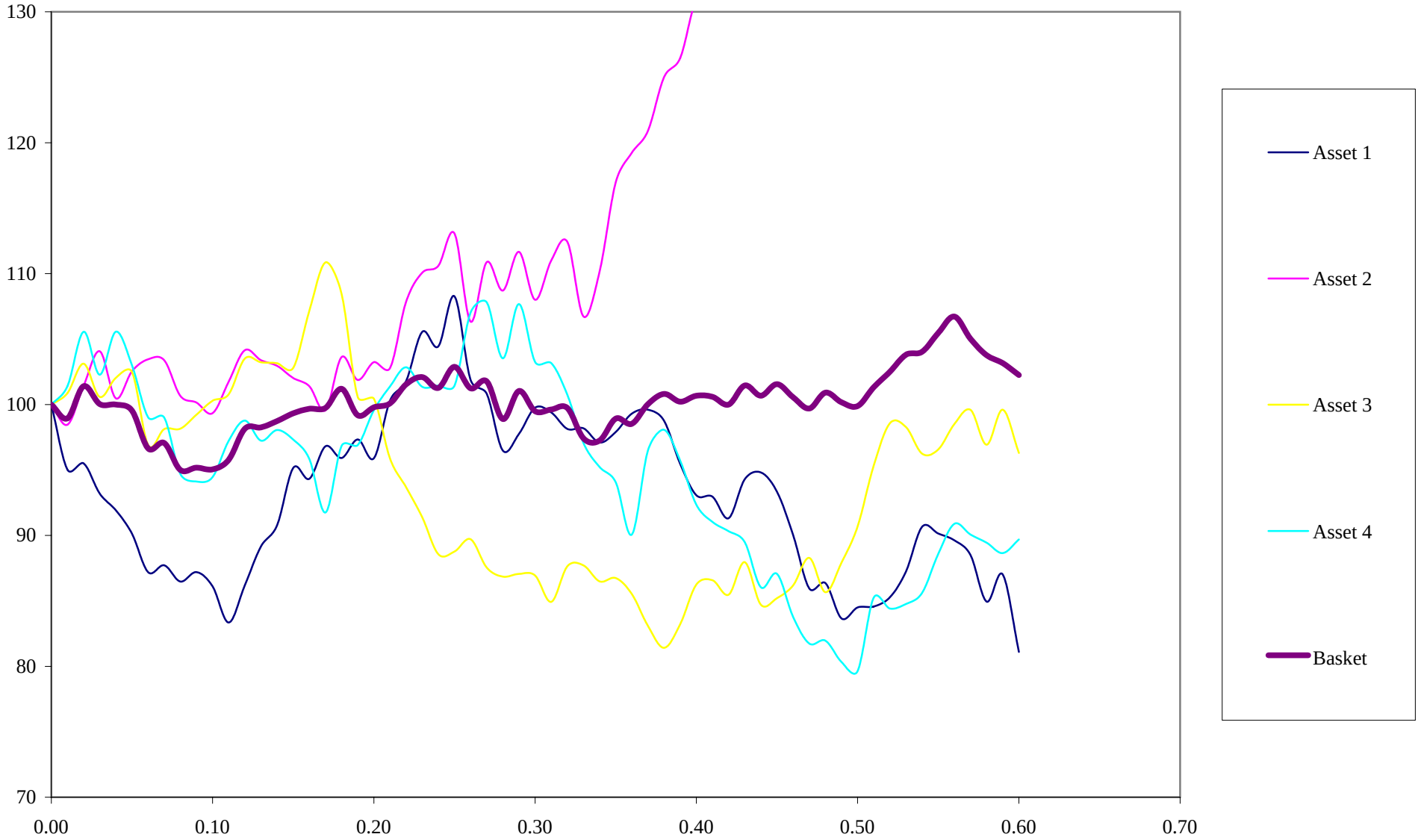
	A	B	C	D	E	F	G	H	I	J	K
1	**CQFMike1.XLS**										
2	**Benefits of diversification**										
3				**Time**		**Asset 1**	**Asset 2**	**Asset 3**	**Asset 4**		**Basket**
4	Share Price (S)	**100.00**		0.00		100.00	100.00	100.00	100.00		100.00
5	Drift (μ)	**0.10**		0.01		95.02	98.46	100.87	101.41		98.94
6	Volatility (σ)	**0.25**		0.02		95.50	101.43	103.12	105.56		101.40
7	Timestep (dt)	**0.01**		0.03		93.19	104.07	100.58	102.28		100.03
8				0.04		91.91	100.47	102.04	105.56		100.00
9	**Press F9 for new sample**			0.05		90.12	102.55	102.48	102.99		99.53
10				0.06		87.19	103.45	96.91	99.02		96.64
11	formula in cell D5			0.07		87.72	103.37	98.13	98.99		97.05
12	=D4+$B$7			0.08		86.48	100.66	98.15	94.70		95.00
13				0.09		87.20	100.15	99.22	94.12		95.17
14	formula in cell F4			0.10		86.11	99.34	100.29	94.46		95.05
15	=$B$4			0.11		83.34	101.75	100.78	97.23		95.77
16				0.12		86.19	104.15	103.51	98.77		98.15
17	formula in cell F5			0.13		89.16	103.38	103.23	97.24		98.25
18	=F4*(1+$B$5*$B$7+NORMSINV(RAND())*$B$6*SQRT($B$7))			0.14		90.77	102.95	103.16	98.05		98.73
19				0.15		95.16	102.02	102.80	97.32		99.33
20	formula in cell K4			0.16		94.33	101.40	107.17	95.83		99.68
21	=AVERAGE(F4:I4)			0.17		96.81	99.56	110.86	91.75		99.74
22				0.18		95.91	103.63	108.43	96.85		101.20
23				0.19		97.33	101.88	100.57	96.90		99.17
24				0.20		95.90	103.23	100.44	99.58		99.79
25				0.21		100.30	102.79	95.87	101.39		100.09
26				0.22		101.79	107.84	93.69	102.84		101.54
27				0.23		105.54	110.07	91.40	101.36		102.09
28				0.24		104.44	110.59	88.57	101.45		101.26
29				0.25		108.27	113.06	88.77	101.43		102.88
30				0.26		101.87	106.33	89.71	107.02		101.23
31				0.27		100.82	110.87	87.54	107.81		101.76
32				0.28		96.48	108.70	86.85	103.53		98.89
33				0.29		97.76	111.66	87.06	107.67		101.04
34				0.30		99.76	108.00	86.94	103.25		99.49
