金融工程

第十三章　期权的交易策略及其应用

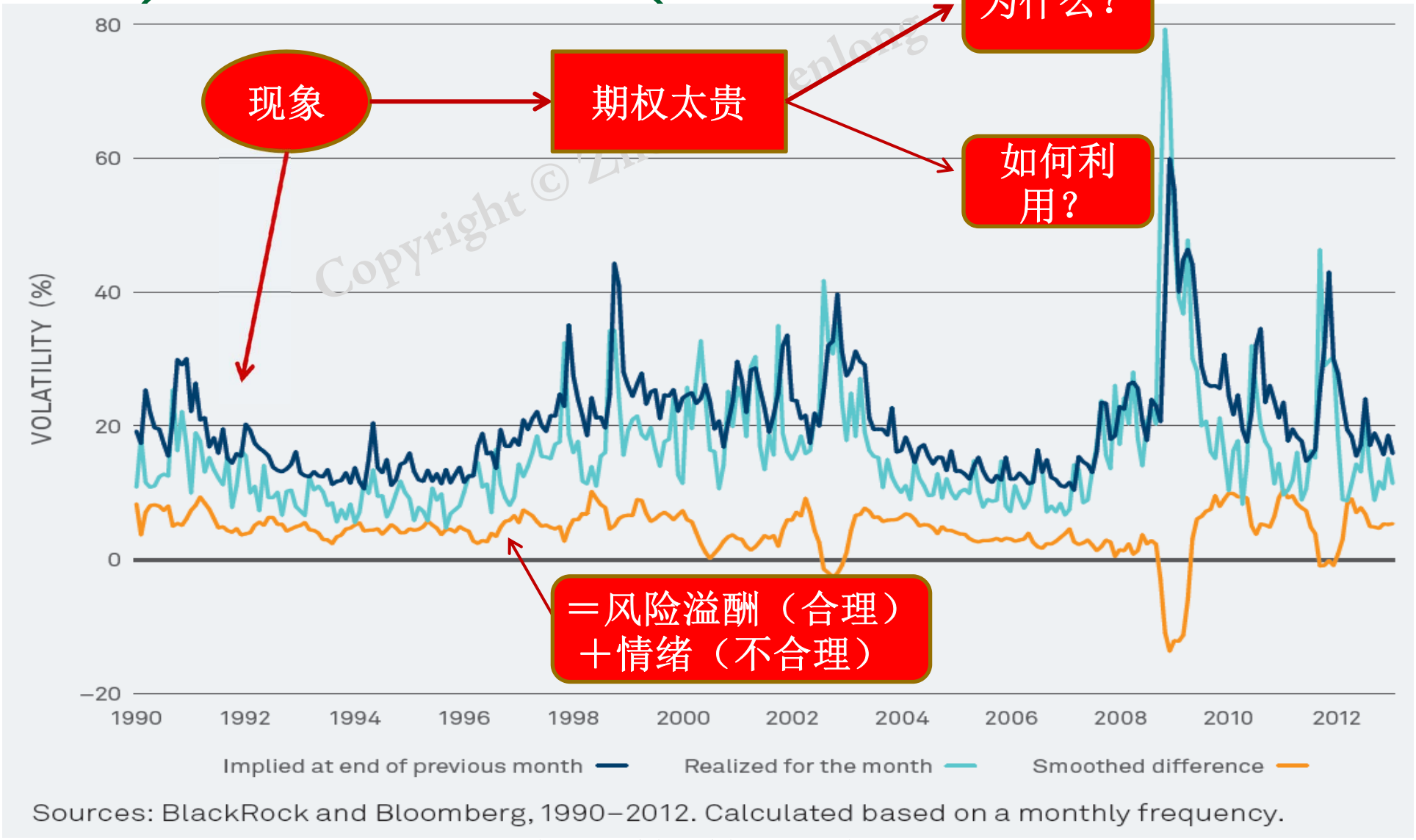
厦门大学金融系

郑振龙 陈蓉

目录

利用绝对定价偏差的策略

现象1：VIX与S&P500已实现波动率



隐含波动率与未来的波动率

- 隐含波动率是风险中性世界对未来波动率的预期。$\tilde{\sigma}=\hat{E}(\sigma(t,T))$
- 它可以分解成：现实世界的预期、情绪和风险溢酬三部分。
- 哪部分最重要？

VIX指数（2003年起改为无模型隐含波动率）

科学问题：为何需要风险溢酬？

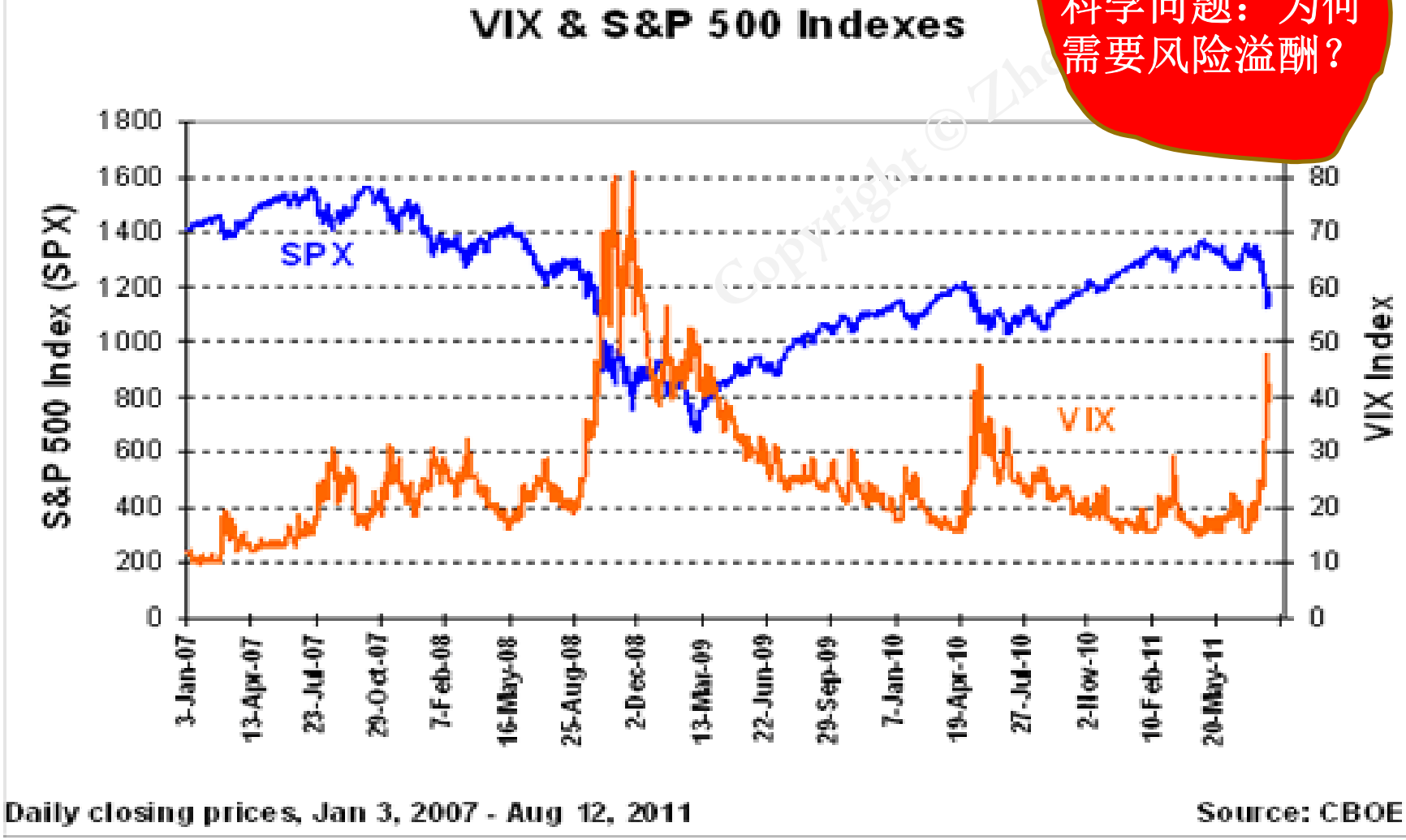


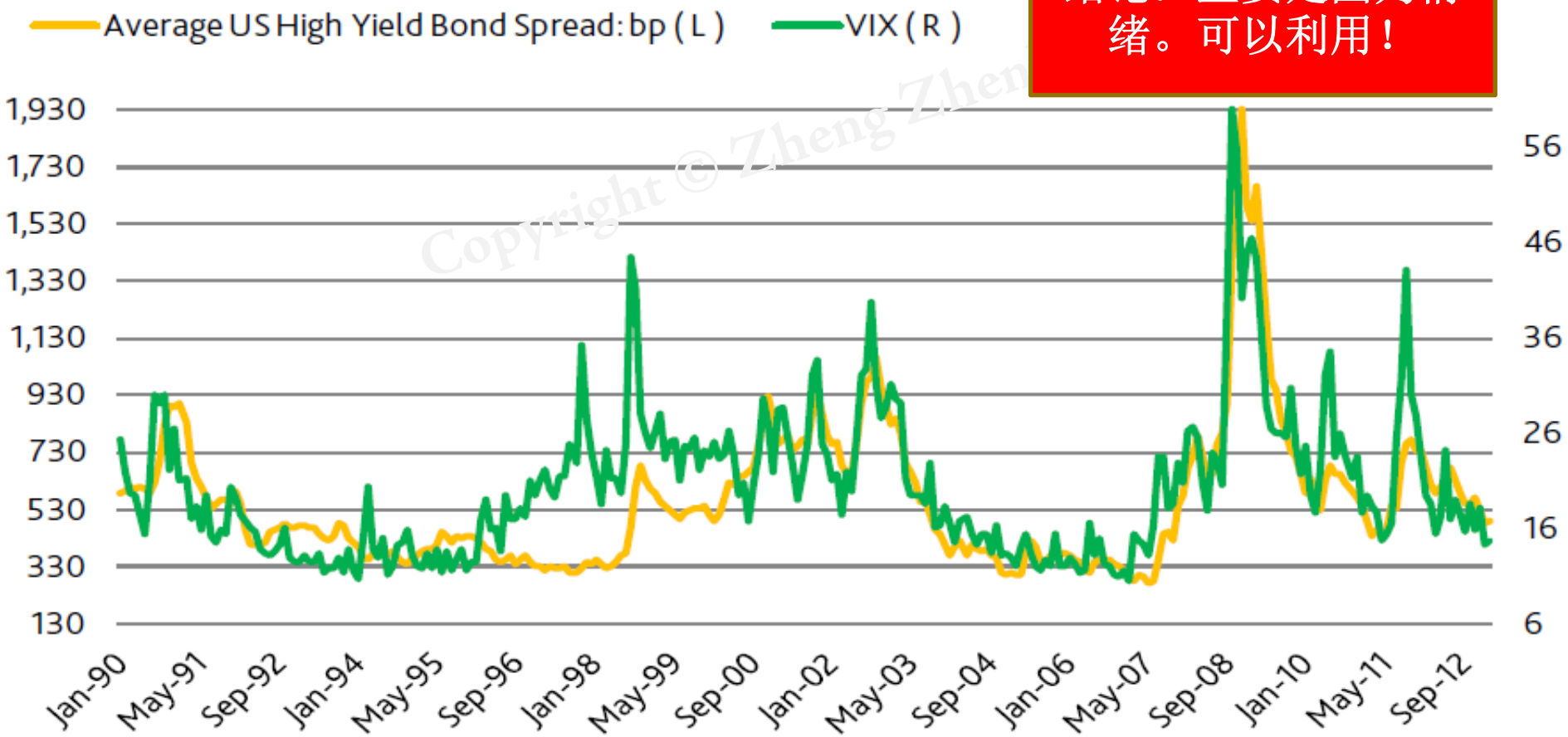
EXHIBIT 1: VOLATILITY HAS A NEGATIVE CORRELATION WITH COMMON PORTFOLIOS

	Correlation with VIX Index (changes) (1/90–12/12)	Correlation with VIX futures (long position) (4/04–12/12)
S&P 500	–70%	–78%
60/40 Equity / Bond	–69%	–78%
25/75 Equity / Bond	–58%	–69%
Barclays US Aggregate	–8%	–10%

Sources: BlackRock and Bloomberg, as of 12/31/12.
Correlation is calculated with monthly data.

VIX作为情绪指标

Figure 5: US High Yield Bond Spread vs VIX



结论：主要是因为情绪。可以利用！

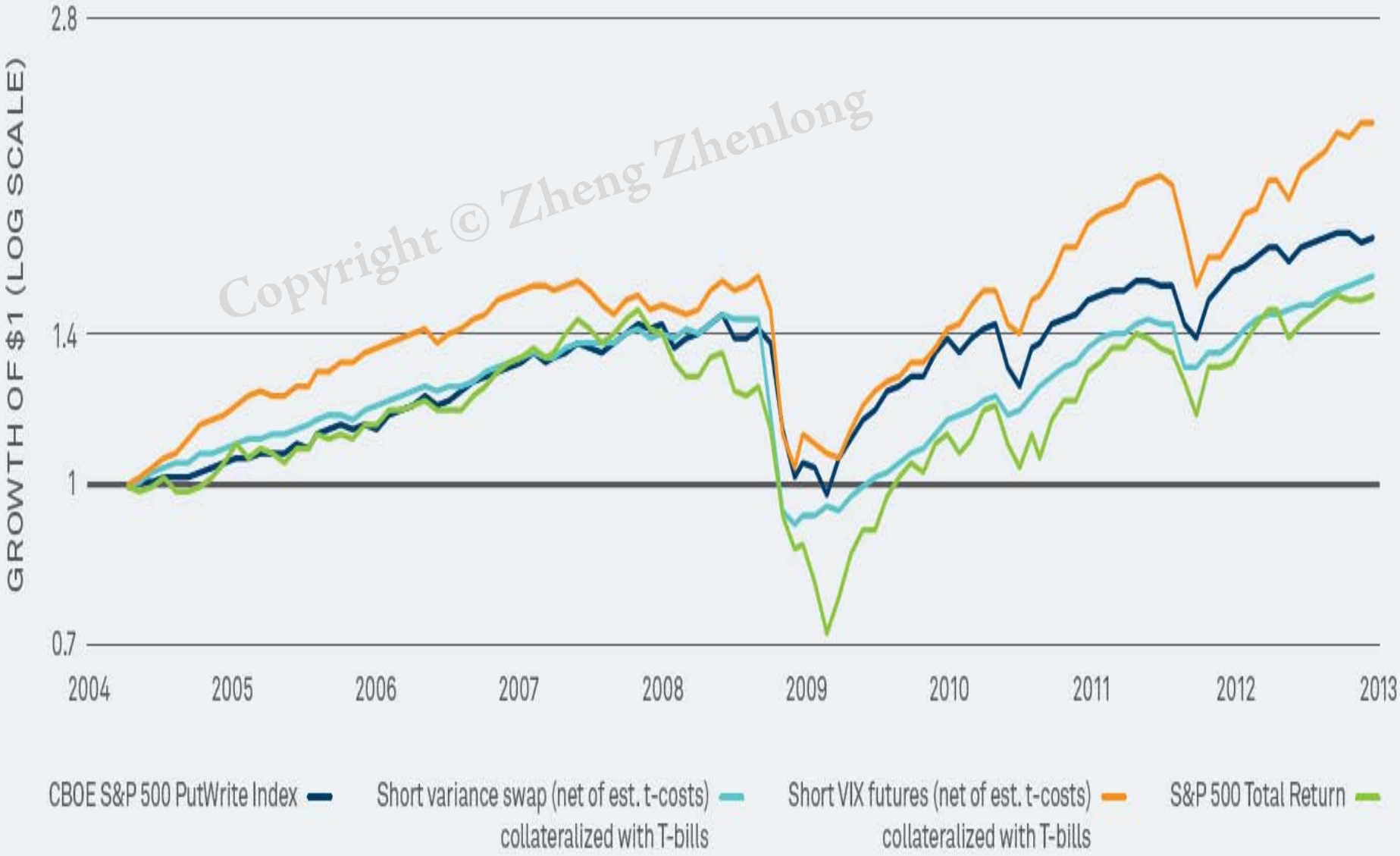
Sources: CBOE, Moody's Analytics

如何赚钱1：土办法

实践问题：如何制定交易策略？

- 卖空put，用国库券全额担保（PUT)
- 卖空call，用全额股票担保(BXM)
- 卖空虚值call，用全额股票担保(BXY)
- 做空波动率期货，用国库券全额担保
- Benchmark
  - S&P500 总收益指数
  - 买虚值看跌、卖虚值看涨、全额股票担保（CLL）

EXHIBIT 8: ALL THREE SHORT-VOLATILITY STRATEGIES HAVE OUTPERFORMED THE S&P 500



	CBOE S&P 500 PutWrite Index	Short variance swap (net of est. t-costs) collateralized w/T-bills	Short VIX futures (net of est. t-costs) collateralized w/T-bills	S&P 500 Total Return
Cumulative return (annualized)	6.4%	5.4%	9.5%	4.9%
Volatility	11.8%	11.0%	14.0%	15.2%
Sharpe ratio	0.39	0.33	0.55	0.20
Max drawdown	–32.7%	–36.8%	–34.2%	–50.9%
VaR 5% (5th percentile downside)	–5.3%	–2.6%	–6.4%	–7.8%
Skewness	–1.9	–4.9	–2.5	–0.8
Excess kurtosis	8.7	27.5	12.8	2.0
Minimum monthly return	–17.7%	–19.4%	–23.7%	–16.8%
Maximum monthly return	9.0%	3.3%	7.8%	10.9%
Correlation with PutWrite Index	100%	65%	82%	87%
Correlation with variance swap	65%	100%	76%	62%
Correlation with VIX futures	82%	76%	100%	79%

Sources: BlackRock and Bloomberg, 04/04–12/12. Calculated with monthly returns.

