

Managing risk dynamically

Market maker



Managing risk dynamically

- Purpose:
 - Use option risk measures (i.e., “Greeks”) to manage risks through time.



Dynamic risk management

- *Dynamic risk management* involves three steps.
 - Identify portfolio's risk exposures.
 - Identify available hedge instruments.
 - Identify lowest cost hedge.



Market maker

- Problem information:
 - Market maker for ABC option class.
 - Assume:
 - ABC's stock pays no dividends, has a current price of \$75 and has a volatility rate is 40%.
 - Interest rate is 5%.
 - Stock options are European-style.

Market maker

- Problem information:
 - Assume following option series on ABC's stock are also available:

<i>Option series</i>							
<i>Exercise price</i>	<i>(C)all/ (P)ut</i>	<i>Years to expiration</i>	<i>Value</i>	<i>Delta</i>	<i>Gamma</i>	<i>Vega</i>	<i>Rho - r</i>
65	c	0.250	12.536	0.810	0.018	10.175	12.054
70	c	0.250	9.143	0.694	0.023	13.153	10.728
75	c	0.250	6.414	0.565	0.026	14.764	8.982
80	c	0.250	4.336	0.436	0.026	14.770	7.098
85	c	0.250	2.832	0.322	0.024	13.438	5.321
65	p	0.250	1.729	-0.190	0.018	10.175	-3.994
70	p	0.250	3.274	-0.306	0.023	13.153	-6.554
75	p	0.250	5.483	-0.435	0.026	14.764	-9.535
80	p	0.250	8.343	-0.564	0.026	14.770	-12.654
85	p	0.250	11.777	-0.678	0.024	13.438	-15.665



Market maker

- Problem information:
 - Supporting file: ABC market maker.xlsx



Market maker

- Problem information:
 - Market maker's current position:
 - short 30 65-calls
 - short 50 65-puts
 - short 10 80-calls
 - What are her net risk exposures?



Market maker

- Compute risks of current position.
 - Multiply each option's Greek by number of contracts.
 - Sum across options.

Market maker

- Problem information:
 - Net risk exposures are:

<i>Option series</i>			<i>No. of</i>	<i>Value</i>	<i>Delta</i>	<i>Gamma</i>	<i>Vega</i>	<i>Rho</i>
<i>Exercise price</i>	<i>(C)all/ (P)ut</i>	<i>Years to expiration</i>	<i>contracts (+ long/ -short)</i>					
65	c	0.25	-30	376.085	-24.301	-0.543	-305.257	-361.620
65	p	0.25	-50	86.436	9.499	-0.904	-508.762	199.707
80	c	0.25	-10	43.363	-4.364	-0.263	-147.696	-70.978
Unhedged portfolio risk attributes				505.885	-19.166	-1.710	-961.715	-232.891



Market maker

□ Problem information:

- Suppose market maker wants to hedge her delta exposure using 75-call. How many calls should she buy?

$$19.166 / 0.565 = 33.92$$

Now, what are her exposures?

Market maker

- Problem information:
 - New net risk exposures:

<i>Option series</i>			<i>No. of contracts</i>	<i>Value</i>	<i>Delta</i>	<i>Gamma</i>	<i>Vega</i>	<i>Rho</i>
<i>Exercise price</i>	<i>(C)all/ (P)ut</i>	<i>Years to expiration</i>	<i>(+ long/ -short)</i>					
65	c	0.25	-30	376.085	-24.301	-0.543	-305.257	-361.620
65	p	0.25	-50	86.436	9.499	-0.904	-508.762	199.707
80	c	0.25	-10	43.363	-4.364	-0.263	-147.696	-70.978
Unhedged portfolio risk attributes				505.885	-19.166	-1.710	-961.715	-232.891
Hedge instruments								
75	c	0.25	33.95	-217.768	19.166	0.891	501.234	304.920
Hedged portfolio risk attributes				288.117	0.000	-0.819	-460.480	72.029



Market maker

□ Problem information:

- Suppose market maker wants to hedge her delta and vega exposures.
- To hedge two different exposures, two options are needed.
- Assume she uses 75-call and 75-put.

Market maker

□ Problem information:

- Solve analytically.

$$\text{Delta hedge: } 19.166 = .565n_C + (-.435)n_P$$

$$\text{Vega hedge: } 961.715 = 14.764n_C + 14.764n_P$$

$$n_C = 47.53 \quad \text{and} \quad n_P = 17.61$$

- Solve numerically (e.g., SOLVER).