35				0.31		99.39	111.00	84.92	103.16		99.62
36				0.32		98.13	112.42	87.65	100.74		99.73
37				0.33		98.17	106.72	87.71	97.05		97.41
38				0.34		97.09	110.18	86.49	95.22		97.24
39				0.35		97.91	116.99	86.74	94.05		98.92
40				0.36		99.30	119.23	85.53	90.06		98.53
41				0.37		99.60	120.91	83.09	96.49		100.02
42				0.38		98.75	125.01	81.41	98.07		100.81
43				0.39		95.46	126.47	83.22	95.70		100.21
44				0.40		93.07	131.00	86.25	92.35		100.67
45				0.41		92.95	131.78	86.58	91.03		100.59
46				0.42		91.32	132.88	85.47	90.32		100.00
47				0.43		94.29	134.11	87.96	89.49		101.46
48				0.44		94.81	137.14	84.70	86.04		100.67
49				0.45		93.33	140.61	85.21	87.06		101.55
50				0.46		90.03	142.22	86.19	83.77		100.55
51				0.47		85.95	142.82	88.28	81.74		99.70
52				0.48		86.36	149.66	85.66	81.96		100.91
53				0.49		83.65	148.77	87.92	80.32		100.17
54				0.50		84.50	144.69	90.67	79.63		99.87
55				0.51		84.57	140.11	95.33	85.24		101.31
56				0.52		85.27	141.73	98.56	84.41		102.49
57				0.53		87.23	144.93	98.28	84.76		103.80
58				0.54		90.66	143.60	96.24	85.61		104.03
59				0.55		90.15	146.56	96.56	88.59		105.46
60				0.56		89.63	147.87	98.51	90.89		106.72
61				0.57		88.51	141.91	99.59	90.07		105.02
62				0.58		84.94	143.77	96.93	89.44		103.77
63				0.59		87.01	137.40	99.61	88.65		103.17
64				0.60		81.10	141.90	96.30	89.69		102.25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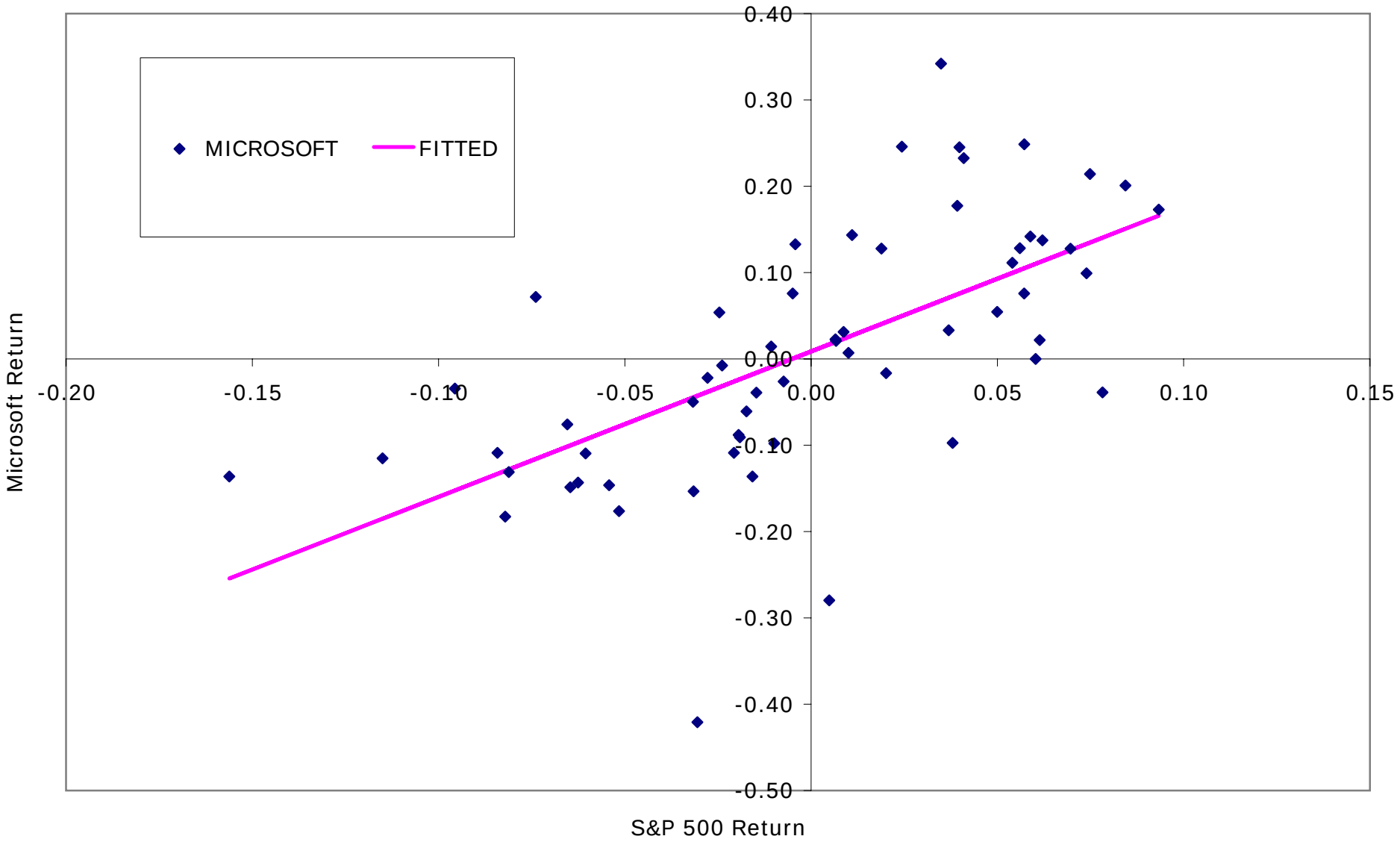
Asset 1
Asset 2
Asset 3
Asset 4
Basket

	A	B	C	D	E	F	G	H	I	J	K
1	**CQFMike1.XLS**										
2	**Minimise portfolio risk for target return**										
3		**A**	**B**	**C**	**D**						
4	Return (rvec)	**10.0%**	**15.0%**	**18.0%**	**20.0%**		Target return	**20.00%**			
5	Volatility (vvec)	**20.0%**	**30.0%**	**25.0%**	**35.0%**		Portfolio return	14.60%	=SUMPRODUCT(B6:E6,B4:E4)		
6	Weights (wvec)	40.0%	**20.0%**	**20.0%**	**20.0%**		Portfolio risk	15.60%	=SQRT(H17)		
