Risk Management II

Advance Risk Models

Plan

Greeks	• Delta, Gamma, Vega, Theta
Hedging	• Derivative Portfolio • Method II, EGS Case
Credit Risk	• DPD Analysis • PD Models, Barclays Bank
Capital Adequacy & ICAAP	• Capital Adequacy Models • Stress Testing, Solvency II
How to kill a bank in one day	• Integrated Bank Simulation • Liquidity, Capital, Market Risk

ALM	• Asset Liability Management
Delta Hedging	• Derivative Portfolio Greeks
Barclays Bank	• Libor Crisis, FI Limits, PD Models
Value at Risk	• Margin Lending & FI Limits
Liquidity Stress Testing	• Extending Capital Adequacy
Enron Gas Services	• Running a risk book

Option Greeks

A quick review

Moneyness & value change

Deep Out of Money

- Change in value?
- Volatility

At or Near Money

- Change in value?
- Strike, Spot

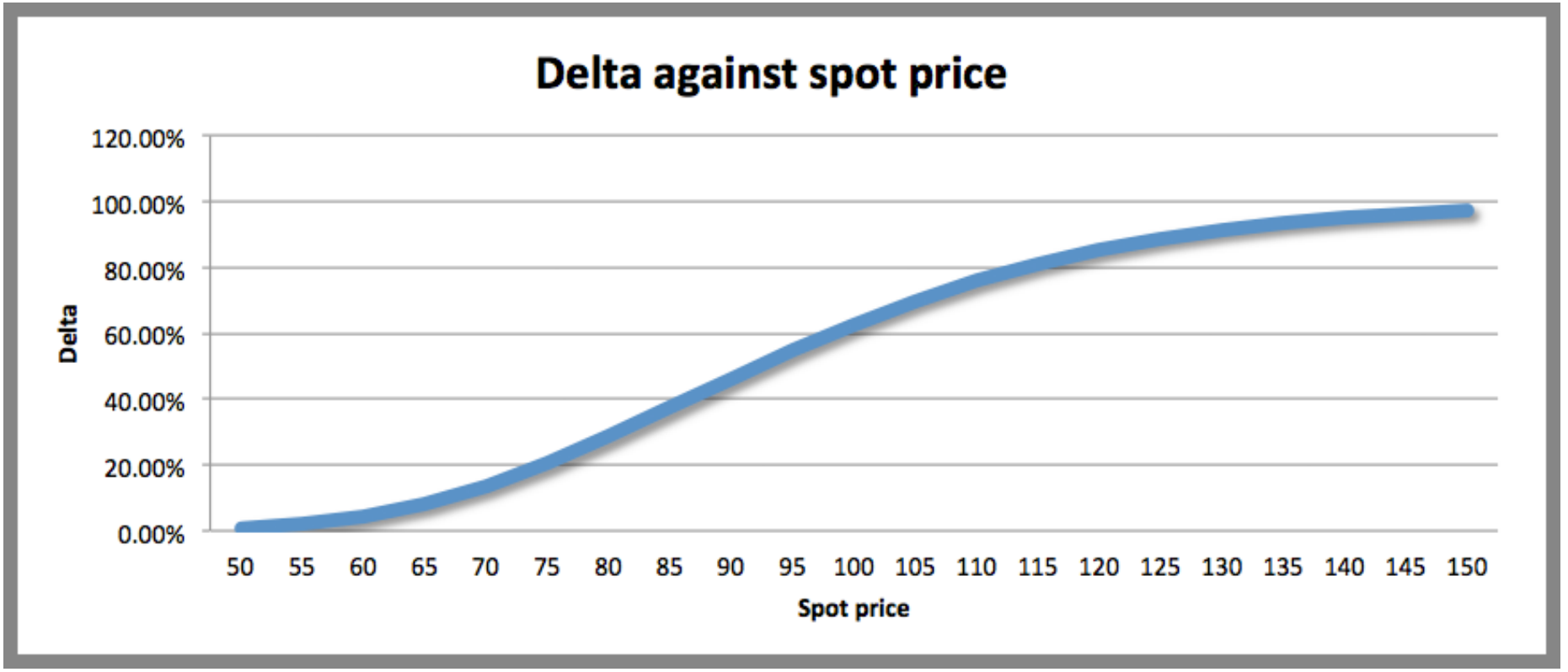
Deep in Money

- Change in value?
- Time

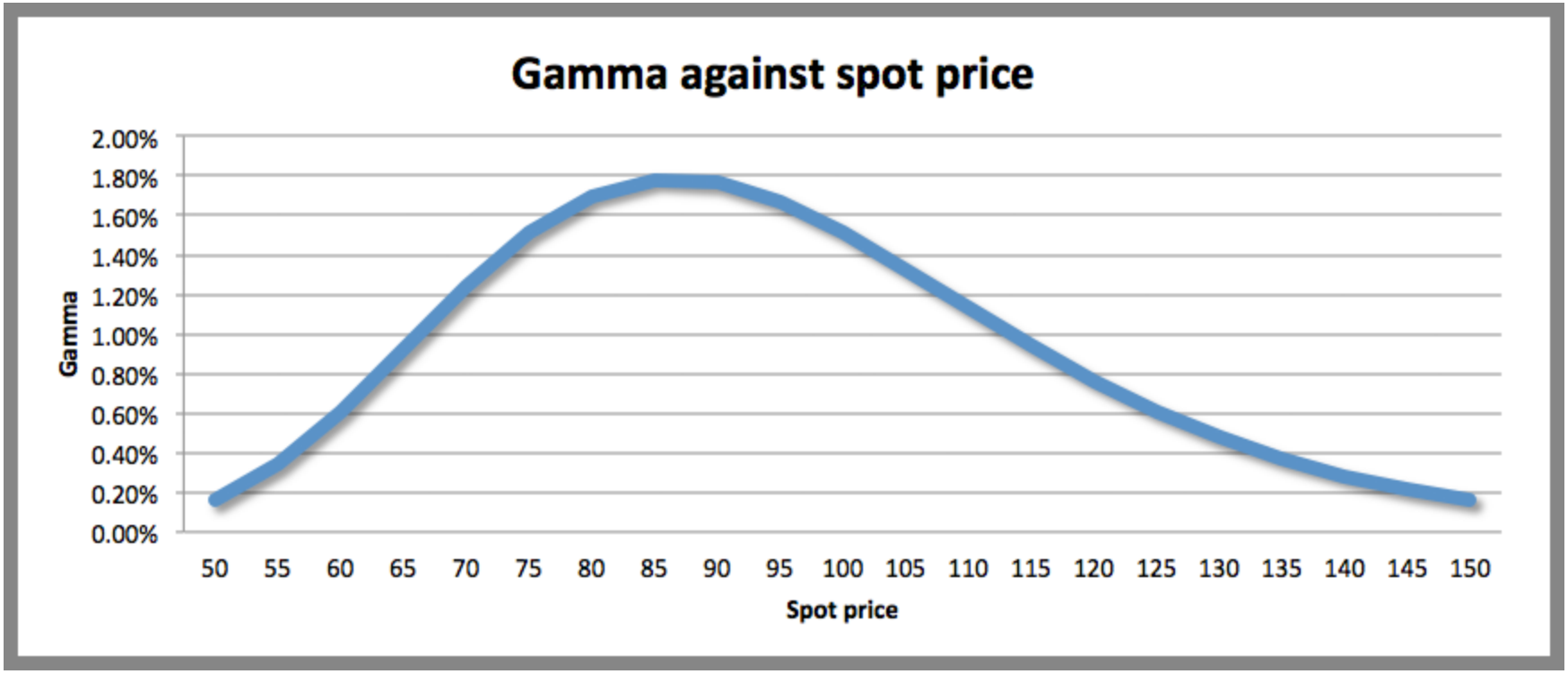
The Greeks

Delta	• Change in value on account of a unit change in the underlying
Gamma	• Change in Delta on account of a unit change in the underlying
Vega	• Change in value on account of change in volatility
Theta	• Change in value on account of change in time
Rho	• Change in value on account of change in interest rates