Market maker

- Problem information:
 - New net risk exposures:

<i>Exercise price</i>	<i>Option series</i>		<i>No. of contracts (+ long/-short)</i>	<i>Value</i>	<i>Delta</i>	<i>Gamma</i>	<i>Vega</i>	<i>Rho</i>
	<i>(C)all/(P)ut</i>	<i>Years to expiration</i>						
65	c	0.25	-30	376.085	-24.301	-0.543	-305.257	-361.620
65	p	0.25	-50	86.436	9.499	-0.904	-508.762	199.707
80	c	0.25	-10	43.363	-4.364	-0.263	-147.696	-70.978
Unhedged portfolio risk attributes				505.885	-19.166	-1.710	-961.715	-232.891
Hedge instruments								
75	c	0.25	47.53	-304.886	26.833	1.248	701.753	426.904
75	p	0.25	17.61	-96.539	-7.667	0.462	259.961	-167.898
Hedged portfolio risk attributes				104.460	0.000	0.000	0.000	26.115



Dynamic risk management

- *Dynamic risk management* involves three steps.
 - Identify portfolio's risk exposures
 - Identify available hedge instruments
 - Identify lowest cost hedge

Index option market maker

- Illustration: Suppose market maker in S&P 500 index options ends the day with:

Option series			No. of
Exercise price	(C)all/ (P)ut	Days to expiration	contracts (+ long/ -short)
900	c	30	-100
950	c	30	-200
1000	c	90	-150
900	p	90	50
950	p	360	-100
1000	p	720	-200
1100	c	720	-100



Index option market maker

- Illustration: Assume he wants to hedge delta risk overnight.
 - Consider two hedging alternatives.
 - use S&P 500 futures or 975-call options
 - S&P 500 index:
 - current level 1,000
 - dividend yield 2%
 - volatility rate 20%
 - S&P 500 futures:
 - 90 days to expiration
 - current price at full carry, 1004.94
 - delta 1.0049.
 - S&P 975-call (European-style):
 - 90 days to expiration
 - current price 55.432
 - delta 0.635
 - Risk-free interest rate 4%
 - Identify the number of contracts to enter in each case.

