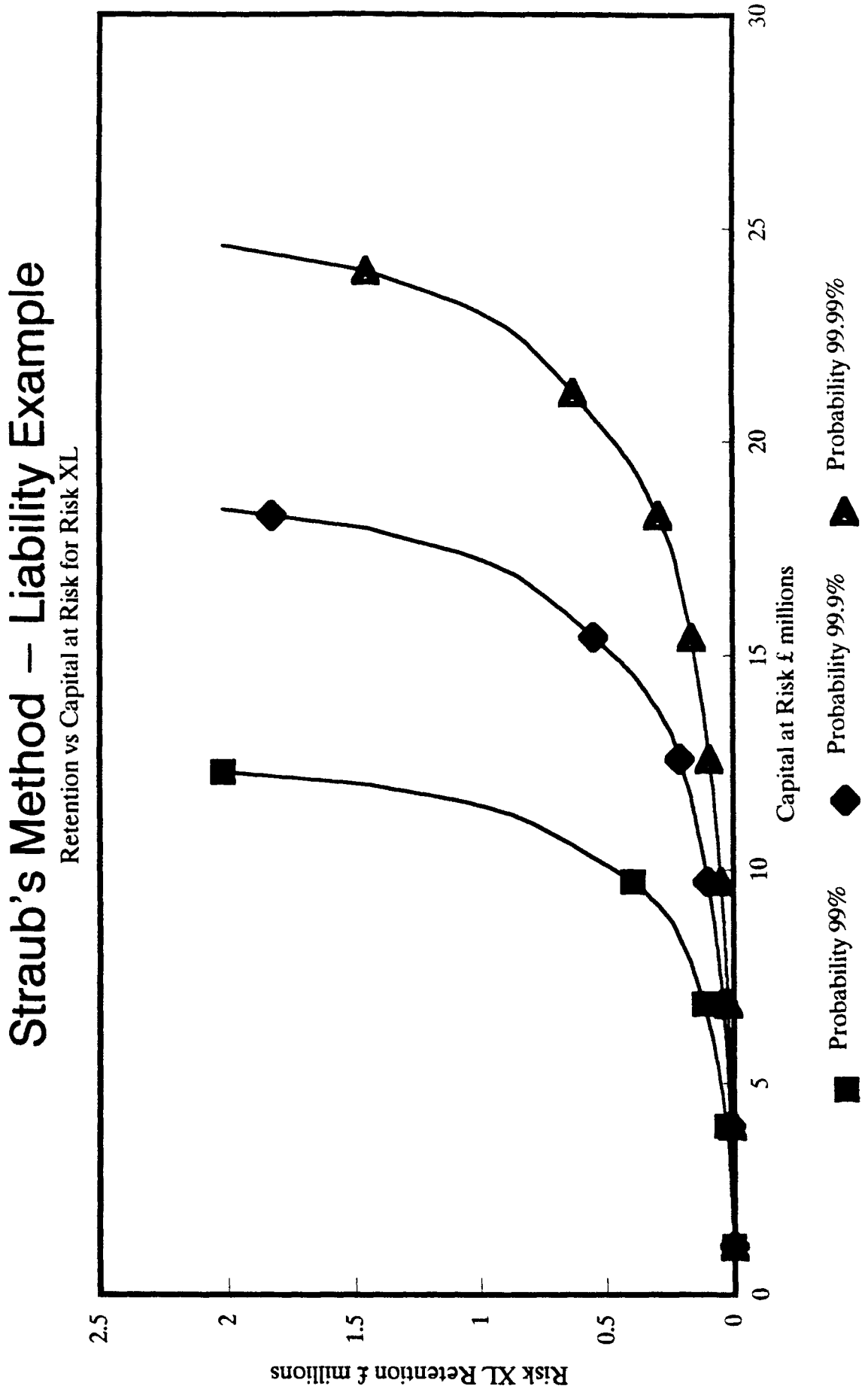
For different Probabilities:-

Probability (1 in ...)	Retention
1,000	Retention = 404796
100,000	Retention = 228819
1,000,000	Retention = 189917
100,000,000	Retention = 141289
1,000,000,000	Retention = 125335

For different Capital at risk:-

Capital at risk As % prem	Amount(M)	Retention
5%	5.25	Retention = 30594
18%	18.88	Retention = 112772
100%	104.90	Retention = 737865
500%	524.50	Retention = 8119757
1000%	1049.00	Retention = 27613906


Straub's Method – Liability Example
Retention vs Capital at Risk for Quota Share
Quota Share Retention
100
80
60
40
20
0
0
5
10
15
20
25
30
Capital at Risk £ millions
Probat lity 99%
Probability 99.9%
Probability 99.99%


Straub's Method – Liability Example
Retention vs Capital at Risk for Risk XL
Risk XL Retention £ millions
2.5
2
1.5
1
0.5
0
0
5
10
15
20
25
30
Capital at Risk £ millions
Probability 99%
Probability 99.9%
Probability 99.99%

Straub's Method - Liability Example

Assumptions

Reference.....Liability example
Claim amount dist'n.....User Defined
Claim number dist'n.....Poisson
Total Gross Premiums(M).....14.3
Capital at risk(M).....8.6
Total Loading in prems(%).....30
Profit Loading(%).....10
Probability (1 in ...).....1000
Reinsurance type.....Quota Share

Summary statistics

Claim amount Average.....38133
Claim amount CV.....3.62
Number of claims.....262.5
Aggregate claim average.....10010000
Aggregate claim CV.....0.23

Results

The above assumptions imply Retention = 46%

For different Probabilities:-

Probability (1 in ...)	Retention
1,000	Retention = 46%
100,000	Retention = 27%
1,000,000	Retention = 23%
100,000,000	Retention = 17%
1,000,000,000	Retention = 15%

For different Capital at risk:-

Capital at risk As % prem	Amount(M)	Retention
5%	0.72	Retention = 3%
18%	2.57	Retention = 13%
100%	14.30	Retention = 76%
500%	71.50	No Quota Share reinsurance required!
1000%	143.00	No Quota Share reinsurance required!

Straub's Method - Liability Example

Assumptions

Reference.....Liability example
Claim amount dist'n.....User Defined
Claim number dist'n.....Poisson
Total Gross Premiums(M).....14.3
Capital at risk(M).....8.6
Total Loading in prems(%).....30
Profit Loading(%).....10
Probability (1 in ...).....1000
Reinsurance type.....Risk XL

Summary statistics

Claim amount Average.....38133
Claim amount CV.....3.62
Number of claims.....262.5
Aggregate claim average.....10010000
Aggregate claim CV.....0.23

Results

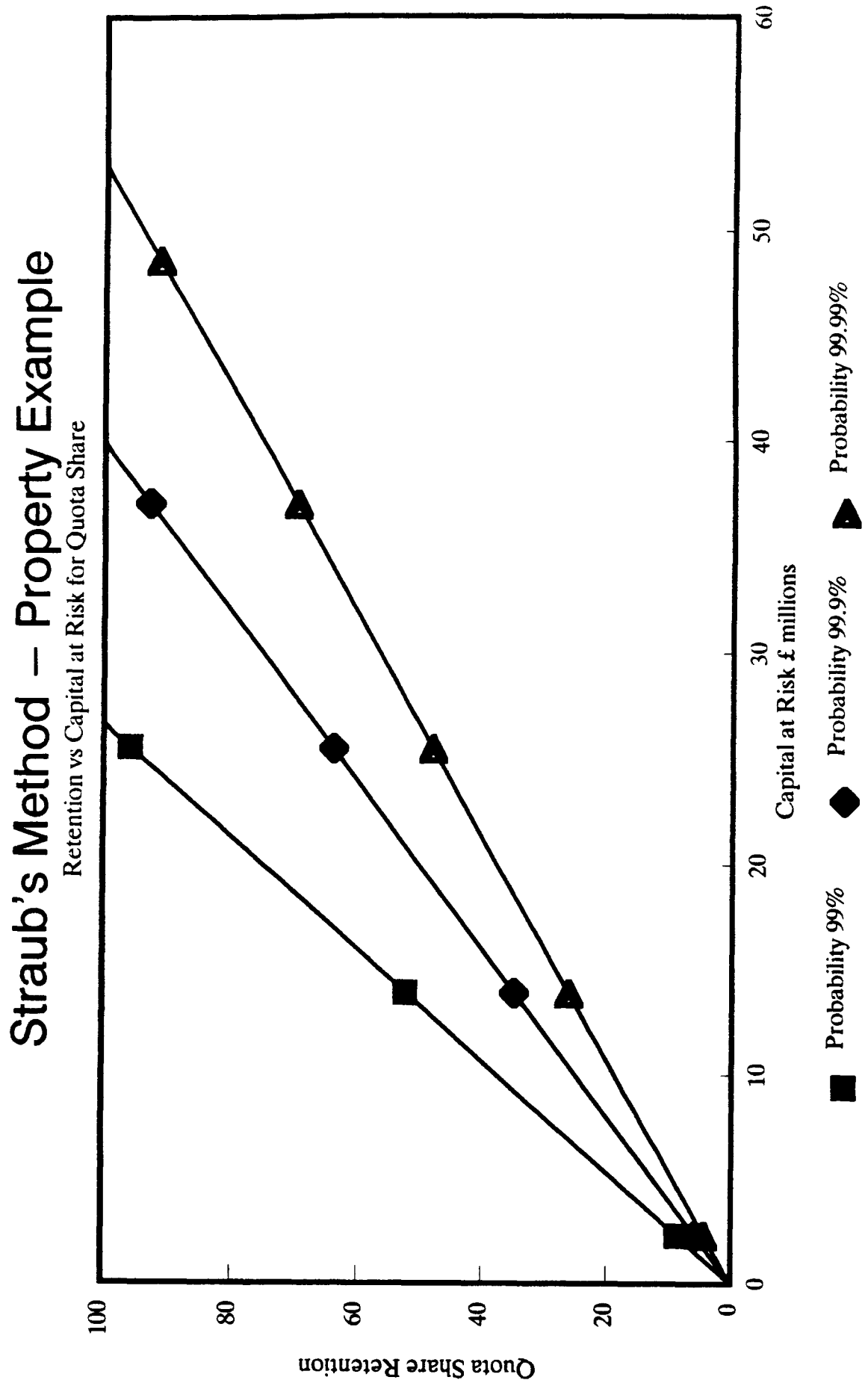
The above assumptions imply Retention = 75178

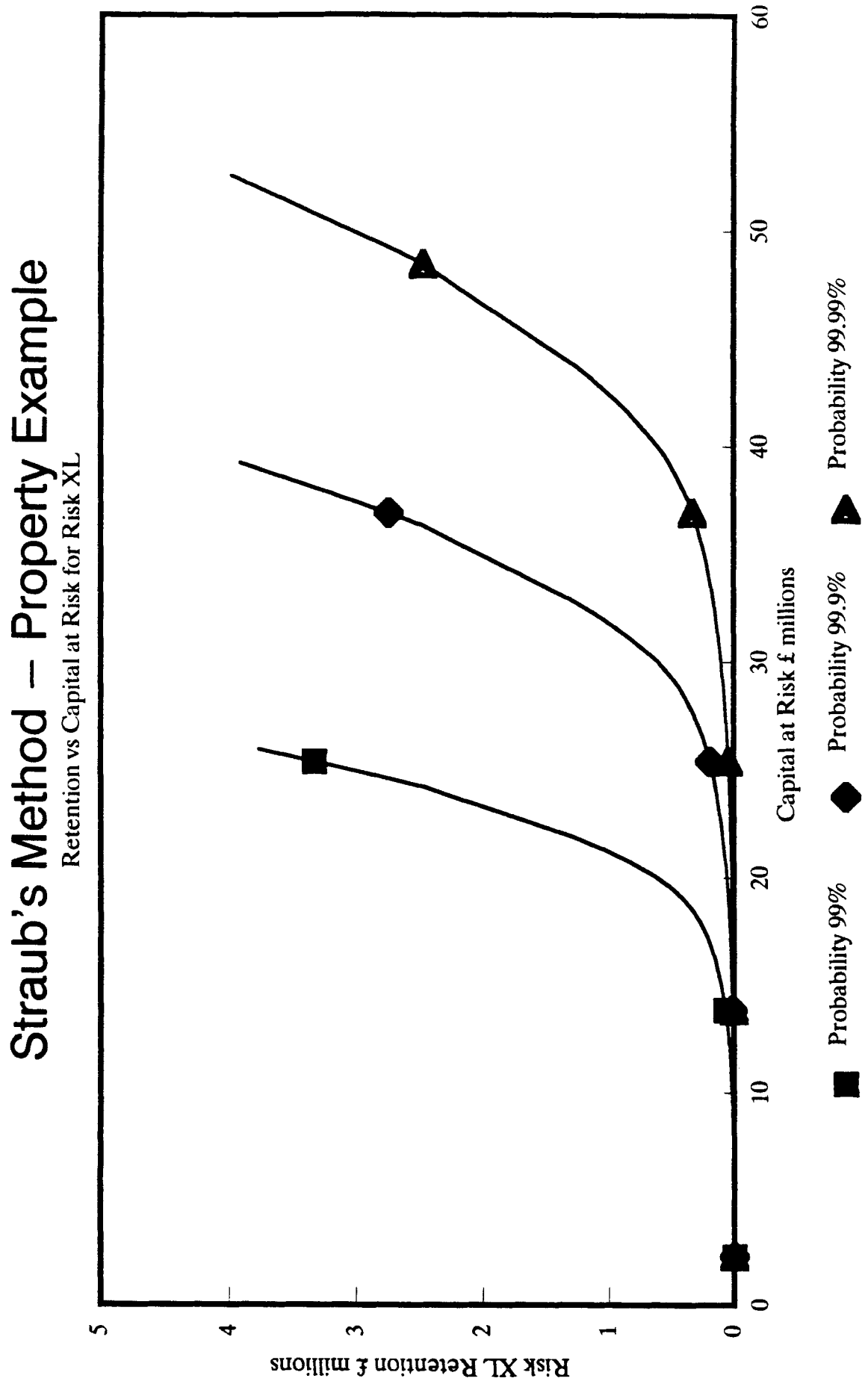
For different Probabilities:-

Probability (1 in ...)	Retention
1,000	Retention = 75178
100,000	Retention = 24110
1,000,000	Retention = 17610
100,000,000	Retention = 11137
1,000,000,000	Retention = 9327

For different Capital at risk:-

Capital at risk As % prem	Amount(M)	Retention
5%	0.72	Retention = 1606
18%	2.57	Retention = 7959
100%	14.30	Retention = 359715
500%	71.50	No Risk XL reinsurance required!
1000%	143.00	No Risk XL reinsurance required!


Straub's Method – Property Example
Retention vs Capital at Risk for Quota Share
Quota Share Retention
100
80
60
40
20
0
0
10
20
30
40
50
60
Capital at Risk £ millions
Probability 99%
Probability 99.9%
Probability 99.99%


Straub's Method – Property Example
Retention vs Capital at Risk for Risk XL
Risk XL Retention £ millions
0
1
2
3
4
5
0
10
20
30
40
50
60
Capital at Risk £ millions
Probability 99%
Probability 99.9%
Probability 99.99%

Straub's Method - Property Example

Assumptions

Reference.....Property example
Claim amount dist'n.....User Defined
Claim number dist'n.....Poisson
Total Gross Premiums(M).....57.7
Capital at risk(M).....34.6
Total Loading in prems(%).....30
Profit Loading(%).....10
Probability (1 in ...).....1000
Reinsurance type.....Quota Share

Summary statistics

Claim amount Average.....2956
Claim amount CV.....19.7
Number of claims.....13659.44
Aggregate claim average.....40390000
Aggregate claim CV.....0.17

Results

The above assumptions imply Retention = 87%

For different Probabilities:-

Probability (1 in ...)	Retention
1,000	Retention = 87%
100,000	Retention = 52%
1,000,000	Retention = 43%
100,000,000	Retention = 32%
1,000,000,000	Retention = 29%

For different Capital at risk:-

Capital at risk As % prem	Amount(M)	Retention
5%	2.89	Retention = 7%
18%	10.39	Retention = 26%
100%	57.70	No Quota Share reinsurance required!
500%	288.50	No Quota Share reinsurance required!
1000%	577.00	No Quota Share reinsurance required!