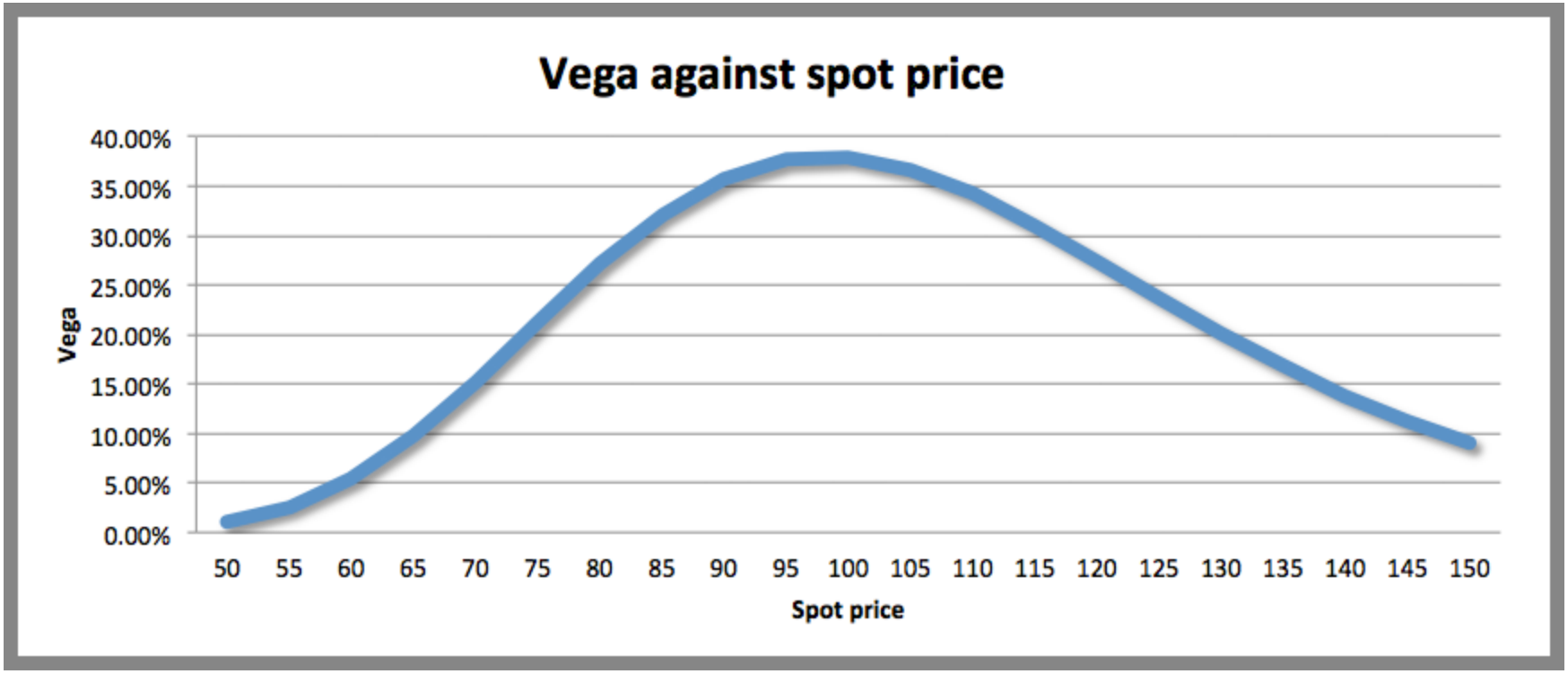
Delta



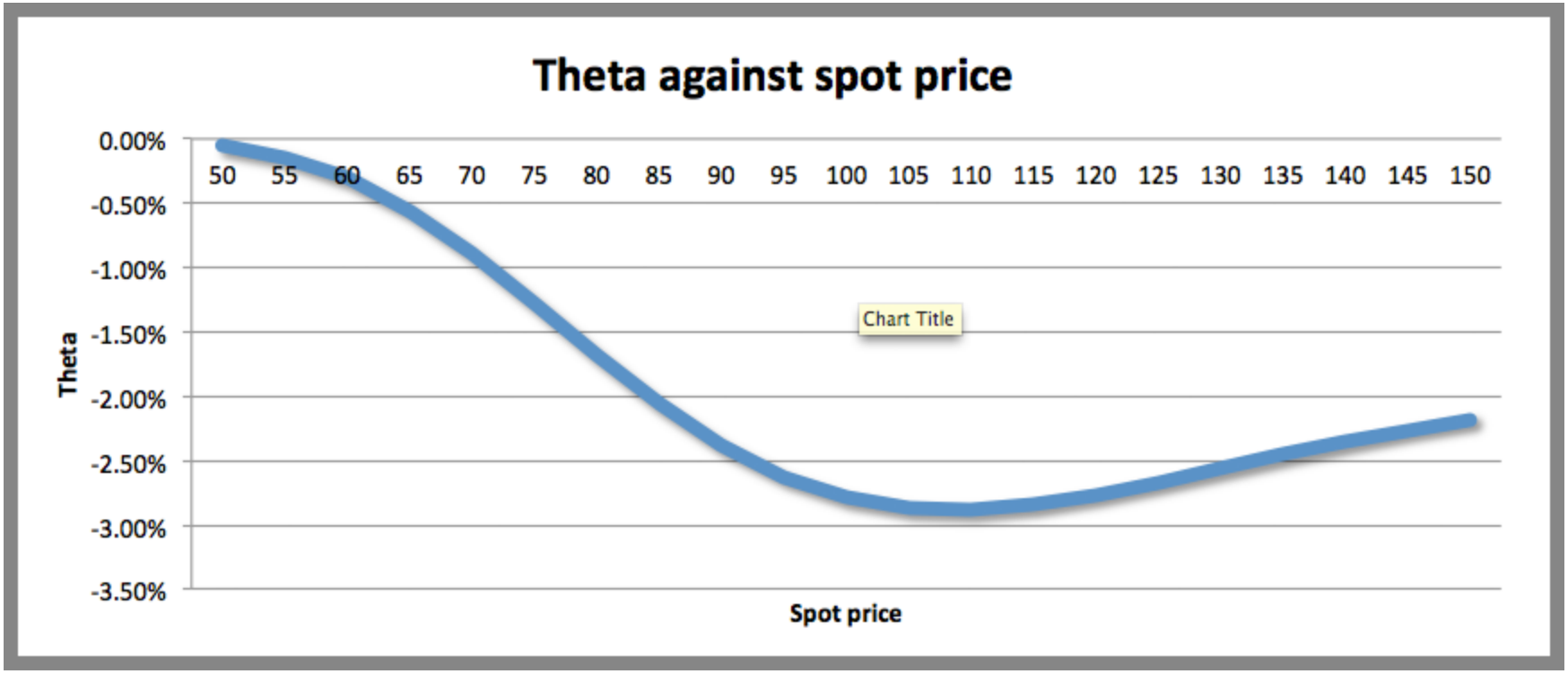
Gamma



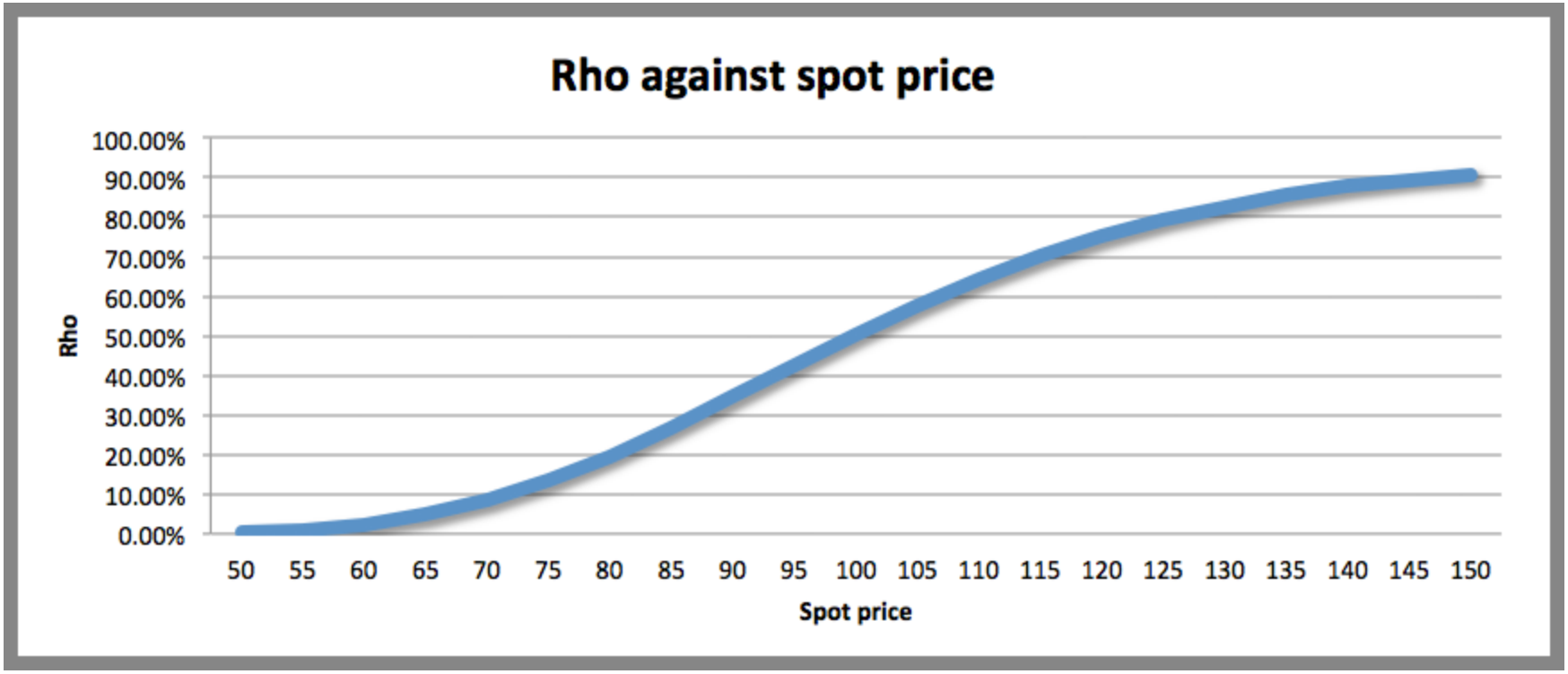
Vega



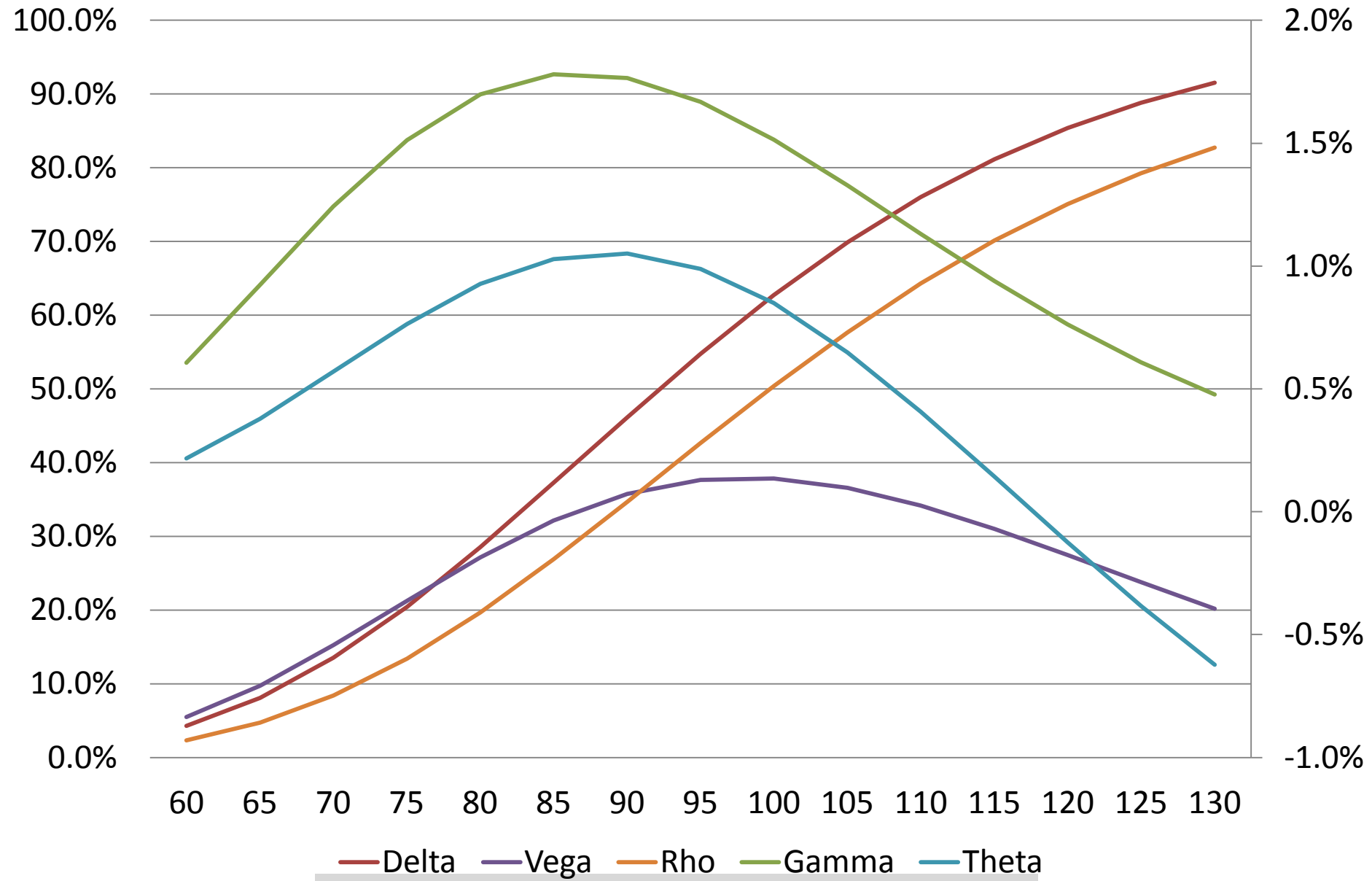
Theta



Rho



The Greeks against Spot



Delta Call

$$\Delta Call = N(d1)$$

Delta Put

$$\Delta Put = 1 - N(d1)$$

Greek Summary

$$delta_{Call} = \frac{\partial C}{\partial S} = N(d_1)$$

$$gamma_{Call} = \frac{\partial delta}{\partial S} = \frac{N'(d_1)}{S\sigma\sqrt{T}}$$

$$vega_{Call} = \frac{\partial C}{\partial \sigma} = S\sqrt{T}\,N'(d_1)$$

$$theta_{Call} = \frac{\partial C}{\partial T} = -\left(\frac{S_t N'(d_1)\sigma}{2\sqrt{T}}\right) - RX\,e^{-RfT}\,N(d_2)$$

$$rho_{Call} = \frac{\partial C}{\partial R} = XT\,e^{-RfT}\,N(d_2)$$

N prime & Gamma

$$N'(d_1) = e^{\left[\frac{-(d_1)^2}{2}\right]} \frac{1}{\sqrt{2\pi}}$$

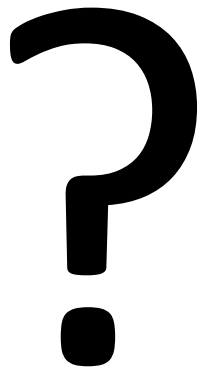
$$gamma_{\ call} = \frac{\partial delta}{\partial S} = \frac{N'(d_1)}{S\sigma\sqrt{T}}$$

Gamma Call

$$\Delta Call = N(d1)$$

$$\gamma Call = {N'(d1)}\Big/{S\sigma\sqrt{T}}$$

Gamma Put



Gamma Put

$$\Delta Put = 1 - N(d1)$$

$$\gamma Put = {N'(d1)}\Big/{S\sigma\sqrt{T}}$$

Vega Call

$$\Delta Call = N(d1)$$

$$\gamma Call = {N(d1)}\Big/{S\delta\sqrt{T}}$$

$$Vega\ Call = SN'(d1)\sqrt{T}$$

Vega Put

?