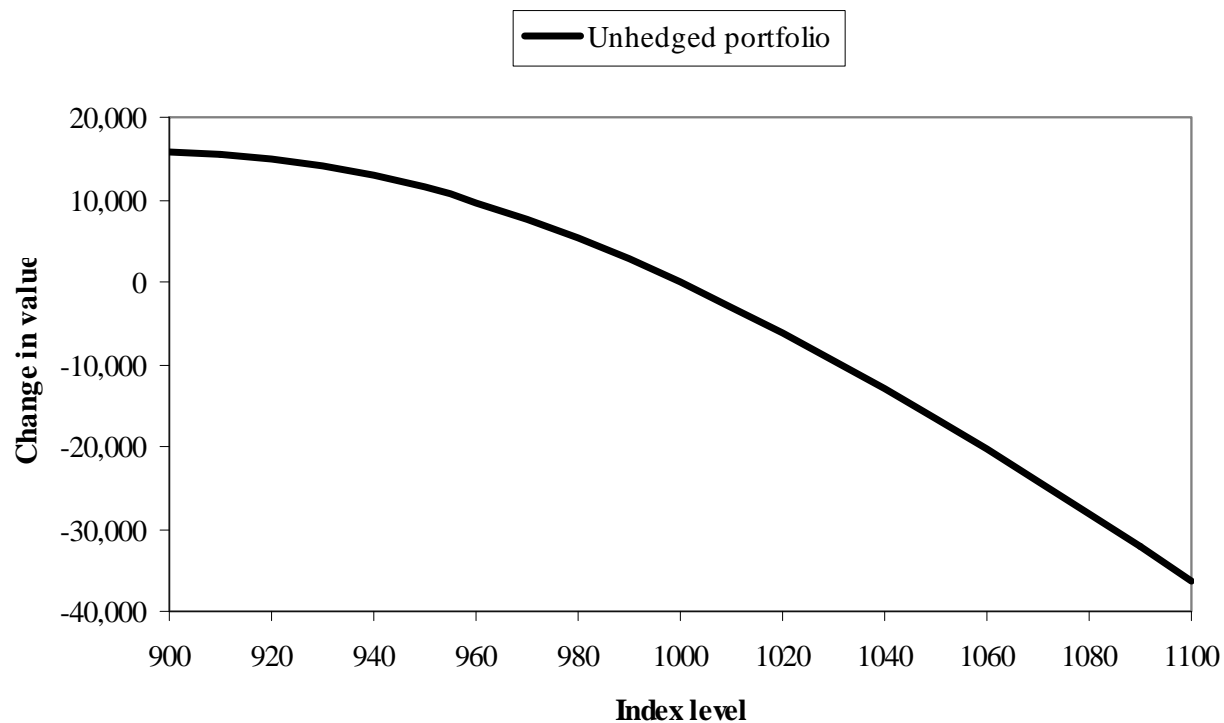
Index option market maker

- Supporting file: S&P 500 market maker.xls

Option series			No. of contracts					
Exercise price	(C)all/ (P)ut	Days to expiration	(+ long/ -short)	Value	Delta	Gamma	Vega	Rho
900	c	30	-100	10,196.59	-96.94	-0.1154	-1,896.45	-7,129.19
950	c	30	-200	11,367.74	-165.61	-0.8831	-14,516.94	-12,677.73
1000	c	90	-150	6,271.21	-80.54	-0.5966	-29,423.39	-18,311.65
900	p	90	50	-313.98	-6.12	0.1020	5,028.22	-1,586.17
950	p	360	-100	4,601.73	31.76	-0.1774	-34,996.41	35,859.39
1000	p	720	-200	17,546.70	74.87	-0.2625	-103,560.06	182,293.85
1100	c	720	-100	8,500.74	-45.83	-0.1363	-53,771.90	-73,630.18
Portfolio				58,170.73	-288.41	-2.07	-233,136.93	104,818.32