Exhibit 2: Growth of One Dollar (June 30, 1986—December 31, 2011)

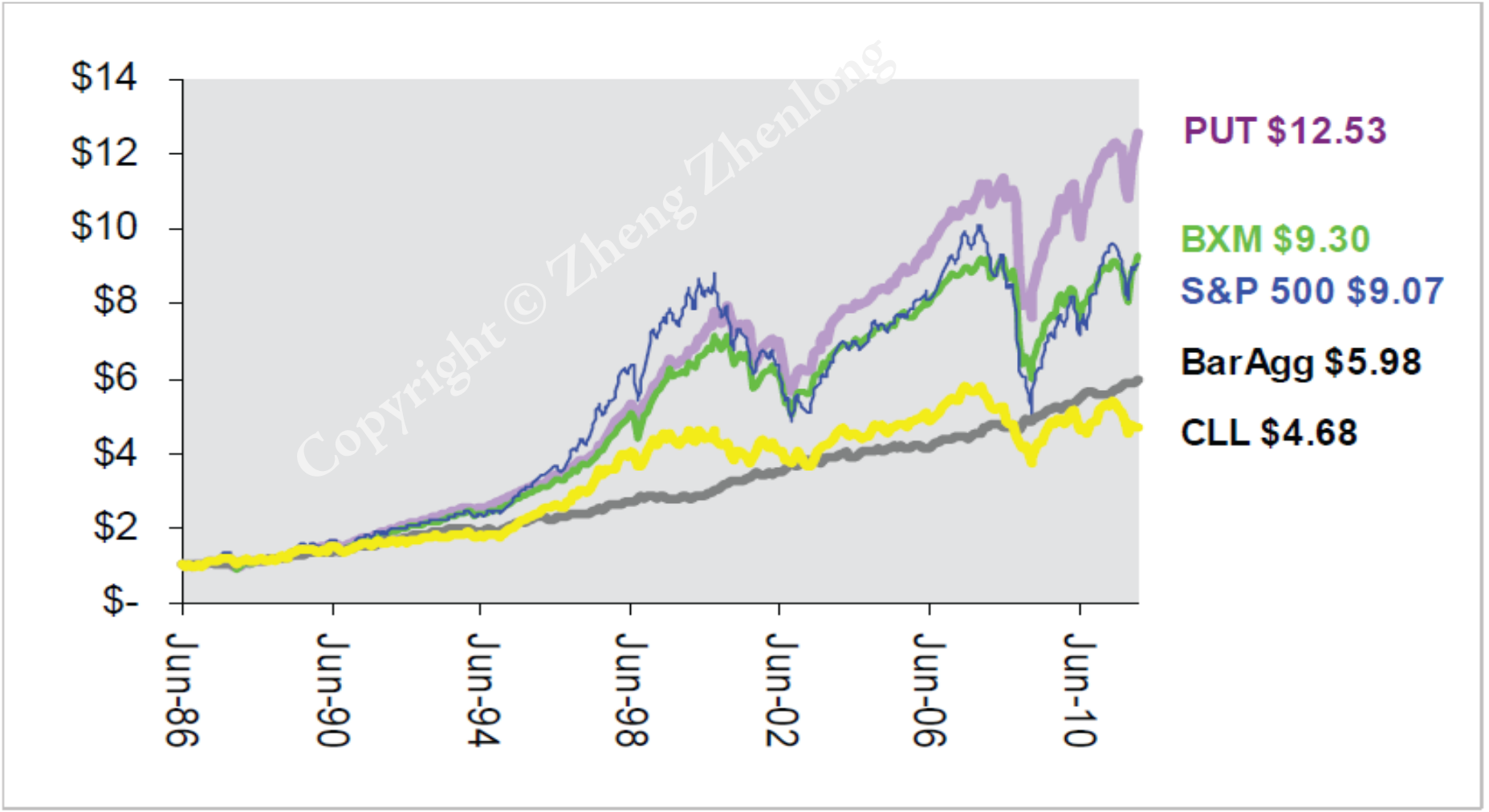


Exhibit 2: The growth in the value of a dollar invested on June 30, 1986. The BXY Index is not included in Exhibit 2 because its data history begins in June 1988. Source: Bloomberg.

Exhibit 1: Profit-and-Loss Diagram for SPX Stocks, BuyWrite, Put-Write and Collar

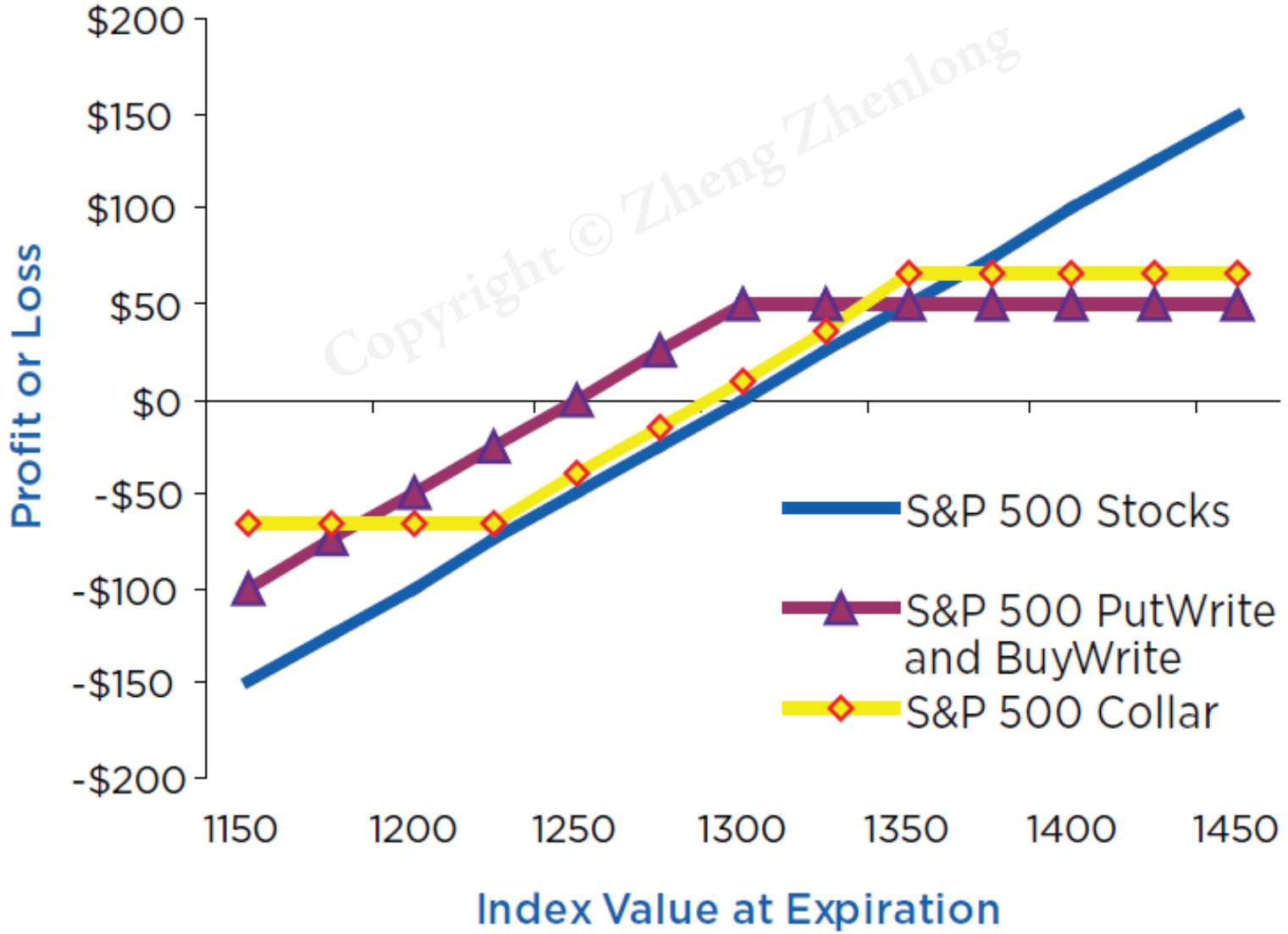


Exhibit 3: Annualized Returns (June 30, 1988 - December 31, 2011)

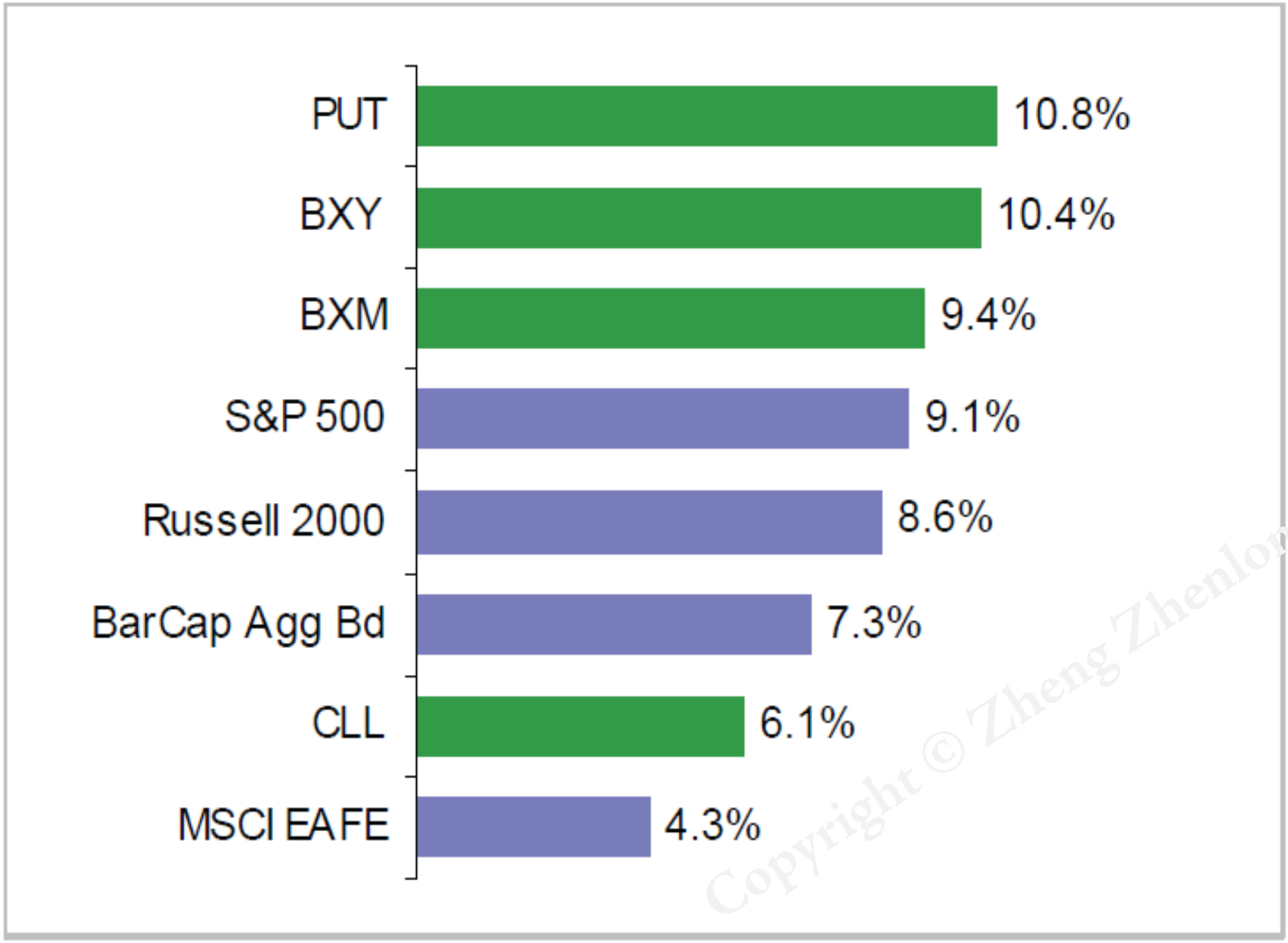


Exhibit 4: Standard Deviation (June 30, 1988 - December 31, 2011)

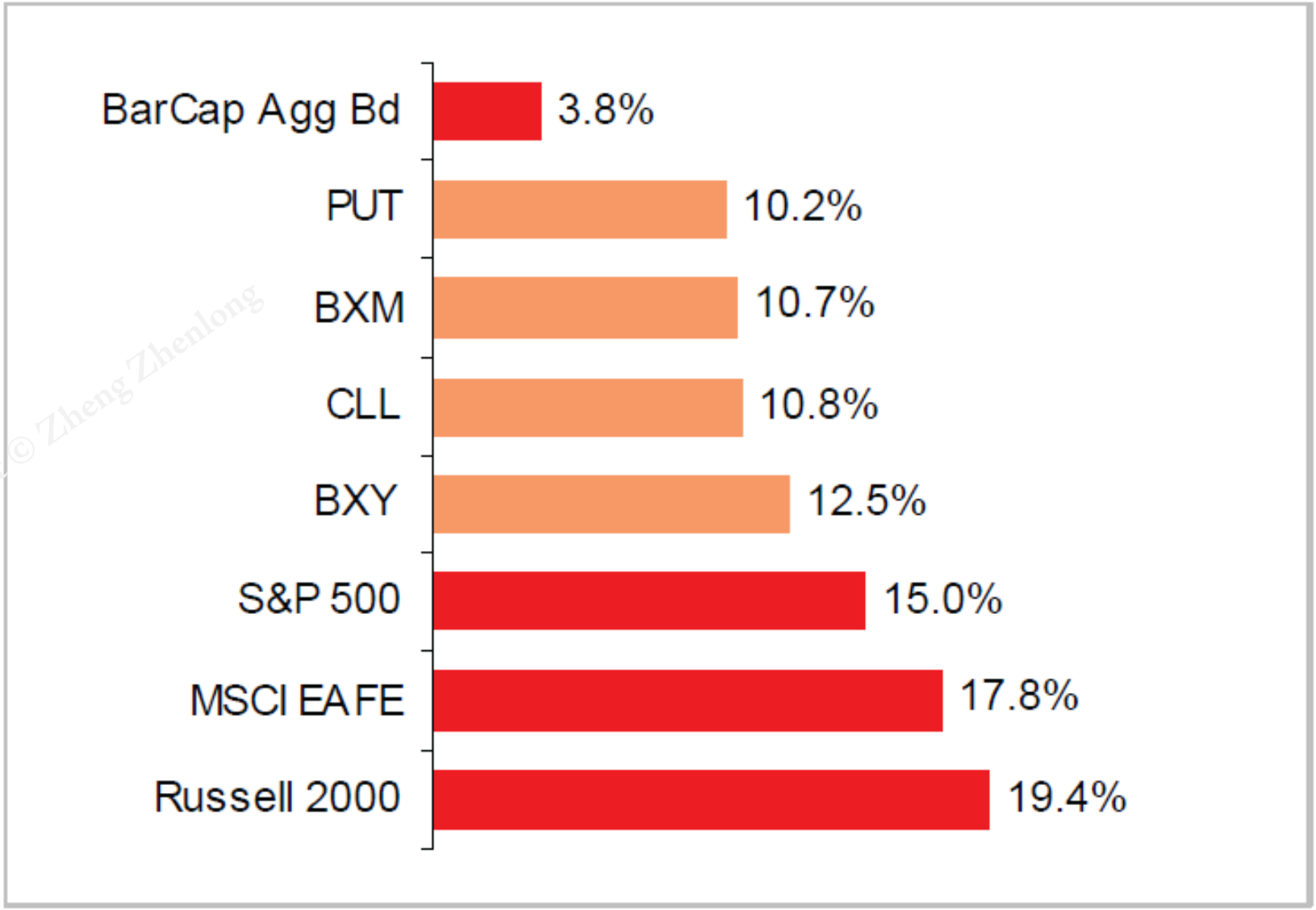
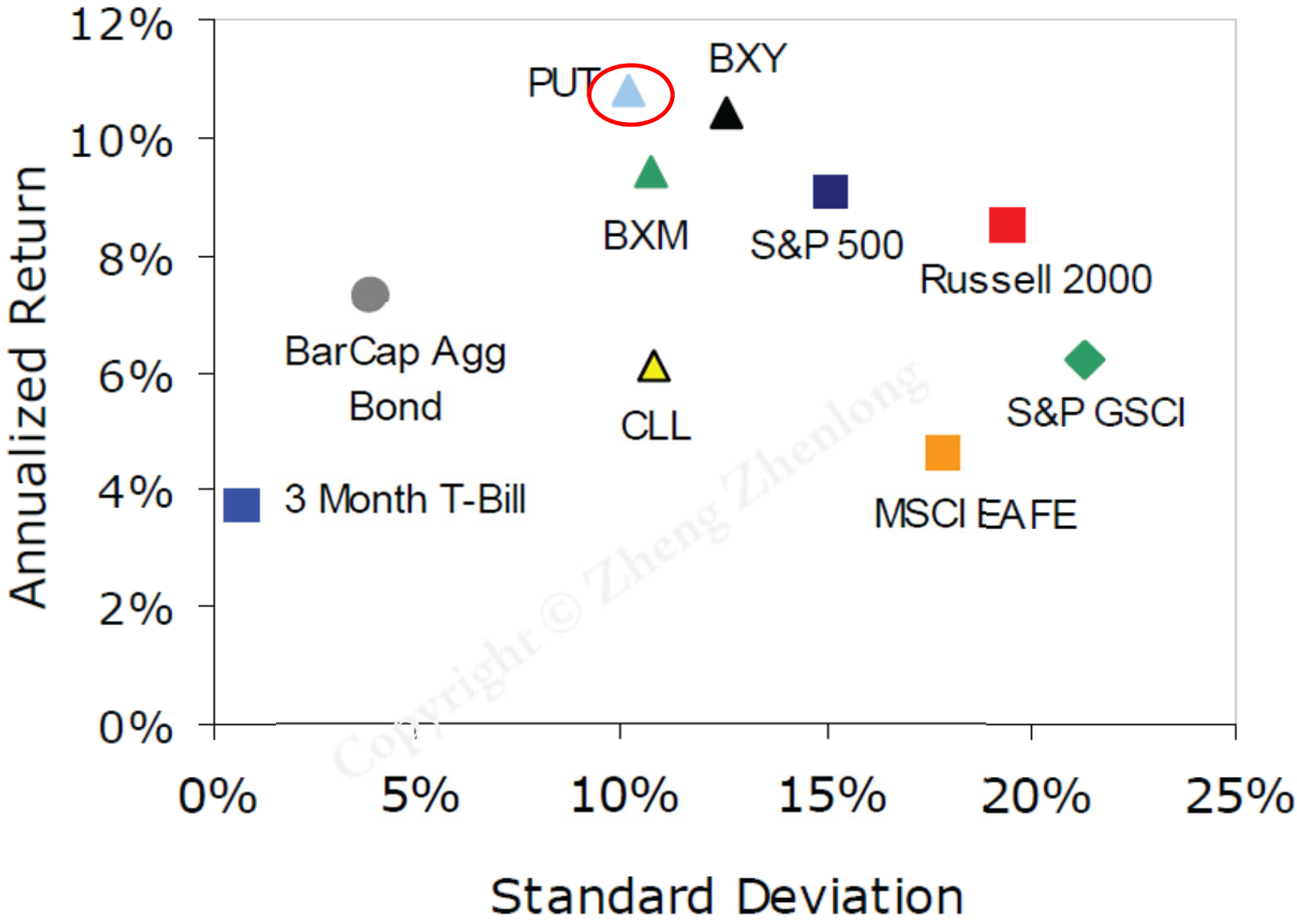