7											
8	Correlations	A	B	C	D		$vvec^T$	$wvec^T$		via fn	
9	A	1.00	**0.20**	**0.30**	**0.10**		20.0%	40.0%		-25.7%	
10	B	0.20	1.00	**0.05**	**0.10**		30.0%	20.0%		25.7%	
11	C	0.30	0.05	1.00	**0.05**		25.0%	20.0%		64.4%	
12	D	0.10	0.10	0.05	1.00		35.0%	20.0%		35.7%	
13							in cells J9:J12				
14	Variance Covariance Matrix	A	B	C	D		=TRANSPOSE(HLPortfolioWeights(H4,-1,B4:E4,B15:E18))				
15	A	0.0400	0.0120	0.0150	0.0070		in cell B15	=B9*$G9*B$5			
16	B	0.0120	0.0900	0.0038	0.0105						
17	C	0.0150	0.0038	0.0625	0.0044		Portfolio variance	0.0243			
18	D	0.0070	0.0105	0.0044	0.1225		=MMULT(B6:E6,MMULT(B15:E18,H9:H12))				
19											
20	**Maximise Sharpe ratio**										
21		**A**	**B**	**C**	**D**						
22	Return (rvec)	**10.0%**	**15.0%**	**18.0%**	**20.0%**						
23	Volatility (vvec)	**20.0%**	**30.0%**	**25.0%**	**35.0%**		Portfolio return	14.60%	=SUMPRODUCT(B24:E24,B22:E22)		
24	Weights (wvec)	40.0%	**20.0%**	**20.0%**	**20.0%**		Portfolio risk	15.60%	=SQRT(H35)		
25											
26	Correlations	A	B	C	D		$vvec^T$	$wvec^T$			
27	A	1.00	**0.20**	**0.30**	**0.10**		20.0%	40.0%			
28	B	0.20	1.00	**0.05**	**0.10**		30.0%	20.0%			
29	C	0.30	0.05	1.00	**0.05**		25.0%	20.0%			
30	D	0.10	0.10	0.05	1.00		35.0%	20.0%			
31											
32	Variance Covariance Matrix	A	B	C	D						
33	A	0.0400	0.0120	0.0150	0.0070		in cell B33	=B27*$G27*B$5			
34	B	0.0120	0.0900	0.0038	0.0105						
35	C	0.0150	0.0038	0.0625	0.0044		Portfolio variance	0.0243			
36	D	0.0070	0.0105	0.0044	0.1225						
37							Risk-free rate	**5.00%**			
38							Sharpe ratio	0.6155	=(H23-H37)/H24		

	A	B	C	D	E	F	G	H	I	J	K	L
1	**CQFMike1.XLS**				in cell E6	in cell F6	in cell F7		in cells J6:K10			
2	**Estimating betas using regression**				=LN(C6/C5)	=LN(B6/B5)	=$K$6+E6*$J$6		=LINEST(F6:F65,E6:E65,TRUE,TRUE)			
3												
4	Name	MICROSOFT	S&P 500		S&P 500	MICROSOFT	FITTED		Output from LINEST			