Index option market maker

□ Delta-exposure



Index option market maker

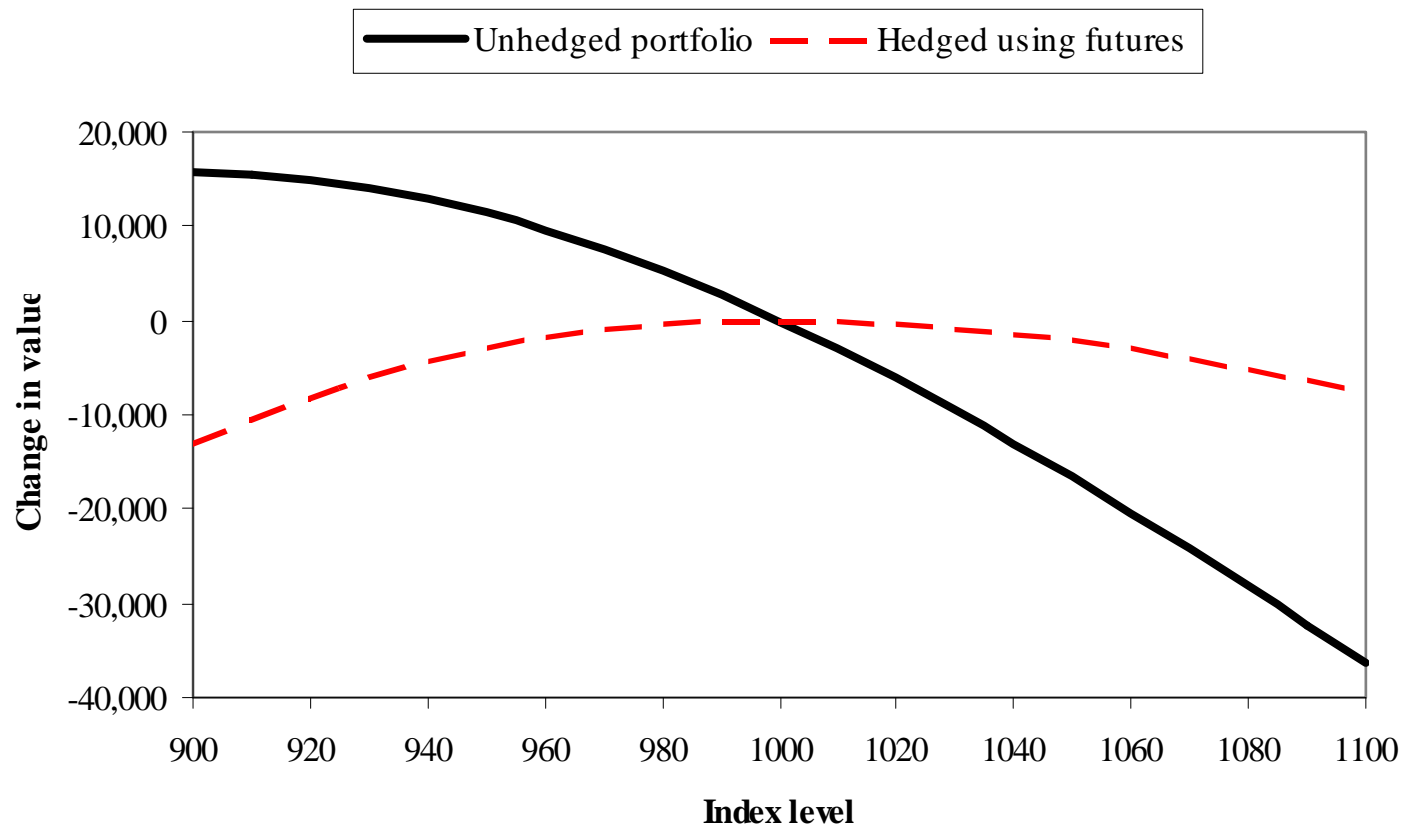
- Use futures

$$n_F = \frac{288.41}{1.0049} = 286.99$$

<u>Option series</u>			No. of contracts					
Exercise price	(C)all/ (P)ut	Days to expiration	(+ long/ -short)	Value	Delta	Gamma	Vega	Rho
Unhedged portfolio				58,170.73	-288.41	-2.07	-233,136.93	104,818.32
Hedge instruments								
	F	90	286.99	0.00	288.41	0.00	0.00	0.00
Hedged portfolio				58,170.73	0.00	-2.07	-233,136.93	104,818.32