Applications?

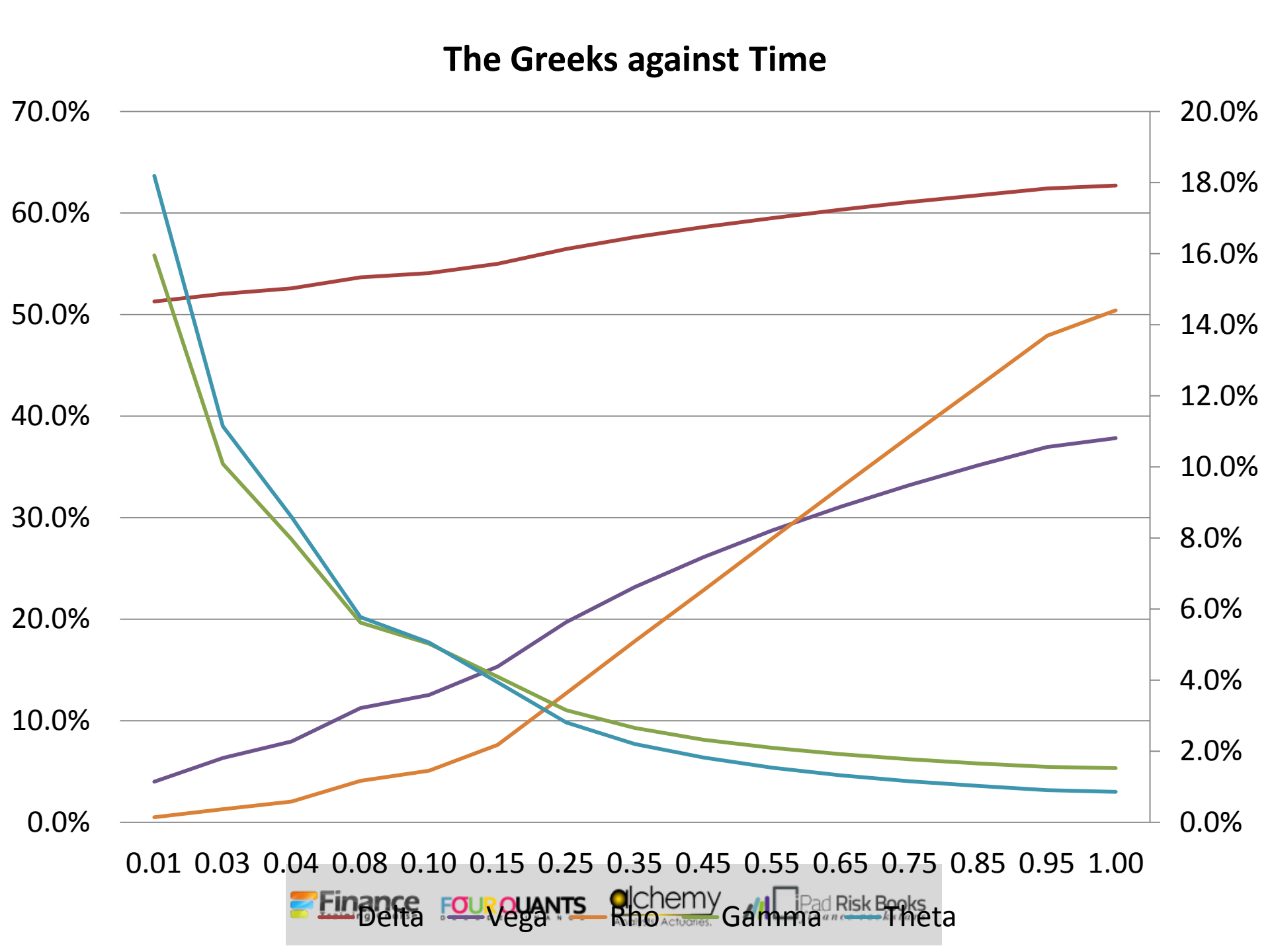
Value of a Call

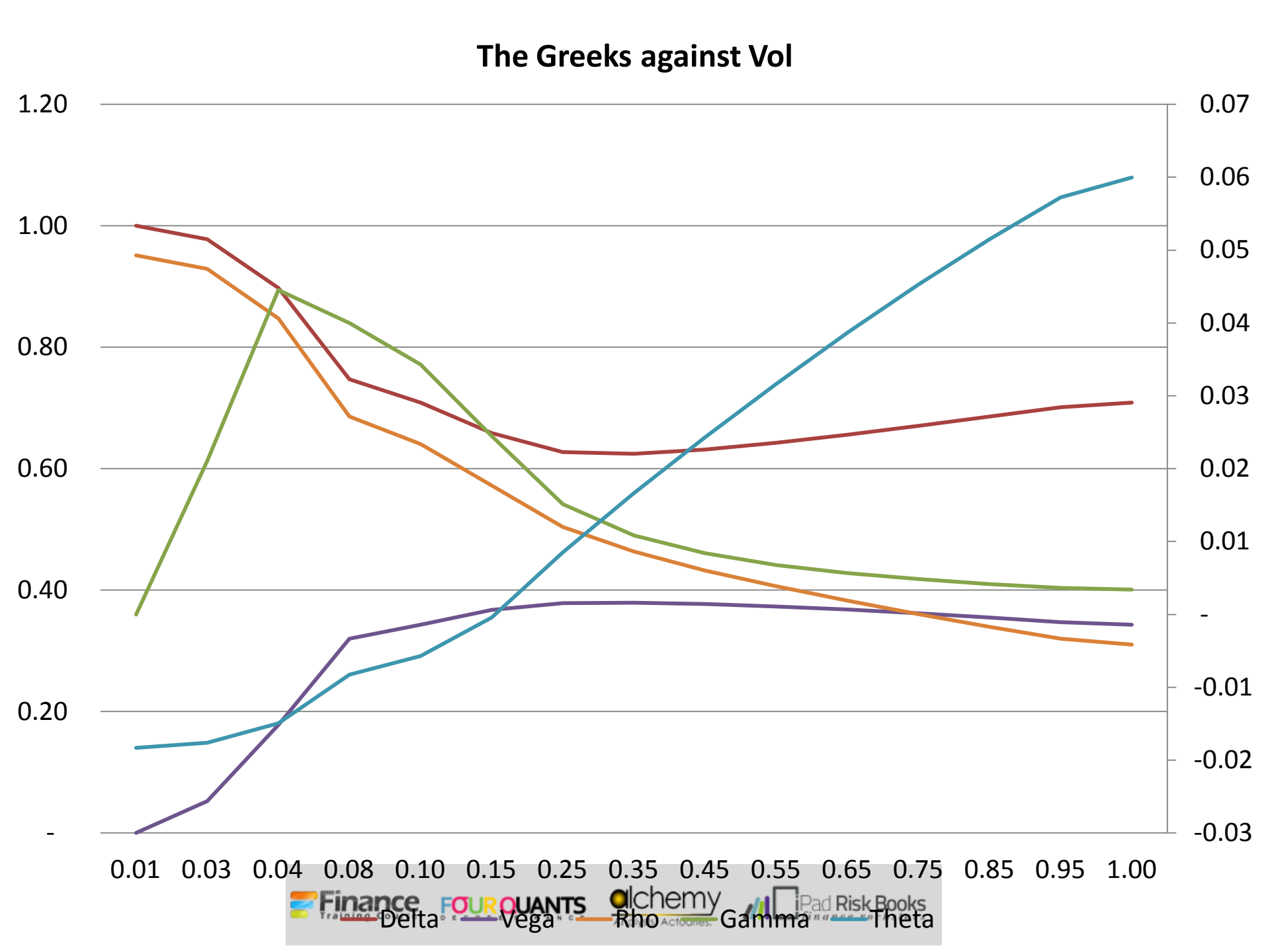
Call = Delta * S - Borrowing

Greeks

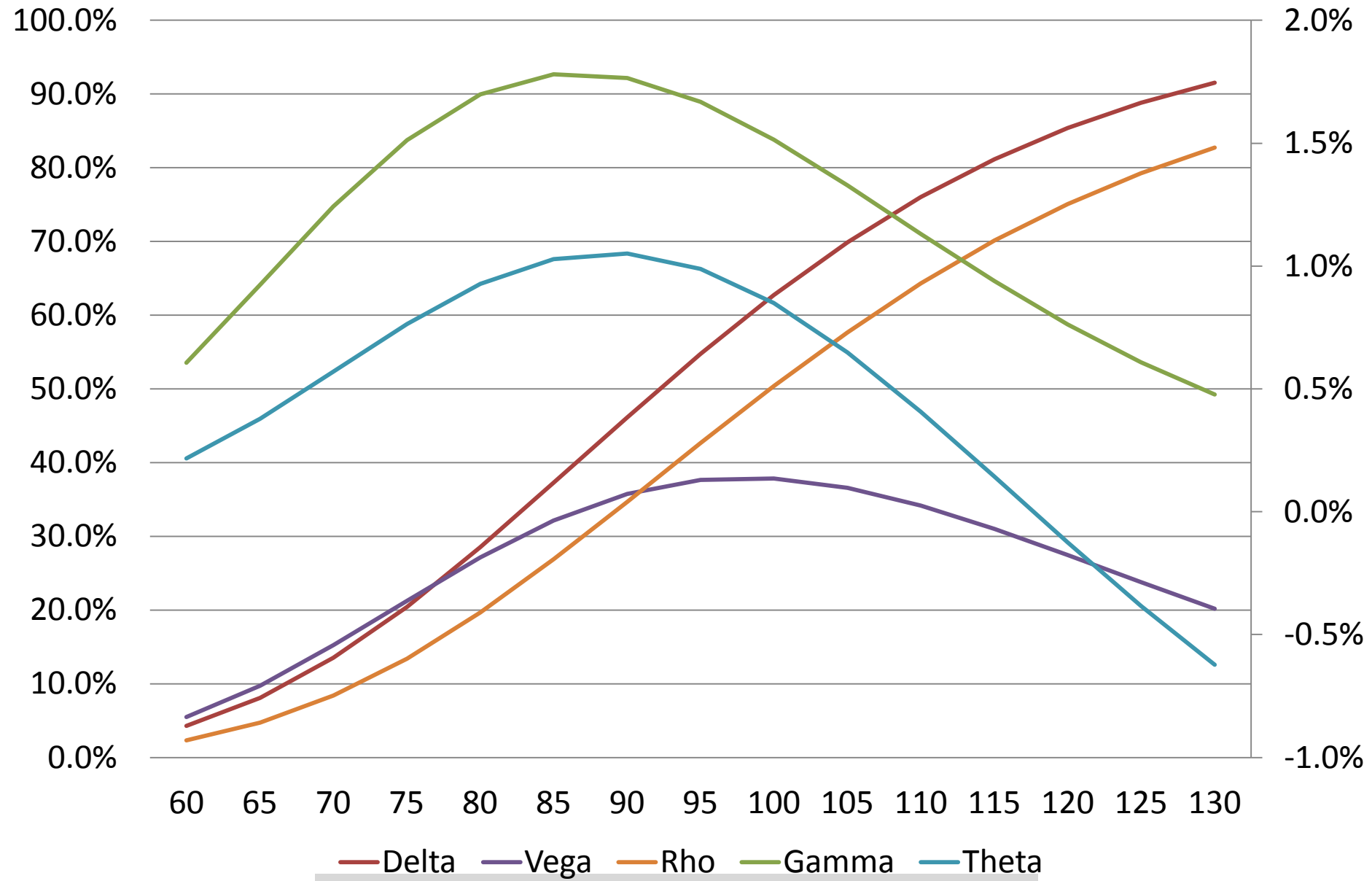
Behaving badly

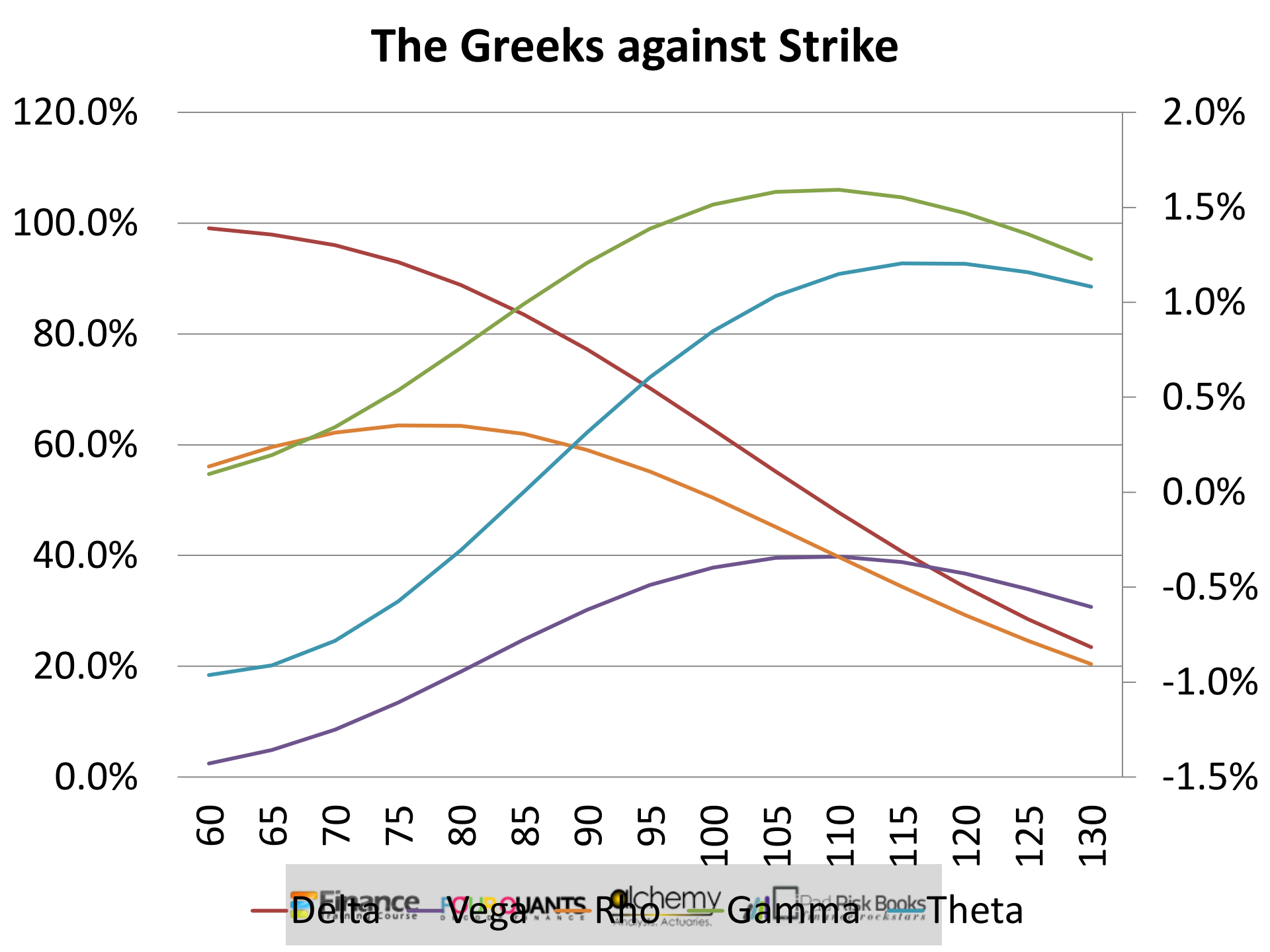
At, Near Money Call Options

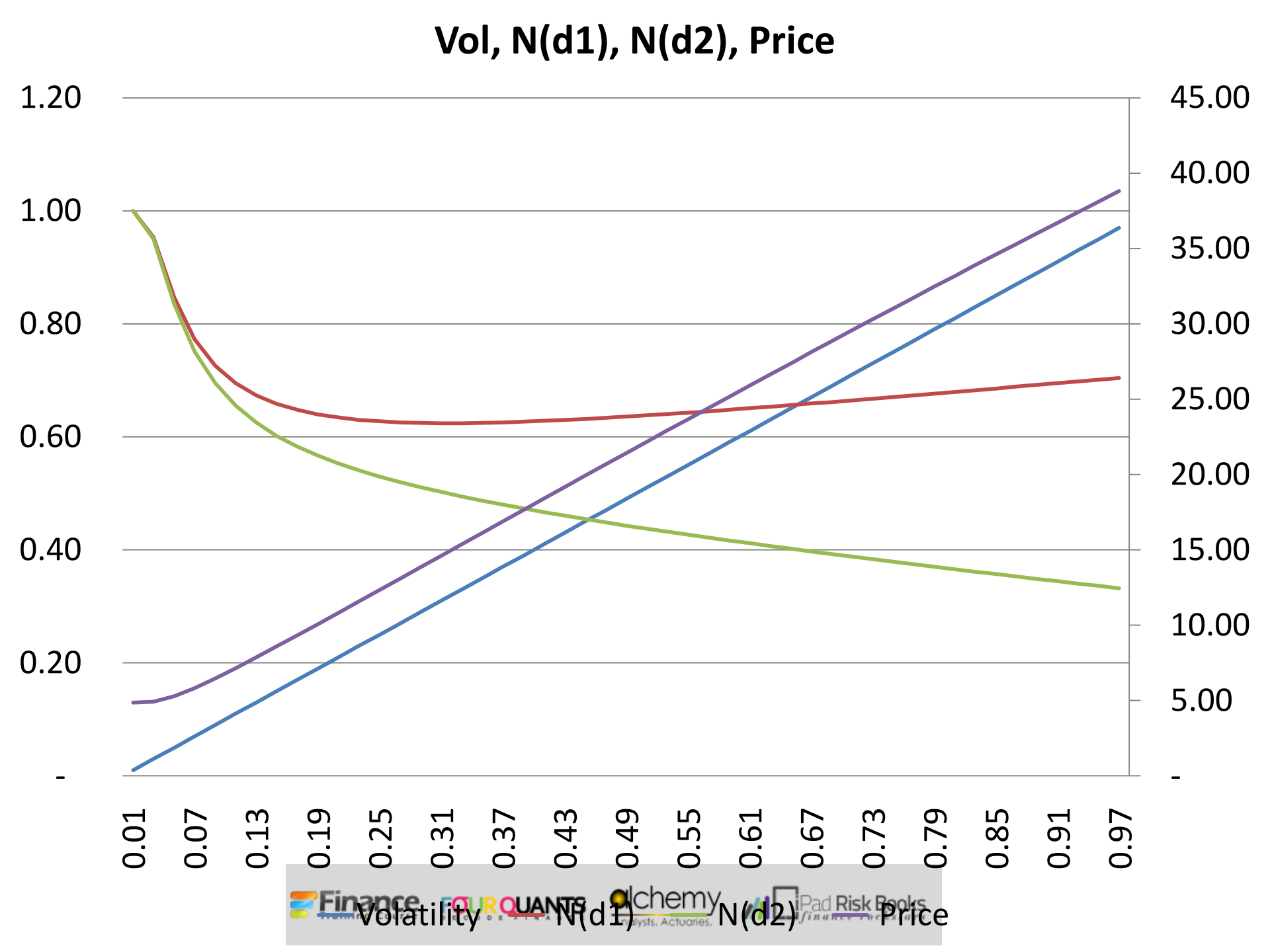

The Greeks against Time
70.0%
60.0%
50.0%
40.0%
30.0%
20.0%
10.0%
0.0%
20.0%
18.0%
16.0%
14.0%
12.0%
10.0%
8.0%
6.0%
4.0%
2.0%
0.0%
0.01 0.03 0.04 0.08 0.10 0.15 0.25 0.35 0.45 0.55 0.65 0.75 0.85 0.95 1.00
Delta
Vega
Rho
Gamma
Theta


The Greeks against Vol
1.20
1.00
0.80
0.60
0.40
0.20
-
0.07
0.06
0.05
0.04
0.03
0.02
0.01
-
-0.01
-0.02
-0.03
0.01
0.03
0.04
0.08
0.10
0.15
0.25
0.35
0.45
0.55
0.65
0.75
0.85
0.95
1.00
Delta
Vega
Rho
Gamma
Theta

The Greeks against Spot




The Greeks against Strike
120.0%
100.0%
80.0%
60.0%
40.0%
20.0%
0.0%
2.0%
1.5%
1.0%
0.5%
0.0%
-0.5%
-1.0%
-1.5%
60
65
70
75
80
85
90
95
100
105
110
115
120
125
130
Delta
Vega
Rho
Gamma
Theta


Vol, N(d1), N(d2), Price
1.20
1.00
0.80
0.60
0.40
0.20
-
45.00
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
-
0.01
0.07
0.13
0.19
0.25
0.31
0.37
0.43
0.49
0.55
0.61
0.67
0.73
0.79
0.85
0.91
0.97
Volatility
N(d1)
N(d2)
Price