5	31-Dec-97	16616.20	1298.82		Ln Returns							
6	31-Jan-98	19179.30	1313.19		0.011	0.143	0.027		Beta	1.6843	0.0087	Alpha
7	28-Feb-98	21790.70	1407.90		0.070	0.128	0.126		Beta (SE)	0.2639	0.0144	Alpha (SE)
8	31-Mar-98	23012.00	1480.00		0.050	0.055	0.093		RSQ	0.4126	0.1119	STEYX
9	30-Apr-98	23172.70	1494.89		0.010	0.007	0.026		F	40.7410	58.00	N-2
10	31-May-98	21806.70	1469.19		-0.017	-0.061	-0.021		Regression SS	0.5097	0.7256	Residual SS
11	30-Jun-98	27865.10	1528.87		0.040	0.245	0.076					
12	31-Jul-98	28266.80	1512.59		-0.011	0.014	-0.009					
13	31-Aug-98	24667.20	1293.90		-0.156	-0.136	-0.254		Beta	1.6843		
14	30-Sep-98	28299.00	1376.79		0.062	0.137	0.113		Beta (SE)	0.2639		
15	31-Oct-98	27222.30	1488.78		0.078	-0.039	0.140		Beta (T)	2.59		
16	30-Nov-98	31368.30	1579.01		0.059	0.142	0.108					
17	31-Dec-98	35658.90	1670.01		0.056	0.128	0.103		Alpha	0.0087		
18	31-Jan-99	44995.50	1739.84		0.041	0.233	0.078		Alpha (SE)	0.0144		
19	28-Feb-99	38599.70	1685.77		-0.032	-0.153	-0.045		Alpha (T)	0.60		
20	31-Mar-99	46088.20	1753.21		0.039	0.177	0.075					
21	30-Apr-99	41813.70	1821.11		0.038	-0.097	0.073					
22	31-May-99	41492.30	1778.10		-0.024	-0.008	-0.032					
23	30-Jun-99	46377.50	1876.78		0.054	0.111	0.100					
24	31-Jul-99	44127.70	1818.18		-0.032	-0.050	-0.045					
25	31-Aug-99	47598.80	1809.19		-0.005	0.076	0.000					
26	30-Sep-99	46570.30	1759.59		-0.028	-0.022	-0.038					
27	31-Oct-99	47598.80	1870.94		0.061	0.022	0.112					
28	30-Nov-99	46819.40	1908.97		0.020	-0.017	0.043					
29	31-Dec-99	60036.90	2021.40		0.057	0.249	0.105					
30	31-Jan-00	50330.70	1919.84		-0.052	-0.176	-0.078					
31	29-Feb-00	45959.70	1883.50		-0.019	-0.091	-0.024					
32	31-Mar-00	54637.40	2067.75		0.093	0.173	0.166					
33	30-Apr-00	35867.80	2005.55		-0.031	-0.421	-0.043					
34	31-May-00	32171.80	1964.40		-0.021	-0.109	-0.026					