Index option market maker

- Use futures



Index option market maker

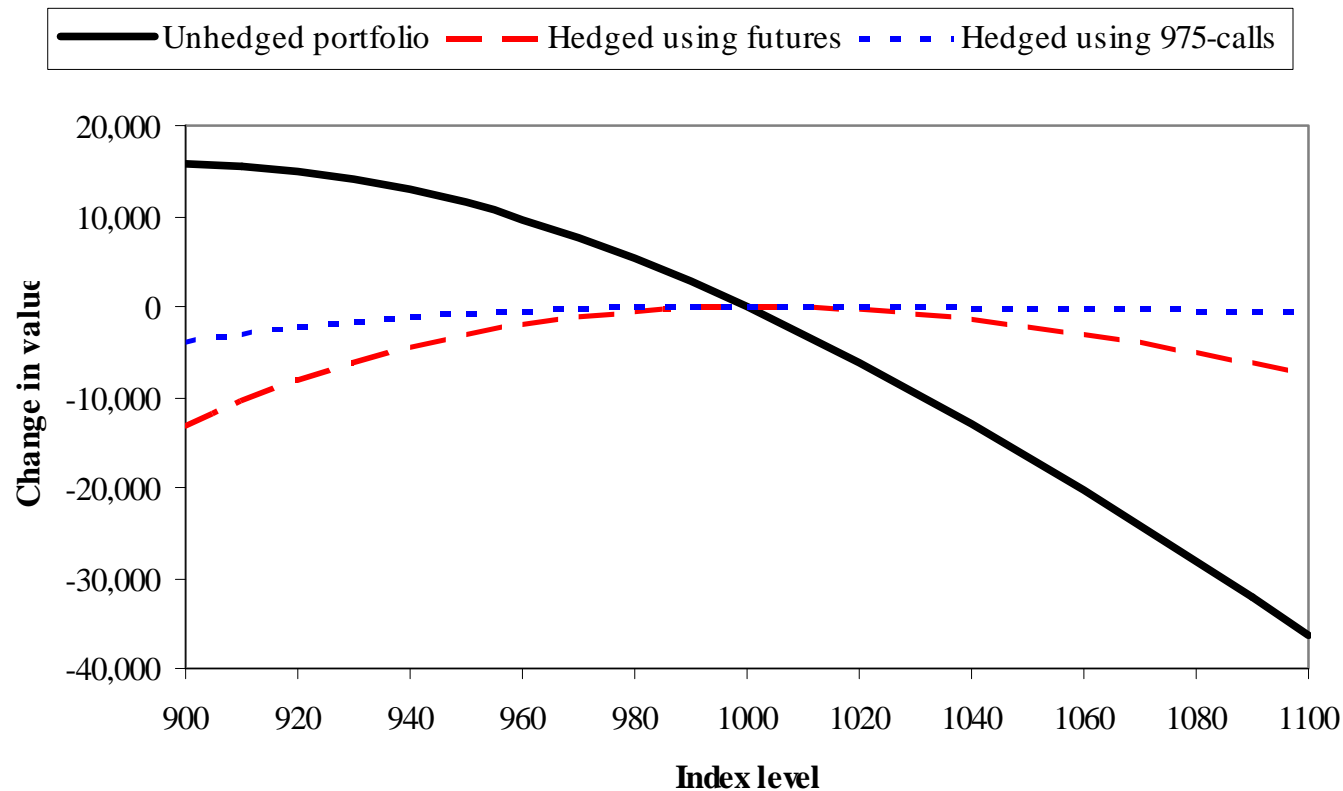
- Use 975-call

$$n_{975 \text{ call}} = \frac{288.41}{0.635} = 453.98$$

Option series			No. of contracts					
Exercise price	(C)all/ (P)ut	Days to expiration	(+ long/ -short)	Value	Delta	Gamma	Vega	Rho
Unhedged portfolio				58,170.73	-288.41	-2.07	-233,136.93	104,818.32
Hedge instruments								
975	c	90	453.98	-25,165.31	288.41	1.7043	84,049.44	
Hedged portfolio				33,005.43	0.00	-0.37	-149,087.49	104,818.32

Index option market maker

- Use 975-call



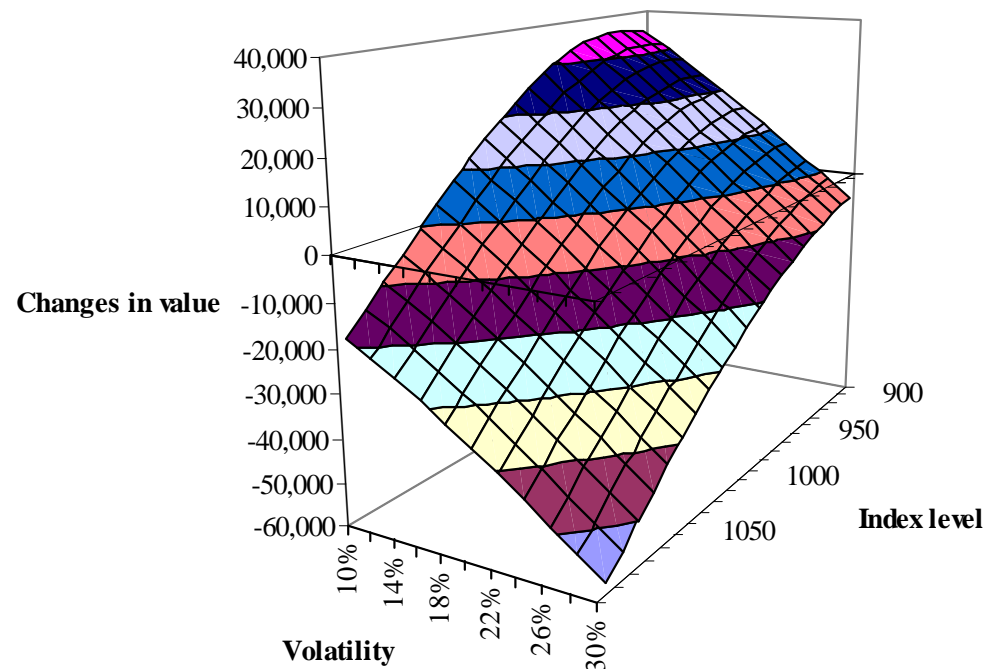
Index option market maker

- Illustration: Assume he wants to hedge delta and vega risks overnight.
 - Use S&P 500 futures and 975-call options

Option series			No. of contracts					
Exercise price	(C)all/ (P)ut	Days to expiration	(+ long/ -short)	Value	Delta	Gamma	Vega	Rho
Unhedged portfolio				58,170.73	-288.41	-2.07	-233,136.93	104,818.32

Index option market maker

- Illustration: Assume he wants to hedge delta and vega risks overnight.