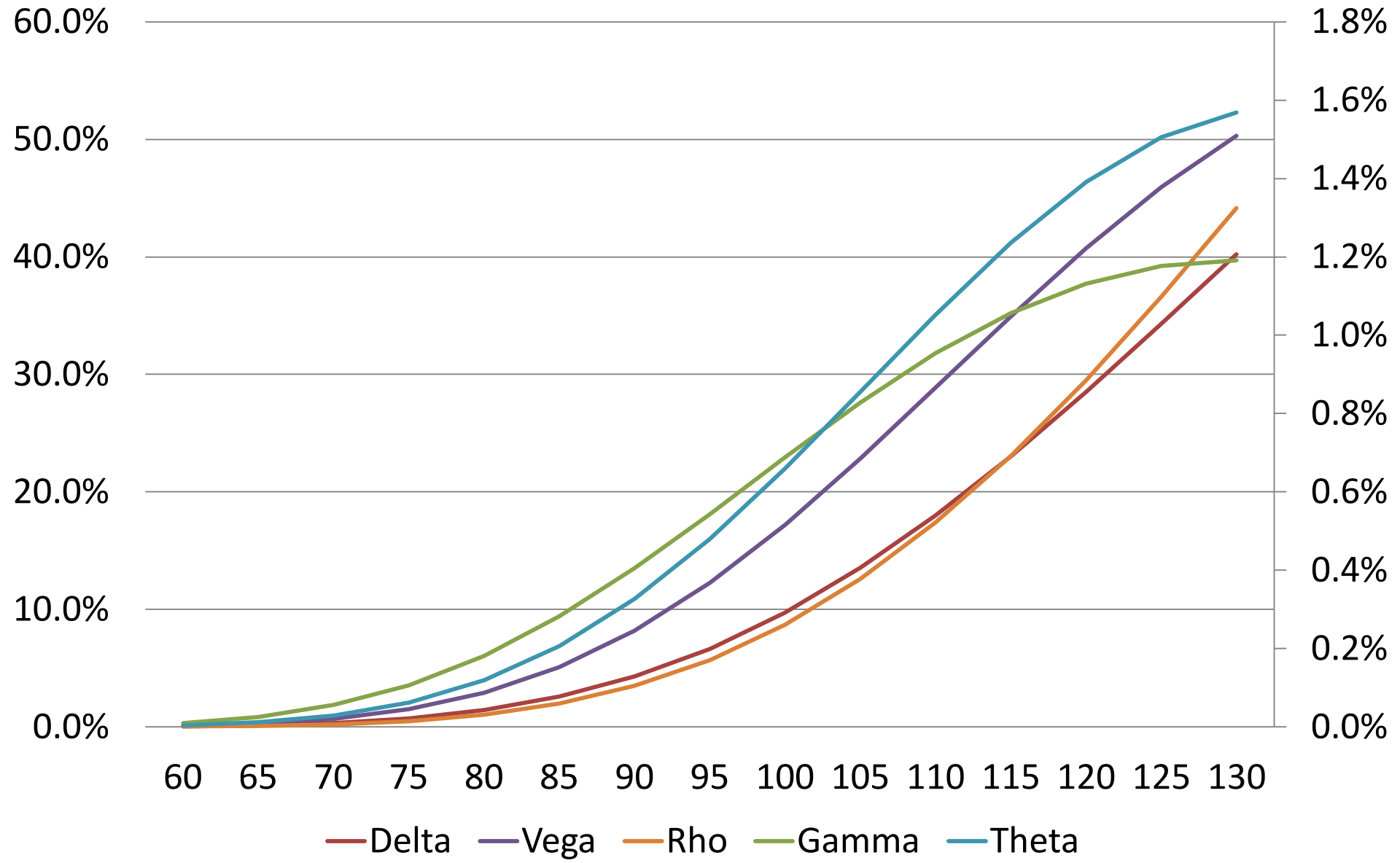
Greeks

Behaving badly

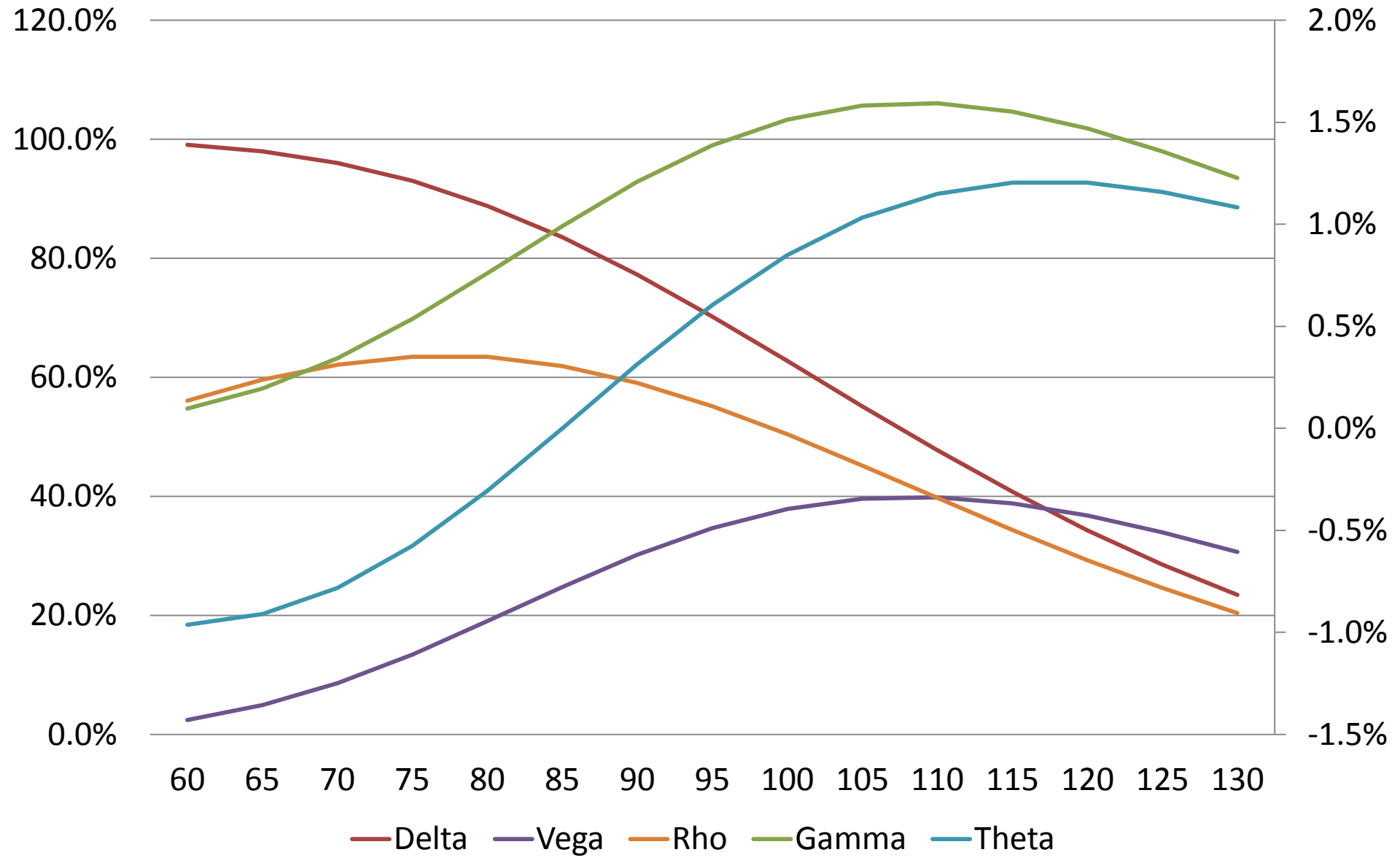
Deep out of Money

Call Options

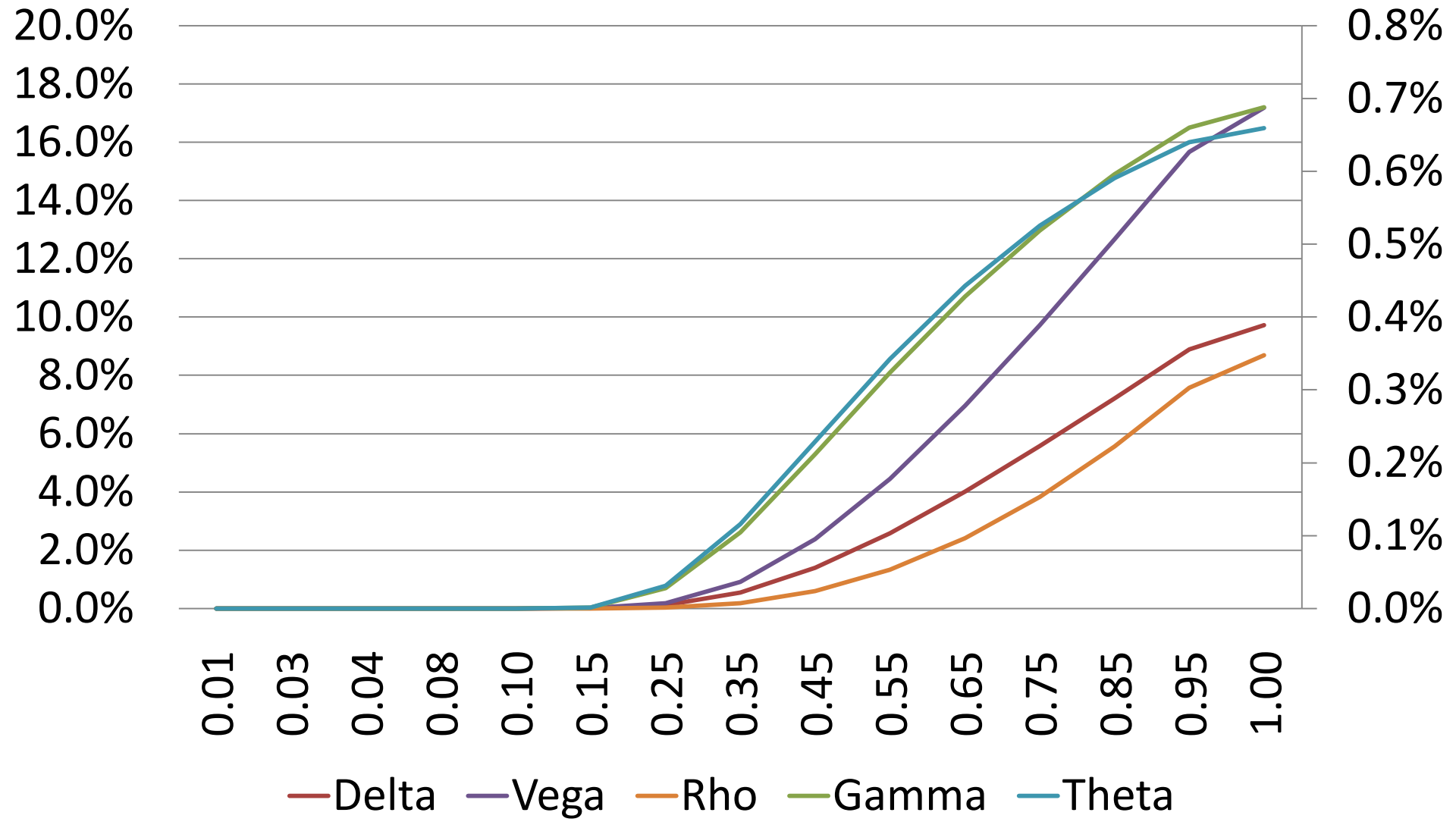
The Greeks against Spot



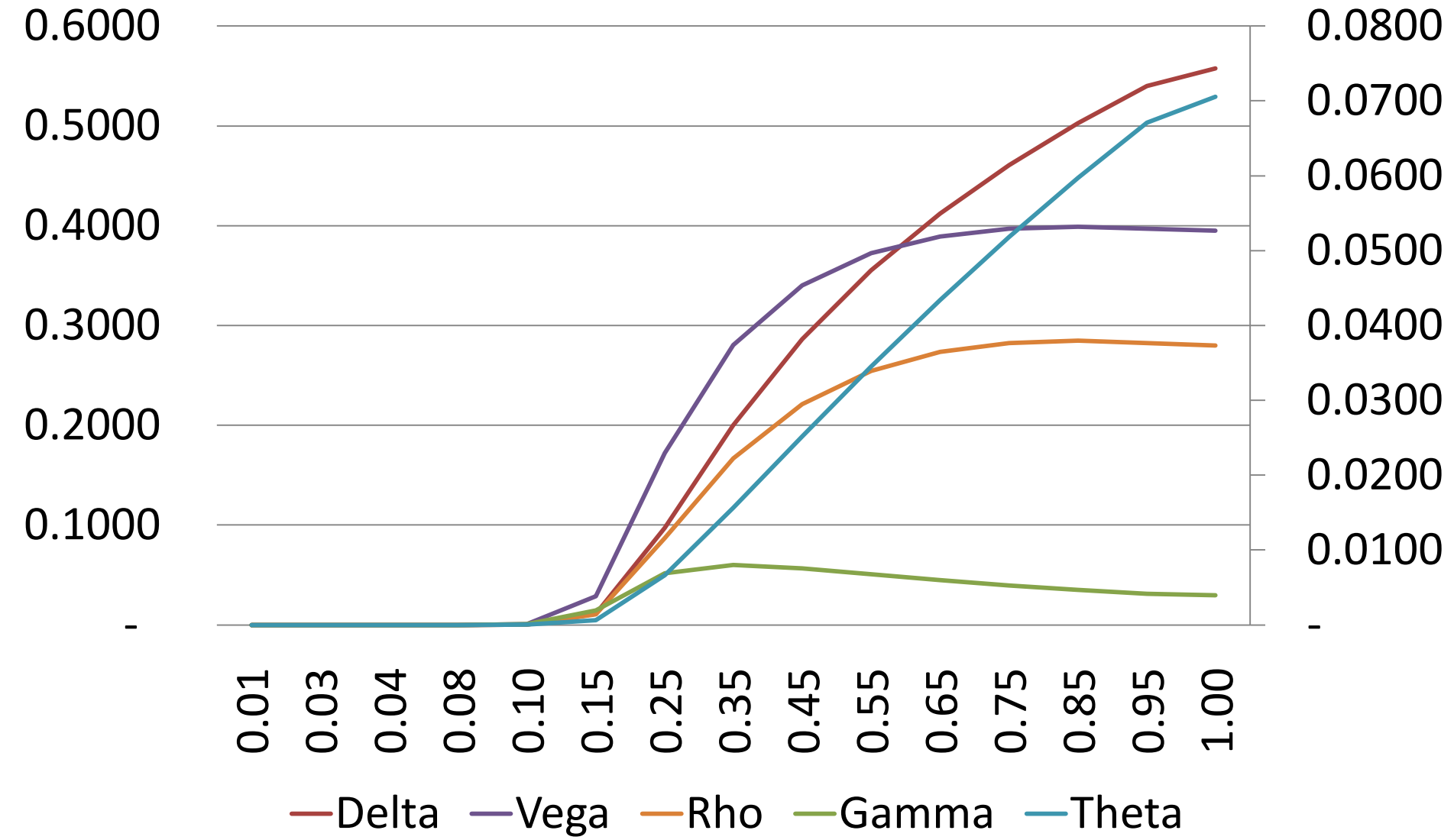
The Greeks against Strike



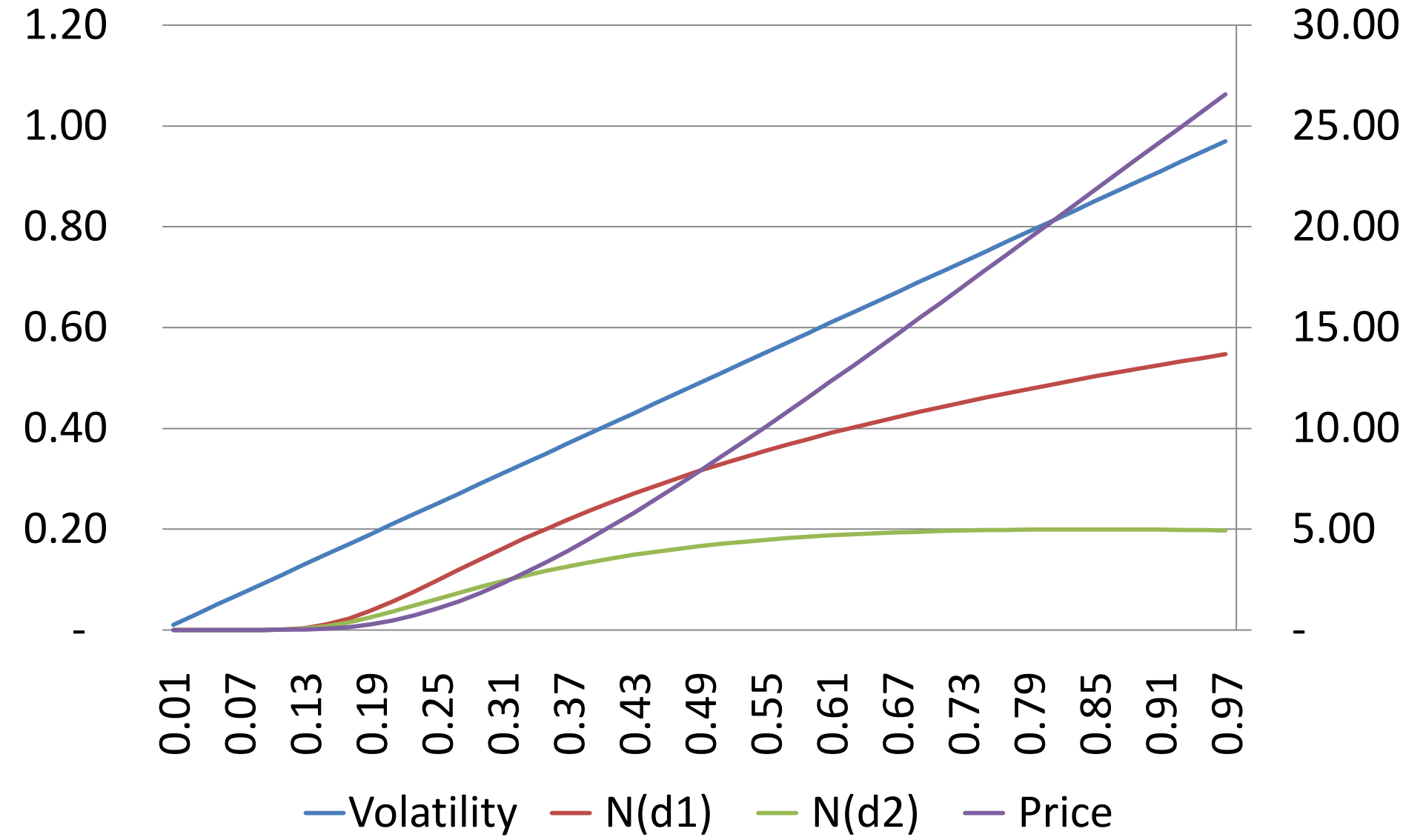