Straub's Method - Property Example

Assumptions

Reference.....Property example
Claim amount dist'n.....User Defined
Claim number dist'n.....Poisson
Total Gross Premiums(M).....57.7
Capital at risk(M).....34.6
Total Loading in prems(%).....30
Profit Loading(%).....10
Probability (1 in ...).....1000
Reinsurance type.....Risk XL

Summary statistics

Claim amount Average.....2956
Claim amount CV.....19.7
Number of claims.....13659.44
Aggregate claim average.....40390000
Aggregate claim CV.....0.17

Results

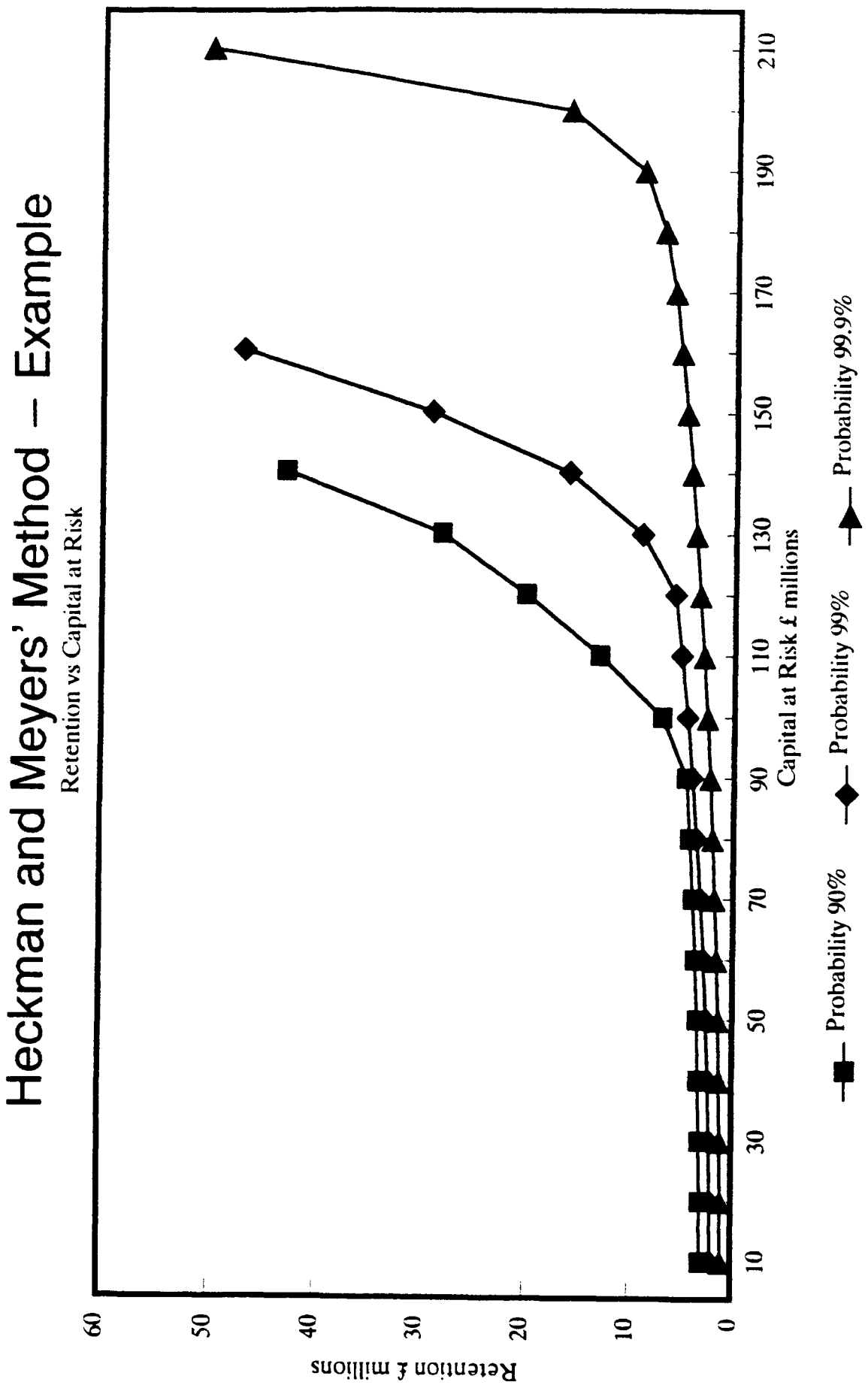
The above assumptions imply Retention = 1874895

For different Probabilities:-

Probability (1 in ...)	Retention
1,000	Retention = 1874895
100,000	Retention = 69274
1,000,000	Retention = 32947
100,000,000	Retention = 12044
1,000,000,000	Retention = 8336

For different Capital at risk:-

Capital at risk As % prem	Amount(M)	Retention
5%	2.89	Retention = 392
18%	10.39	Retention = 6181
100%	57.70	No Risk XL reinsurance required!
500%	288.50	No Risk XL reinsurance required!
1000%	577.00	No Risk XL reinsurance required!


Heckman and Meyers' Method – Example
Retention vs Capital at Risk
Retention £ millions
0
10
20
30
40
50
60
10
30
50
70
90
110
130
150
170
190
210
Capital at Risk £ millions
Probability 90%
Probability 99%
Probability 99.9%

Heckman and Meyers' Method - Aviation Example
Aggregate Claims Distribution

Aggregate Mean	Claim Severity Distribution	Contagion Parameter	Claim Freq. Mean	Claim Freq. Std Dev
73398		0.0000	8.000	2.828

Mixing Parameter	Aggregate Mean	Aggregate Std Dev	H	Number Of Intervals	Est Trunc Er In EPP Ratio
0.00%	73,398	58,553	0.8350	134	0.000008

Aggregate Claim Amount	Entry Ratio	Cumulative Probability	Excess Pure Premium	Excess Pure Premium Ratio
7,340	0.10000	6.46%	66,252	90.3%
14,680	0.20000	15.42%	59,726	81.4%
22,019	0.30000	21.91%	53,769	73.3%
29,359	0.40000	28.12%	48,257	65.8%
36,699	0.50000	34.49%	43,222	58.9%
44,039	0.60000	39.39%	38,602	52.6%
51,378	0.70000	43.42%	34,303	46.7%
58,718	0.80000	48.26%	30,323	41.3%
66,058	0.90000	52.97%	26,704	36.4%
73,398	1.00000	56.89%	23,399	31.9%
80,738	1.10000	60.62%	20,371	27.8%
88,077	1.20000	64.84%	17,627	24.0%
95,417	1.30000	69.56%	15,223	20.7%
102,757	1.40000	73.40%	13,135	17.9%
110,097	1.50000	76.72%	11,306	15.4%
117,436	1.60000	79.84%	9,715	13.2%
124,776	1.70000	82.40%	8,332	11.4%
132,116	1.80000	84.51%	7,120	9.7%
139,456	1.90000	86.50%	6,055	8.3%
146,796	2.00000	88.38%	5,135	7.0%
161,475	2.20000	91.30%	3,655	5.0%
176,155	2.40000	93.74%	2,561	3.5%
190,834	2.60000	95.56%	1,784	2.4%
205,514	2.80000	96.87%	1,234	1.7%
220,193	3.00000	97.78%	845	1.2%
234,873	3.20000	98.46%	572	0.8%
249,552	3.40000	98.94%	383	0.5%
264,232	3.60000	99.29%	255	0.4%
278,911	3.80000	99.52%	168	0.2%
293,591	4.00000	99.68%	110	0.2%
308,271	4.20000	99.79%	72	0.1%
322,950	4.40000	99.86%	46	0.1%
337,630	4.60000	99.91%	30	0.0%
352,309	4.80000	99.94%	19	0.0%
366,989	5.00000	99.96%	12	0.0%
381,668	5.20000	99.98%	7	0.0%
396,348	5.40000	99.99%	5	0.0%
411,027	5.60000	99.99%	3	0.0%
425,707	5.80000	99.99%	2	0.0%
440,387	6.00000	100.00%	1	0.0%

Heckman and Meyers' Method - Aviation Example

Retention	Net Aggregate Claims				Reinsurance Risk Premium	Reinsurance Premium Net of Expenses	Premium Net of Reinsurance and Expenses
	90%	99%	99.9%	Mean			
Infinity	154,940	252,069	333,960	73,398	0	0	83,883
75,000	149,531	240,757	319,190	71,527	1,871	2,138	81,746
50,000	125,913	199,173	260,325	63,186	10,212	11,671	72,213
25,000	85,422	129,077	164,548	46,028	27,370	31,280	52,603
15,000	60,711	88,903	112,555	34,256	39,142	44,733	39,150
10,000	46,002	66,253	82,448	26,969	46,429	53,062	30,822
5,000	30,001	41,930	51,304	18,417	54,981	62,835	21,048
1,000	9,110	12,102	14,472	6,030	67,368	76,992	6,892
500	5,138	6,778	8,071	3,452	69,946	79,938	3,945
100	1,130	1,481	1,755	767	72,631	83,007	877

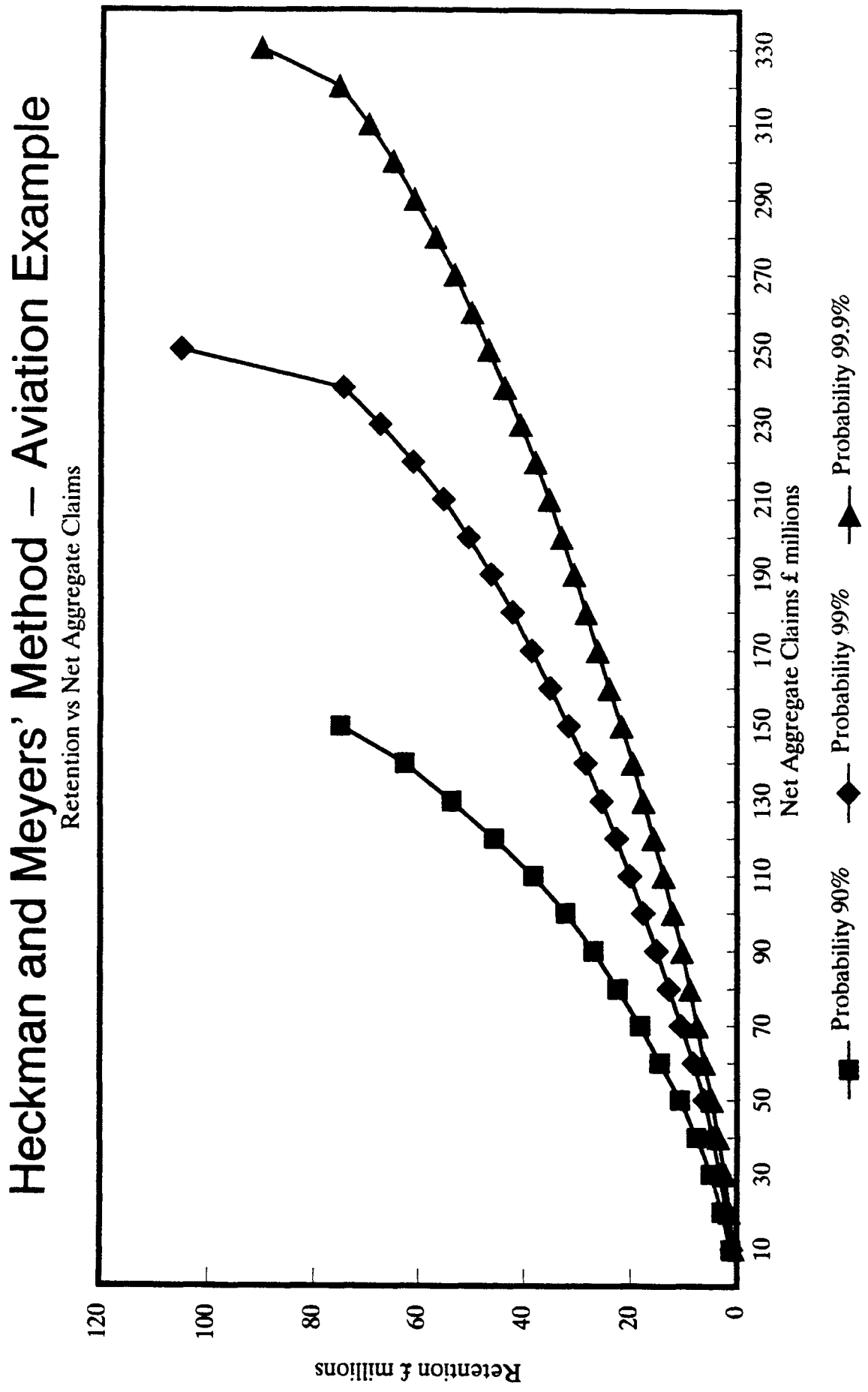
Retention	Capital at Risk		
	90%	99%	99.9%
Infinity	71,057	168,186	250,077
75,000	67,785	159,011	237,444
50,000	53,700	126,960	188,112
25,000	32,819	76,474	111,945
15,000	21,561	49,753	73,405
10,000	15,180	35,431	51,626
5,000	8,953	20,882	30,256
1,000	2,218	5,210	7,580
500	1,193	2,833	4,126
100	253	604	878

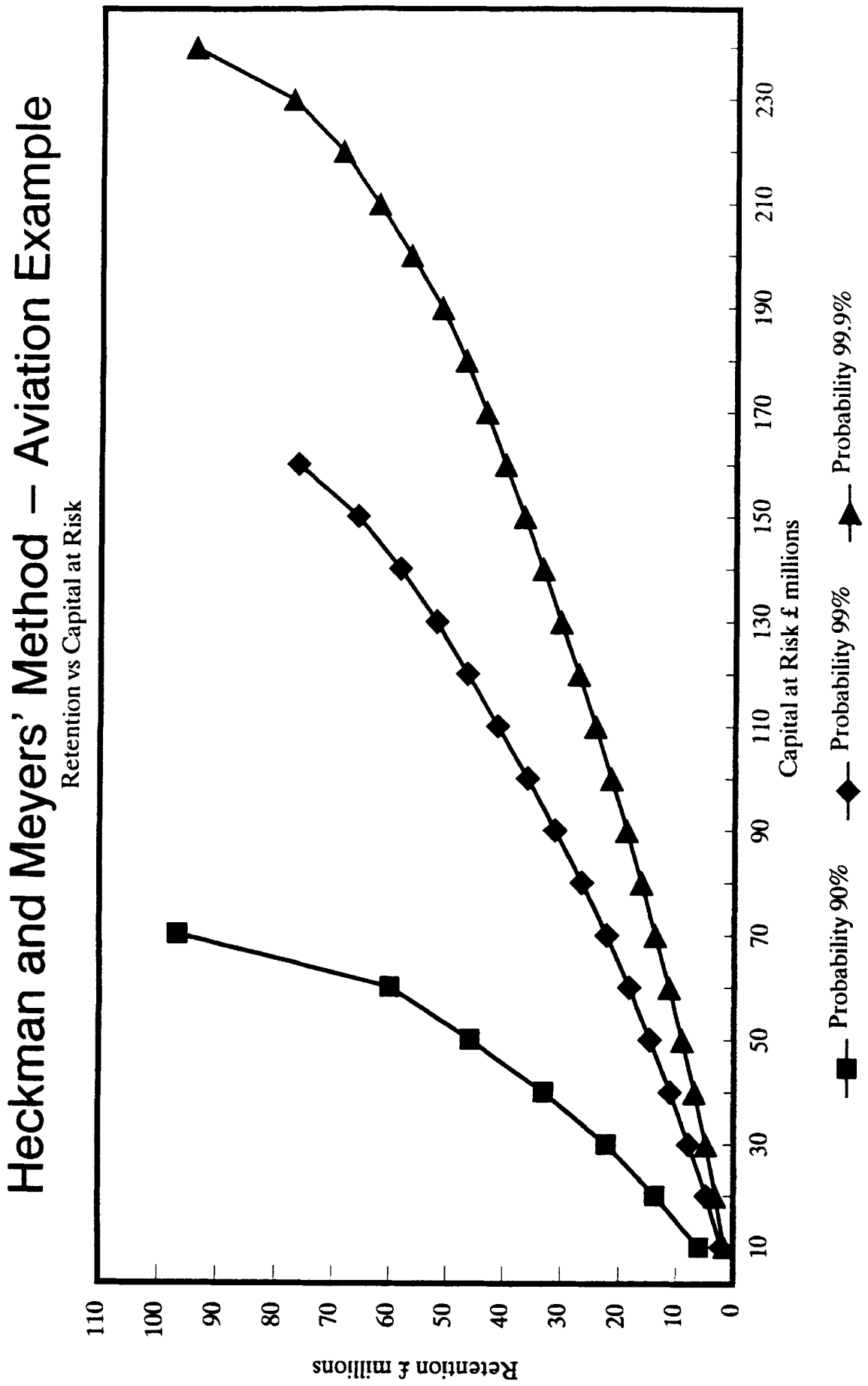
Retention	Capital at Risk as a Percentage of Total Gross Premium			Retention
	90%	99%	99.9%	
Infinity	67.77	160.40	238.50	Infinity
75,000	64.65	151.65	226.45	71.53
50,000	51.21	121.08	179.40	47.69
25,000	31.30	72.93	106.76	23.84
15,000	20.56	47.45	70.01	14.31
10,000	14.48	33.79	49.24	9.54
5,000	8.54	19.92	28.86	4.77
1,000	2.12	4.97	7.23	0.95
500	1.14	2.70	3.93	0.48
100	0.24	0.58	0.84	0.10

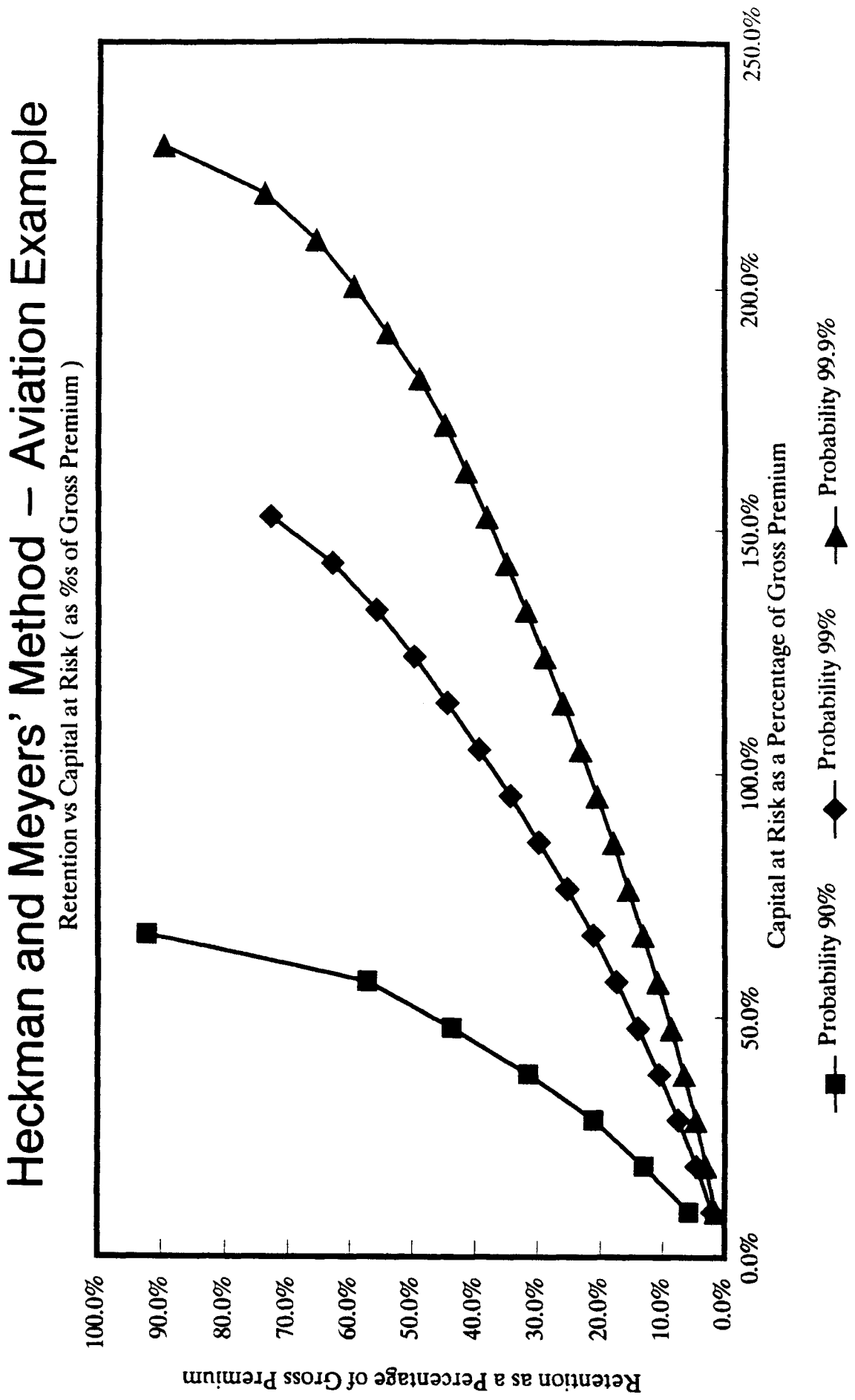
Retention	Capital at Risk as a Percentage of Net Premium			Retention
	90%	99%	99.9%	
Infinity	67.77	160.40	238.50	Infinity
75,000	66.34	155.62	232.38	73.40
50,000	59.49	140.65	208.40	55.39
25,000	49.91	116.30	170.25	38.02
15,000	44.06	101.67	150.00	30.65
10,000	39.40	91.96	134.00	25.96
5,000	34.03	79.37	115.00	19.00
1,000	25.75	60.49	88.00	11.61
500	24.19	57.44	83.66	10.14
100	23.13	55.16	80.17	9.13