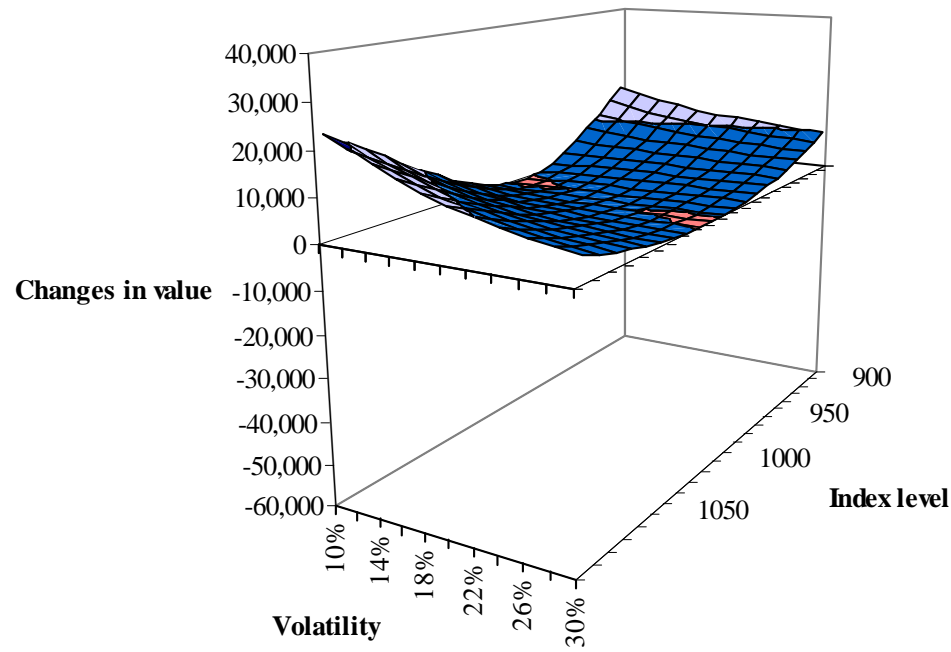
Index option market maker

- Illustration: Assume he wants to hedge delta and vega risks overnight. Solve analytically.

Option series			No. of contracts					
Exercise price	(C)all/ (P)ut	Days to expiration	(+ long/ -short)	Value	Delta	Gamma	Vega	Rho
Unhedged portfolio				58,170.73	-288.41	-2.07	-233,136.93	104,818.32
Hedge instruments								
	F	90	-509.06	-0.01	-511.58	0.00	0.00	0.00
975	c	90	1,259.27	-69,803.70	799.99	4.7275	233,136.93	180,045.24
Hedged portfolio				-11,632.97	0.00	2.66	0.00	284,863.57

Index option market maker

- Illustration: Assume he wants to hedge delta and vega risks overnight. After hedge is in place:





Index option market maker

- Illustration: Assume he wants to hedge delta and vega risks overnight. The costs/benefits of hedge instrument positions include:
 - Bid/ask spreads and commissions:
 - Assume commission rate of \$5 per contract
 - Opportunity cost of funds
 - Assume lending/borrowing rate of 4%
 - Erosion in time premium of options
- Identify least cost hedge portfolio assuming his hedging horizon is one day.

Index option market maker

- Illustration: Assume he wants to hedge delta and vega risks overnight.
 - Available hedge instruments.

Exercise price	(F)utures/ (C)all/ (P)ut	Days to expiration	Price
	F	90	1,004.94
975	c	90	25.78
975	p	90	55.43
1025	c	90	50.52
1025	p	90	30.66

Index option market maker

- Illustration: Use SOLVER to identify hedge.

Option series			No. of contracts					Trading costs	Interest cost	Time erosion
Exercise price	(C)all/ (P)ut	Days to expiration	(+ long/ -short)	Value	Delta	Vega	Theta			
Unhedged portfolio				58,170.73	-288.41	-233,136.93	122.82			
Hedge instruments										
	F	90	-0.20	0.00	-0.20	0.00	-4.09	-1.02		-0.01
975	c	90	61.78	-3,424.74	39.25	11,438.27	-5,286.85	-308.91	-0.38	-14.48
975	p	90	0.00	0.00	0.00	0.04	-0.01	0.00	0.00	0.00
1025	c	90	886.72	-27,184.37	388.81	172,858.34	-76,792.54	-4,433.62	-2.98	-210.39
1025	p	90	250.54	-12,656.40	-139.45	48,840.29	-16,512.19	-1,252.70	-1.39	-45.24
Hedged portfolio				14,905.22	0.00	0.00	-98,472.86	-5,996.25	-4.74	-270.13
								Total costs	6,271.12	