Exhibit 5 : Return and Volatility (June 30, 1988 - December 31, 2011)



年度表现比较

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
BXM	-10.9%	-7.6%	19.4%	8.3%	4.2%	13.3%	6.6%	-28.7%	25.9%	5.9%	5.7%
BXY	-11.4%	-12.3%	24.9%	9.7%	4.4%	17.1%	6.1%	-31.2%	32.1%	9.8%	7.2%
PUT	-10.6%	-8.6%	21.8%	9.5%	6.7%	15.2%	9.5%	-26.8%	31.5%	9.0%	6.2%
CLL	3.8%	-11.1%	17.9%	4.9%	2.0%	11.7%	0.9%	-23.6%	17.6%	4.1%	-8.8%
S&P 500	-11.9%	-22.1%	28.7%	10.9%	4.9%	15.8%	5.5%	-37.0%	26.5%	15.1%	2.1%

Exhibit 8a: BXM and S&P 500

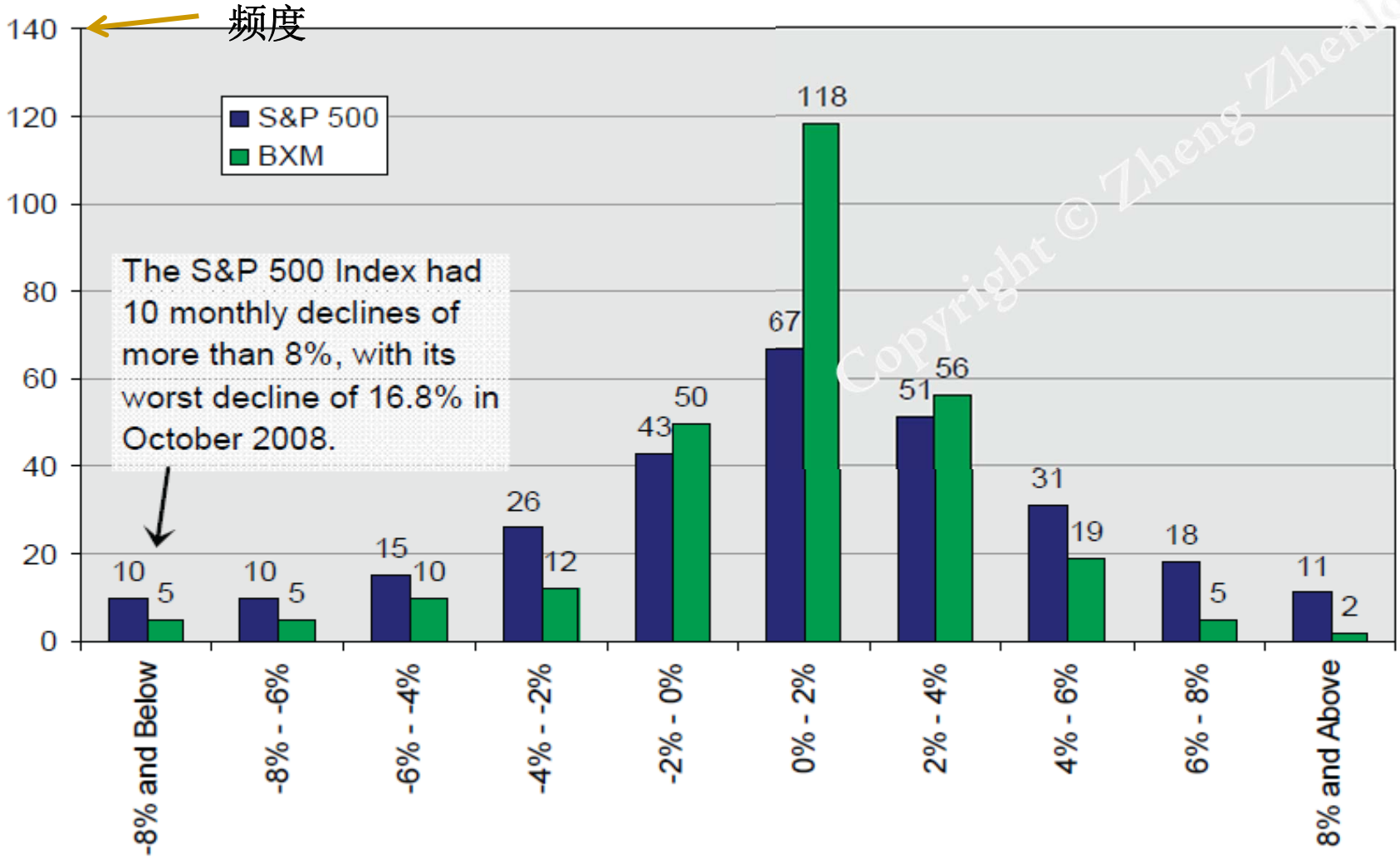


Exhibit 8a: The frequency of the BXM monthly returns is significantly greater in the –2.0% to +4.0% range highlighting the impact of the options. The distributions are tighter for the BXM reflecting cushion during declines and upside reduction.

Exhibit 8c: BXY and S&P 500

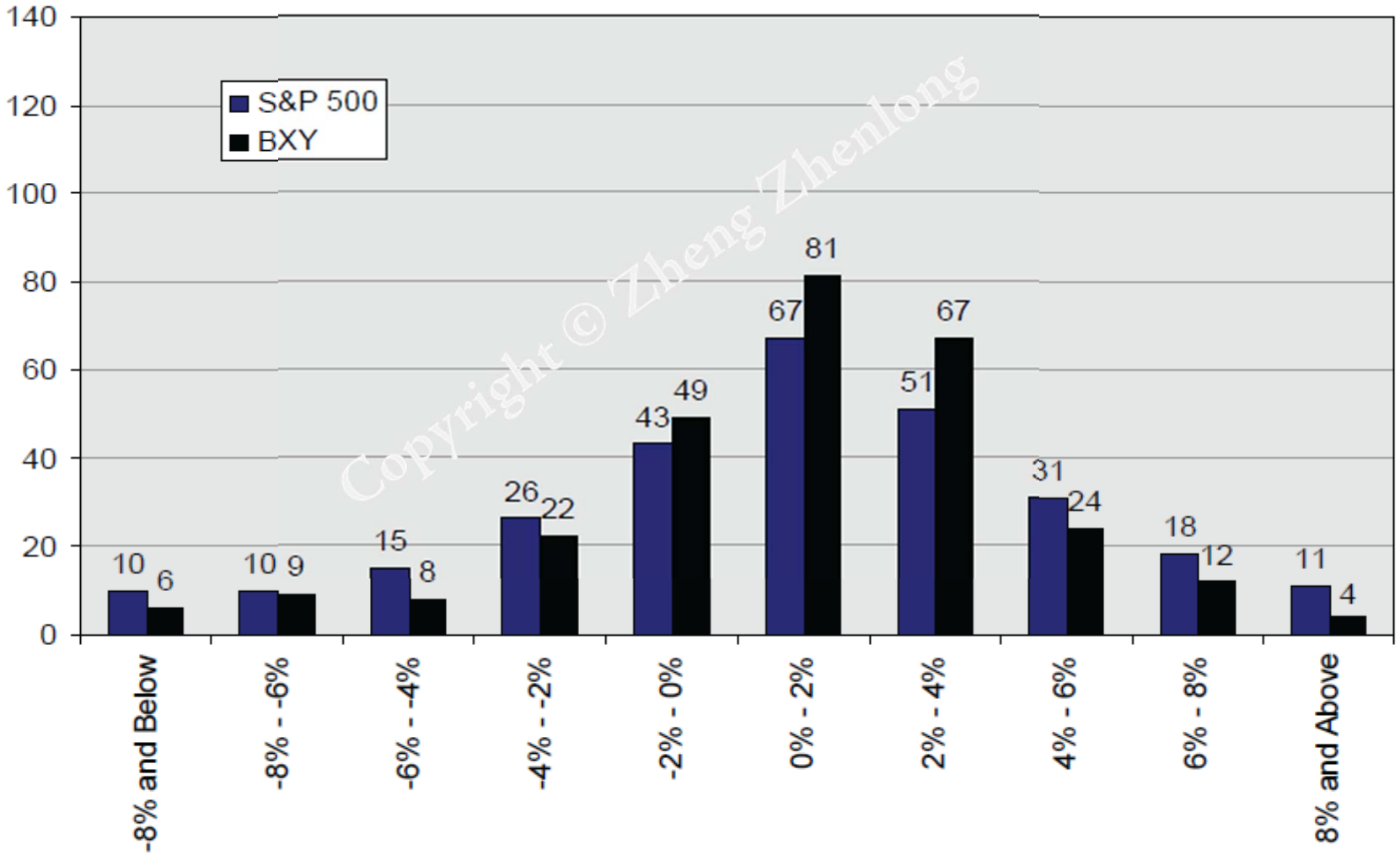


Exhibit 8c: The BXY chart shows greater frequency of higher returns than the BXM. The BXY had 91 months of returns in the +2.0% to +6.0% range versus 75 for the BXM.

Exhibit 8b: PUT and S&P 500

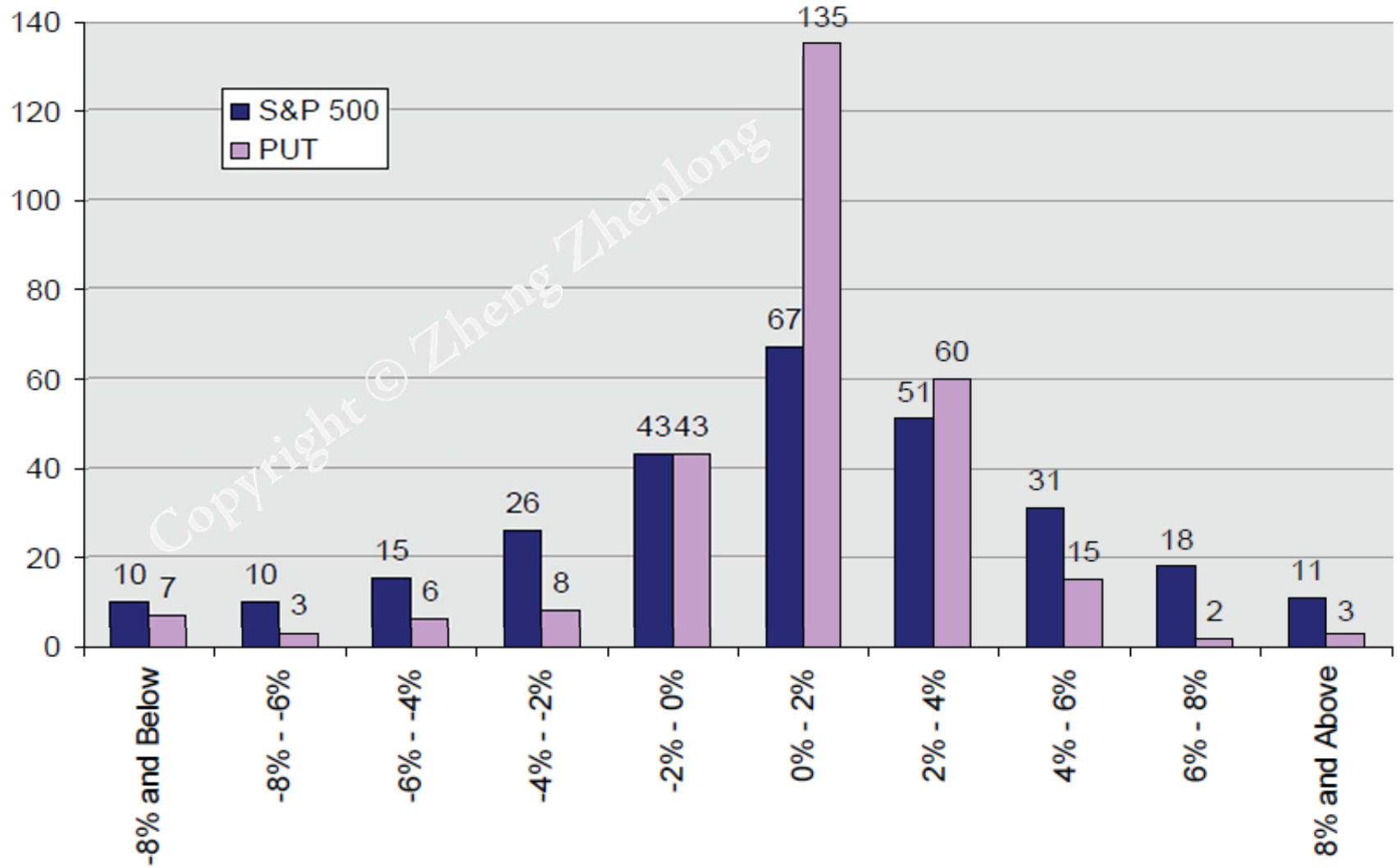


Exhibit 8b: The frequency of returns of the PUT are very similar to the BXM.