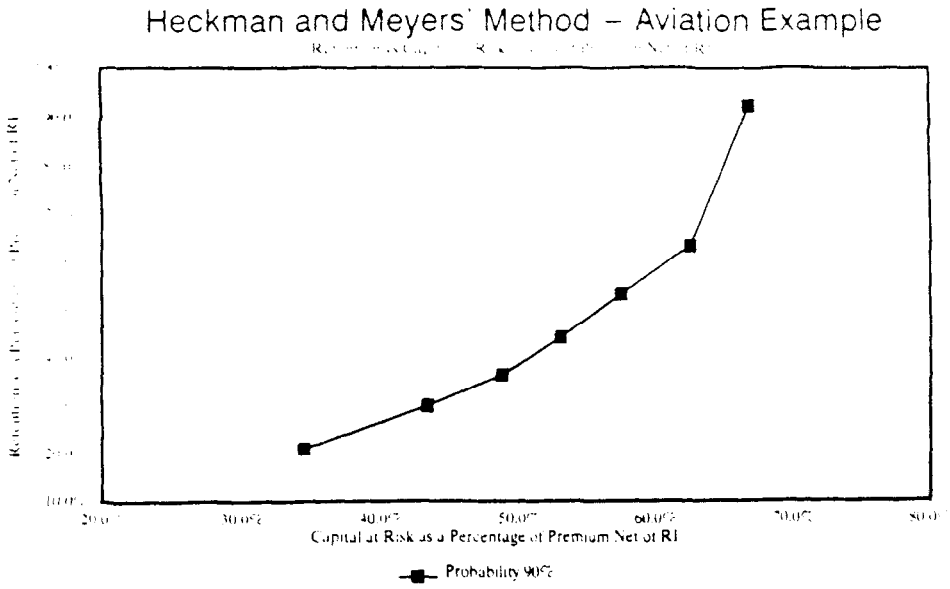
Total Gross Premium =	104,854
Total Loading in Premiums =	30%
Expense Element of Premium =	20%

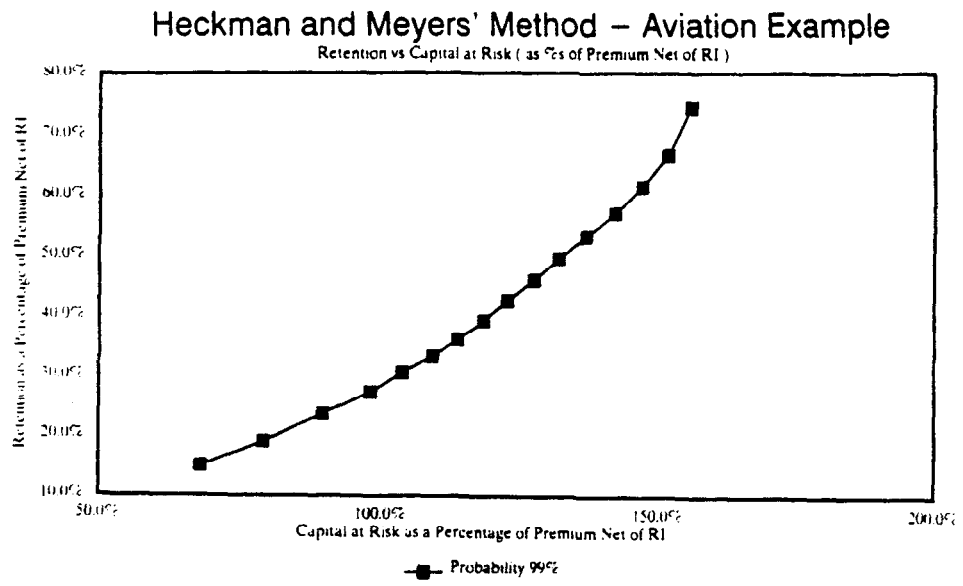
Capital at Risk = Net Aggregate Claims - Premium Net of Reinsurance and Expenses

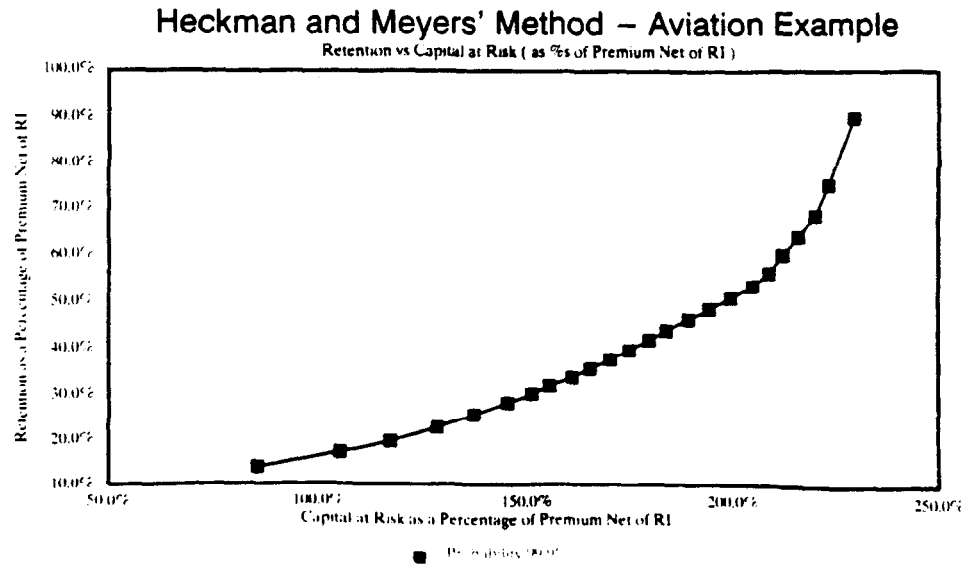

Heckman and Meyers' Method – Aviation Example
Retention vs Net Aggregate Claims
Retention £ millions
120
100
80
60
40
20
0
10
30
50
70
90
110
130
150
170
190
210
230
250
270
290
310
330
Net Aggregate Claims £ millions
Probability 90%
Probability 99%
Probability 99.9%


Heckman and Meyers' Method – Aviation Example
Retention vs Capital at Risk
Retention £ millions
0
10
20
30
40
50
60
70
80
90
100
110
10
30
50
70
90
110
130
150
170
190
210
230
Capital at Risk £ millions
Probability 90%
Probability 99%
Probability 99.9%


Heckman and Meyers' Method – Aviation Example
Retention vs Capital at Risk (as %s of Gross Premium)
Retention as a Percentage of Gross Premium
100.0%
90.0%
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
0.0%
50.0%
100.0%
150.0%
200.0%
250.0%
Capital at Risk as a Percentage of Gross Premium
Probability 90%
Probability 99%
Probability 99.9%


Heckman and Meyers' Method – Aviation Example
30.0%
40.0%
50.0%
60.0%
Capital at Risk as a Percentage of Premium Net of RI
Probability 90%


Heckman and Meyers' Method – Aviation Example
Retention vs Capital at Risk (as %s of Premium Net of RI)
Retention as a Percentage of Premium Net of RI
80.0%
70.0%
60.0%
50.0%
40.0%
20.0%
10.0%
100.0%
150.0%
200.0%
Capital at Risk as a Percentage of Premium Net of RI
Probability 99%


Heckman and Meyers' Method – Aviation Example
Retention vs Capital at Risk (as %s of Premium Net of RI)
Retention as a Percentage of Premium Net of RI
100.0%
90.0%
80.0%
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
150.0%
200.0%
250.0%
Capital at Risk as a Percentage of Premium Net of RI

Heckman and Meyers' Method - Liability Example
Aggregate Claims Distribution

Aggregate Mean	Claim Severity Distribution	Contagion Parameter	Claim Freq. Mean	Claim Freq. Std Dev
10,000,000		0.0000	262.234	16.194

Mixing Parameter	Aggregate Mean	Aggregate Std Dev	H	Number Of Intervals	Est Trunc Er In EPP Ratio
0.00%	10,000,000	2,324,725	0.5840	18	0.000002

Aggregate Claim Amount	Entry Ratio	Cumulative Probability	Excess Pure Premium	Excess Pure Premium Ratio
5,000,000	0.50000	0.20%	5,000,613	50.0%
6,000,000	0.60000	1.95%	4,009,019	40.1%
7,000,000	0.70000	8.07%	3,054,407	30.5%
8,000,000	0.80000	20.08%	2,190,394	21.9%
9,000,000	0.90000	36.47%	1,470,742	14.7%
10,000,000	1.00000	53.94%	923,332	9.2%
11,000,000	1.10000	69.41%	542,675	5.4%
12,000,000	1.20000	81.28%	299,431	3.0%
13,000,000	1.30000	89.37%	155,651	1.6%
14,000,000	1.40000	94.36%	76,511	0.8%
15,000,000	1.50000	97.19%	35,694	0.4%
16,000,000	1.60000	98.68%	15,859	0.2%
17,000,000	1.70000	99.41%	6,733	0.1%
18,000,000	1.80000	99.75%	2,739	0.0%
19,000,000	1.90000	99.90%	1,070	0.0%
20,000,000	2.00000	99.96%	403	0.0%
21,000,000	2.10000	99.98%	146	0.0%
22,000,000	2.20000	99.99%	52	0.0%
23,000,000	2.30000	100.00%	18	0.0%

Heckman and Meyers' Method - Liability Example

Retention	Net Aggregate Claims 90%	99%	99.9%	Mean	Reinsurance Risk Premium	Reinsurance Premium Net of Expenses	Premium Net of Reinsurance and Expenses
Infinity	13,126,253	16,438,356	19,000,000	10,000,000	0	0	11,428,571
2,000,000	12,913,981	16,049,921	18,593,955	9,916,776	83,224	95,113	11,333,458
1,500,000	12,478,817	15,287,212	17,455,986	9,697,770	302,230	345,406	11,083,166
1,000,000	11,774,667	14,103,513	15,929,301	9,301,782	698,218	797,963	10,630,608
500,000	9,918,055	11,493,230	12,862,369	8,173,411	1,826,589	2,087,530	9,341,041
250,000	8,381,349	9,599,945	10,490,672	7,099,776	2,900,224	3,314,542	8,114,030
100,000	5,966,927	6,625,811	7,142,855	5,165,027	4,834,973	5,525,683	5,902,888
50,000	4,376,672	4,782,366	5,090,672	3,905,886	6,094,114	6,964,702	4,463,870

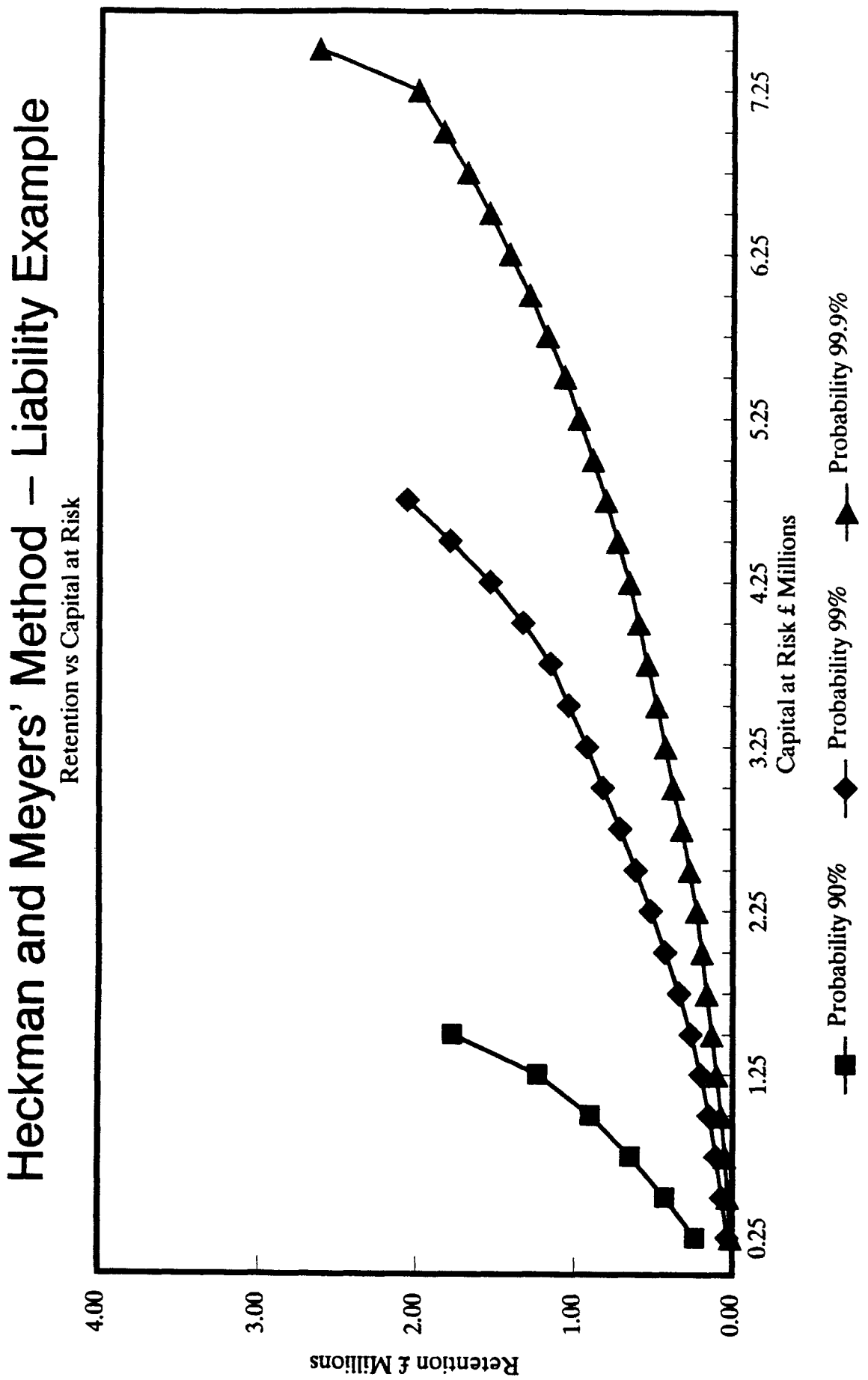
Retention	Capital at Risk 90%	99%	99.9%
Infinity	1,697,682	5,009,785	7,571,429
2,000,000	1,580,523	4,716,463	7,260,497
1,500,000	1,395,651	4,204,046	6,372,820
1,000,000	1,144,059	3,472,905	5,298,693
500,000	577,014	2,152,189	3,521,328
250,000	267,319	1,485,915	2,376,642
100,000	64,039	722,923	1,239,967
50,000	(87,198)	318,496	626,802

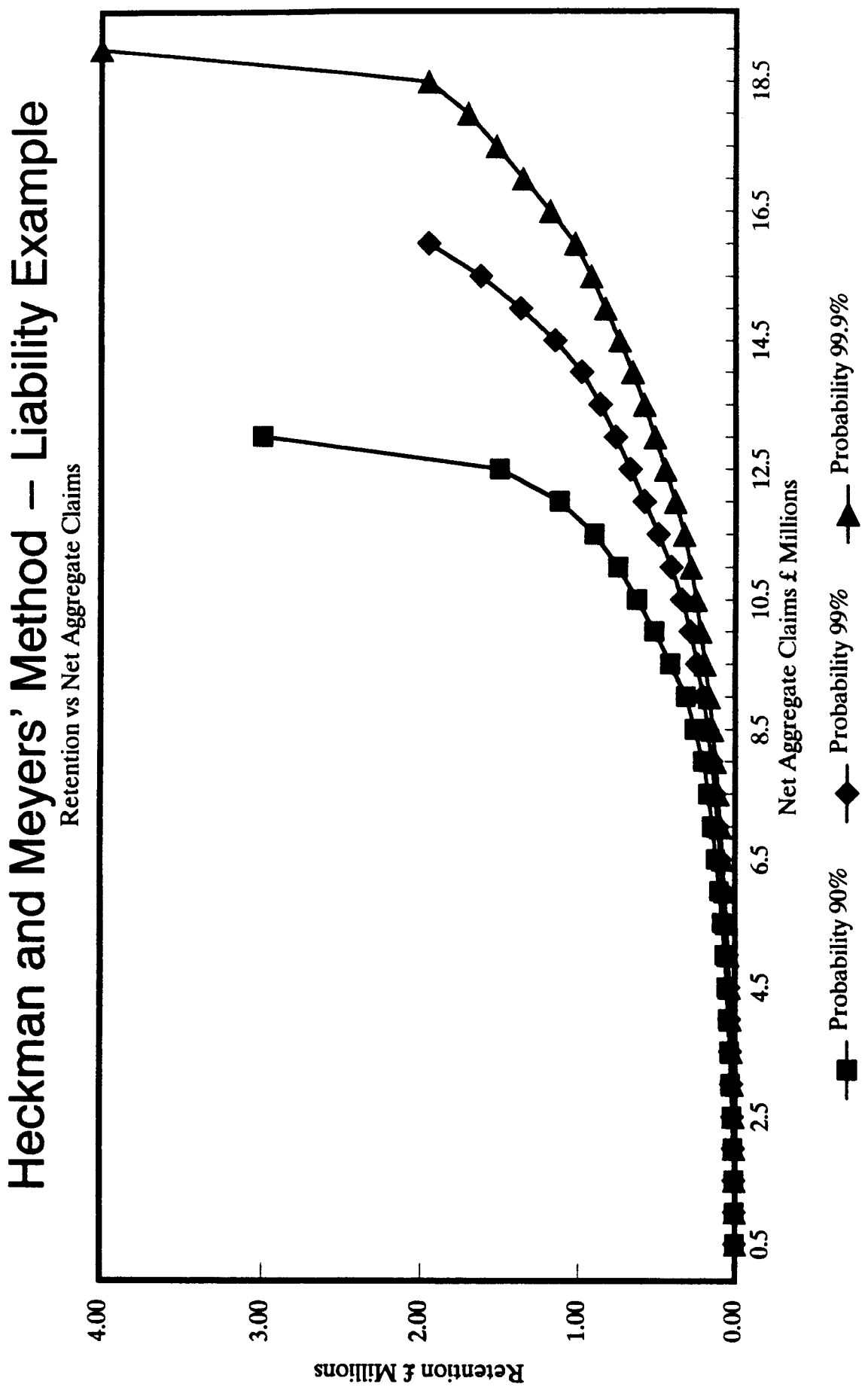
Retention	Capital at Risk as a Percentage of Total Gross Premium 90%	99%	99.9%	Retention
Infinity	11.88	35.07	53.00	Infinity
2,000,000	11.06	33.02	50.82	14.00
1,500,000	9.77	29.43	44.61	10.50
1,000,000	8.01	24.31	37.09	7.00
500,000	4.04	15.07	24.65	3.50
250,000	1.87	10.40	16.64	1.75
100,000	0.45	5.06	8.68	0.70
50,000	(0.61)	2.23	4.39	0.35