Index option market maker

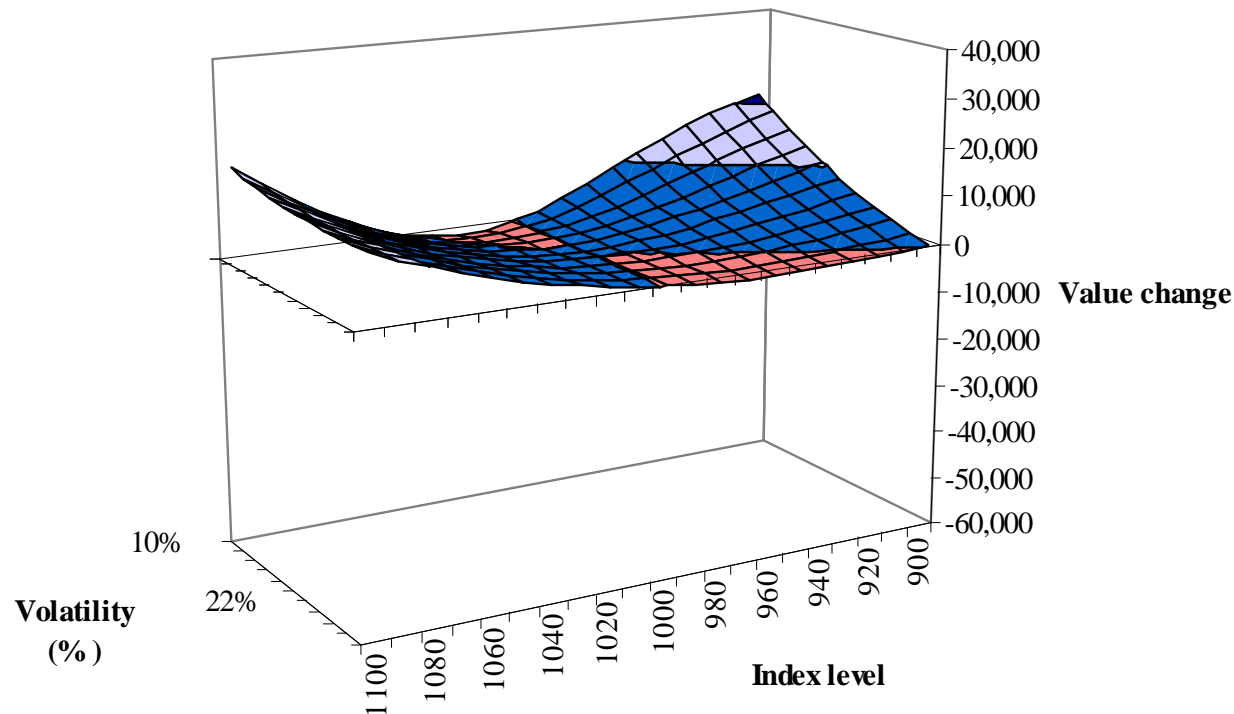
- Illustration: Drop contracts and re-solve.

Option series			No. of contracts	Value	Delta	Vega	Theta	Trading costs	Interest cost	Time erosion
Exercise price	(C)all/ (P)ut	Days to expiration	(+ long/ -short)							
Unhedged portfolio				58,170.73	-288.41	-233,136.93	122.82			
Hedge instruments										
975	c	90	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1025	c	90	958.78	-29,393.47	420.41	186,905.42	-83,032.98	-4,793.92	-3.22	-227.49
1025	p	90	237.16	-11,980.36	-132.00	46,231.51	-15,630.20	-1,185.79	-1.31	-42.82
Hedged portfolio				16,796.90	0.00	0.00	-98,540.36	-5,979.70	-4.53	-270.31
									Total costs	6,254.55

Total costs are less (6,254.55 v. 6.271.12).

Index option market maker

- Illustration: Drop contracts and re-solve.





Lesson summary

- Steps in dynamically hedging risk.
 - Identify portfolio's risk exposures.
 - Identify available hedge instruments.
 - Identify lowest cost hedge.
 - Minimize costs.
 - trading costs
 - interest costs
 - erosion of time premium