35	30-Jun-00	41138.70	2012.83		0.024	0.246	0.050					
36	31-Jul-00	35900.00	1981.36		-0.016	-0.136	-0.018					
37	31-Aug-00	35900.00	2104.43		0.060	0.000	0.110					
38	30-Sep-00	31014.80	1993.33		-0.054	-0.146	-0.083					
39	31-Oct-00	35417.90	1984.90		-0.004	0.133	0.002					
40	30-Nov-00	29504.20	1828.42		-0.082	-0.183	-0.130					
41	31-Dec-00	22304.90	1837.36		0.005	-0.280	0.017					
42	31-Jan-01	31400.40	1902.55		0.035	0.342	0.067					
43	28-Feb-01	30339.80	1729.07		-0.096	-0.034	-0.152					
44	31-Mar-01	28122.20	1619.54		-0.065	-0.076	-0.102					
45	30-Apr-01	34839.40	1745.39		0.075	0.214	0.135					
46	31-May-01	35574.70	1757.09		0.007	0.021	0.020					
47	30-Jun-01	37539.10	1714.32		-0.025	0.054	-0.033					
48	31-Jul-01	34037.20	1697.44		-0.010	-0.098	-0.008					
49	31-Aug-01	29337.10	1591.18		-0.065	-0.149	-0.100					
50	30-Sep-01	26313.40	1462.69		-0.084	-0.109	-0.133					
51	31-Oct-01	29902.70	1490.58		0.019	0.128	0.040					
52	30-Nov-01	33019.00	1604.92		0.074	0.099	0.133					
53	31-Dec-01	34068.00	1618.98		0.009	0.031	0.023					
54	31-Jan-02	32761.90	1595.35		-0.015	-0.039	-0.016					
55	28-Feb-02	30000.40	1564.59		-0.019	-0.088	-0.024					
56	31-Mar-02	31013.50	1623.43		0.037	0.033	0.071					
57	30-Apr-02	26873.90	1525.00		-0.063	-0.143	-0.097					
58	31-May-02	26179.70	1513.77		-0.007	-0.026	-0.004					
59	30-Jun-02	28128.60	1405.93		-0.074	0.072	-0.116					
60	31-Jul-02	24673.00	1296.34		-0.081	-0.131	-0.128					
61	31-Aug-02	25238.60	1304.85		0.007	0.023	0.020					
62	30-Sep-02	22492.60	1163.04		-0.115	-0.115	-0.185					
63	31-Oct-02	27496.10	1265.41		0.084	0.201	0.151					
64	30-Nov-02	29661.00	1339.89		0.057	0.076	0.105					
65	31-Dec-02	26585.90	1261.18		-0.061	-0.109	-0.093					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	A	B	C	D	E	F	G	H	I	J
1	**CQFMike1.XLS**									
2	**LTCM Exercise**									
3		Asset 0	Asset 1	Asset 2		Risk Aversion Coef (A)				