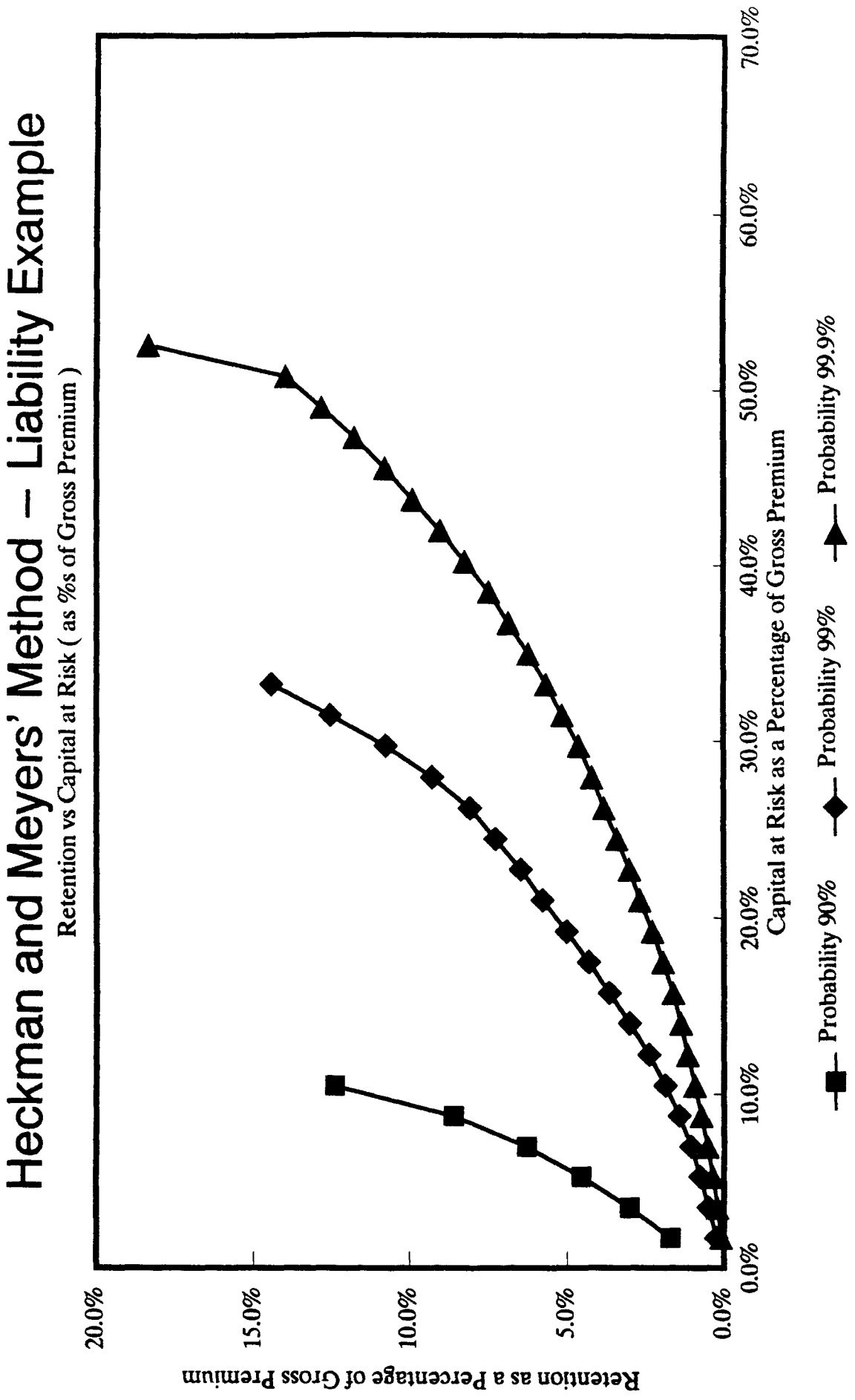
Retention	Capital at Risk as a Percentage of Net Premium 90%	99%	99.9%	Retention
Infinity	11.88	35.07	53.00	Infinity
2,000,000	11.16	33.29	51.25	14.12
1,500,000	10.07	30.35	46.00	10.83
1,000,000	8.61	26.14	39.87	7.53
500,000	4.94	18.43	30.16	4.28
250,000	2.64	14.65	23.43	2.46
100,000	0.87	9.80	16.80	1.36
50,000	(1.56)	5.71	11.23	0.90

Total Gross Premium = 14,285,714
Total Loading in Premiums = 30%
Expense Element of Premium = 20%

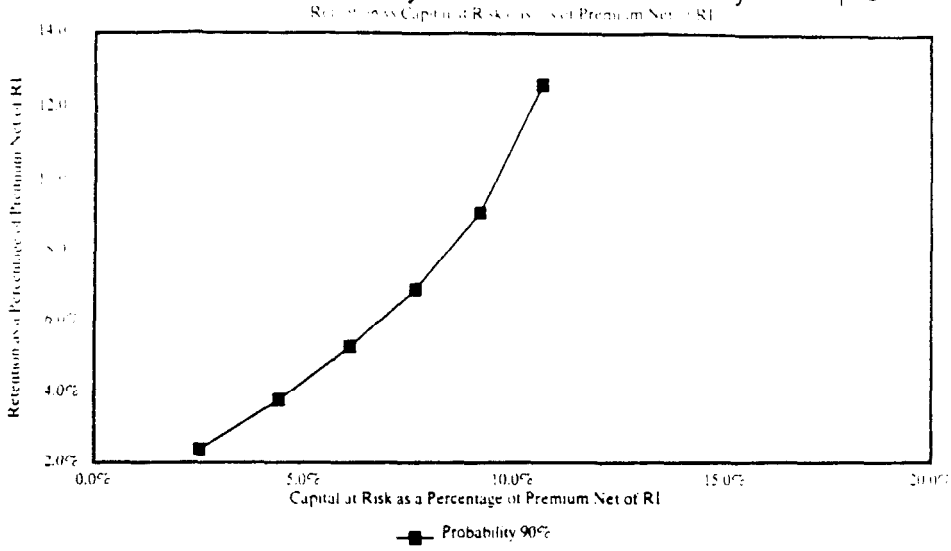
Capital at Risk = Net Aggregate Claims - Premium Net of Reinsurance and Expenses


Heckman and Meyers' Method – Liability Example
Retention vs Capital at Risk
Retention £ Millions
4.00
3.00
2.00
1.00
0.00
0.25
1.25
2.25
3.25
4.25
5.25
6.25
7.25
Capital at Risk £ Millions
Probability 90%
Probability 99%
Probability 99.9%


Heckman and Meyers' Method – Liability Example
Retention vs Net Aggregate Claims
Retention £ Millions
4.00
3.00
2.00
1.00
0.00
0.5
2.5
4.5
6.5
8.5
10.5
12.5
14.5
16.5
18.5
Net Aggregate Claims £ Millions
Probability 90%
Probability 99%
Probability 99.9%

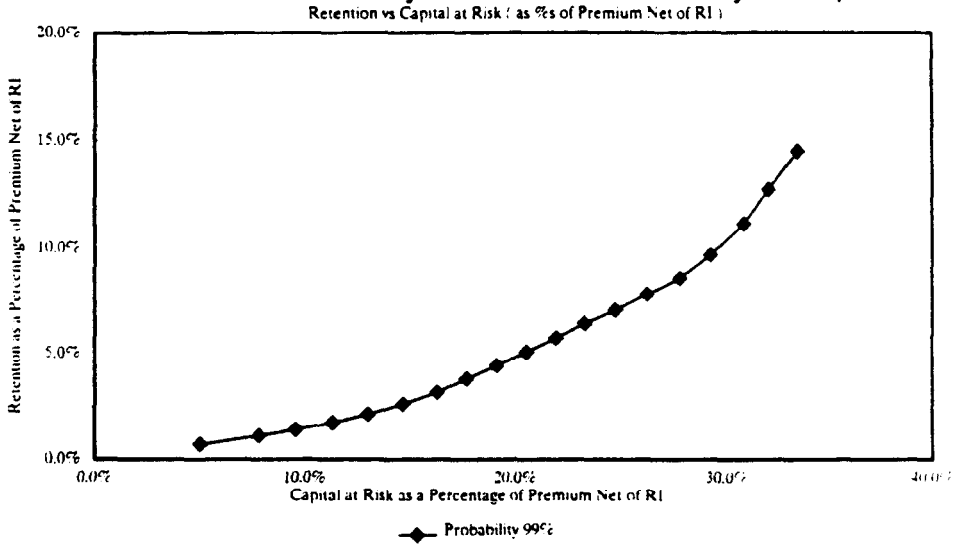

Heckman and Meyers' Method – Liability Example
Retention vs Capital at Risk (as %s of Gross Premium)
Retention as a Percentage of Gross Premium
20.0%
15.0%
10.0%
5.0%
0.0%
0.0%
10.0%
20.0%
30.0%
40.0%
50.0%
60.0%
70.0%
Capital at Risk as a Percentage of Gross Premium
Probability 90%
Probability 99%
Probability 99.9%

Heckman and Meyers' Method – Liability Example



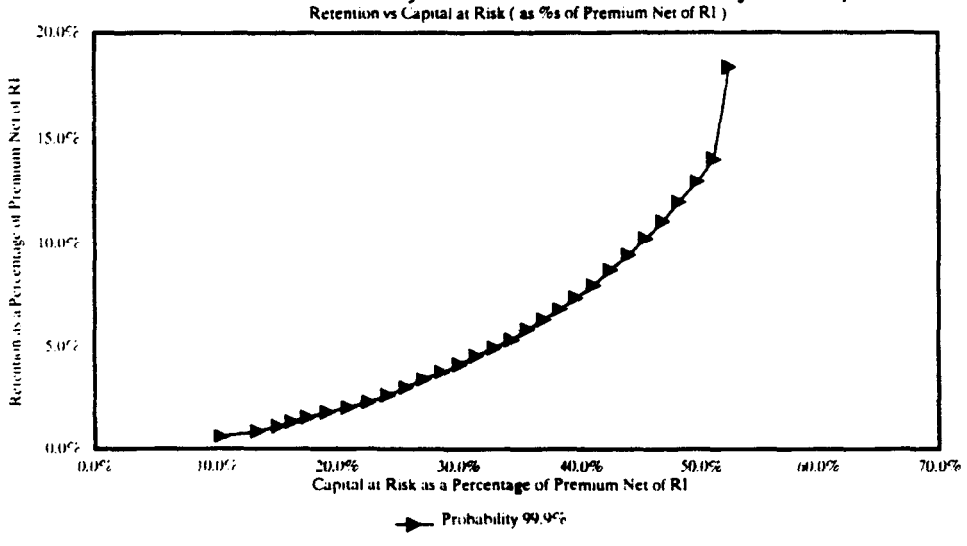
Heckman and Meyers' Method – Liability Example

Retention vs Capital at Risk (as %s of Premium Net of RI)



Heckman and Meyers' Method – Liability Example

Retention vs Capital at Risk (as %s of Premium Net of RI)



Heckman and Meyers' Method - Property Example
Aggregate Claims Distribution

Aggregate Mean	Claim Severity Distribution	Contagion Parameter	Claim Freq. Mean	Claim Freq. Std Dev
40,383,860		0.0000	13,661.000	116.960

Mixing Parameter	Aggregate Mean	Aggregate Std Dev	H	Number Of Intervals	Est Trunc Er In EPP Ratio
0.00%	40,383,860	6,858,151	0.6100	24	0.000002

Aggregate Claim Amount	Entry Ratio	Cumulative Probability	Excess Pure Premium	Excess Pure Premium Ratio
28,268,702	0.70000	1.83%	12,138,070	30.1%
32,307,088	0.80000	11.01%	8,325,236	20.6%
36,345,474	0.90000	29.98%	5,086,805	12.6%
40,383,860	1.00000	53.49%	2,732,753	6.8%
44,422,246	1.10000	73.94%	1,287,311	3.2%
44,826,085	1.11000	75.62%	1,185,492	2.9%
45,229,923	1.12000	77.24%	1,090,339	2.7%
45,633,762	1.13000	78.78%	1,001,556	2.5%
46,037,600	1.14000	80.25%	918,847	2.3%
46,441,439	1.15000	81.64%	841,917	2.1%
48,460,632	1.20000	87.55%	533,773	1.3%
48,864,471	1.21000	88.53%	485,497	1.2%
49,268,309	1.22000	89.45%	441,057	1.1%
49,672,148	1.23000	90.31%	400,209	1.0%
50,075,986	1.24000	91.11%	362,716	0.9%
50,479,825	1.25000	91.86%	328,350	0.8%
50,883,664	1.26000	92.55%	296,896	0.7%
51,287,502	1.27000	93.20%	268,144	0.7%
51,691,341	1.28000	93.80%	241,899	0.6%
52,095,179	1.29000	94.35%	217,975	0.5%
52,499,018	1.30000	94.86%	196,194	0.5%
52,902,857	1.31000	95.33%	176,392	0.4%
53,306,695	1.32000	95.76%	158,411	0.4%
53,710,534	1.33000	96.16%	142,106	0.4%
54,114,372	1.34000	96.52%	127,340	0.3%
54,518,211	1.35000	96.86%	113,985	0.3%
56,537,404	1.40000	98.14%	64,467	0.2%
60,575,790	1.50000	99.40%	19,121	0.1%
64,614,176	1.60000	99.83%	5,193	0.0%
68,652,562	1.70000	99.96%	1,340	0.0%
70,671,755	1.75000	99.98%	691	0.0%

Heckman and Meyers' Method - Property Example

Retention	Net Aggregate Claims 90%	99%	99.9%	Mean	Reinsurance Risk Premium	Reinsurance Premium Net of Expenses	Premium Net of Reinsurance and Expenses
Infinity	49,819,650	59,303,860	67,099,340	40,383,860	0	0	46,152,987
1,000,000	36,041,260	39,664,130	42,220,870	32,339,390	8,044,470	9,193,680	36,959,307
500,000	32,466,640	34,852,050	36,703,350	29,779,590	10,604,270	12,119,166	34,033,821
250,000	28,937,770	30,639,720	31,943,310	26,979,140	13,404,720	15,319,680	30,833,307
200,000	27,733,100	29,247,760	30,362,690	25,978,770	14,405,090	16,462,960	29,690,027
150,000	26,160,000	27,462,100	28,426,640	24,647,370	15,736,490	17,984,560	28,168,427
100,000	23,881,340	24,905,960	25,678,690	22,667,190	17,716,670	20,247,623	25,905,364
50,000	20,524,950	21,237,130	21,790,610	19,660,700	20,723,160	23,683,611	22,469,376
10,000	12,782,330	13,056,330	13,277,990	12,439,930	27,943,930	31,935,920	14,217,067
5,000	9,987,180	10,173,110	10,320,780	9,765,680	30,618,180	34,992,206	11,160,781
2,500	7,550,660	7,666,410	7,765,550	7,408,590	32,975,270	37,686,023	8,466,964
1,000	4,935,690	4,998,530	5,047,590	4,859,290	35,524,570	40,599,509	5,553,478
500	3,420,490	3,459,020	3,489,060	3,373,200	37,010,660	42,297,897	3,855,090