月度收益率的频率

	S&P 500	BXM	PUT	BXY	CLL
Positive Returns (#)	178	200	215	188	165
Negative Returns (#)	104	82	67	94	117
Total (#)	282	282	282	282	282
Positive Returns (%)	63%	71%	76%	67%	59%
Negative Returns (%)	37%	29%	24%	33%	41%
Total (%)	100%	100%	100%	100%	100%
Highest Month	11.4%	10.0%	9.0%	11.4%	8.3%
Lowest Month	-16.8%	-15.1%	-17.7%	-15.7%	-8.0%

更多策略：构造和描述

"Tail Risk" Benchmarks Designed to Reduce Risk of Extreme S&P 500 declines		
VXTH	S&P 500 +N long monthly 30 delta VIX calls The weight of VIX calls in the portfolio is a function of the forward value of VIX	More protection from extreme negative returns than "Cushion benchmarks" but also greater frequency of moderate negative returns
LOVOL	60% VXTH + 40% BXM	A smoothed, less volatile version of VXTH: Smaller protection from extreme negative returns but higher frequency of moderately positive returns
	Benchmarks Designed to Capture VIX Volatility Risk Premium	
VPD	Money market + short VIX futures	Greatest frequency of extreme positive returns, high frequency of extreme negative returns
VPN	Money Market + short VIX futures + long VIX calls	High frequency of extreme positive returns, caps the risk of extreme negative returns relative to VXTH

Table 2. Summary Statistics Rolling One Month Returns 2006-2012

Rolling 1-Month Returns									
2006-2012	SPTR	BXY	BXM	PUT	CLL	VXTH	LOVOL	VPD	VPN
Mean	0.39%	0.51%	0.33%	0.53%	0.05%	0.56%	0.48%	0.87%	0.78%
Median	1.41%	1.68%	1.26%	1.41%	0.47%	1.21%	1.25%	2.06%	1.87%
Ann. Std. Dev	18.98%	15.86%	13.88%	13.67%	11.86%	15.20%	13.44%	25.15%	22.04%
Neg. Dev.	14.33%	12.08%	10.97%	10.74%	8.76%	10.28%	9.45%	20.39%	17.20%
Pos. Dev.	12.47%	10.40%	8.55%	8.63%	7.98%	11.34%	9.67%	14.96%	13.99%
Skew	-1.00	-1.32	-1.63	-1.90	-0.34	-0.21	-0.43	-2.39	-1.63
Kurt.	3.74	5.29	7.26	8.81	-0.10	2.46	3.06	10.02	4.67
Return Frequencies									
<=-0.1	3.76%	2.86%	2.33%	2.39%		1.37%	1.43%	5.91%	6.21%
>-.1 and <=0	33.65%	30.73%	28.88%	26.19%	44.93%	36.10%	34.13%	26.97%	28.64%
Total Negative	37.41%	33.59%	31.21%	28.58%	45.05%	37.47%	35.56%	32.88%	34.84%
>0 and <=.1	60.38%	65.16%	68.20%	70.94%	54.89%	60.74%	63.54%	64.02%	62.77%
>.1	2.21%	1.25%	0.60%			1.79%	0.89%	3.10%	2.39%
Total Positive	63%	66%	69%	71%	55%	63%	64%	67%	65%

更多细节
（以保护性Short Call为例）

如何选择协议价格？

ATM表现最好　原因时间价值最大

Exhibit 6: Daily rolls of one week options – strikes: 95%, 98%, 100%, 102 & 105%

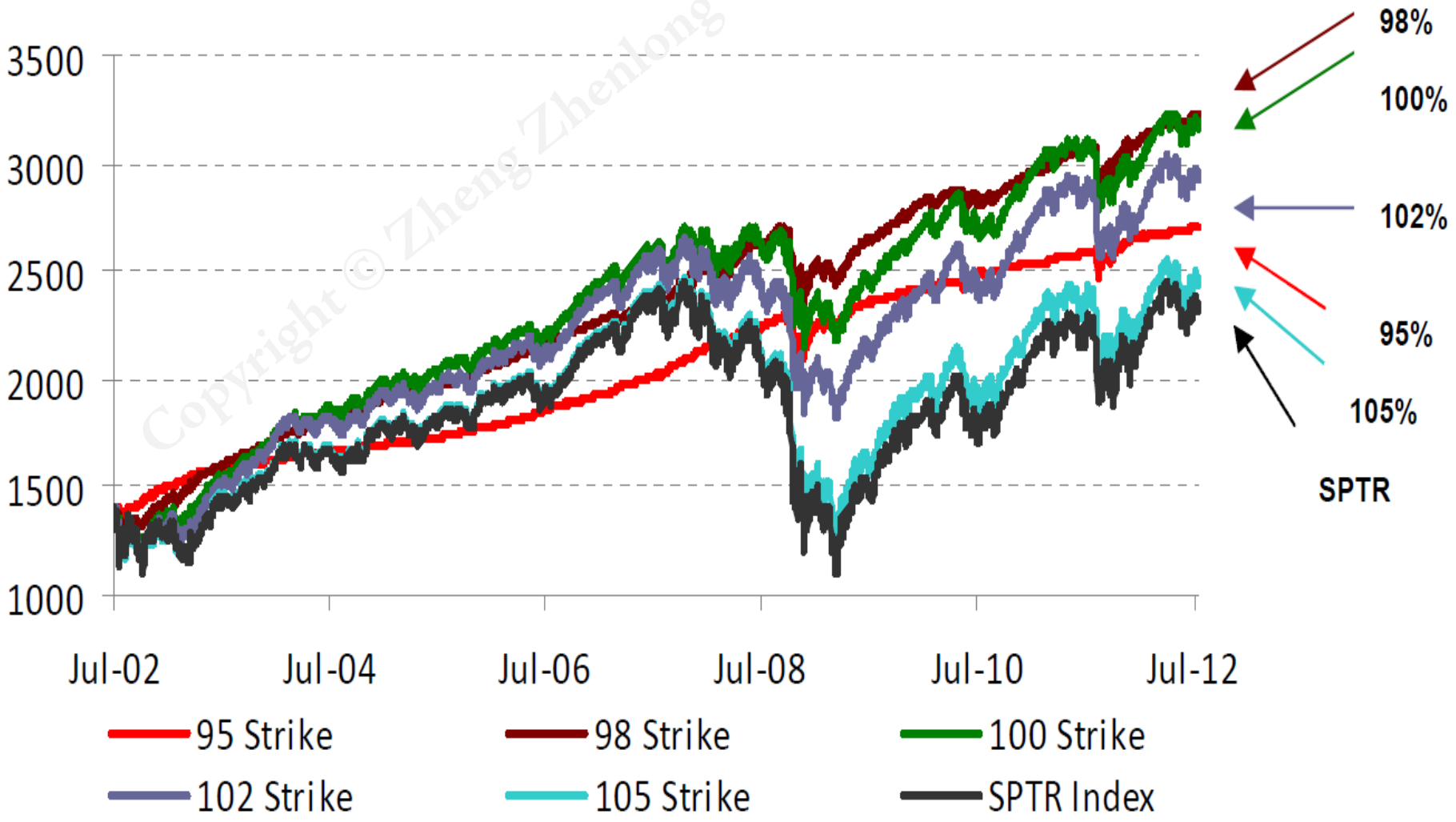
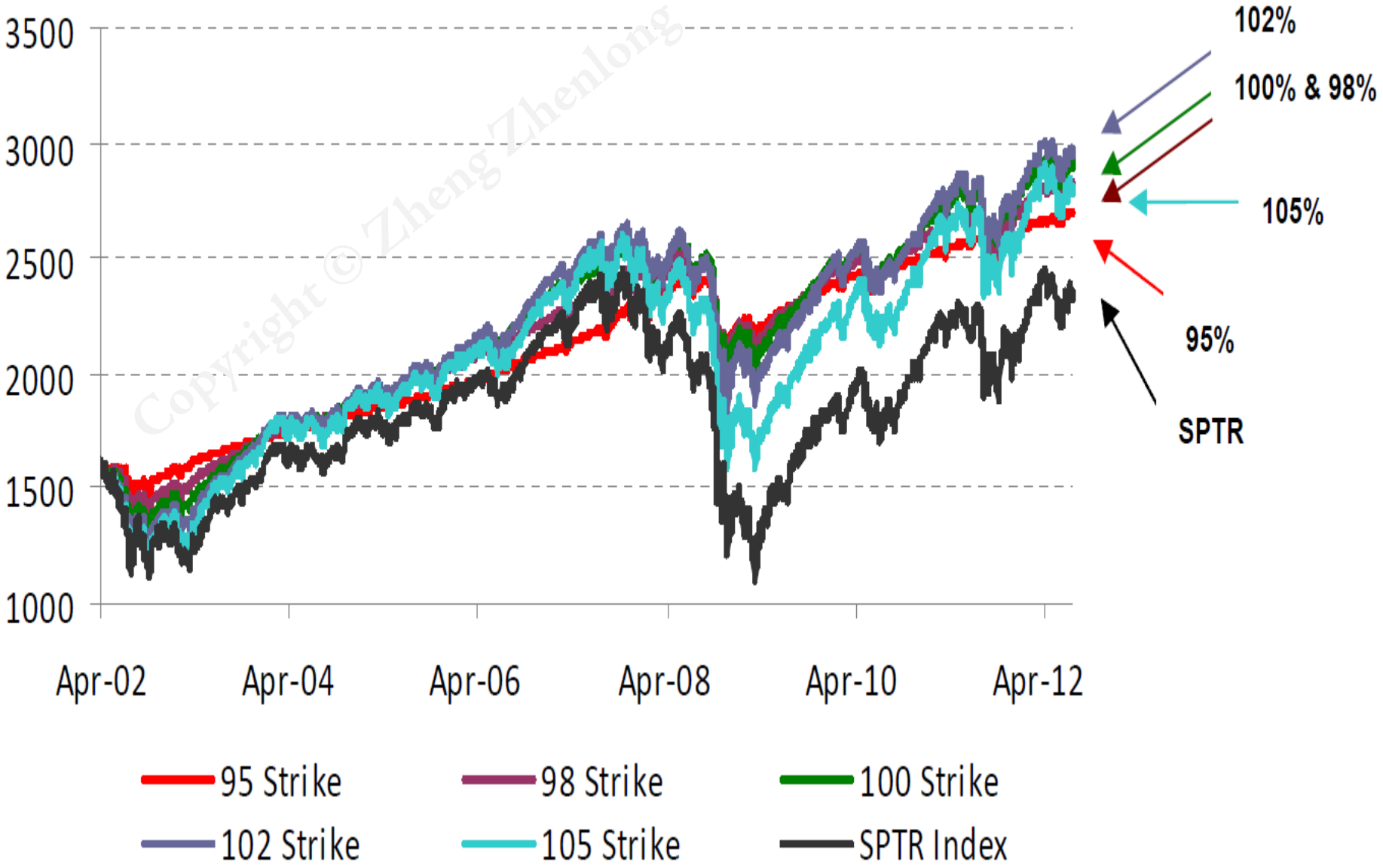


Exhibit 7: Daily rolls of one month options – strikes: 95%, 98%, 100%, 102 & 105%



什么期限好？
短期期权表现最好，因为时间价值衰减最快

Exhibit 8: Comparison of weekly, monthly, quarterly, and yearly tenor ATM option premiums received on an annual basis[1]

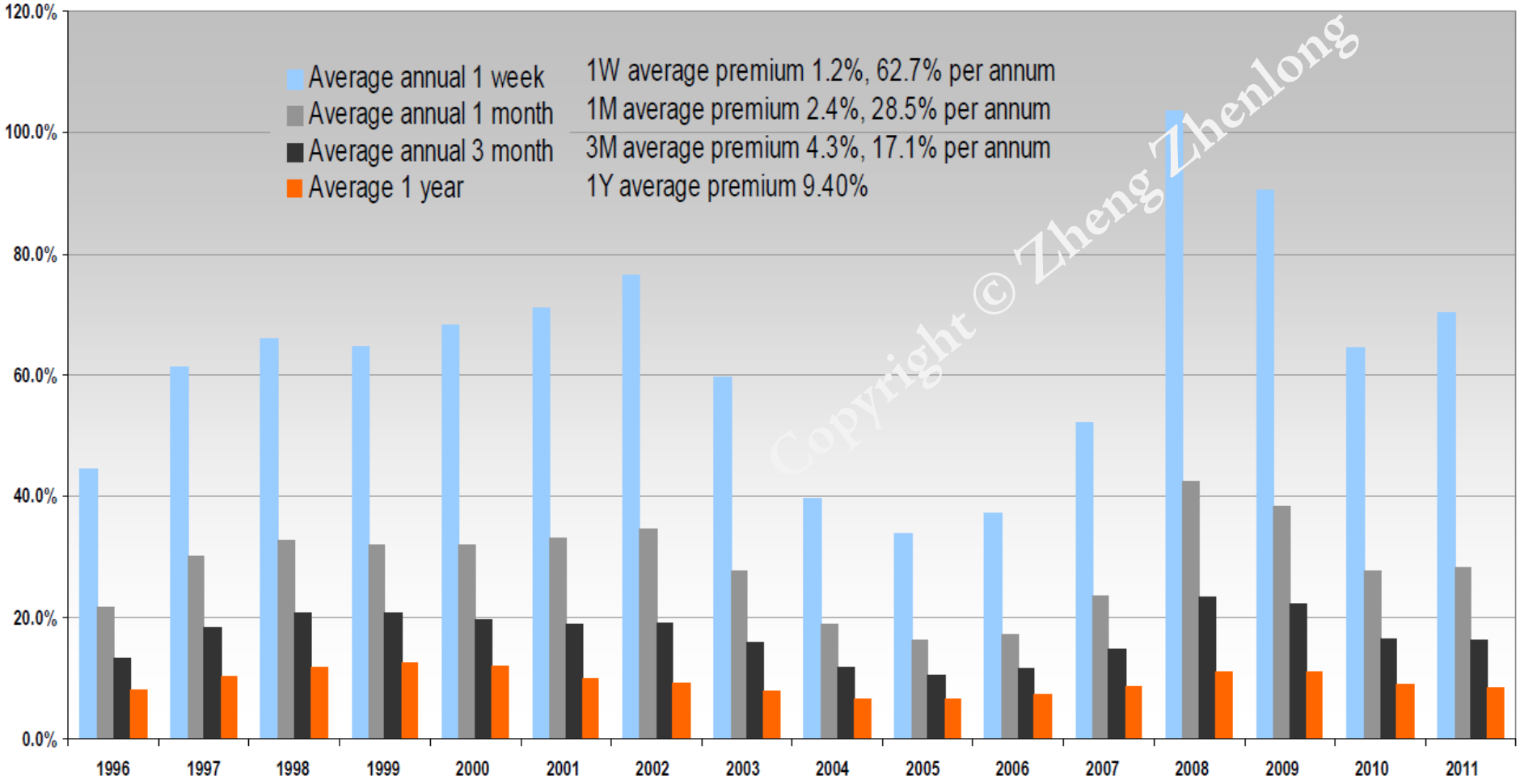
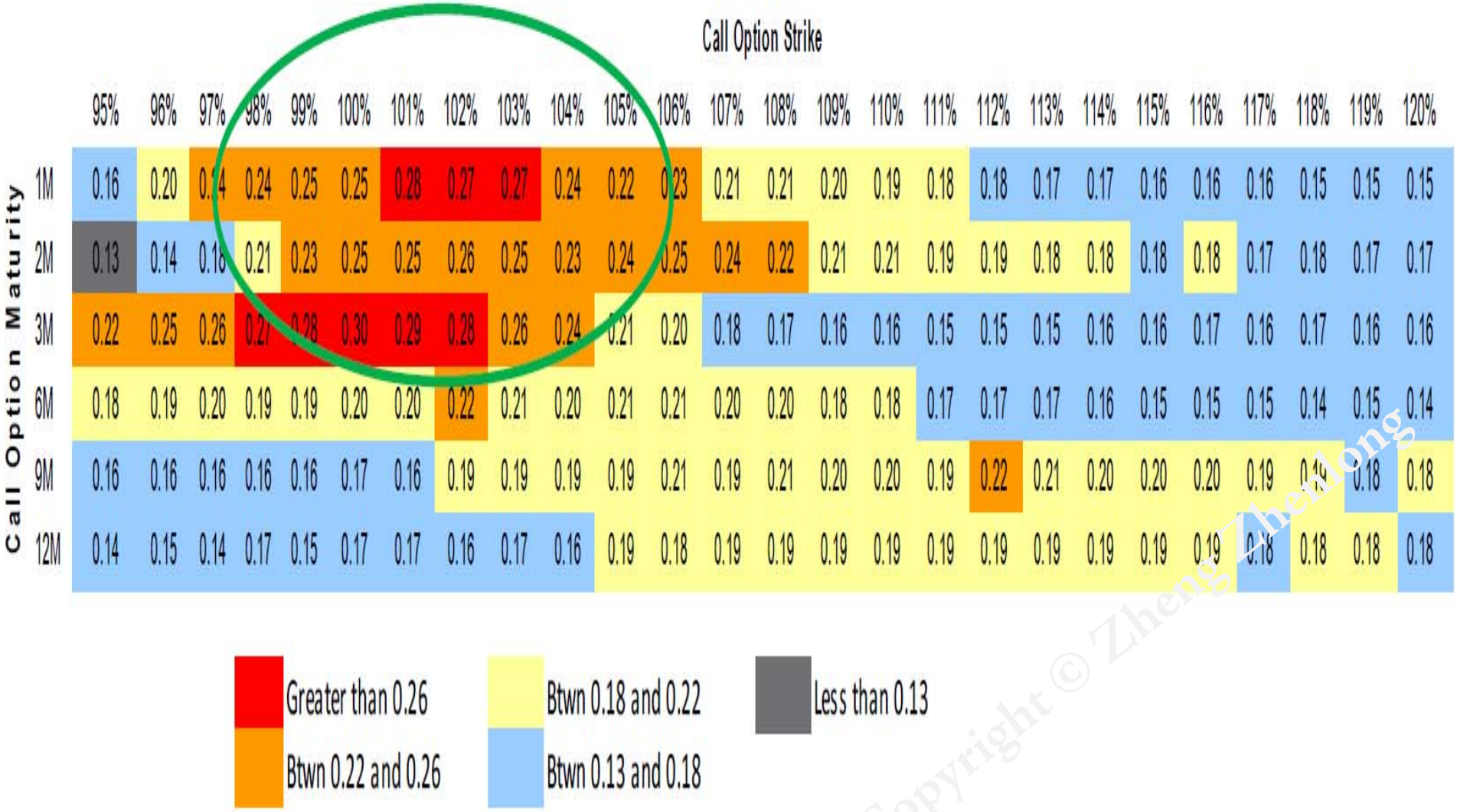