The Greeks against Time



The Greeks against Vol



Vol, N(d1), N(d2), Price

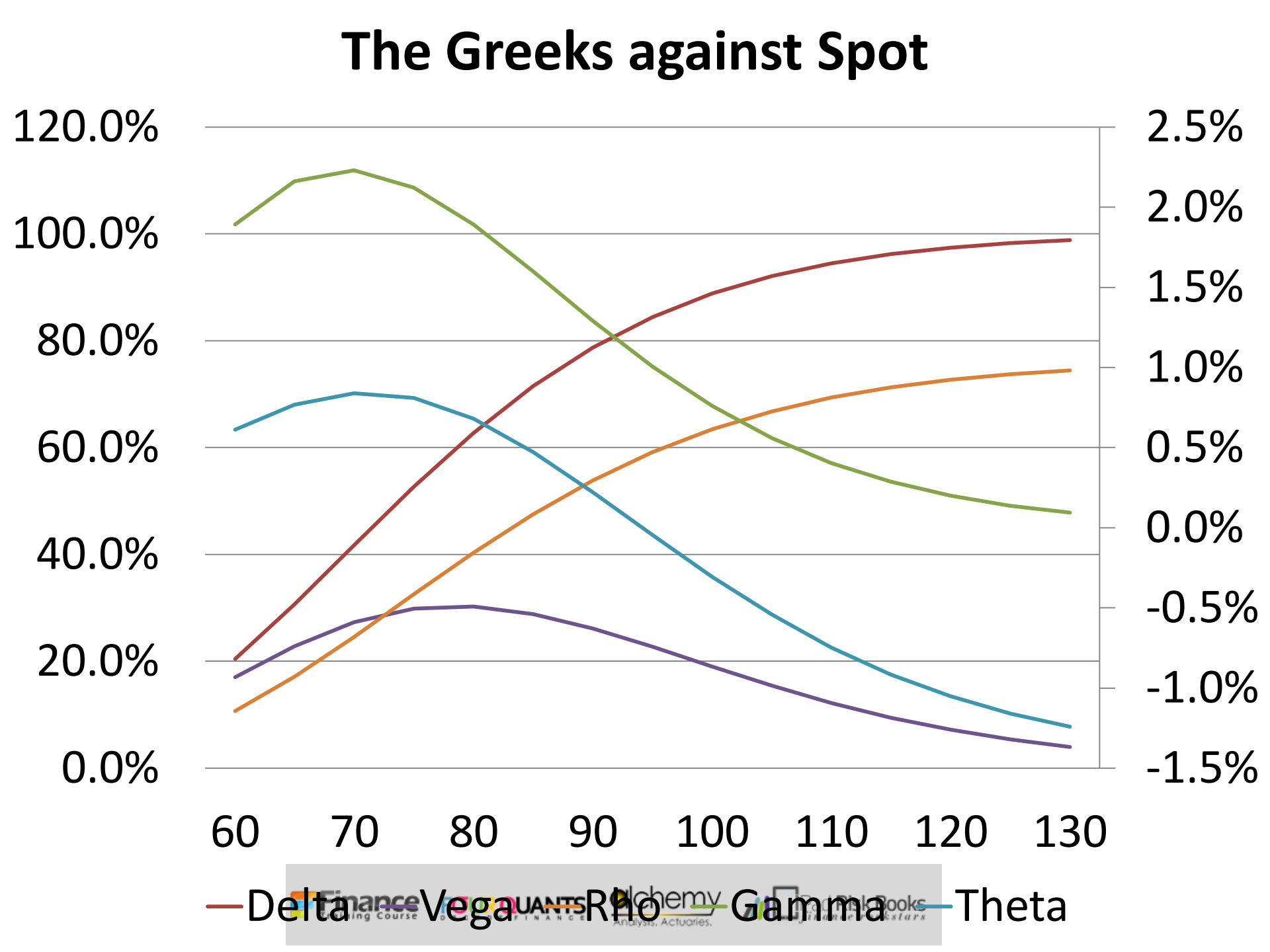


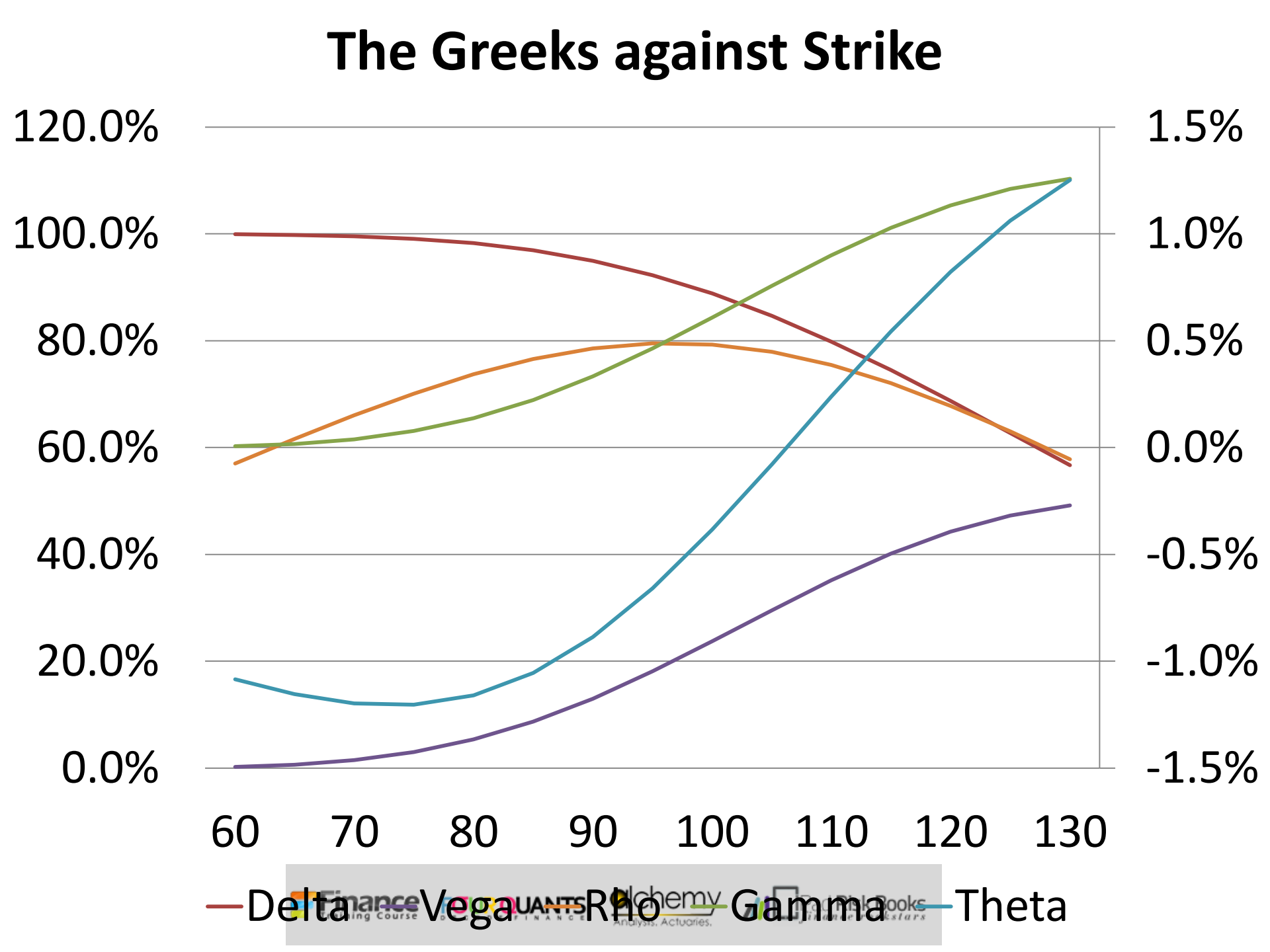
Greeks

Behaving badly

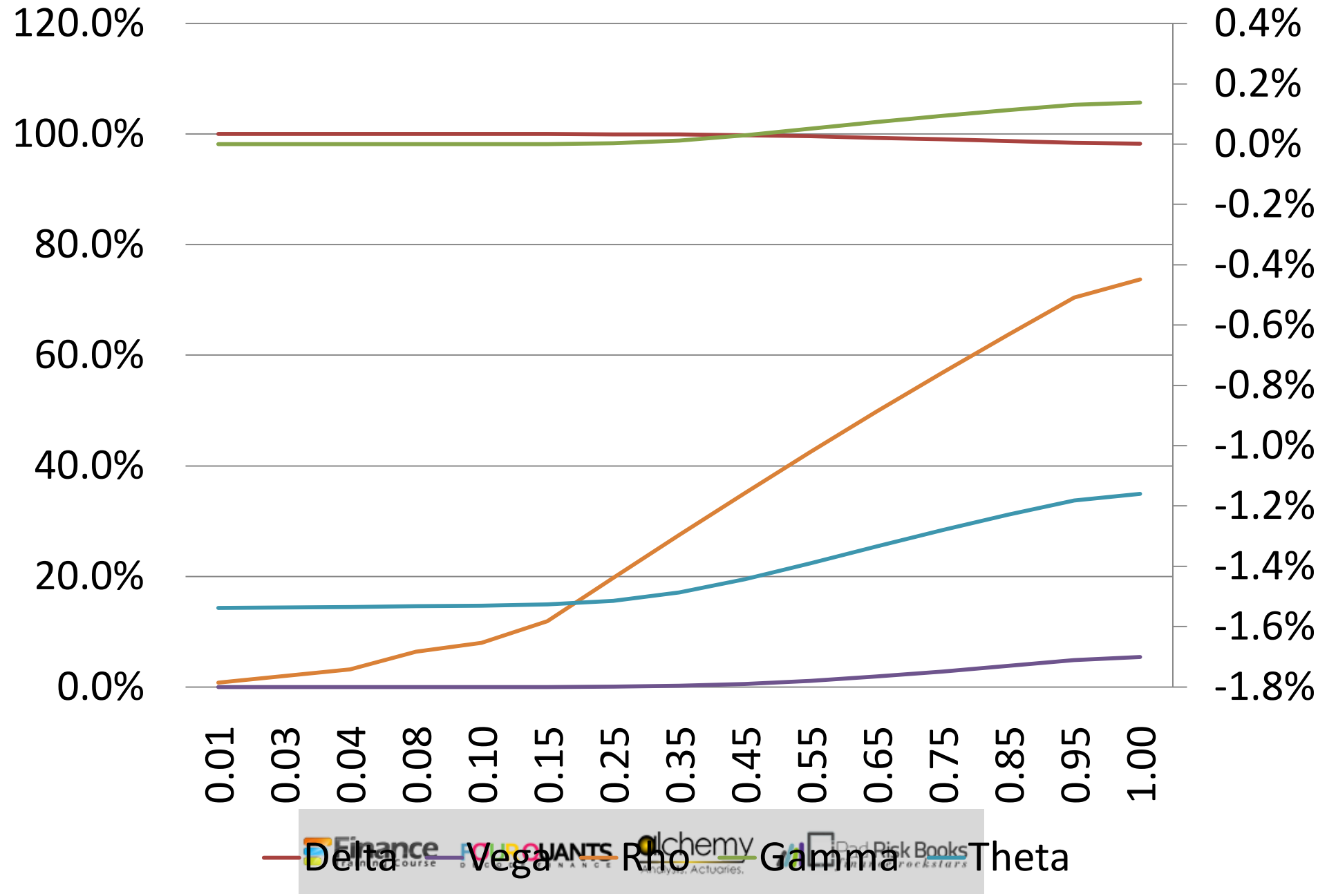
Deep In Money

Call Options

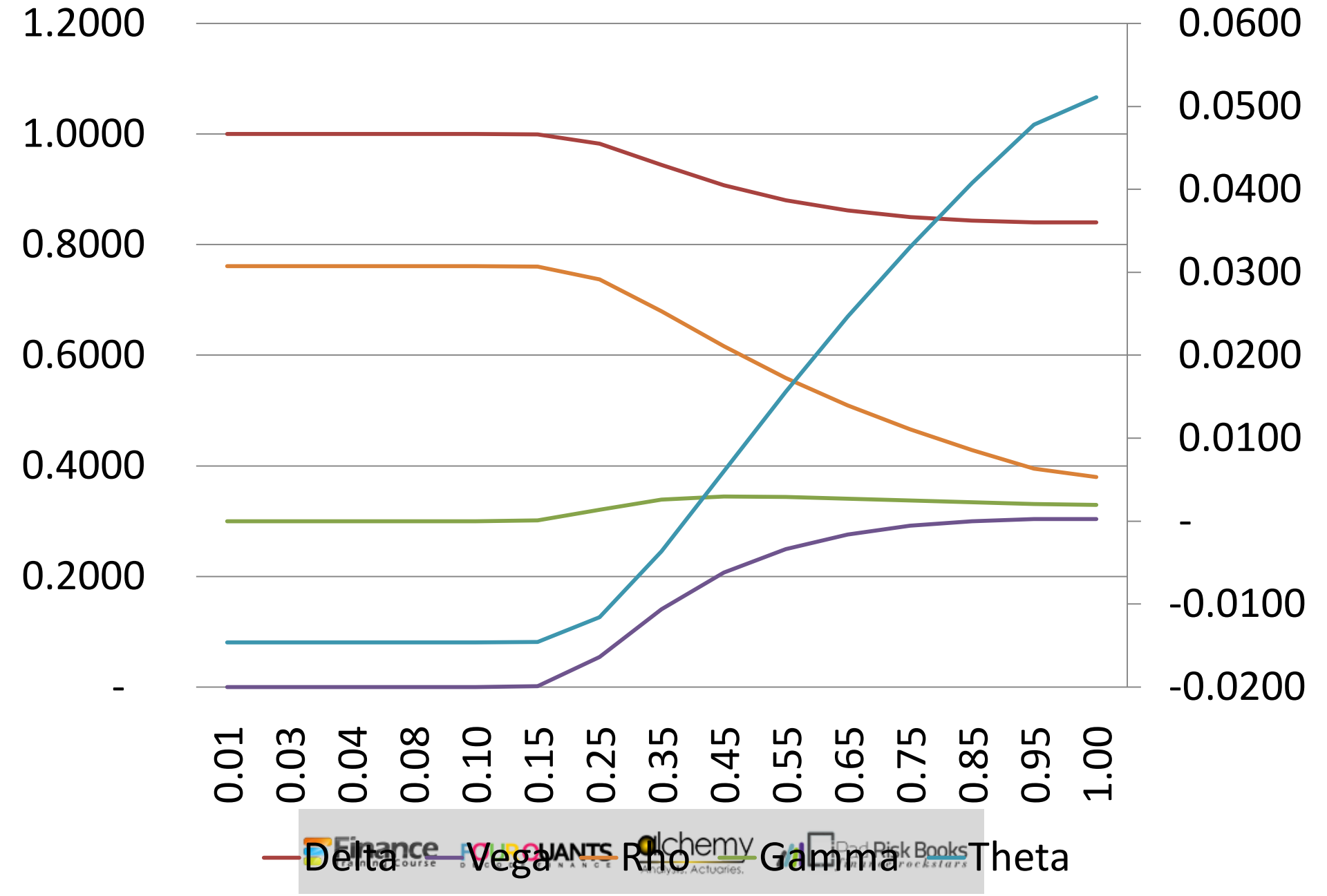

The Greeks against Spot
120.0%
100.0%
80.0%