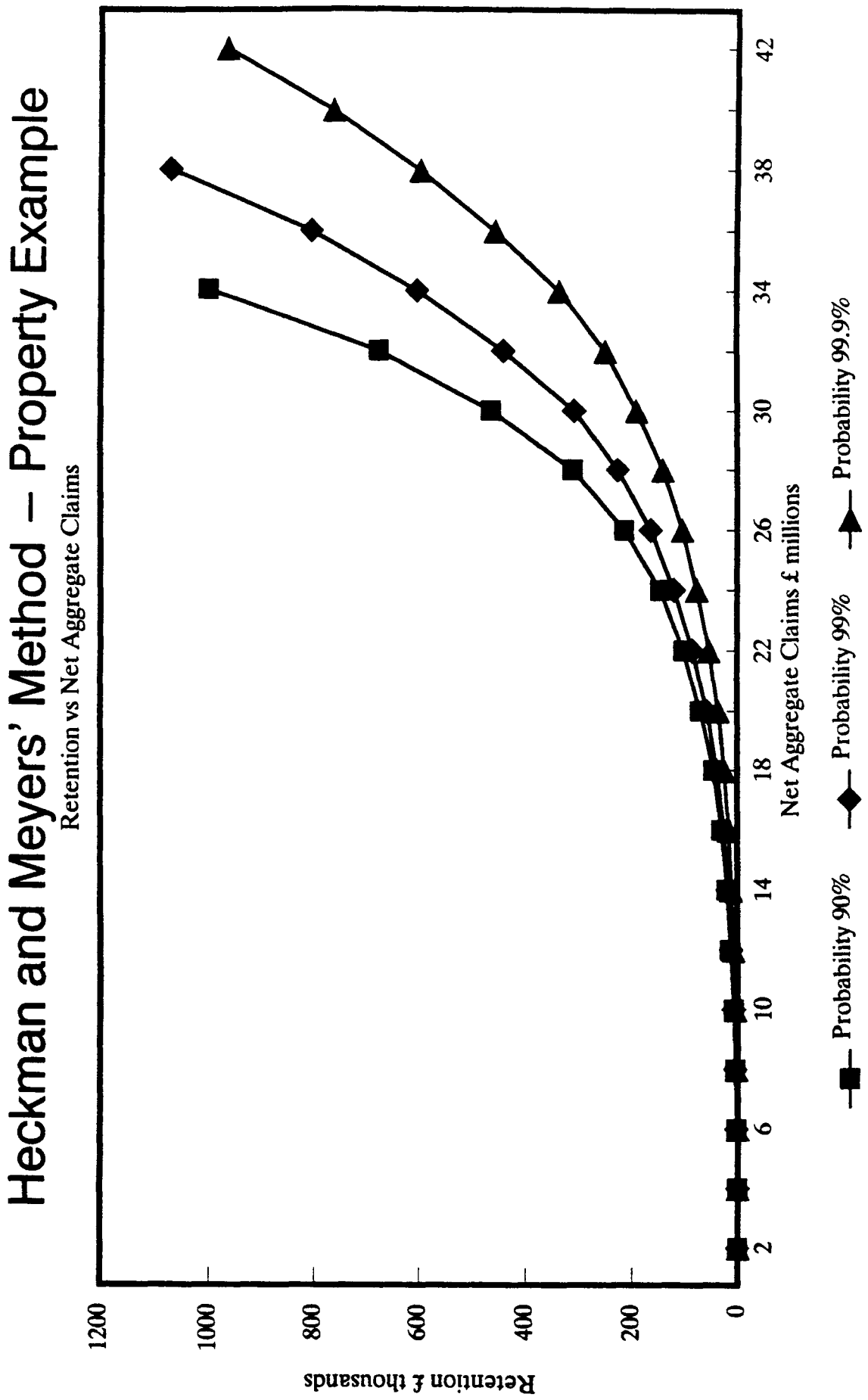
Retention	Capital at Risk 90%	99%	99.9%
Infinity	3,666,663	13,150,873	20,946,353
1,000,000	(918,047)	2,704,823	5,261,563
500,000	(1,567,181)	818,229	2,669,529
250,000	(1,895,537)	(193,587)	1,110,003
200,000	(1,956,927)	(442,267)	672,663
150,000	(2,008,427)	(706,327)	258,213
100,000	(2,024,024)	(999,404)	(226,674)
50,000	(1,944,426)	(1,232,246)	(678,766)
10,000	(1,434,737)	(1,160,737)	(939,077)
5,000	(1,173,601)	(987,671)	(840,001)
2,500	(916,304)	(800,554)	(701,414)
1,000	(617,788)	(554,948)	(505,888)
500	(434,600)	(396,070)	(366,030)

Retention	Capital at Risk as a Percentage of Total Gross Premium 90%	99%	99.9%	Retention
Infinity	6.36	22.80	36.31	Infinity
1,000,000	(1.59)	4.69	9.12	1.73
500,000	(2.72)	1.42	4.63	0.87
250,000	(3.29)	(0.34)	1.92	0.43
200,000	(3.39)	(0.77)	1.17	0.35
150,000	(3.48)	(1.22)	0.45	0.26
100,000	(3.51)	(1.73)	(0.39)	0.17
50,000	(3.37)	(2.14)	(1.18)	0.09
10,000	(2.49)	(2.01)	(1.63)	0.02
5,000	(2.03)	(1.71)	(1.46)	0.01
2,500	(1.59)	(1.39)	(1.22)	0.00
1,000	(1.07)	(0.96)	(0.88)	0.00

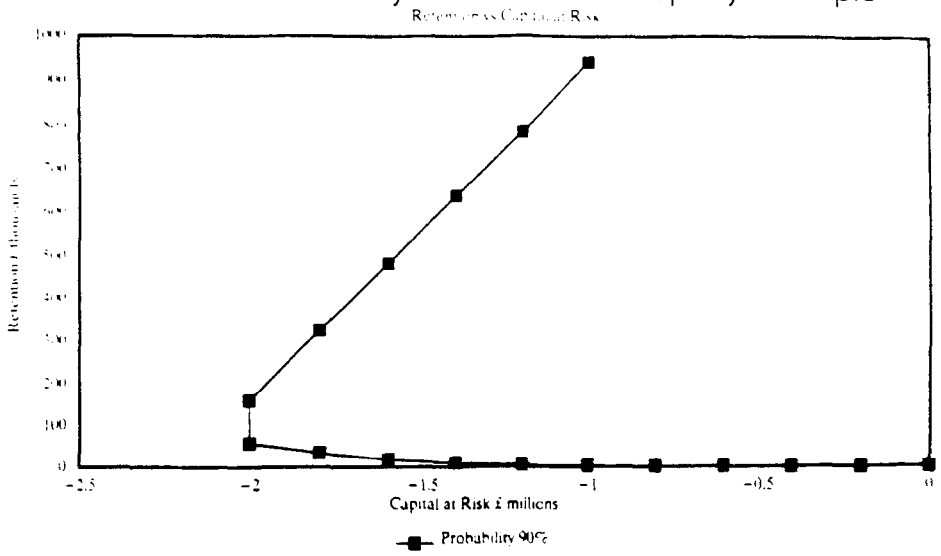
Retention	Capital at Risk as a Percentage of Net Premium 90%	99%	99.9%	Retention
Infinity	7.94	28.49	45.38	Infinity
1,000,000	(2.48)	7.32	14.24	2.71
500,000	(4.60)	2.40	7.84	1.47
250,000	(6.15)	(0.63)	3.60	0.81
200,000	(6.59)	(1.49)	2.27	0.67
150,000	(7.13)	(2.51)	0.92	0.53
100,000	(7.81)	(3.86)	(0.88)	0.39
50,000	(8.65)	(5.48)	(3.02)	0.22
10,000	(10.09)	(8.16)	(6.61)	0.07
5,000	(10.52)	(8.85)	(7.53)	0.04
2,500	(10.82)	(9.46)	(8.28)	0.03
1,000	(11.12)	(9.99)	(9.11)	0.02
500	(11.27)	(10.27)	(9.49)	0.01

Total Gross Premium = 57,691,234
Total Loading in Premiums = 30%
Expense Element of Premium = 20%

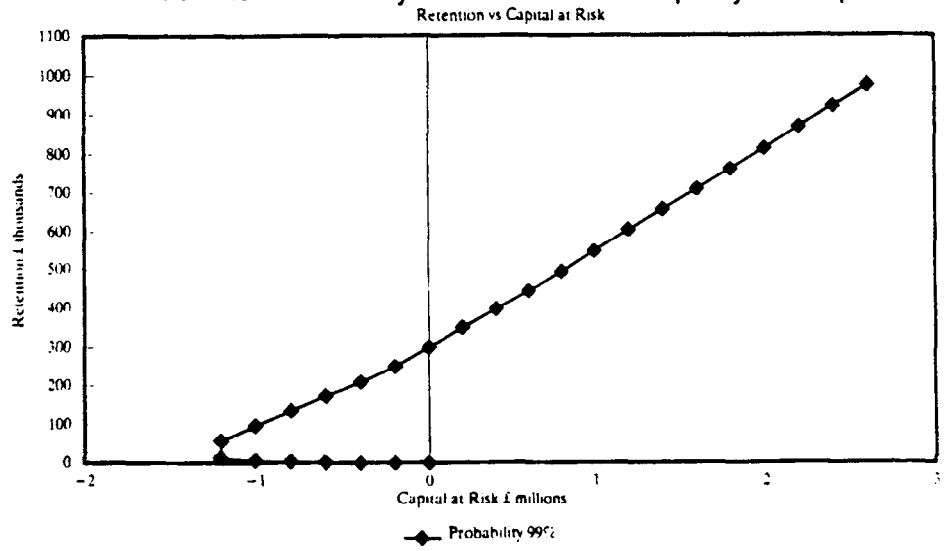
Capital at Risk = Net Aggregate Claims - Premium Net of Reinsurance and Expenses


Heckman and Meyers' Method – Property Example
Retention vs Net Aggregate Claims
Retention £ thousands
1200
1000
800
600
400
200
0
2
6
10
14
18
22
26
30
34
38
42
Net Aggregate Claims £ millions
Probability 90%
Probability 99%
Probability 99.9%

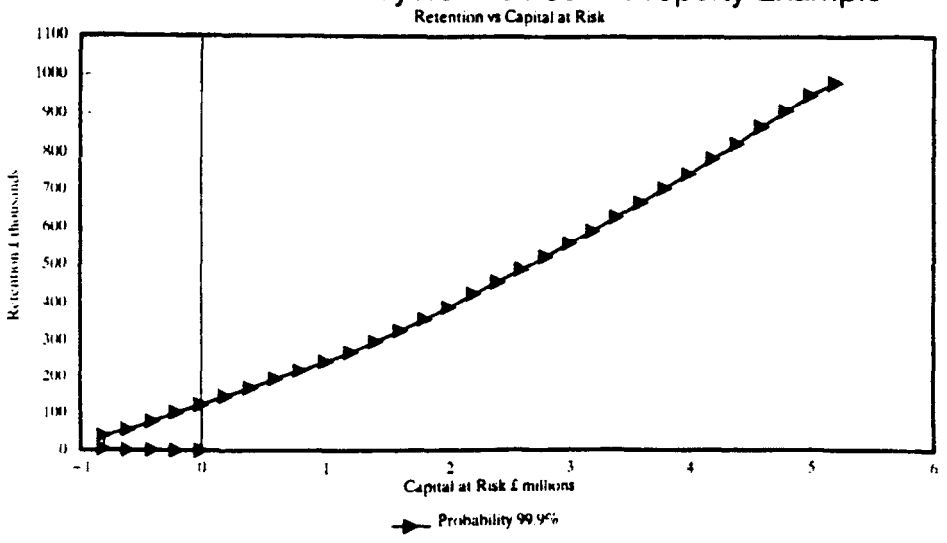
Heckman and Meyers' Method – Property Example



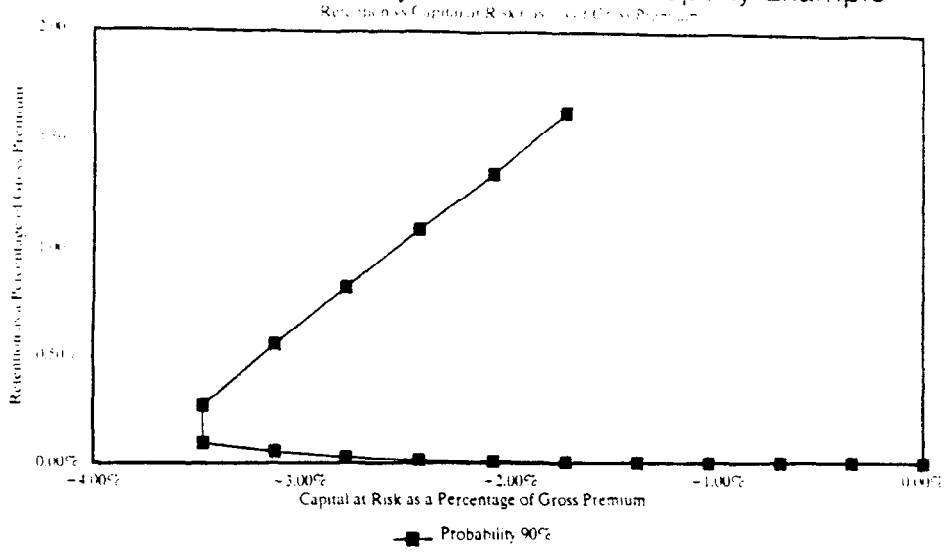
Heckman and Meyers' Method – Property Example



Heckman and Meyers' Method – Property Example

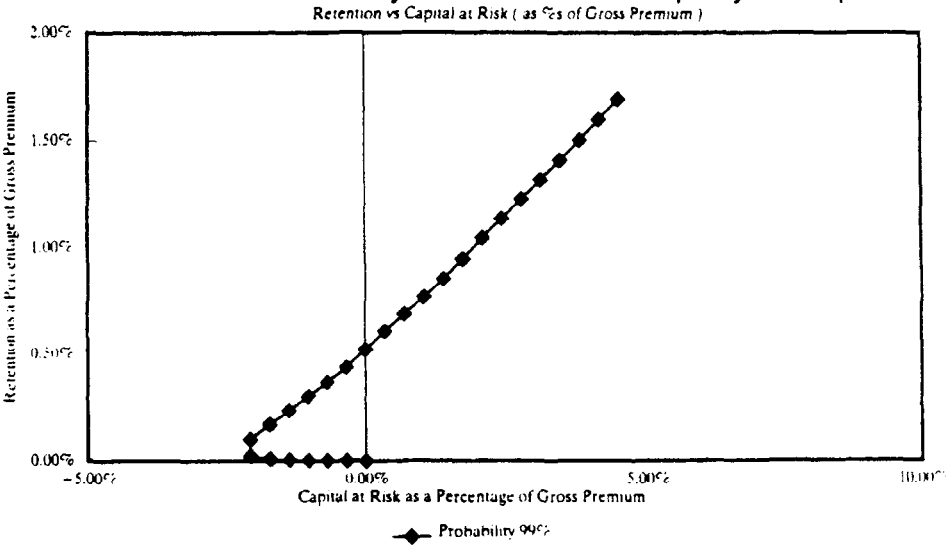


Heckman and Meyers' Method – Property Example



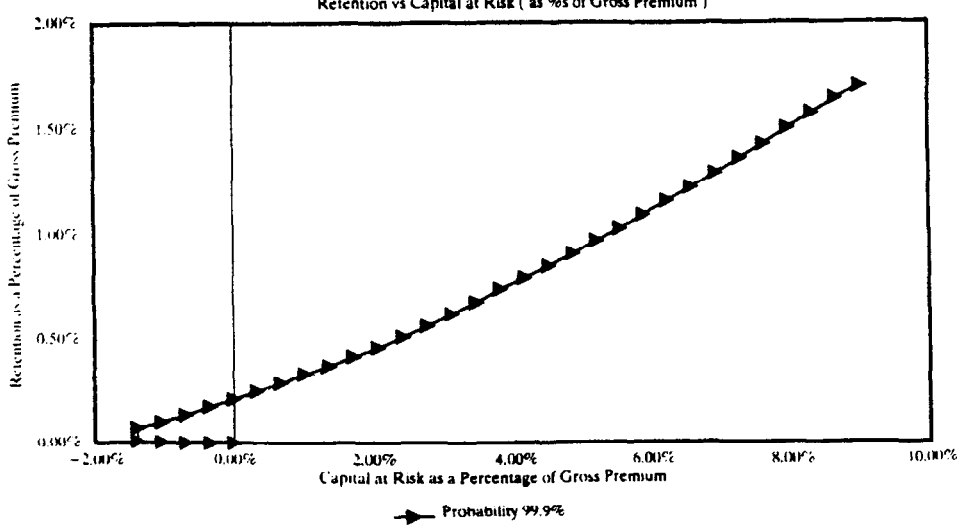
Heckman and Meyers' Method – Property Example

Retention vs Capital at Risk (as %s of Gross Premium)

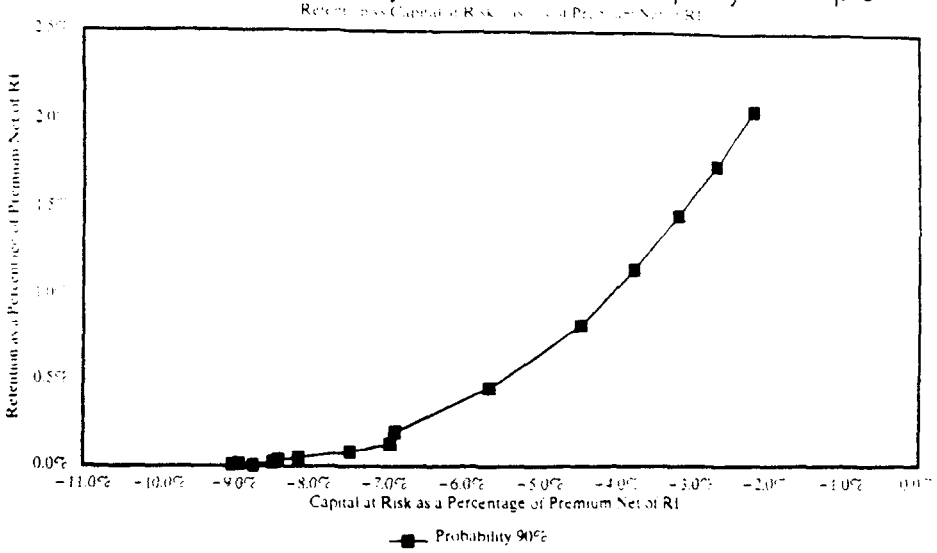


Heckman and Meyers' Method – Property Example

Retention vs Capital at Risk (as %s of Gross Premium)