Exhibit 9: Sharpe ratios of systematic S&P 500 covered call strategies, Dec 20, 1996 to June 29, 2012. Sharpe ratio S&P 500 = 0.13



三：哪天卖？

Exhibit 10: Daily rolls of one week ATM options

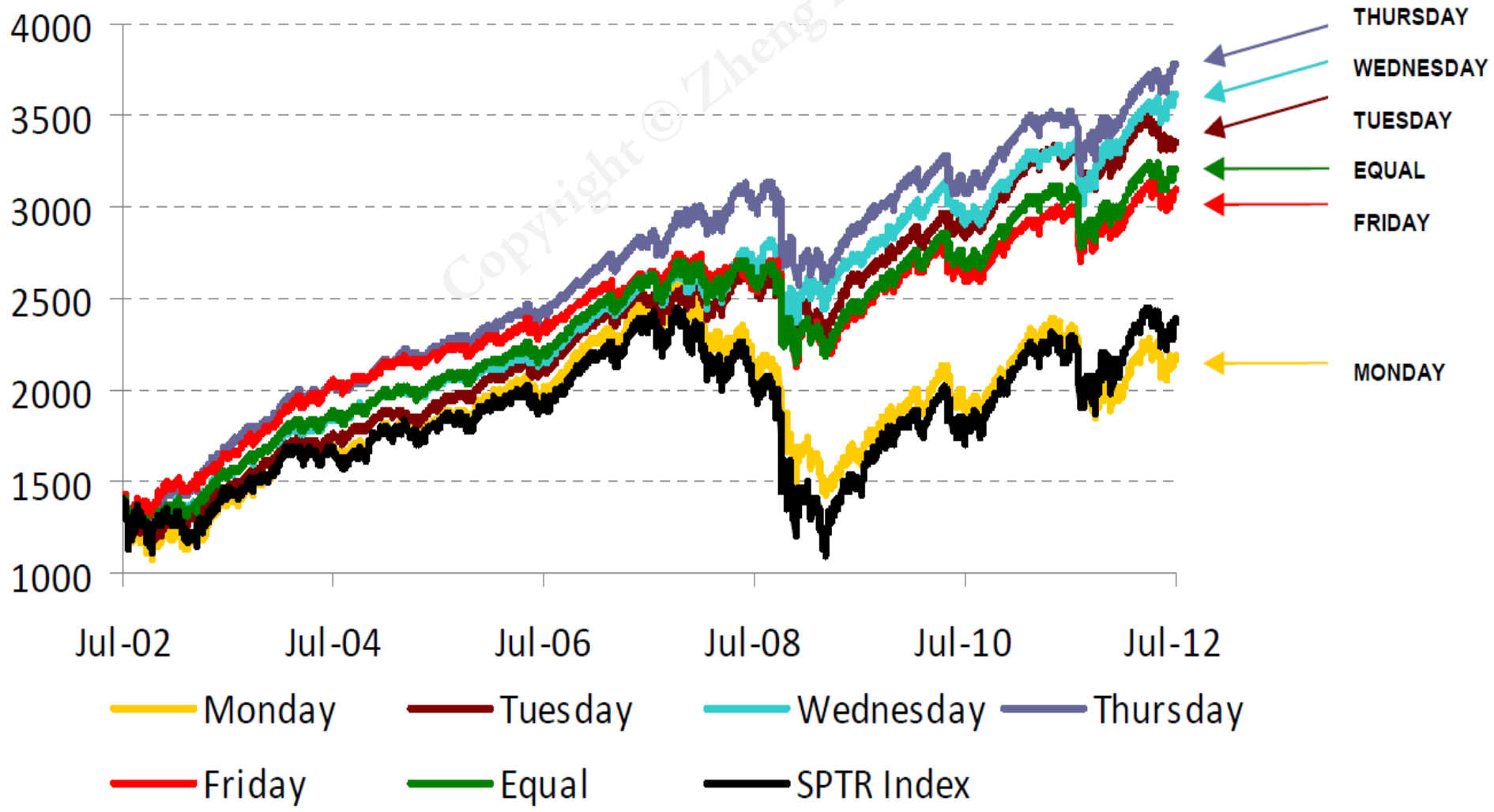
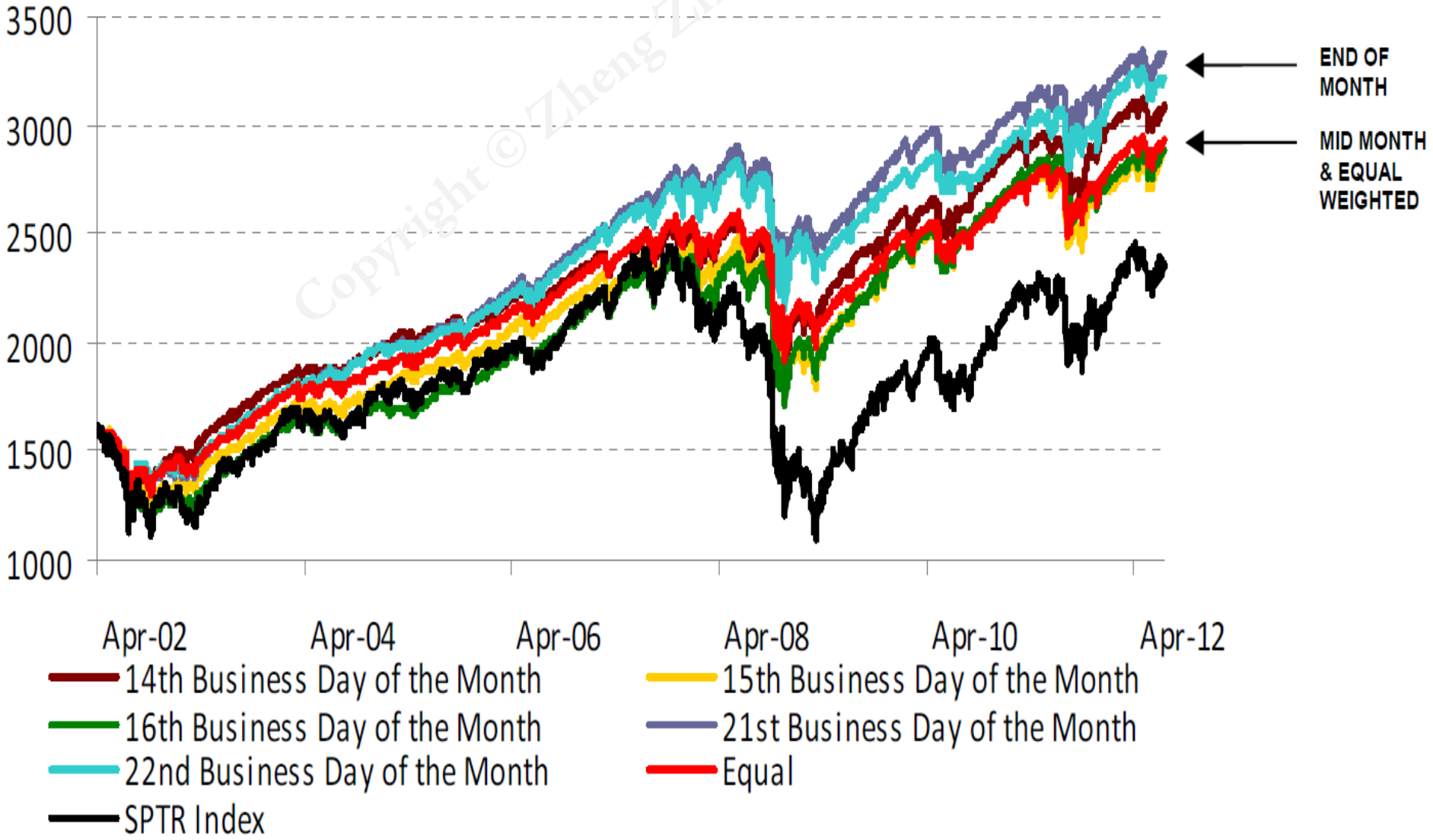


Exhibit 11: Daily rolls of one month ATM options



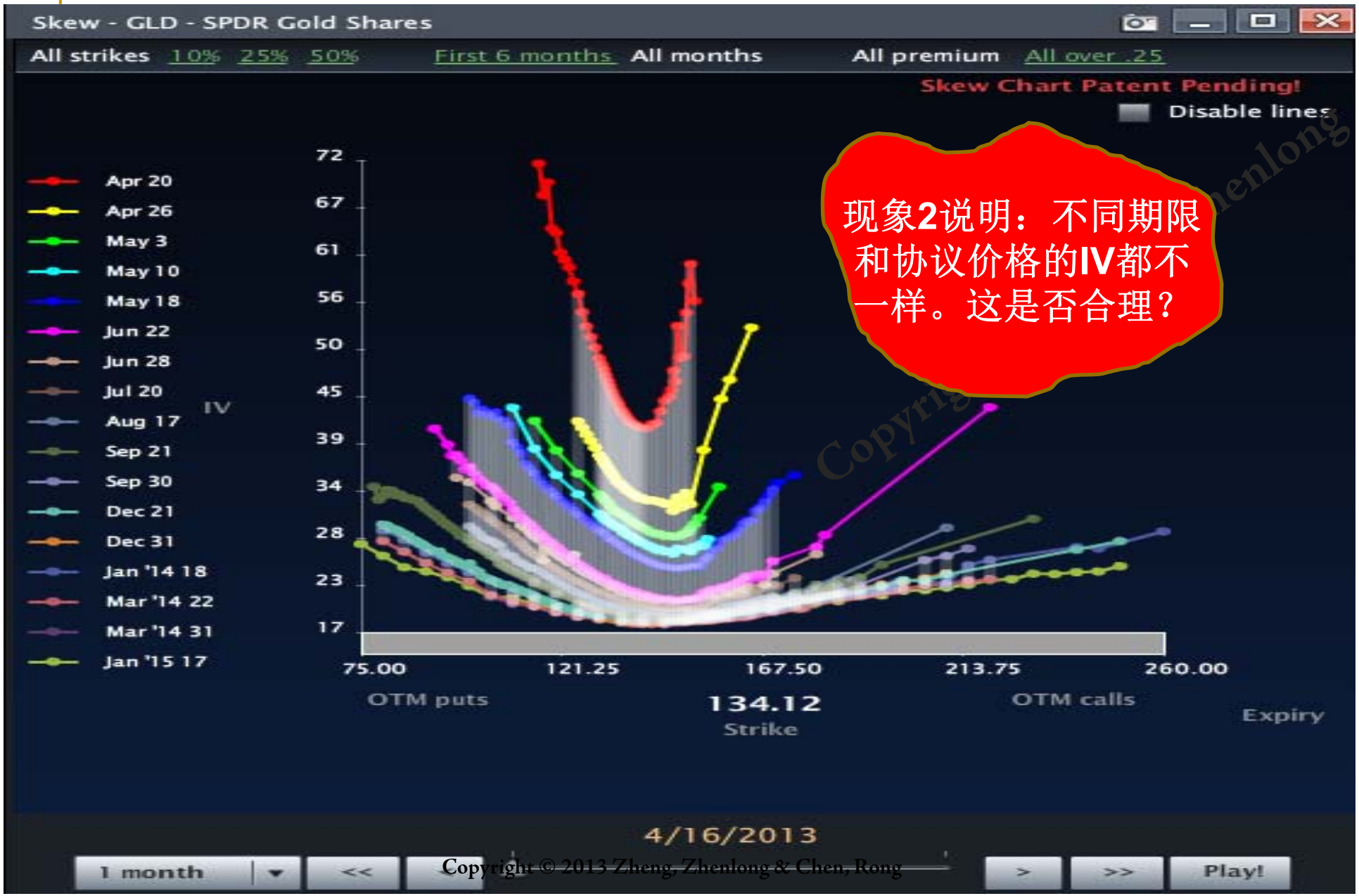
如何赚钱2：复制期权

实践问题：如何制定交易策略？

- 卖出价格高估的期权，然后复制期权，力图实现无风险套利。
- 所谓期权复制，就是利用现货、期货和（或）期权来生产期权。只要生产成本低于期权卖价，就能保证一定赚钱。
- 换一种思路：我们可以卖出价格被高估的期权，然后用其他证券动态对冲，形成套利组合。只要这个组合对标的资产价格、波动率、利率等都不敏感，我们就实现了无风险套利的目的。因此复制的关键是敏感性分析。