4	Return (rvec)	**0.45%**	**0.48%**	**0.61%**		**4.00**				
5	Volatility (vvec)	**0.00%**	**1.90%**	**1.58%**						
6										
7	Correlations	Asset 0	Asset 1	Asset 2		$vvec^T$				
8	Asset 0	1.0000	**0.0000**	**0.0000**		0.00%				
9	Asset 1	0.0000	1.0000	**0.9654**		1.90%				
10	Asset 2	0.0000	0.9654	1.0000		1.58%				
11										
12	Variance Covariance Matrix	Asset 0	Asset 1	Asset 2						
13	Asset 0	0.0000	0.0000	0.0000		in cell B13	=B8*$F8*B$5			
14	Asset 1	0.0000	0.0004	0.0003						
15	Asset 2	0.0000	0.0003	0.0002						
16										
17	in cell C21	=Prob2OptimalRiskyWeight1(C4,D4,B4,C5,D5,D9,F4)								
18	in cell D23	=SUMPRODUCT(C21:D21,C4:D4)								
19	in cell D24	=SQRT(MMULT(C21:D21,MMULT(C14:D15,F23:F24)))								
20										
21	**Opt Risky Weights (wvec12)**		-381.8%	481.8%		$wvec12^T$				
22										
23		Monthly return		1.11%		-381.8%				
24		Monthly std dev		1.99%		481.8%				
25										
26	in cell B30:D30	=Prob3OptimalWeightsVec(C4,D4,B4,C5,D5,D9,F4)								
27	in cell D32	=SUMPRODUCT(B30:D30,B4:D4)								
28	in cell D33	=SQRT(MMULT(B30:D30,MMULT(B13:D15,F31:F33)))								
29										
30	**Opt Weights (wvec012)**	-315.5%	-1586.1%	2001.6%		$wvec012^T$				
31						-315.5%				
32		Monthly return		3.18%		-1586.1%				
33		Monthly std dev		8.26%		2001.6%				
34										
35										
36	**Actual correlation (1 with 2)**	**0.8000**								
37										
38	New VCV matrix	Asset 0	Asset 1	Asset 2		Data Table (Prob of monthly ruin)				
39	Asset 0	0.0000	0.0000	0.0000				0.35%		=D47
40	Asset 1	0.0000	0.0004	0.0002			0.80	0.35%		
41	Asset 2	0.0000	0.0002	0.0002		Corr (1, 2)	0.83	0.26%		
42							0.86	0.18%		
43		Monthly std dev		19.58%			0.89	0.12%		
44		=SQRT(MMULT(B30:D30,MMULT(B39:D41,F31:F33)))					0.92	0.06%		
45							0.95	0.03%		
46		Probability of monthly ruin					0.98	0.00%		
47				0.35%						
48				=TDIST(1/D43,4,1)						