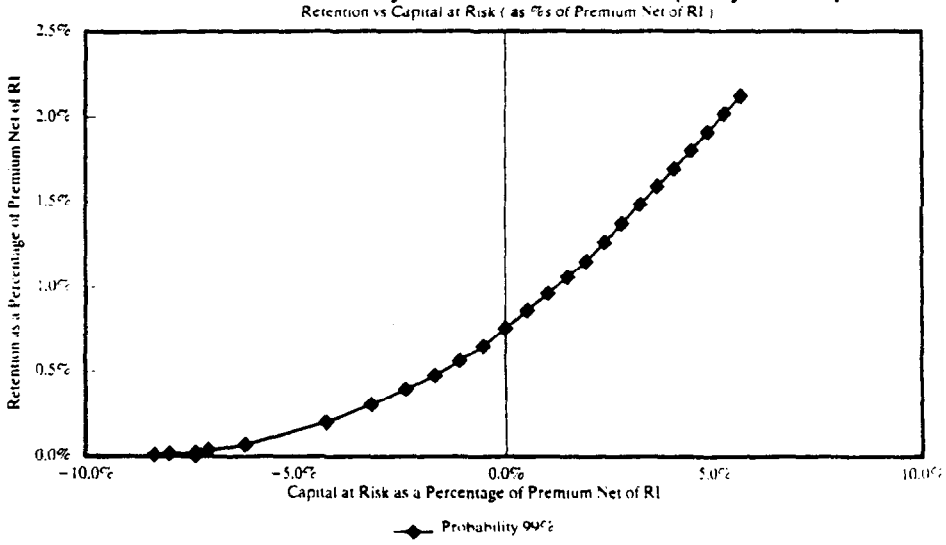


Heckman and Meyers' Method – Property Example



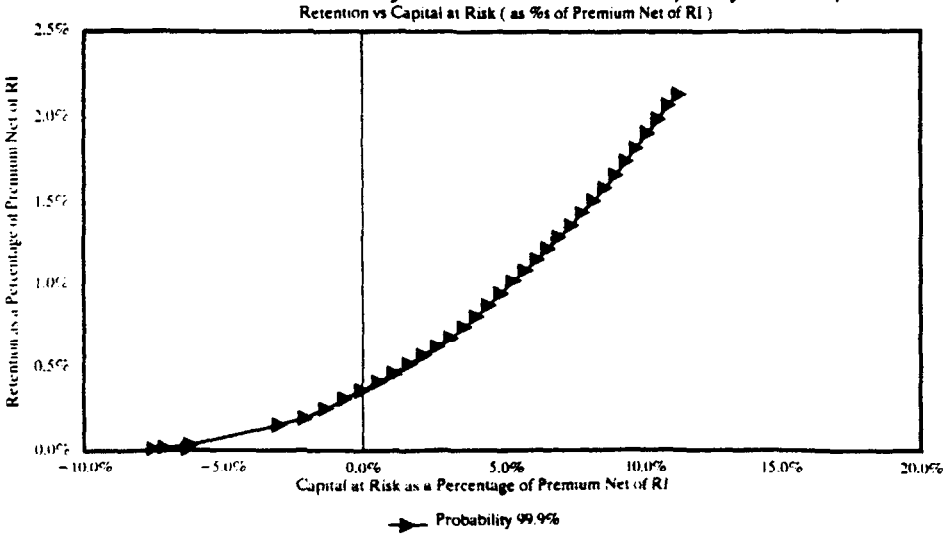
Heckman and Meyers' Method – Property Example

Retention vs Capital at Risk (as %s of Premium Net of RI)



Heckman and Meyers' Method – Property Example

Retention vs Capital at Risk (as %s of Premium Net of RI)



UK Property Catastrophes
Past Claims in excess of £40 million original cost
Amounts in £ millions

Date of Claim	Original Cost	Adjusted to 1990 Values	Claims above £100 million
Jan 79	60	327	327
Dec 81	100	349	349
Dec 81	60	174	174
Jan 82	60	153	153
Jan 82	160	349	349
Jan 84	120	196	196
Jan 85	40	87	0
Jan 85	40	87	0
Feb 85	100	174	174
Dec 85	80	131	131
Mar 86	60	87	0
Jan 87	320	414	414
Oct 87	1,240	1,591	1,591
Jan 90	1,700	1,700	1,700
Feb 90	300	300	300
Average			488

UK Property Catastrophes
Simulation Results for Gross Aggregate Annual Claims Cost
Number of Simulations 5000
Amounts in £ millions

	ESTIMATED COMPANY GROSS COSTS		
	Pareto 1.25	Pareto 1.33	Pareto 1.50
Poisson 0.75			
Average	27	25	21
SD	72	70	51
Poisson 1.00			
Average	37	33	28
SD	83	79	64
Poisson 1.25			
Average	45	42	34
SD	92	94	65

UK Property Catastrophes
Simulation Results for Gross Aggregate Annual Claims Cost
Number of Simulations 5000
Amounts in £ millions

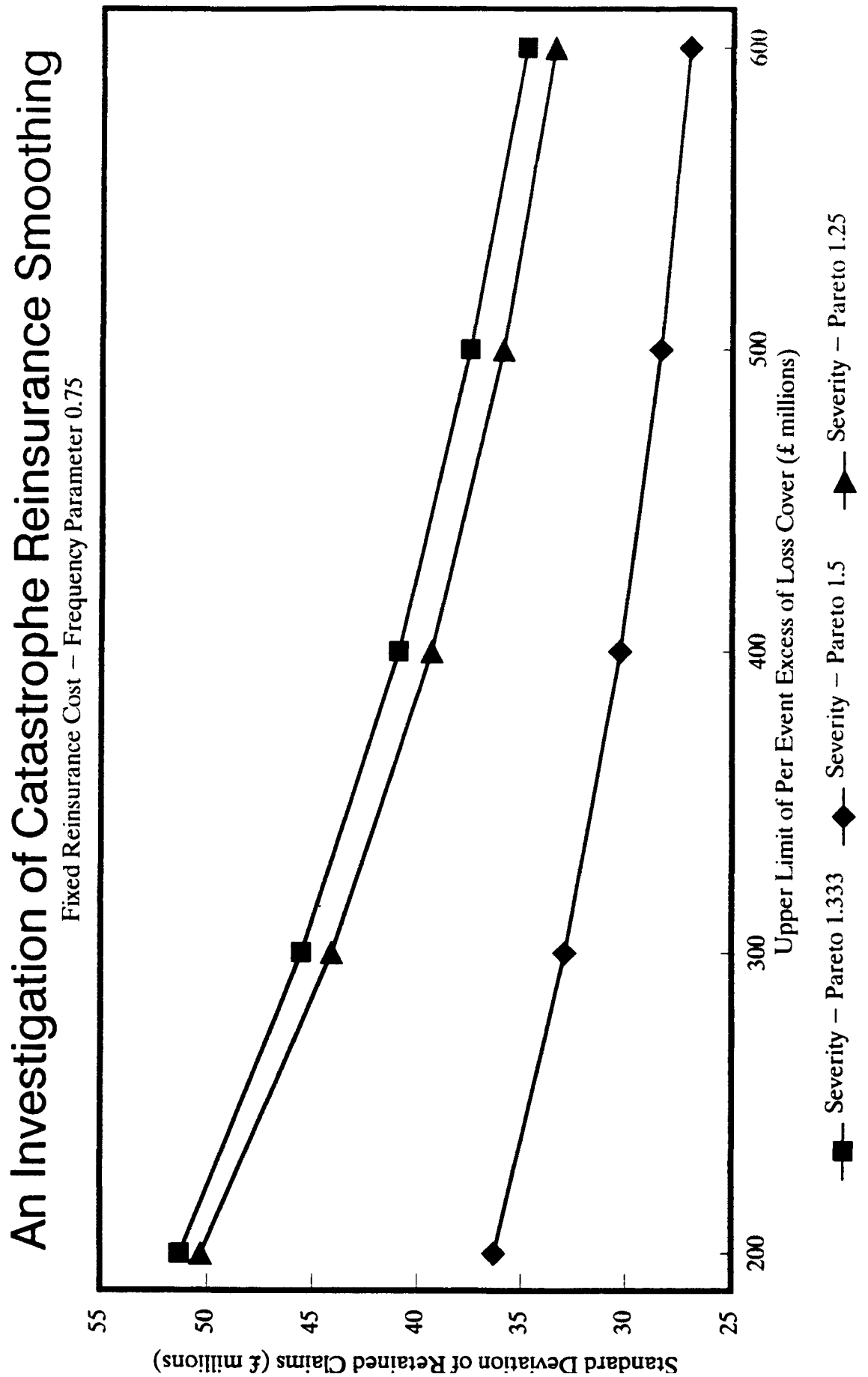
ESTIMATED COMPANY GROSS COSTS

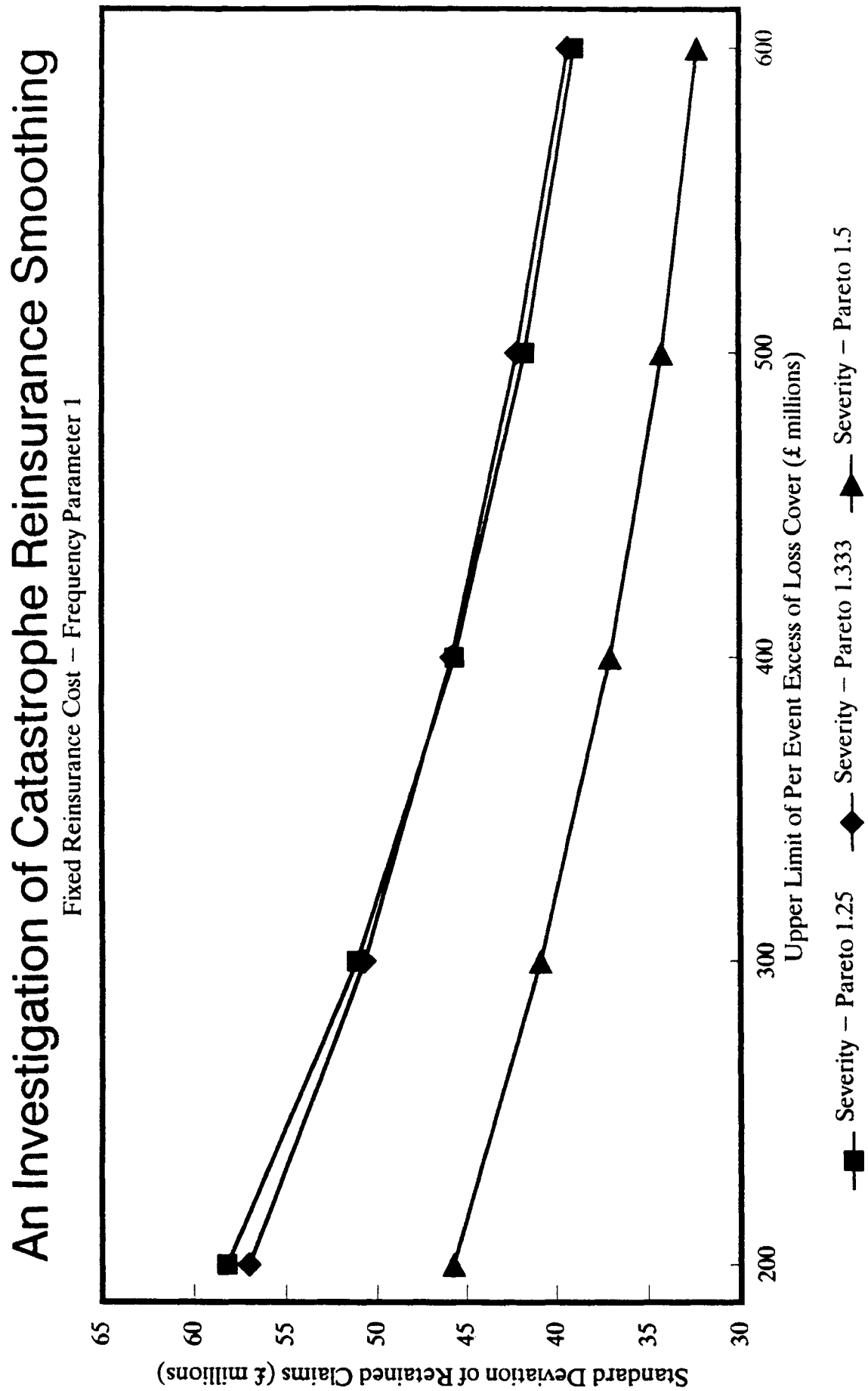
	Pareto 1.25	Pareto 1.33	Pareto 1.50
Poisson 0.75			
Average	27	25	21
SD	72	70	51
Poisson 1.00			
Average	37	33	28
SD	83	79	64
Poisson 1.25			
Average	45	42	34
SD	92	94	65

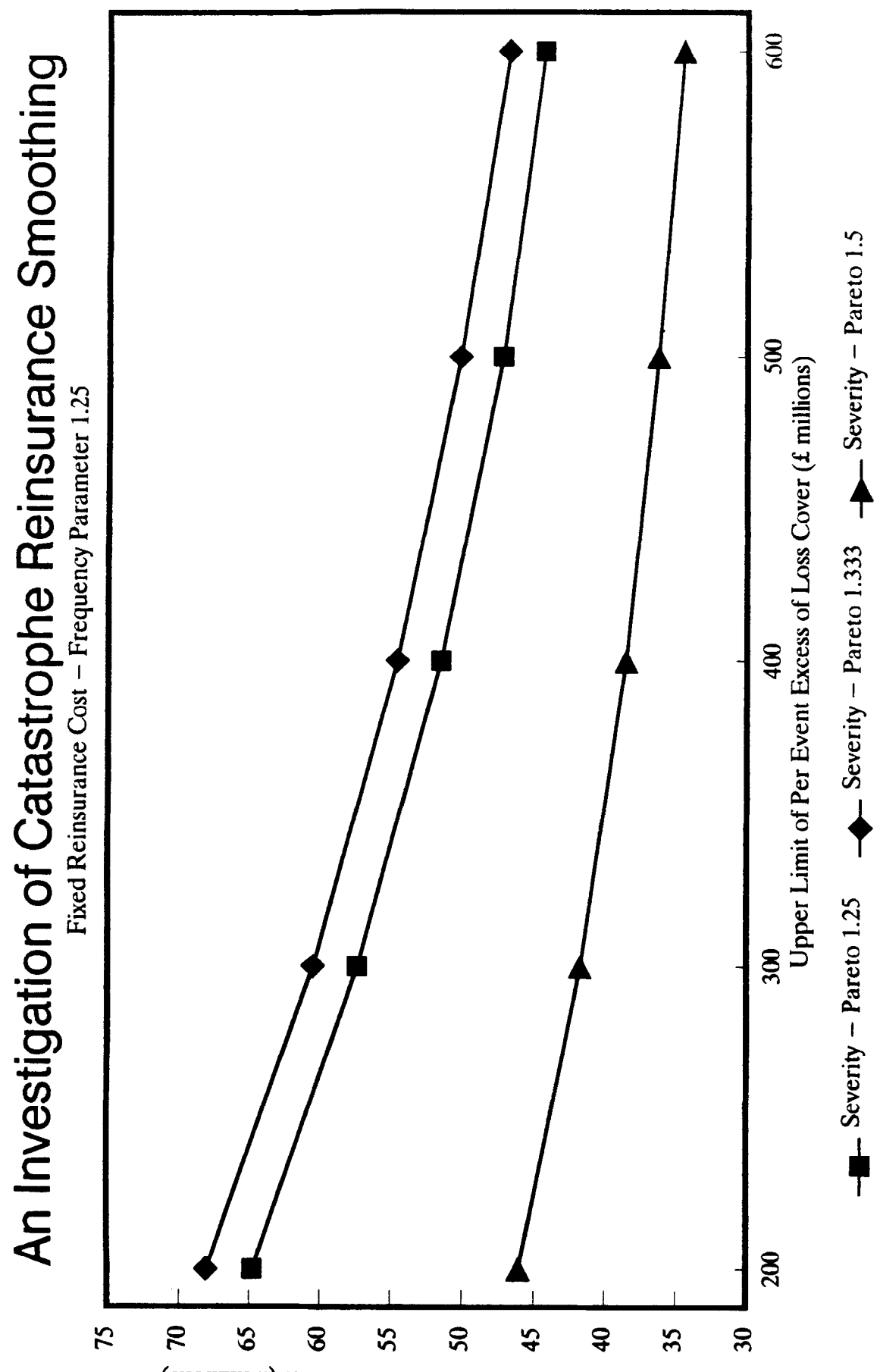
ESTIMATED COMPANY NET COSTS

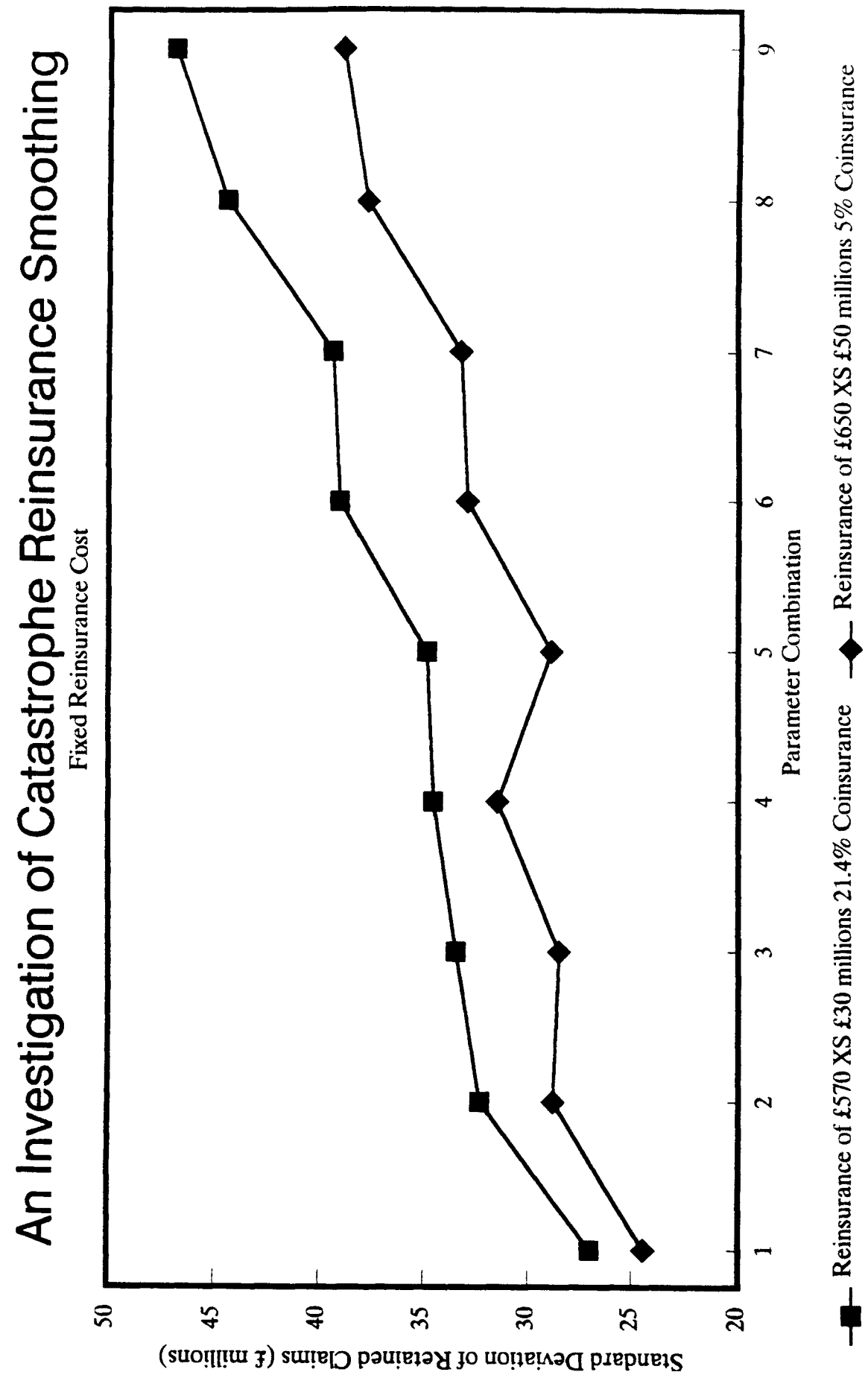
	Pareto 1.25	Pareto 1.33	Pareto 1.50
Poisson 0.75			
Average	19	18	16
SD	50	51	36
Poisson 1.00			
Average	25	24	22
SD	58	57	46
Poisson 1.25			
Average	32	31	26
SD	65	68	46