利用相对定价偏差的策略

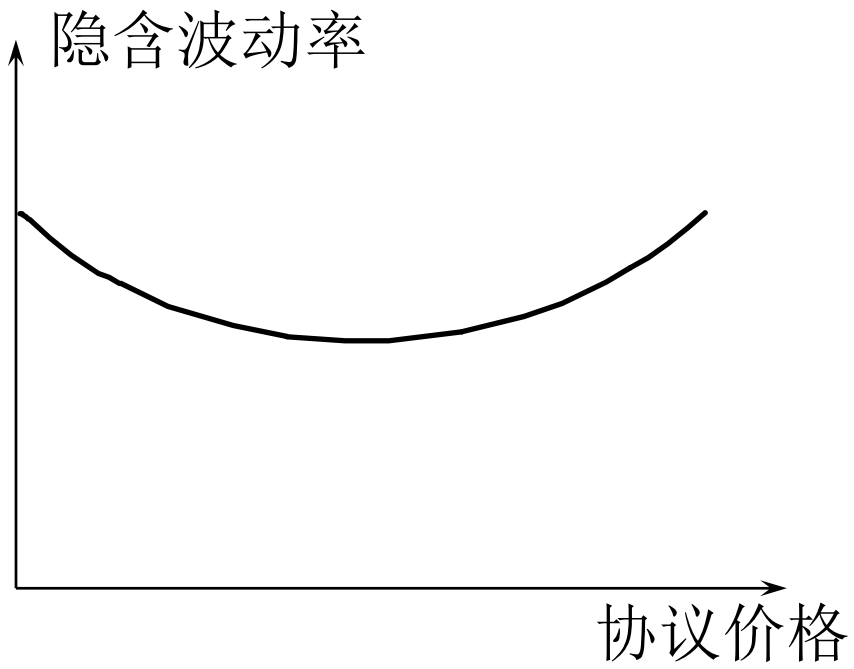
现象2：现实中的波动率曲面



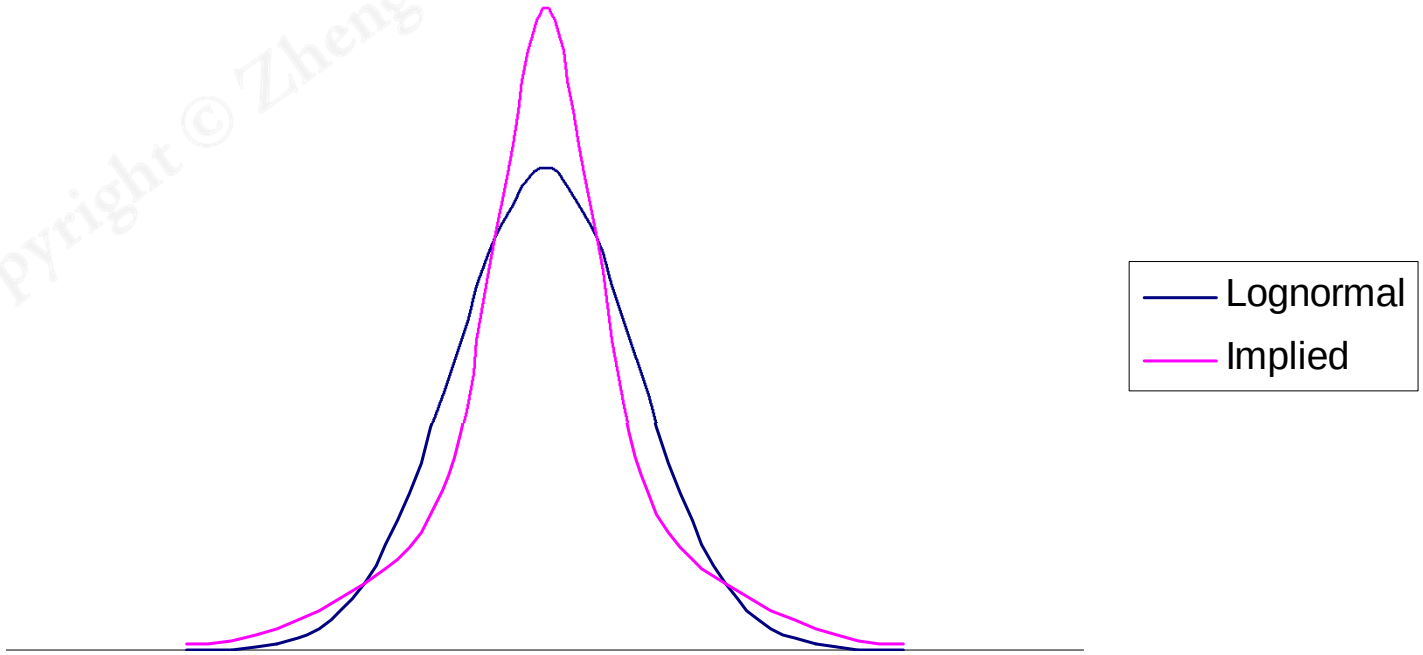
波动率微笑：IV与X的关系

- 同一期限不同协议价格的期权价格所隐含的波动率与该协议价格之间的关系曲线，就是波动率微笑。
- **理论上，看涨期权与看跌期权的波动率微笑应该相等。**

外汇期权的波动率微笑



外汇期权的隐含分布



外汇期权隐含波动率的可能原因

- 汇率经常跳跃而不是连续变动
- 汇率波动率是随机的

如何从期权价格中提取隐含分布

$$c = e^{-rT} \int_{S_T=K}^{\infty} (S_T - K) g(S_T) dS_T$$

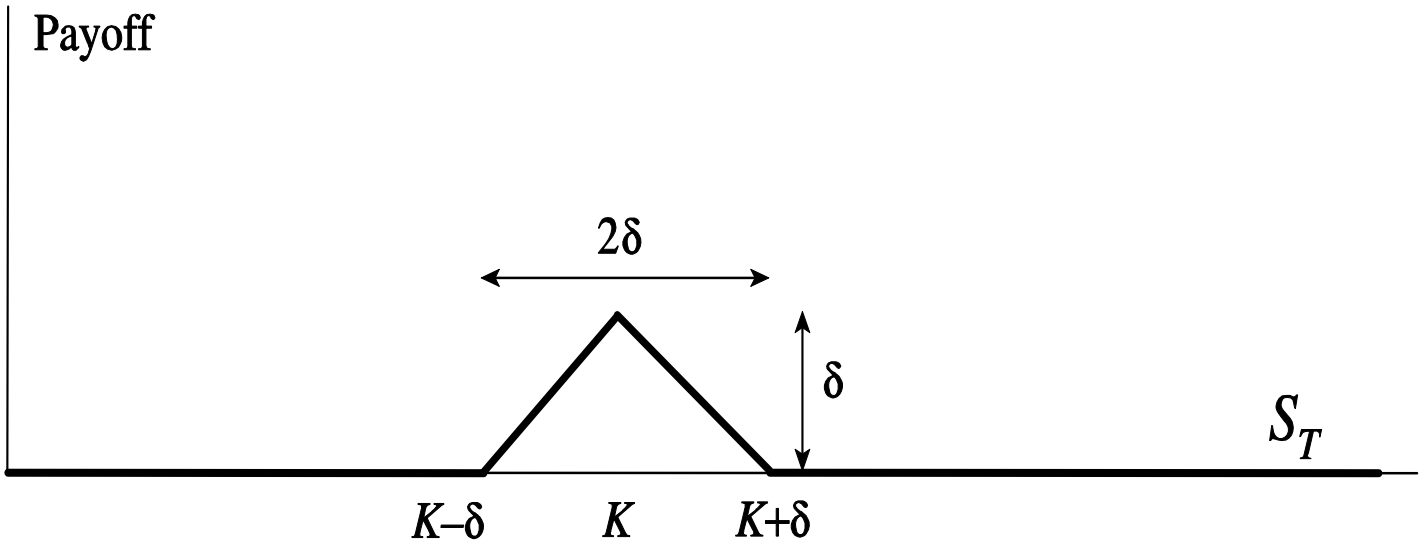
$$\frac{\partial^2 c}{\partial K^2} = e^{-rT} g(K)$$

如果$c_1, c_2, \text{and } c_3$分别表示协议价格为

$K - \delta, K, \text{and } K + \delta$的看涨期权价格，则

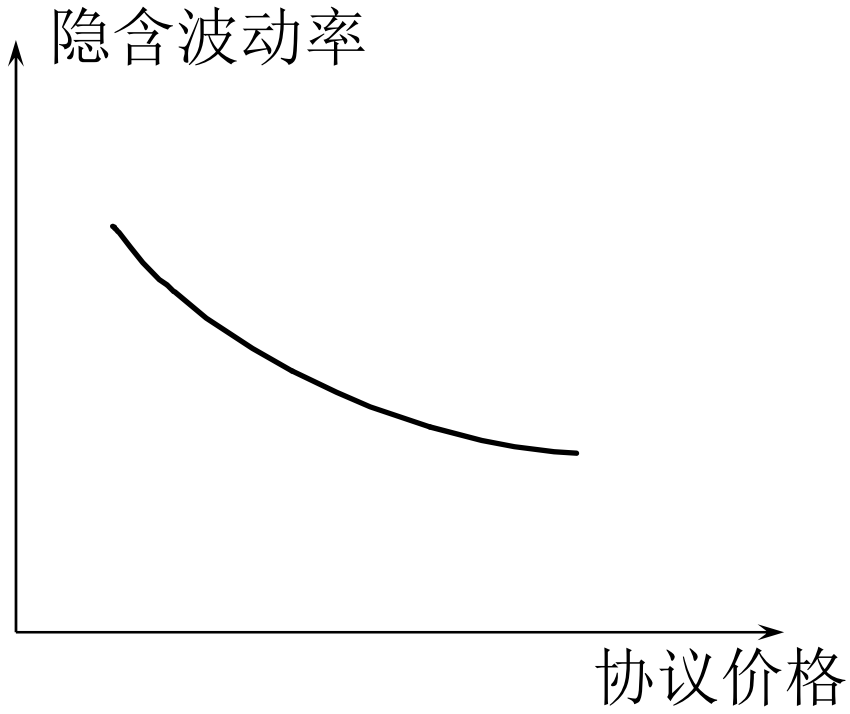
$$g(K) = e^{rT} \frac{c_1 + c_3 - 2c_2}{\delta^2}$$

几何解释



假设$K-\delta$ 到 $K+\delta$的密度函数为$g(K)$,
则$c_1 + c_3 - 2c_2 = e^{-rT}\,\delta^2\,g(K)$

股票期权的波动率微笑



股票期权的隐含分布

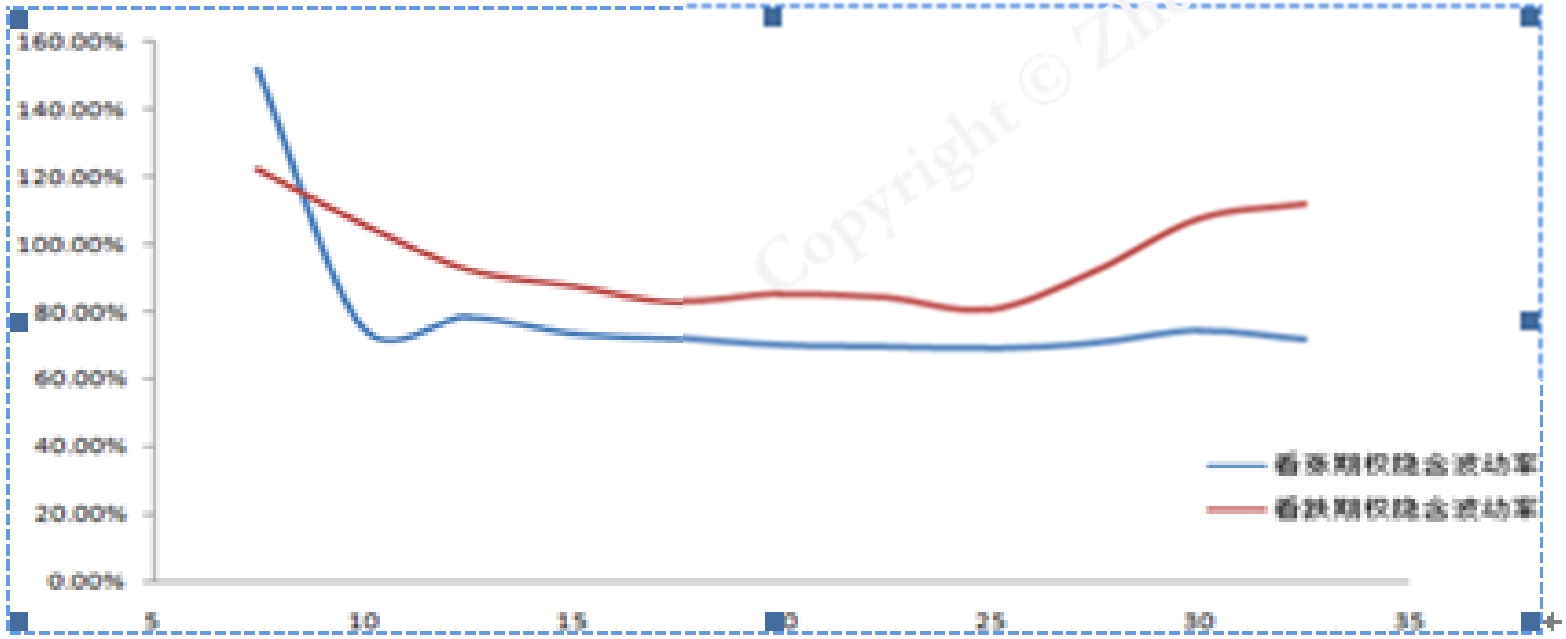
股票期权隐含波动率负偏的可能原因

- 下跳多于上跳。
- 波动率是风险度量，股价下跌时公司杠杆增大，风险也增大。
- 投资者愿意买虚值看跌期权来保护投资组合，使低协议价格的隐含波动率提高；投资者常常卖虚值看涨期权来增加收入，从而降低高协议价格的隐含波动率。

股价指数比个股更负偏

- 股价指数比个股跟负偏
  - 原因：股价下跌时个股相关性提高。
- 因此指数隐含偏度取决于个股隐含偏度和隐含相关性偏度。
- 同理，高度分散的股价指数比分散度较低的股价指数更负偏。

花期银行股票的波动率微笑



协议价格

图 10　2008 年 10 月 20 日花旗银行股票的波动率微笑

注：当天股价等于 15.09 美元。

资料来源：作者计算。

花期银行股票的波动率微笑

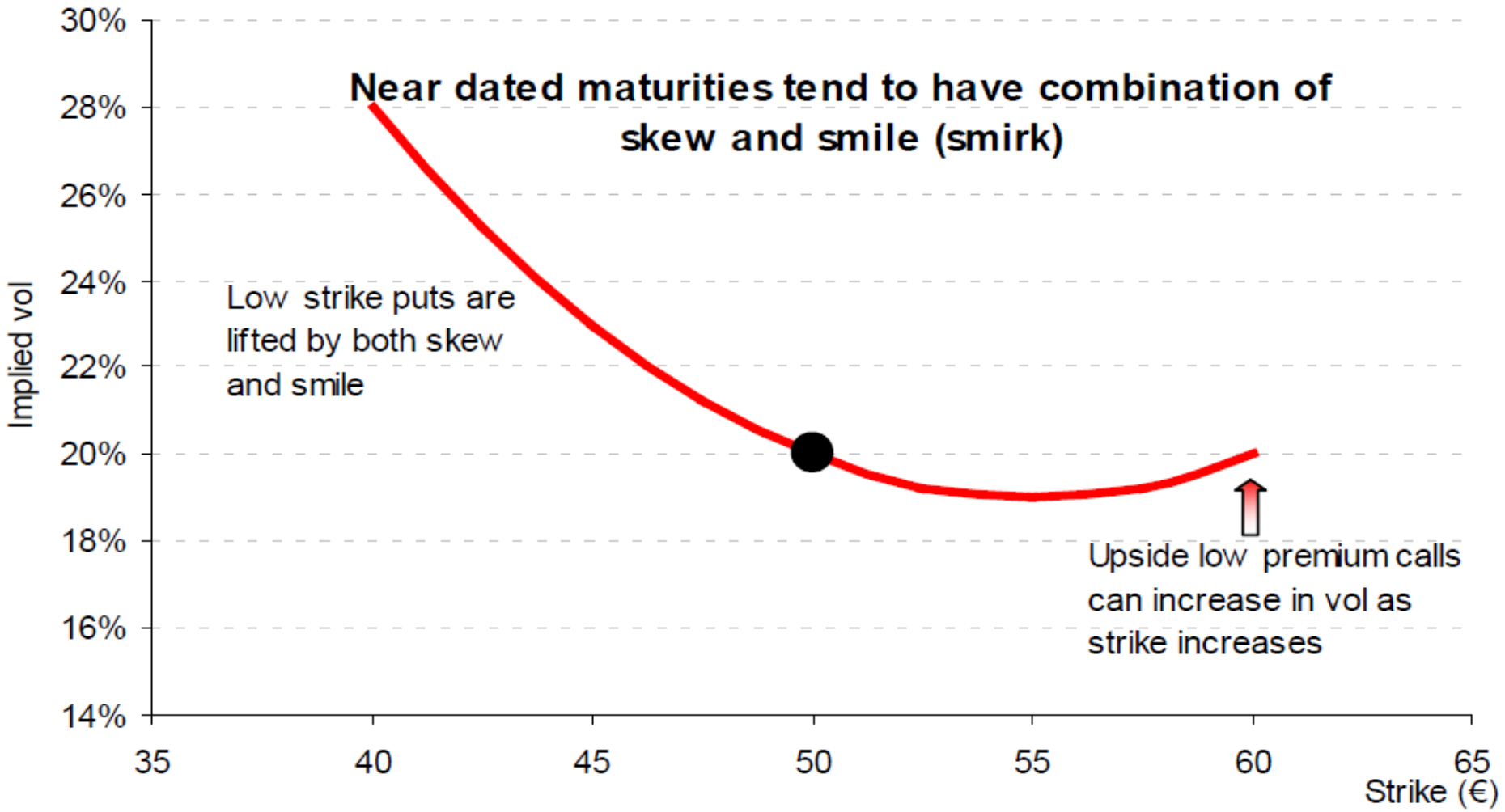
- 该股票波动率微笑却呈现两头翘起的典型“微笑”形状，这说明在金融危机最严重之时，市场预测花旗银行未来大涨和大跌的概率都较大，说明市场对花旗银行的未来命运存在较大分歧；此外，看跌期权价格的隐含波动率大于看涨期权的隐含波动率，这说明市场较为悲观。

如何描述波动率微笑？

- 横坐标用 K/S_0
- 横坐标用K/F0，或者更准确用$\ln(\frac{k}{F_0})$
- 横坐标用期权的delta
  - Note: traders sometimes define at-the money as a call with a delta of 0.5 or a put with a delta of −0.5. Th ese are referred to as "50-delta options"

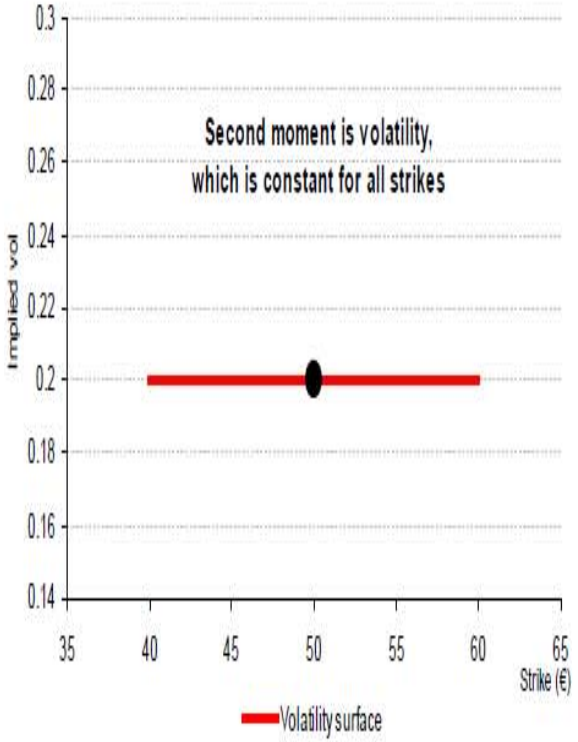
隐含波动率假笑是三阶矩和四阶矩的结合

Figure 93. Near-Dated Implied Volatilities with Smirk (Skew and Smile)