60.0%
40.0%
20.0%
0.0%
2.5%
2.0%
1.5%
1.0%
0.5%
0.0%
-0.5%
-1.0%
-1.5%
60
70
80
90
100
110
120
130
Delta
Vega
Rho
Gamma
Theta

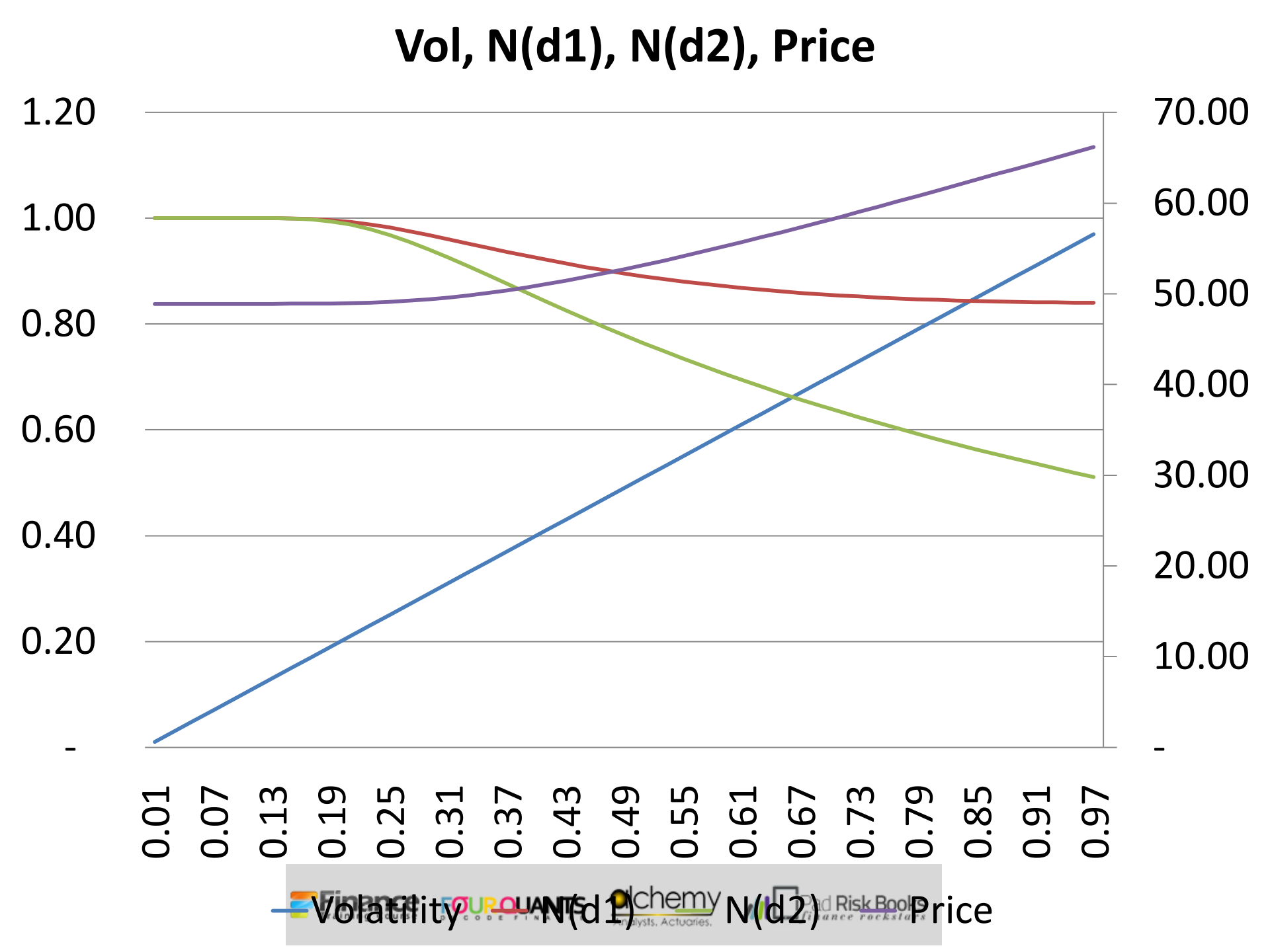

The Greeks against Strike
120.0%
100.0%
80.0%
60.0%
40.0%
20.0%
0.0%
1.5%
1.0%
0.5%
0.0%
-0.5%
-1.0%
-1.5%
60
70
80
90
100
110
120
130
Delta
Vega
Rho
Gamma
Theta