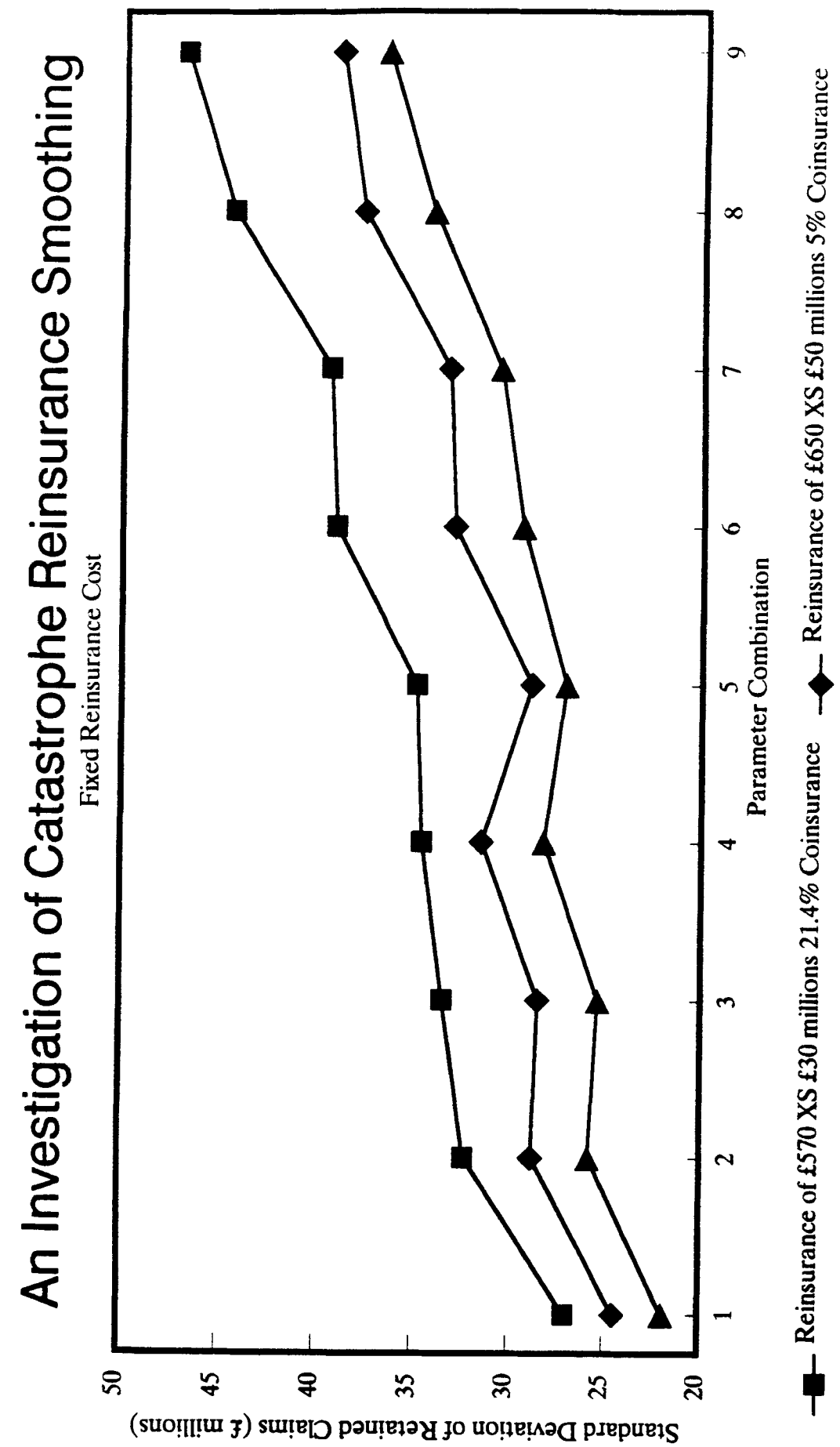
Note : Reinsurance Per Event Catastrophe £170 XS £30 million


An Investigation of Catastrophe Reinsurance Smoothing
Fixed Reinsurance Cost – Frequency Parameter 0.75
Standard Deviation of Retained Claims (£ millions)
55
50
45
40
35
30
25
200
300
400
500
600
Upper Limit of Per Event Excess of Loss Cover (£ millions)
Severity – Pareto 1.333
Severity – Pareto 1.5
Severity – Pareto 1.25


An Investigation of Catastrophe Reinsurance Smoothing
Fixed Reinsurance Cost – Frequency Parameter 1
Standard Deviation of Retained Claims (£ millions)
65
60
55
50
45
40
35
30
200
300
400
500
600
Upper Limit of Per Event Excess of Loss Cover (£ millions)
Severity – Pareto 1.25
Severity – Pareto 1.333
Severity – Pareto 1.5

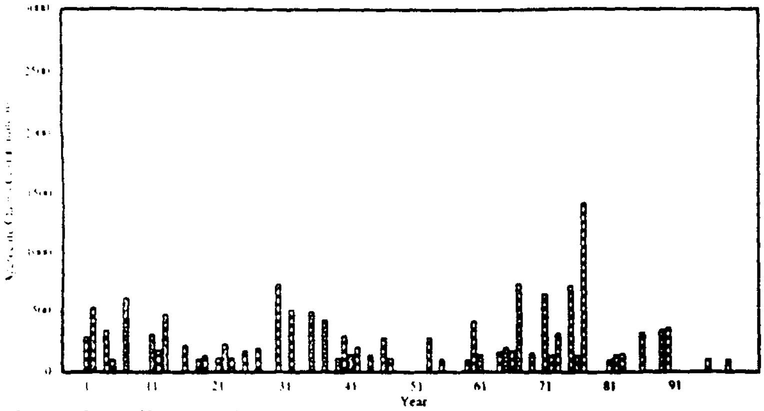

An Investigation of Catastrophe Reinsurance Smoothing
Fixed Reinsurance Cost – Frequency Parameter 1.25
Standard Deviation of Retained Claims (£ millions)
75
70
65
60
55
50
45
40
35
30
200
300
400
500
600
Upper Limit of Per Event Excess of Loss Cover (£ millions)
Severity – Pareto 1.25
Severity – Pareto 1.333
Severity – Pareto 1.5


An Investigation of Catastrophe Reinsurance Smoothing
Fixed Reinsurance Cost
Standard Deviation of Retained Claims (£ millions)
50
45
40
35
30
25
20
1
2
3
4
5
6
7
8
9
Parameter Combination
Reinsurance of £570 XS £30 millions 21.4% Coinsurance
Reinsurance of £650 XS £50 millions 5% Coinsurance


An Investigation of Catastrophe Reinsurance Smoothing
Fixed Reinsurance Cost
Standard Deviation of Retained Claims (£ millions)
50
45
40
35
30
25
20
1
2
3
4
5
6
7
8
9
Parameter Combination
Reinsurance of £570 XS £30 millions 21.4% Coinsurance
Reinsurance of £650 XS £50 millions 5% Coinsurance
Stop Loss on Catastrophe Events £100 XS £50 millions
The cost of the stop loss cover is not known

UK Property Catastrophe Claim Simulations

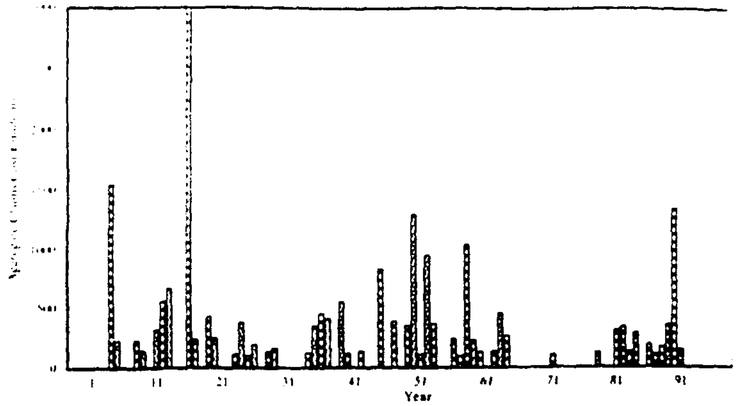
Aggregate annual Claims for 100 Years



Parameters Poisson 0.75 and Pareto 1.5

UK Property Catastrophe Claim Simulations

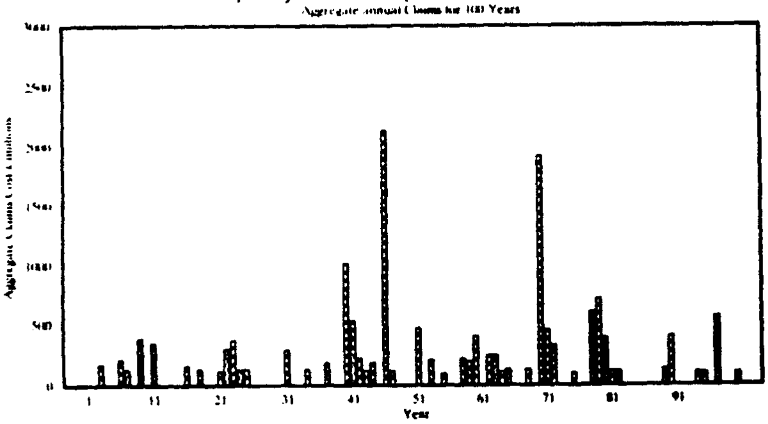
Aggregate annual Claims for 100 Years



Parameters Poisson 0.75 and Pareto 1.333

UK Property Catastrophe Claim Simulations

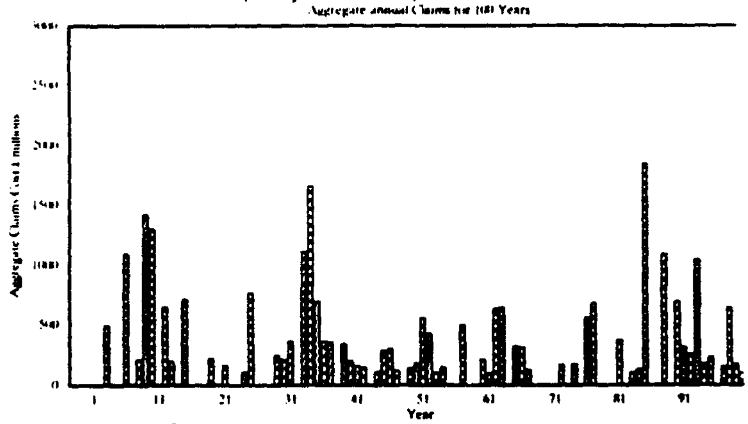
Aggregate annual Claims for 100 Years



Parameters Poisson 0.75 and Pareto 1.25

UK Property Catastrophe Claim Simulations

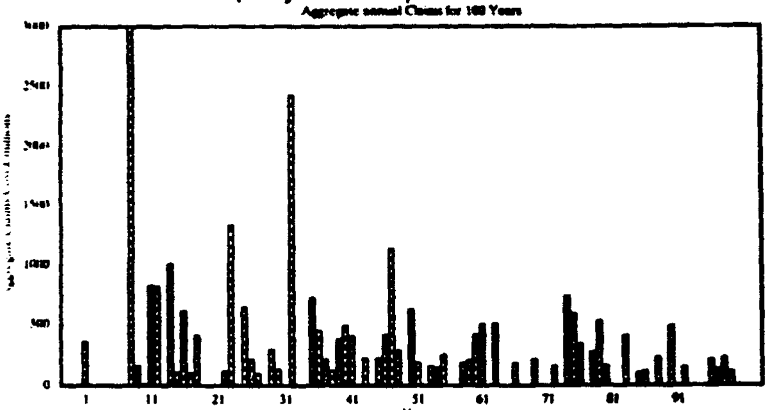
Aggregate annual Claims for 100 Years



Parameters Poisson 1 and Pareto 1.5

UK Property Catastrophe Claim Simulations

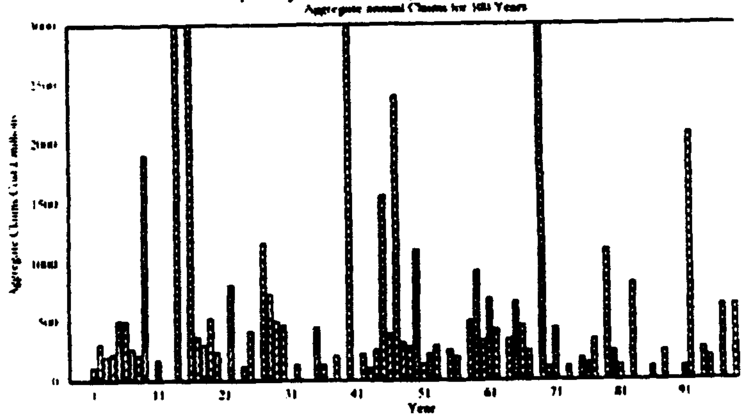
Aggregate annual Claims for 100 Years



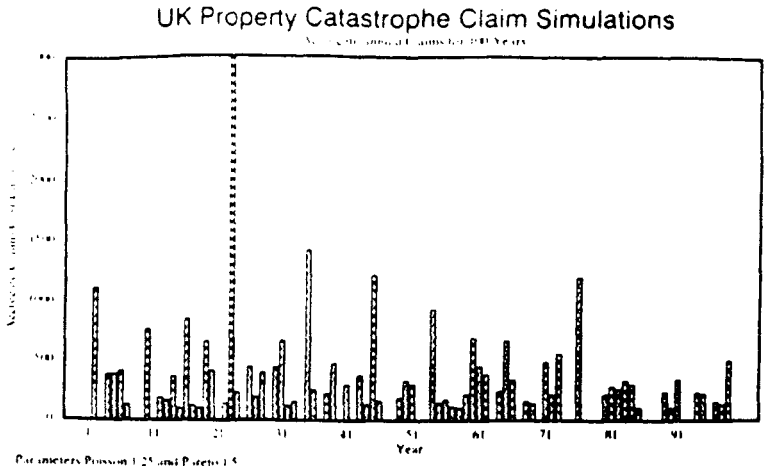
Parameters Poisson 1 and Pareto 1.333

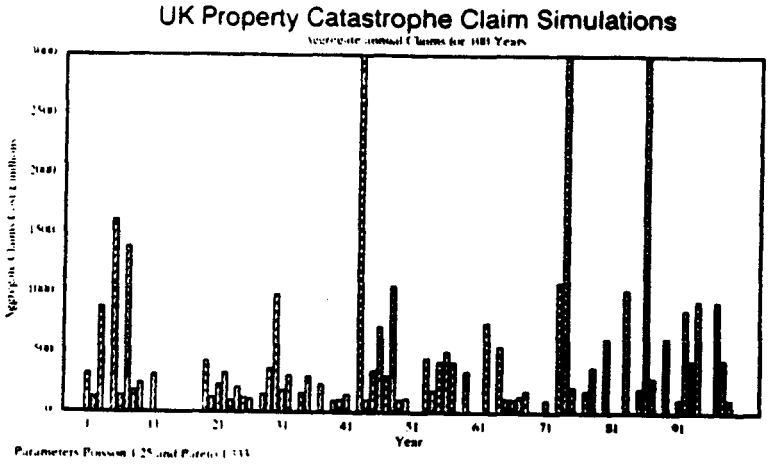
UK Property Catastrophe Claim Simulations

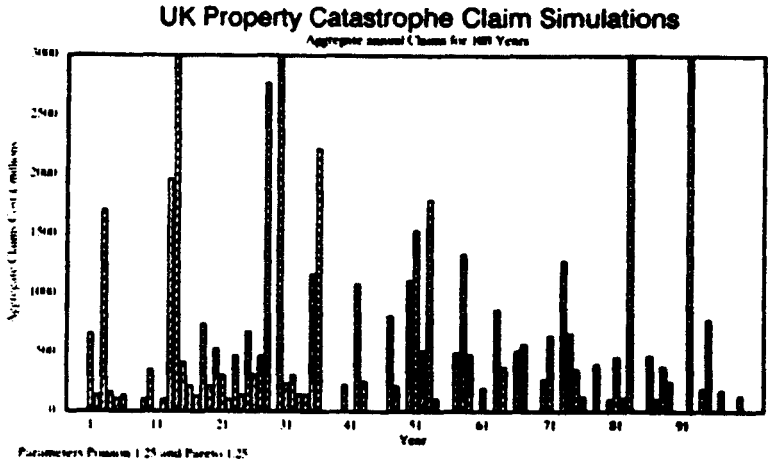
Aggregate annual Claims for 100 Years



Parameters Poisson 1 and Pareto 1.25


UK Property Catastrophe Claim Simulations
Year


UK Property Catastrophe Claim Simulations
Year


UK Property Catastrophe Claim Simulations
Year

UK Property Catastrophes
Actual versus Central Limit Theorem Confidence Limits
Demonstration on Net of Reinsurance Distributions
Reinsurance - Per Event Catastrophe £570 XS £30 million

	<--- Actual --->		<--- One Tail Central Limit --->	
	95% Confidence	99% Confidence	95% Confidence	99% Confidence
Poisson 0.75 Pareto 1.5	54.6	85.9	40.1	57.0
Poisson 0.75 Pareto 1.333	58.2	105.8	47.3	67.3
Poisson 0.75 Pareto 1.25	63.0	116.3	46.8	66.4
Poisson 1 Pareto 1.5	66.5	106.3	47.2	67.1
Poisson 1 Pareto 1.333	72.3	124.2	54.5	77.4
Poisson 1 Pareto 1.25	75.7	124.8	54.0	76.7
Poisson 1.25 Pareto 1.5	73.2	114.7	51.6	73.3
Poisson 1.25 Pareto 1.333	85.1	146.6	63.7	90.5
Poisson 1.25 Pareto 1.25	87.6	145.9	61.8	87.7