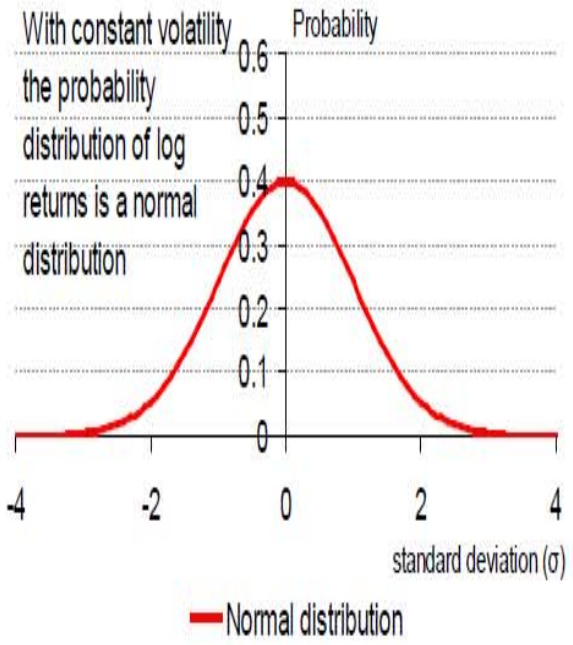


VEGA衡量波动率的头寸

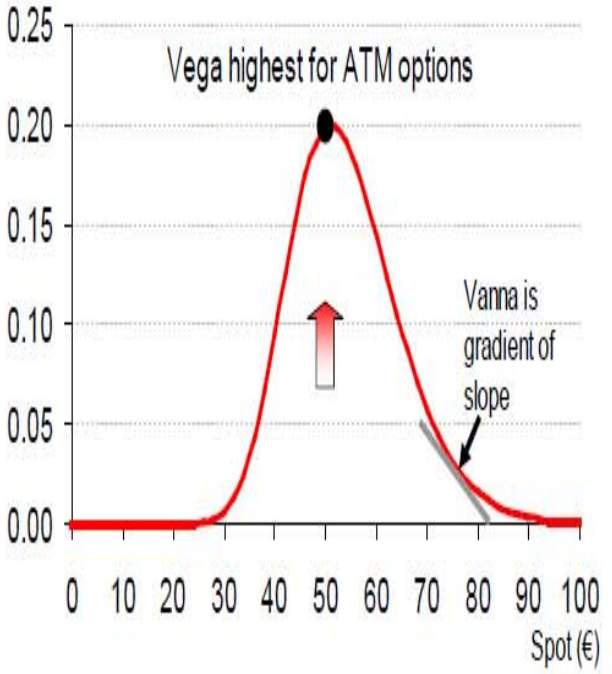
Figure 90. Moment 2 = Variance



Distribution for Constant Volatility



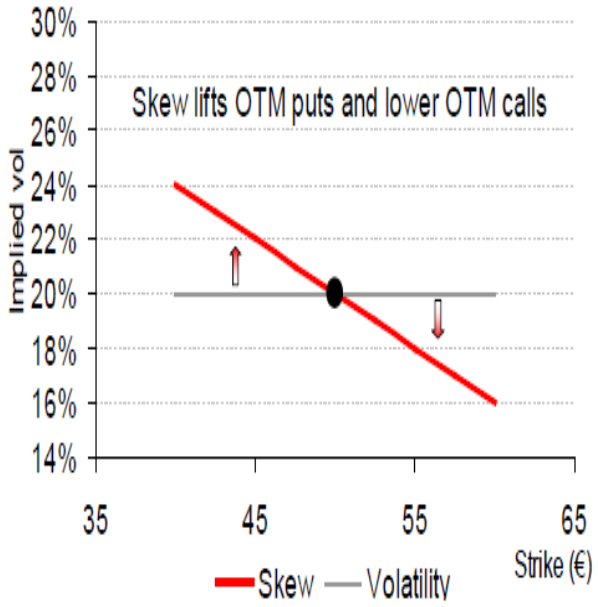
Vega is Size of Volatility Position



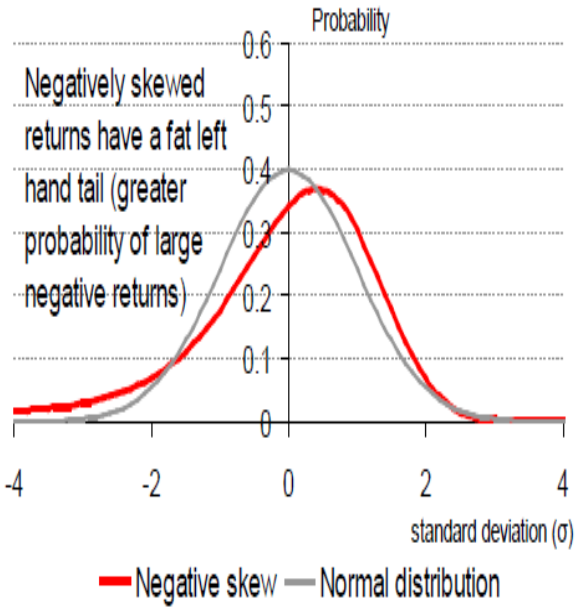
VANNA衡量偏度的头寸

- Vanna ＝dVega/dS ＝dDelta/dVol

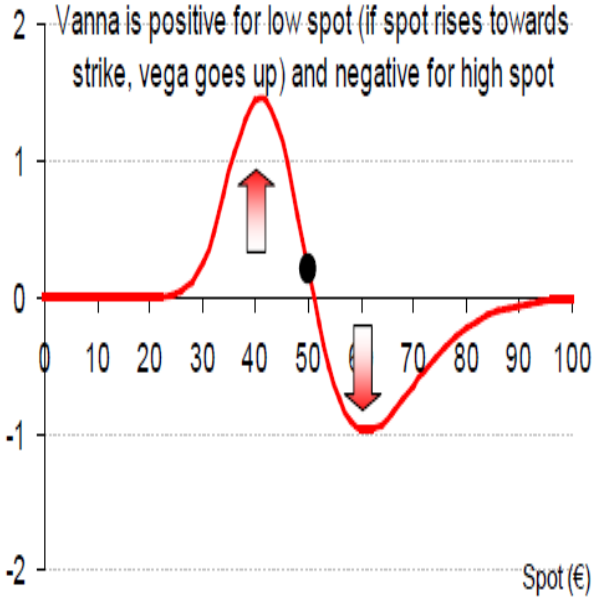
Figure 91. Moment 3 = Skew[31]



Distribution with Skew



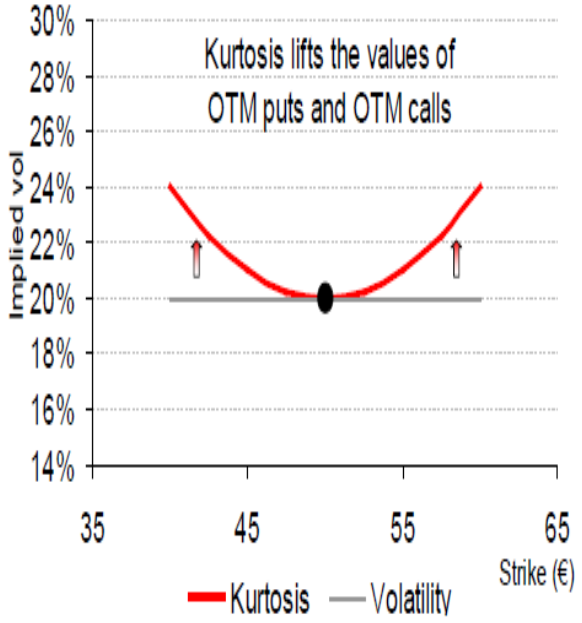
Vanna is Size of Skew Position



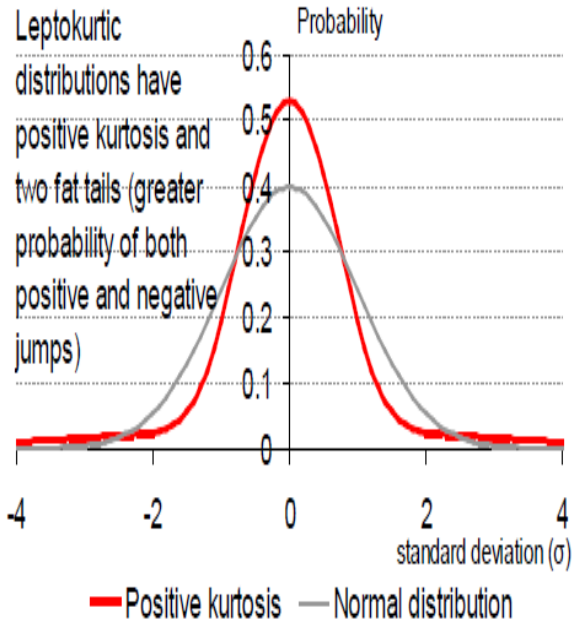
VOLGA衡量波动率曲度的头寸

- Volga = dVega / dVolatility

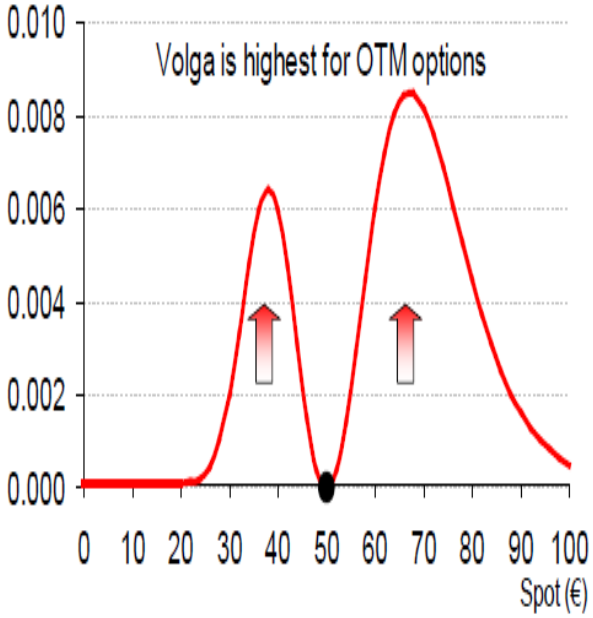
Figure 92. Moment 4 = Kurtosis[31]



Distribution with Kurtosis



Volga = Gamma of Vol



波动率期限结构

- 隐含波动率与期限的关系

July	15.7%	15.3%	14.8%	14.9%	15.3%	
June	14.6%	14.1%	13.7%	13.5%	13.3%	
May	13.5%	13%	12.7%	12.2%	11.8%	
	7300	7400	7500	7600	7700	