The Greeks against Time



The Greeks against Vol

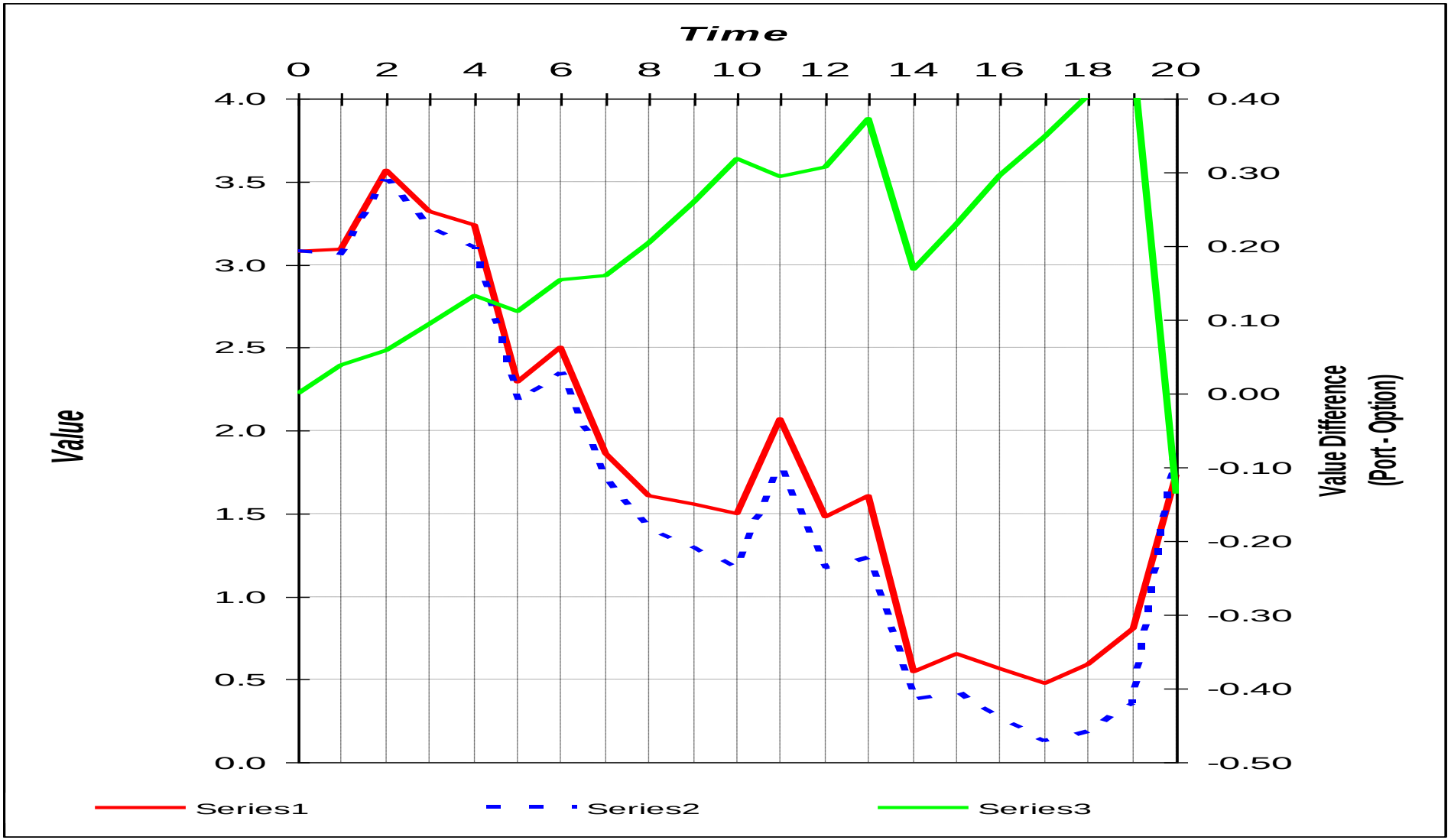



Vol, N(d1), N(d2), Price
1.20
1.00
0.80
0.60
0.40
0.20
-
70.00
60.00
50.00
40.00
30.00
20.00
10.00
-
0.01
0.07
0.13
0.19
0.25
0.31
0.37
0.43
0.49
0.55
0.61
0.67
0.73
0.79
0.85
0.91
0.97
Volatility
N(d1)
N(d2)
Price

Delta Hedging Simulation

Time step	Time to expiration	Stock price	d1	Option delta	Replicating Portfolio: Dollars in stock	Replicating Portfolio: Borrow	Replicating Portfolio Value	Option Value	Difference (port val - option val)	Cost of Purchase	Interest on Balance
0	0.0833	52.00	0.5443	0.7069	36.758	33.680	3.078	3.078	0.000	36.758	0.00701741
1	0.0792	51.53	0.4452	0.6719	34.621	31.886	2.736	2.704	0.032	-2.137	0.00664352
2	0.0750	50.78	0.2752	0.6084	30.896	28.668	2.228	2.177	0.051	-3.725	0.00597311
3	0.0708	51.76	0.5174	0.6976	36.105	33.288	2.818	2.766	0.051	5.209	0.00693565
4	0.0667	51.45	0.4513	0.6741	34.684	32.088	2.596	2.505	0.091	-1.421	0.00668563
5	0.0625	51.63	0.5069	0.6939	35.826	33.116	2.710	2.575	0.135	1.142	0.00689993
6	0.0583	51.93	0.5988	0.7253	37.665	34.756	2.910	2.734	0.175	1.839	0.00724151
7	0.0542	53.65	1.0838	0.8608	46.183	42.029	4.154	4.063	0.091	8.517	0.00875697
8	0.0500	54.39	1.3258	0.9075	49.363	44.582	4.780	4.678	0.102	3.180	0.00928896
9	0.0458	53.70	1.1787	0.8807	47.294	43.153	4.142	4.020	0.121	-2.069	0.00899108
10	0.0417	54.24	1.3930	0.9182	49.801	45.193	4.608	4.468	0.140	2.506	0.00941615
11	0.0375	54.56	1.5636	0.9410	51.343	46.449	4.894	4.736	0.159	1.543	0.00967787
12	0.0333	54.13	1.5056	0.9339	50.550	46.073	4.477	4.297	0.180	-0.794	0.00959951
13	0.0292	54.99	1.9102	0.9719	53.446	48.174	5.272	5.092	0.180	2.896	0.01003722
14	0.0250	54.16	1.7331	0.9585	51.906	47.453	4.453	4.262	0.191	-1.540	0.00988717
15	0.0208	54.78	2.1543	0.9844	53.925	48.884	5.041	4.845	0.196	2.019	0.01018513
16	0.0167	53.97	2.0123	0.9779	52.775	48.544	4.231	4.026	0.205	-1.150	0.01011432
17	0.0125	52.18	1.3087	0.9047	47.208	44.733	2.475	2.292	0.183	-5.567	0.00932032
18	0.0083	51.14	0.8512	0.8027	41.048	39.526	1.522	1.315	0.207	-6.160	0.00823543
19	0.0042	51.59	1.6349	0.9490	48.955	47.081	1.874	1.620	0.254	7.907	0.00980955
20	0.0000	50.89	NA	1.0000	50.888	49.688	1.200	0.888	0.312	1.932	0.01035267

Delta Hedging Simulation



Kill a Bank Simulation

Introduction

What do you control?

	Initial Allocation & Strategy		
	Balance Sheet		
	Assets	**Allocation**	**Volume**
0.25	3 month Tbill	**10%**	14,100,000
0.5	6 month Tbill	**5%**	7,050,000
1	1 year Tbill	**5%**	7,050,000
3	3 year PIB	**5%**	7,050,000
5	**5 year PIB**	**5%**	7,050,000
10	**10 year PIB**	**5%**	7,050,000
1	**1 year Loan**	**5%**	7,050,000
3	**3 year Loan**	**10%**	14,100,000
5	**5 year Loan**	**50%**	70,500,000
100%			141,000,000
	Liabilities		
	Deposits		
0.25	3 month deposit	**35%**	46,550,000
0.5	6 month deposit	**32%**	42,560,000
1	**1 year deposit**	**30%**	39,900,000
2	**2 year deposit**	**1%**	1,330,000
3	**3 year deposit**	**1%**	1,330,000
5	**5 year deposit**	**1%**	1,330,000
100%			133,000,000
	Equity (Surplus)		8,000,000

What do you get?

	min	max	average	stdev	
Maturity - Investment	3.63	4.02	**3.84**	7.981%	**Maturity - Investment**
Maturity - Liabilities	0.63	0.66	**0.65**	0.572%	**Maturity - Liabilities**
Maturity Gap	3.00	3.36	**3.19**	7.446%	**Maturity Gap**
Interest Income	9.31%	21.43%	**15.63%**	2.873%	**Interest Income**
Cost of Funds	6.56%	14.46%	**10.78%**	1.858%	**Cost of Funds**
Net Interest Income	2.76%	6.97%	**4.85%**	1.018%	**Net Interest Income**
Credit Losses	2.39%	11.53%	**6.92%**	2.225%	**Credit Losses**
Net realized Income	**-0.38%**	**1.17%**	**0.38%**	**0.383%**	**Net Realized Income**

What you don't see?

Cost of funds			Core Products	Initial State
Start	**8.0%**		10 year PIB	11.0%
Mean	12.0%		5 year PIB	10.0%
Volatility	5.0%		3 year PIB	9.0%
Investment Spread			1 year Tbill	8.0%
Start	1.0%		6 month Tbill	7.0%
Mean	1.0%		3 month Tbill	6.0%
Volatility	3.0%		1 year Loan	11.0%
Credit Spread			3 year Loan	12.0%
Start	2.0%		5 year Loan	14.0%
Mean	6.0%		3 month deposit	8.0%
Volatility	6.0%		6 month deposit	8.5%
			1 year deposit	9.0%
			2 year deposit	10.0%
			3 year deposit	11.0%
			5 year deposit	11.5%
e purposes	15%			
ark - 3 year PIB	13.25%			

Credit Strategy	Credit Loss as a % of credit spread		Credit Loss	150%
Aggressive	450%		Advances Weight	65%
Moderate	150%			
Passive	90%			
Conservative	50%			

What do you need to manage?

Starting Capital		8,000,000	
(61,266,913)		**20,082,387**	**20,082,387**
Cost to close/NIM		155%	
EAR/NIM		100.9%	
Cost to close		2,111,773	0.13
Net Interest Margin (after Provisions)		1,363,292	
Earnings at Risk		1,375,423	100.9%
Reset GAP		20,082,387	
Average Capital		8,669,565	
Min Capital		(16,806,818)	13.000
Structural Liquidity		**53,860,000**	
Balance Sheet Foot print		141,000,000	
NIM / Capital		17.04%	
NIM / Assets		0.967%	
NIM (excluding provisions)		6,426,326	
Credit Losses & Provisions		5,063,034	

Rules

- Sit and work in groups
- Finalize your strategy and submit
- Repeat

Iterations – Kill a Bank

- Maximize Interest Income
- Minimize credit provisions
- Maximize Gap
- Minimize Gap
- Stabilize Capital
- Reduce probability of shortfall to zero
- Zero Shortfall, Maximize earnings
- Final Round

Greeks - I

- Delta
  - Option Price sensitivity to change in underlying price
- Gamma
  - Option price sensitivity to change in Delta

Greek - II

- Vega
  - Option price sensitivity to changes in volatility
- Theta
  - Option price sensitivity to changes in time to expiry

Greek - III

- Rho
  - Option price sensitivity to changes in the risk free rate