Recursive Method - Aviation Example
Individual Claim Severity Distribution

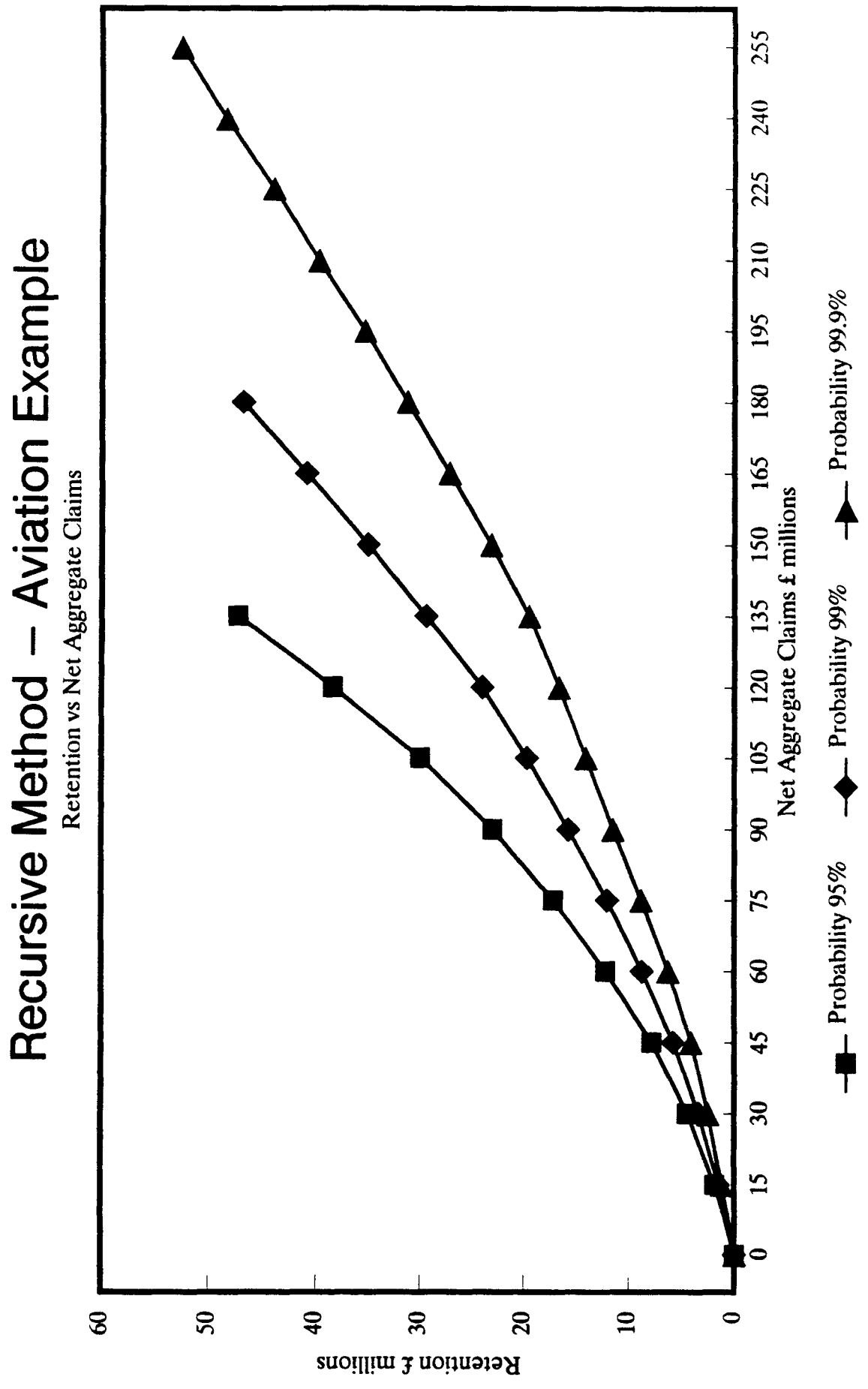
No. of Data Points 40
Scaling Factor 1,500

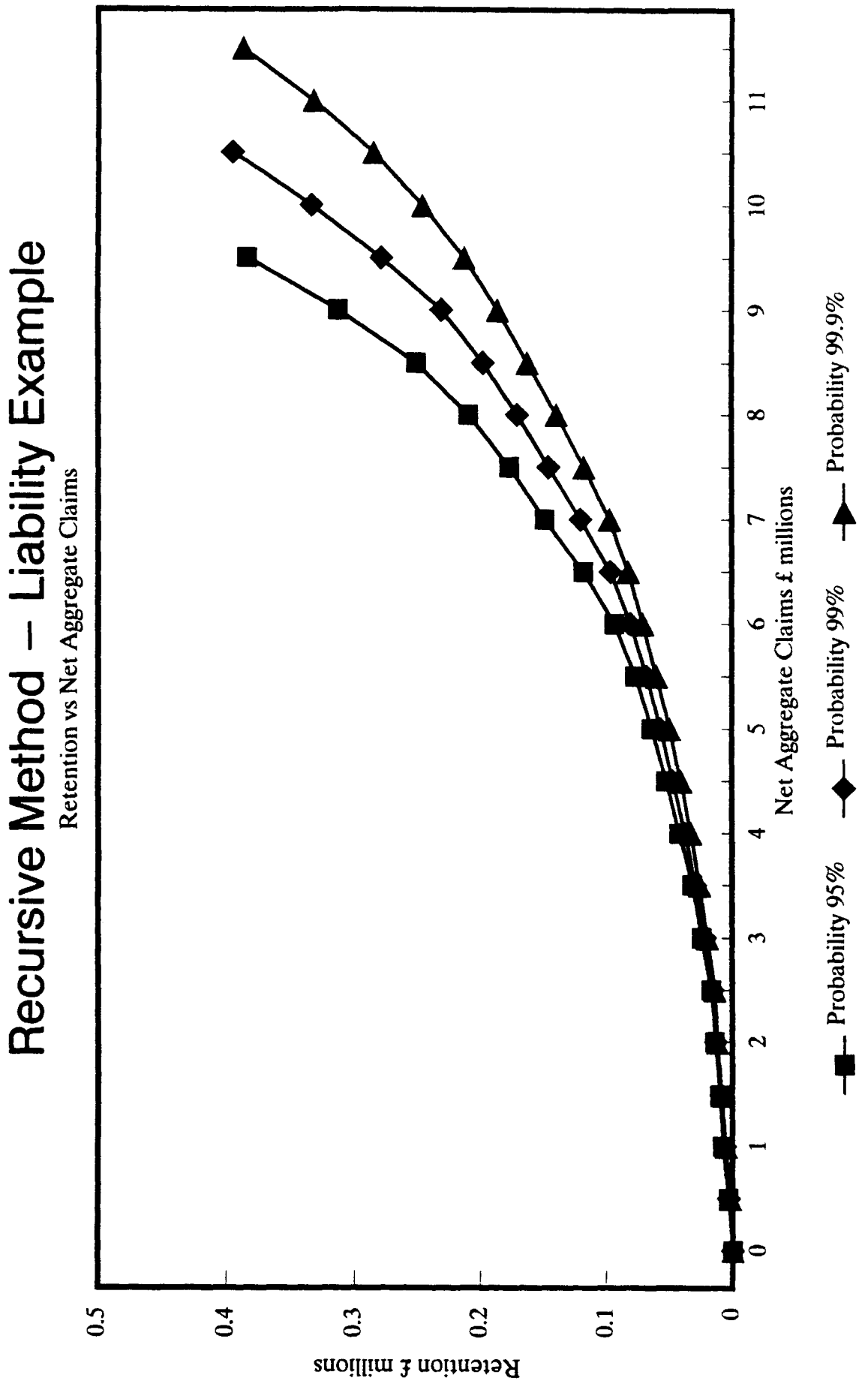
Discretised Distribution of X	Frequency	Relative Frequency f(x)	Cumulative Frequency F(x)	x*f(x)	Col (5) Cumulative	x^2 * f(x)	Col (7) Cumulative
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
0	14	0.350	0.350	0.000	0.000	0.000	0.000
1	8	0.200	0.550	0.200	0.200	0.200	0.200
2	4	0.100	0.650	0.200	0.400	0.400	0.600
3	4	0.100	0.750	0.300	0.700	0.900	1.500
4	2	0.050	0.800	0.200	0.900	0.800	2.300
5	0	0.000	0.800	0.000	0.900	0.000	2.300
6	1	0.025	0.825	0.150	1.050	0.900	3.200
7	0	0.000	0.825	0.000	1.050	0.000	3.200
8	0	0.000	0.825	0.000	1.050	0.000	3.200
9	0	0.000	0.825	0.000	1.050	0.000	3.200
10	1	0.025	0.850	0.250	1.300	2.500	5.700
11	0	0.000	0.850	0.000	1.300	0.000	5.700
12	0	0.000	0.850	0.000	1.300	0.000	5.700
13	1	0.025	0.875	0.325	1.625	4.225	9.925
14	0	0.000	0.875	0.000	1.625	0.000	9.925
15	0	0.000	0.875	0.000	1.625	0.000	9.925
16	1	0.025	0.900	0.400	2.025	6.400	16.325
17	1	0.025	0.925	0.425	2.450	7.225	23.550
18	0	0.000	0.925	0.000	2.450	0.000	23.550
19	0	0.000	0.925	0.000	2.450	0.000	23.550
20	0	0.000	0.925	0.000	2.450	0.000	23.550
21	0	0.000	0.925	0.000	2.450	0.000	23.550
22	0	0.000	0.925	0.000	2.450	0.000	23.550
23	0	0.000	0.925	0.000	2.450	0.000	23.550
24	0	0.000	0.925	0.000	2.450	0.000	23.550
25	0	0.000	0.925	0.000	2.450	0.000	23.550
26	0	0.000	0.925	0.000	2.450	0.000	23.550
27	0	0.000	0.925	0.000	2.450	0.000	23.550
28	0	0.000	0.925	0.000	2.450	0.000	23.550
29	0	0.000	0.925	0.000	2.450	0.000	23.550
30	0	0.000	0.925	0.000	2.450	0.000	23.550
31	0	0.000	0.925	0.000	2.450	0.000	23.550
32	0	0.000	0.925	0.000	2.450	0.000	23.550
33	1	0.025	0.950	0.825	3.275	27.225	50.775
34	0	0.000	0.950	0.000	3.275	0.000	50.775
35	1	0.025	0.975	0.875	4.150	30.625	81.400
36+	1	0.025	1.000	0.900	5.050	32.400	113.800
Total		1.000		5.050		113.800	

Recursive Method - Liability Example
Individual Claim Severity Distribution

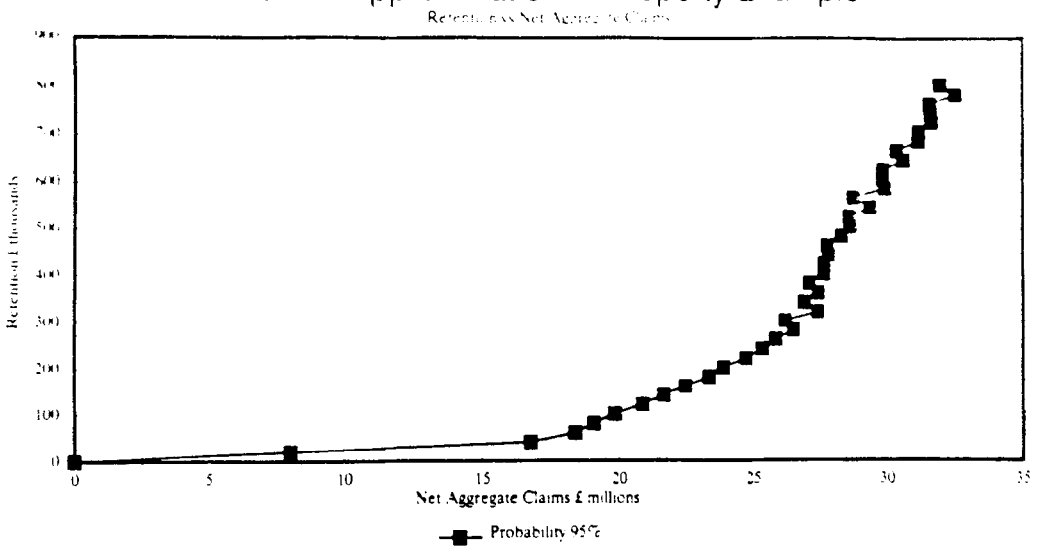
No. of Data Points 638
Scaling Factor 10,000

Discretised Distribution of X	Frequency	Relative Frequency f(x)	Cumulative Frequency F(x)	x*f(x)	Col (5) Cumulative	x^2 * f(x)	Col (7) Cumulative
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
0	268	0.4201	0.4201	0.0000	0.0000	0.0000	0.0000
1	161	0.2524	0.6724	0.2524	0.2524	0.2524	0.2524
2	63	0.0987	0.7712	0.1975	0.4498	0.3950	0.6473
3	41	0.0643	0.8354	0.1928	0.6426	0.5784	1.2257
4	20	0.0313	0.8668	0.1254	0.7680	0.5016	1.7273
5	8	0.0125	0.8793	0.0627	0.8307	0.3135	2.0408
6	11	0.0172	0.8966	0.1034	0.9342	0.6207	2.6614
7	7	0.0110	0.9075	0.0768	1.0110	0.5376	3.1991
8	4	0.0063	0.9138	0.0502	1.0611	0.4013	3.6003
9	7	0.0110	0.9248	0.0987	1.1599	0.8887	4.4890
10	4	0.0063	0.9310	0.0627	1.2226	0.6270	5.1160
11	2	0.0031	0.9342	0.0345	1.2571	0.3793	5.4953
12	2	0.0031	0.9373	0.0376	1.2947	0.4514	5.9467
13	2	0.0031	0.9404	0.0408	1.3354	0.5298	6.4765
14	4	0.0063	0.9467	0.0878	1.4232	1.2288	7.7053
15	0	0.0000	0.9467	0.0000	1.4232	0.0000	7.7053
16	3	0.0047	0.9514	0.0752	1.4984	1.2038	8.9091
17	2	0.0031	0.9545	0.0533	1.5517	0.9060	9.8150
18	1	0.0016	0.9561	0.0282	1.5799	0.5078	10.3229
19	0	0.0000	0.9561	0.0000	1.5799	0.0000	10.3229
20	4	0.0063	0.9624	0.1254	1.7053	2.5078	12.8307
21	3	0.0047	0.9671	0.0987	1.8041	2.0737	14.9044
22	0	0.0000	0.9671	0.0000	1.8041	0.0000	14.9044
23	2	0.0031	0.9702	0.0721	1.8762	1.6583	16.5627
24	1	0.0016	0.9718	0.0376	1.9138	0.9028	17.4655
25	2	0.0031	0.9749	0.0784	1.9922	1.9592	19.4248
26	0	0.0000	0.9749	0.0000	1.9922	0.0000	19.4248
27	2	0.0031	0.9781	0.0846	2.0768	2.2853	21.7100
28	1	0.0016	0.9796	0.0439	2.1207	1.2288	22.9389
29	1	0.0016	0.9812	0.0455	2.1661	1.3182	24.2571
30	1	0.0016	0.9828	0.0470	2.2132	1.4107	25.6677
31	0	0.0000	0.9828	0.0000	2.2132	0.0000	25.6677
32	0	0.0000	0.9828	0.0000	2.2132	0.0000	25.6677
33	0	0.0000	0.9828	0.0000	2.2132	0.0000	25.6677
34	0	0.0000	0.9828	0.0000	2.2132	0.0000	25.6677
35	0	0.0000	0.9828	0.0000	2.2132	0.0000	25.6677
36	0	0.0000	0.9828	0.0000	2.2132	0.0000	25.6677
37	0	0.0000	0.9828	0.0000	2.2132	0.0000	25.6677
38	1	0.0016	0.9843	0.0596	2.2727	2.2633	27.9310
39	3	0.0047	0.9890	0.1834	2.4561	7.1520	35.0831
40	0	0.0000	0.9890	0.0000	2.4561	0.0000	35.0831
41+	7	0.0110	1.0000	0.4498	2.9060	18.4436	53.5266
Total		1.0000		2.9060		53.5266	

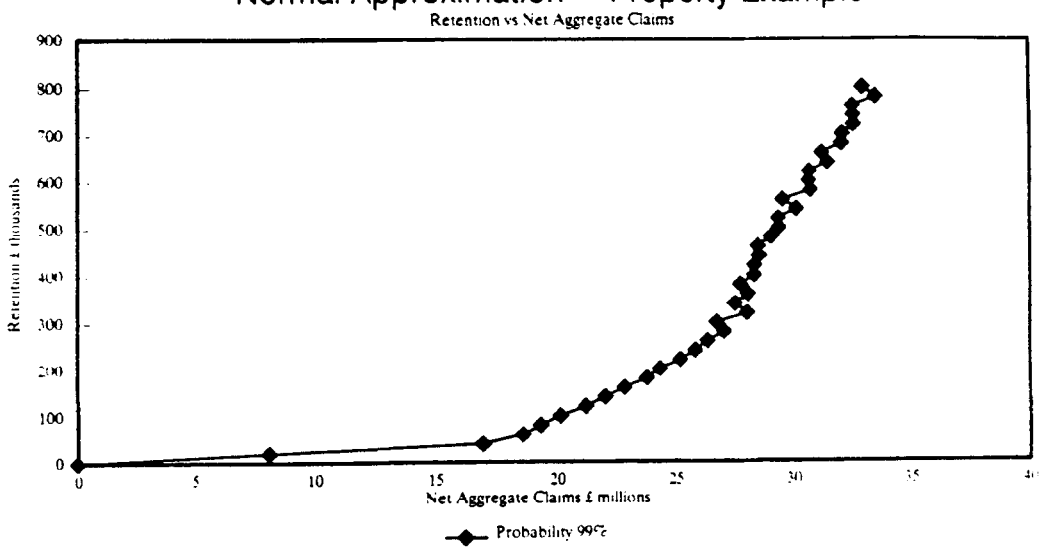

Recursive Method – Aviation Example
Retention vs Net Aggregate Claims
Retention £ millions
0
10
20
30
40
50
60
0
15
30
45
60
75
90
105
120
135
150
165
180
195
210
225
240
255
Net Aggregate Claims £ millions
Probability 95%
Probability 99%
Probability 99.9%


Recursive Method – Liability Example
Retention vs Net Aggregate Claims
Retention £ millions
0.5
0.4
0.3
0.2
0.1
0
0
1
2
3
4
5
6
7
8
9
10
11
Net Aggregate Claims £ millions
Probability 95%
Probability 99%
Probability 99.9%

Normal Approximation – Property Example



Normal Approximation – Property Example



Normal Approximation – Property Example