花期银行股票的波动率期限结构

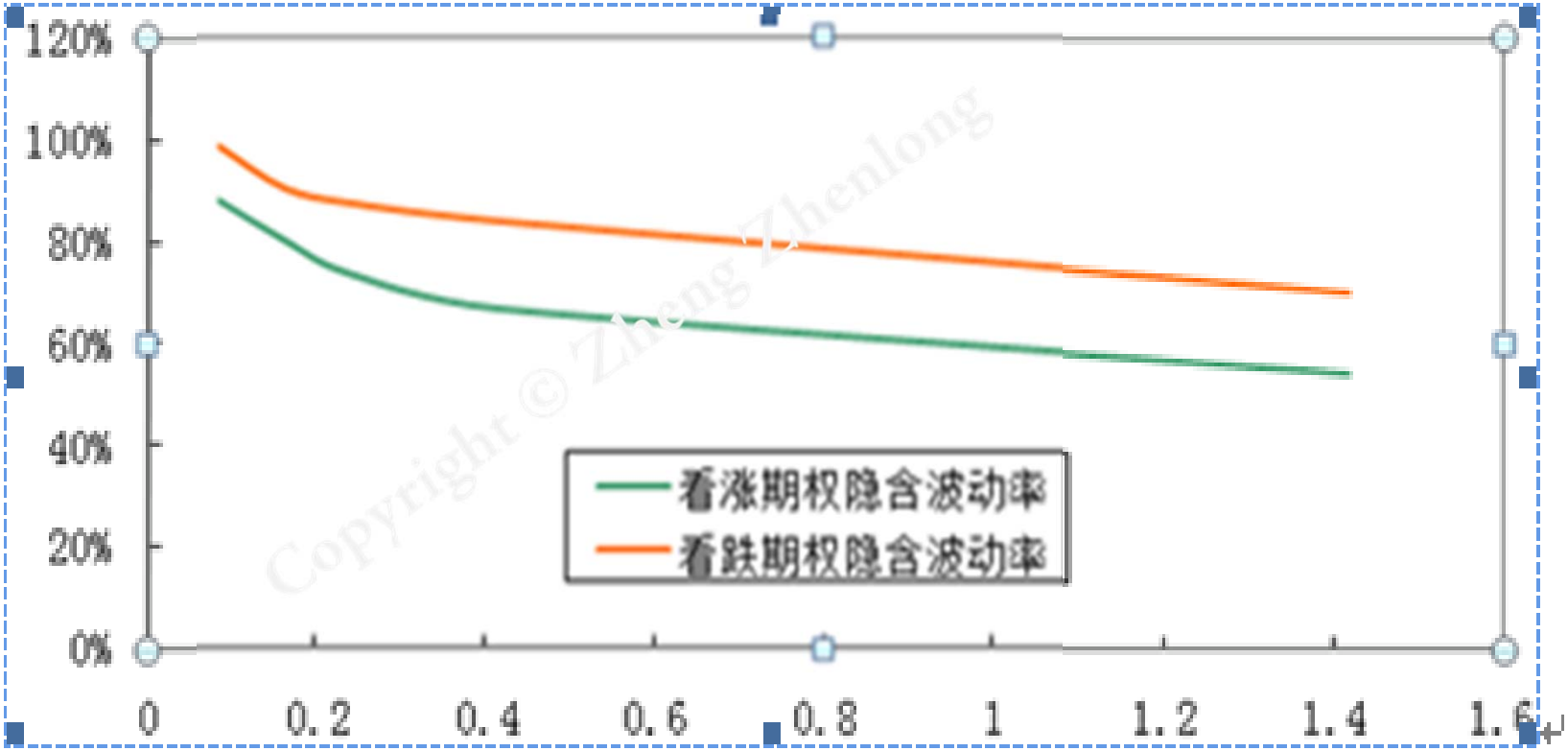


图 11　花旗银行股票波动率的期限结构（2008 年 10 月 20 日）

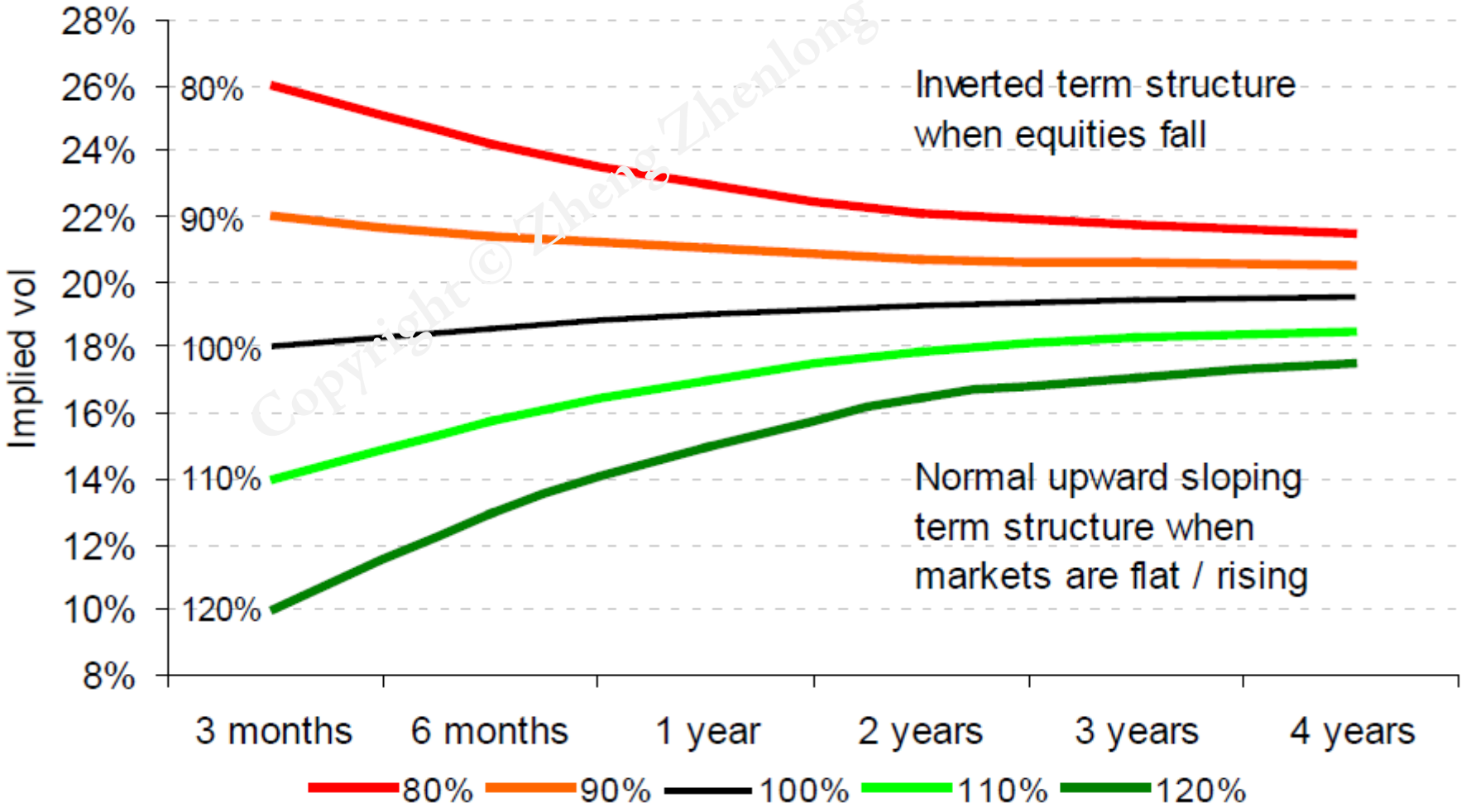
注：协议价格为 15 美元，当天股价为 15.09 美元。

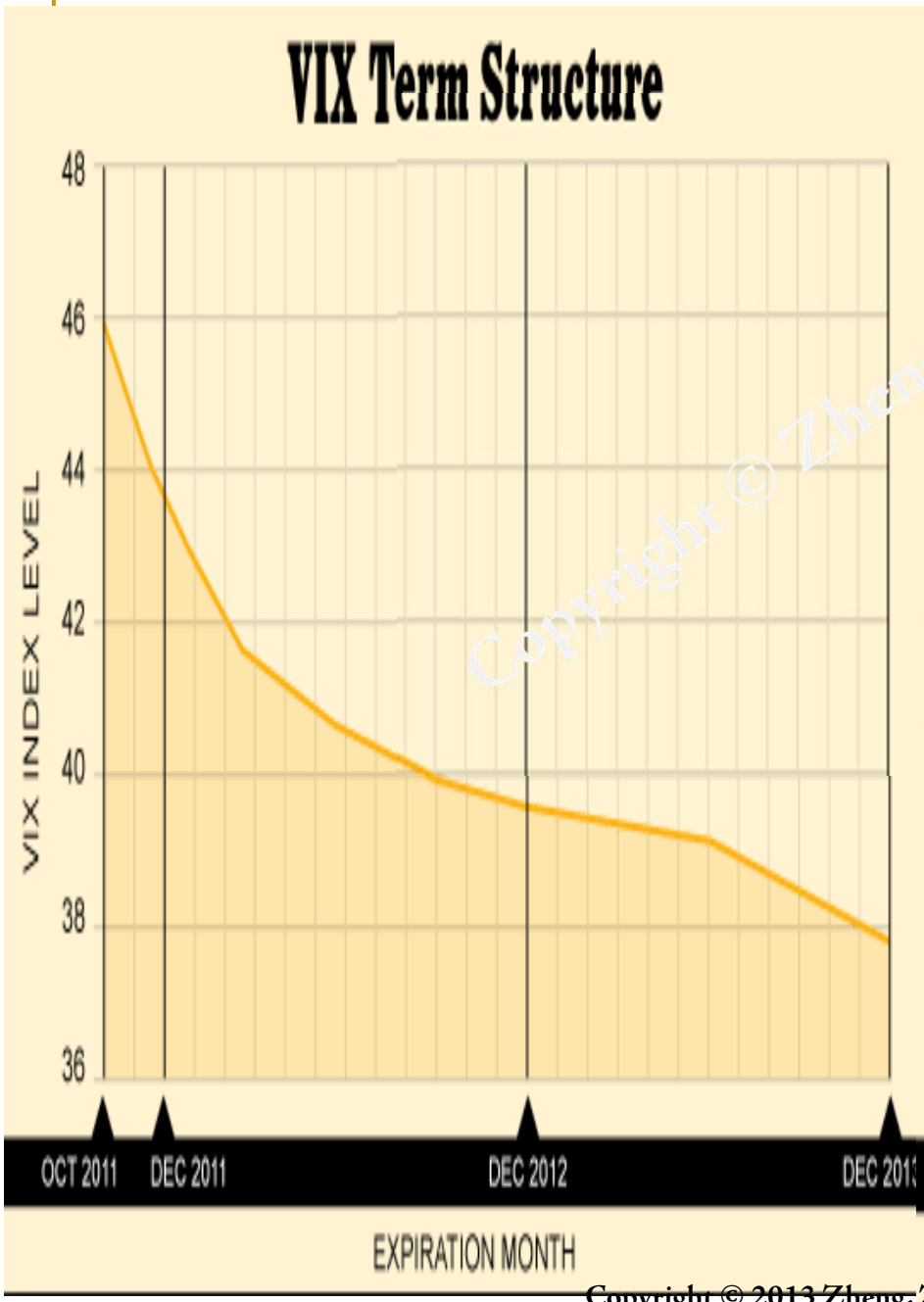
花期银行股票的波动率期限结构

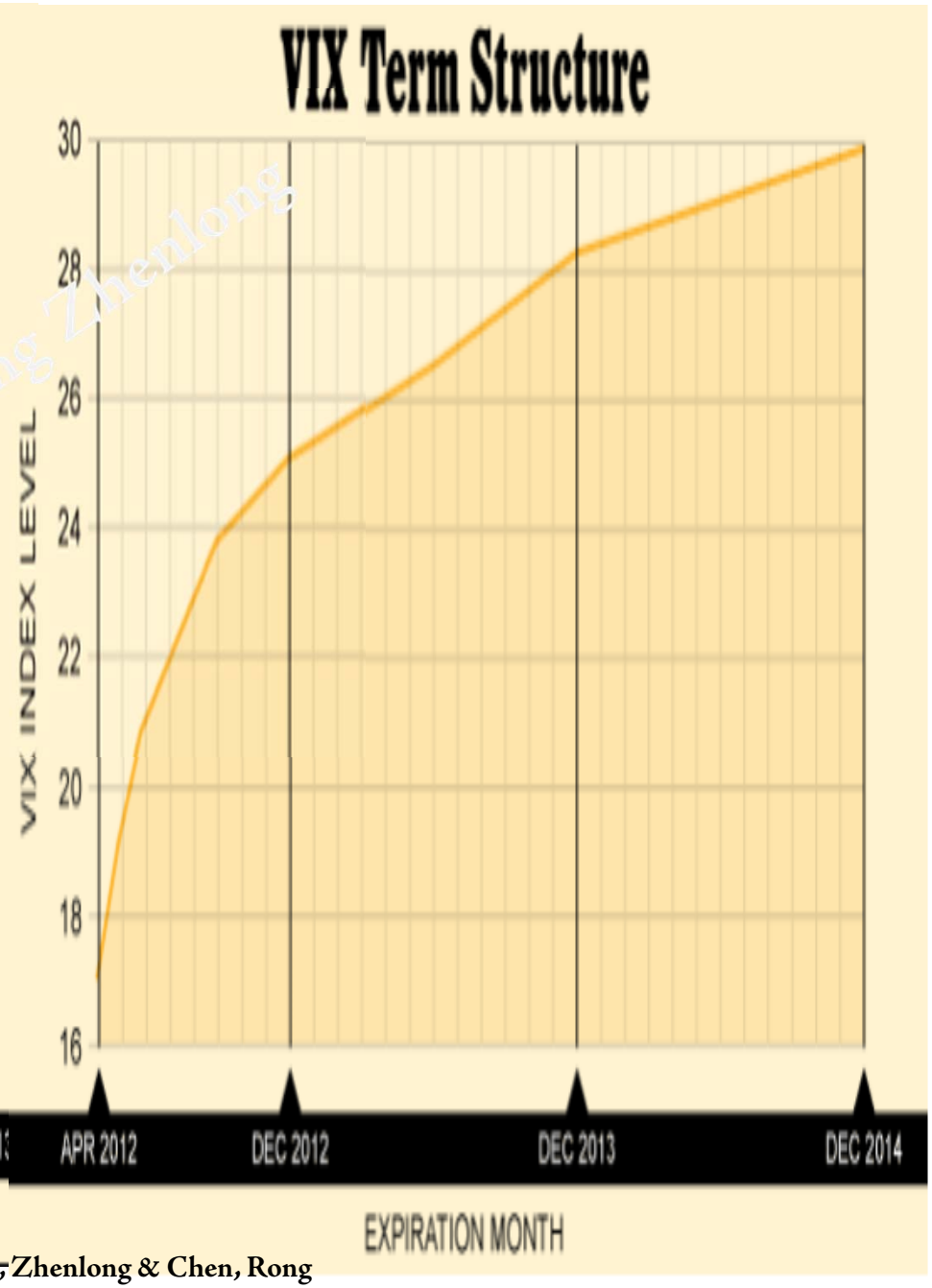
- 从图上可以看出，期限越长，隐含波动率越低，这说明市场普遍预期，随着时间推移花旗银行股票的波动率会逐渐变小。另外，看跌期权的隐含波动率始终大于看涨期权的隐含波动率，再一次说明此时市场比较悲观。

市况与波动率的期限结构

Figure 78. Term Structure for Options of Different Strikes







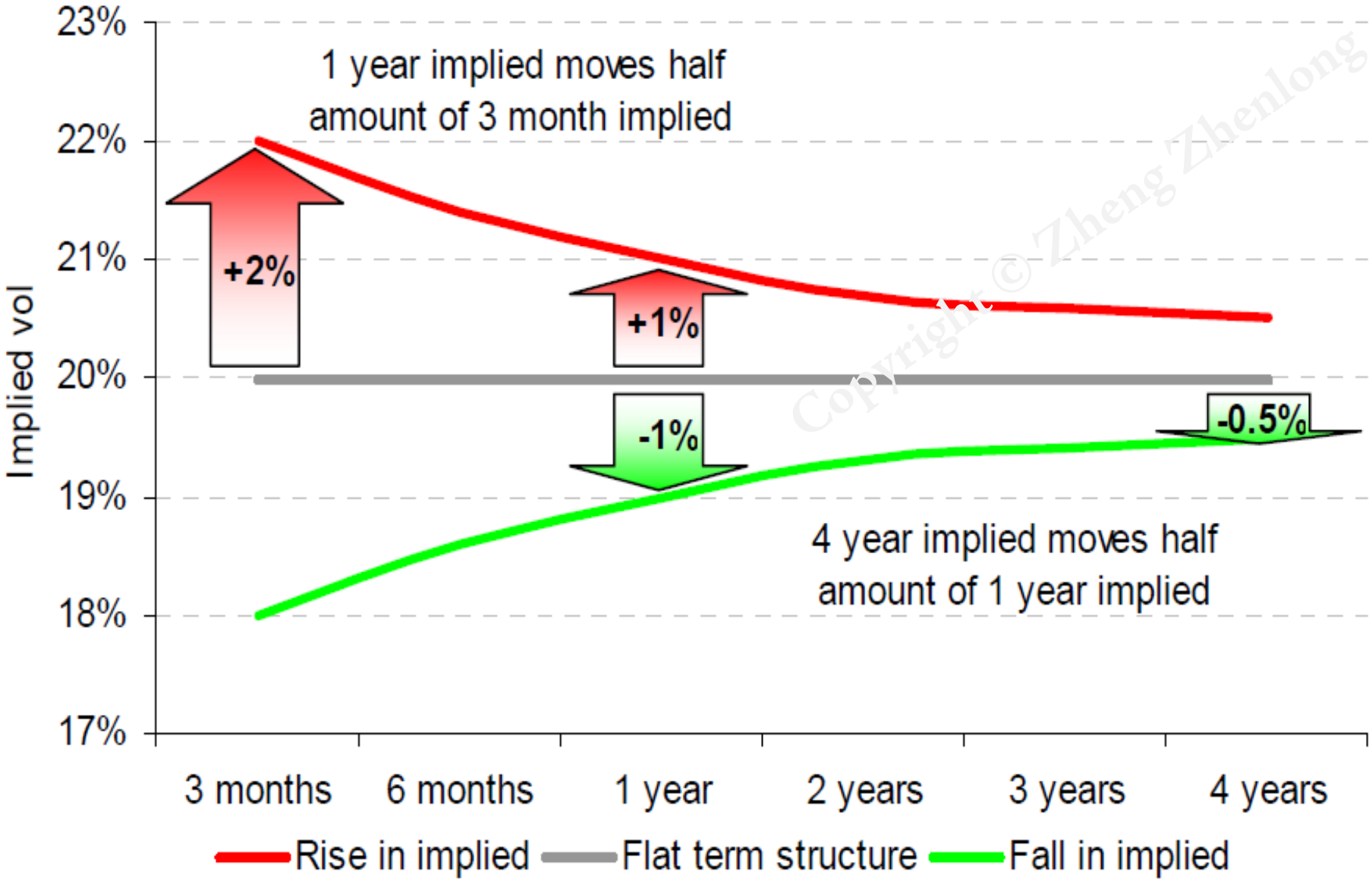
如何刻画波动率期限结构？

- 短期的隐含波动率跟以实现波动率高度相关，而波动率存在均值回归现象，因此长期的隐含波动率更稳定。这样，**平价期权**的期限结构存在如下近似关系：

$$T\text{年期的}\Delta\tilde{\sigma} \approx \frac{1\text{年期的}\Delta\tilde{\sigma}}{T^p}$$

- 业界通常将p设为0.5。这样的期限结构变化如下图所示。

Figure 84. ATM Implied Volatility Moving in a Square Root of Time Manner

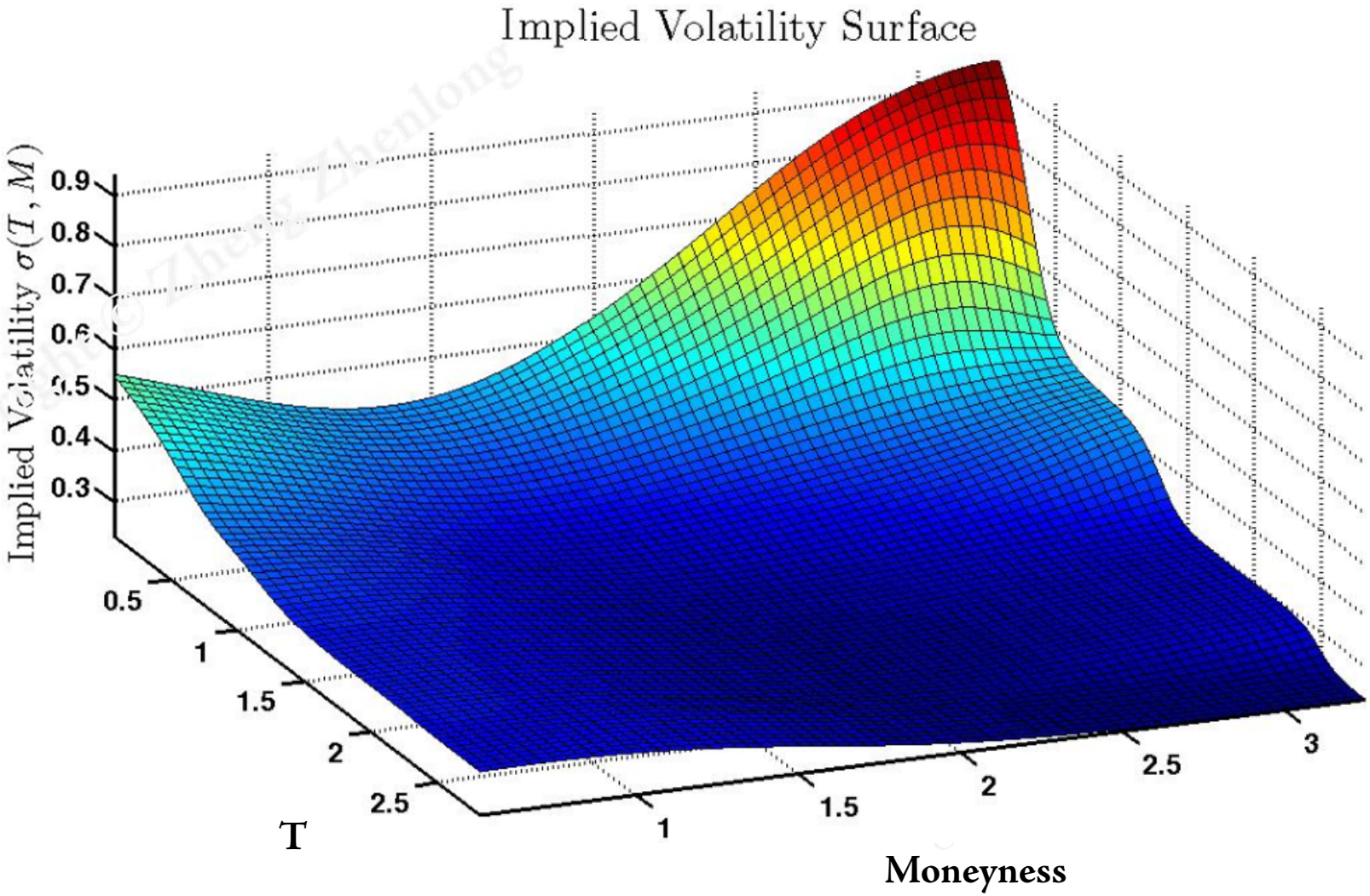


波动率曲面

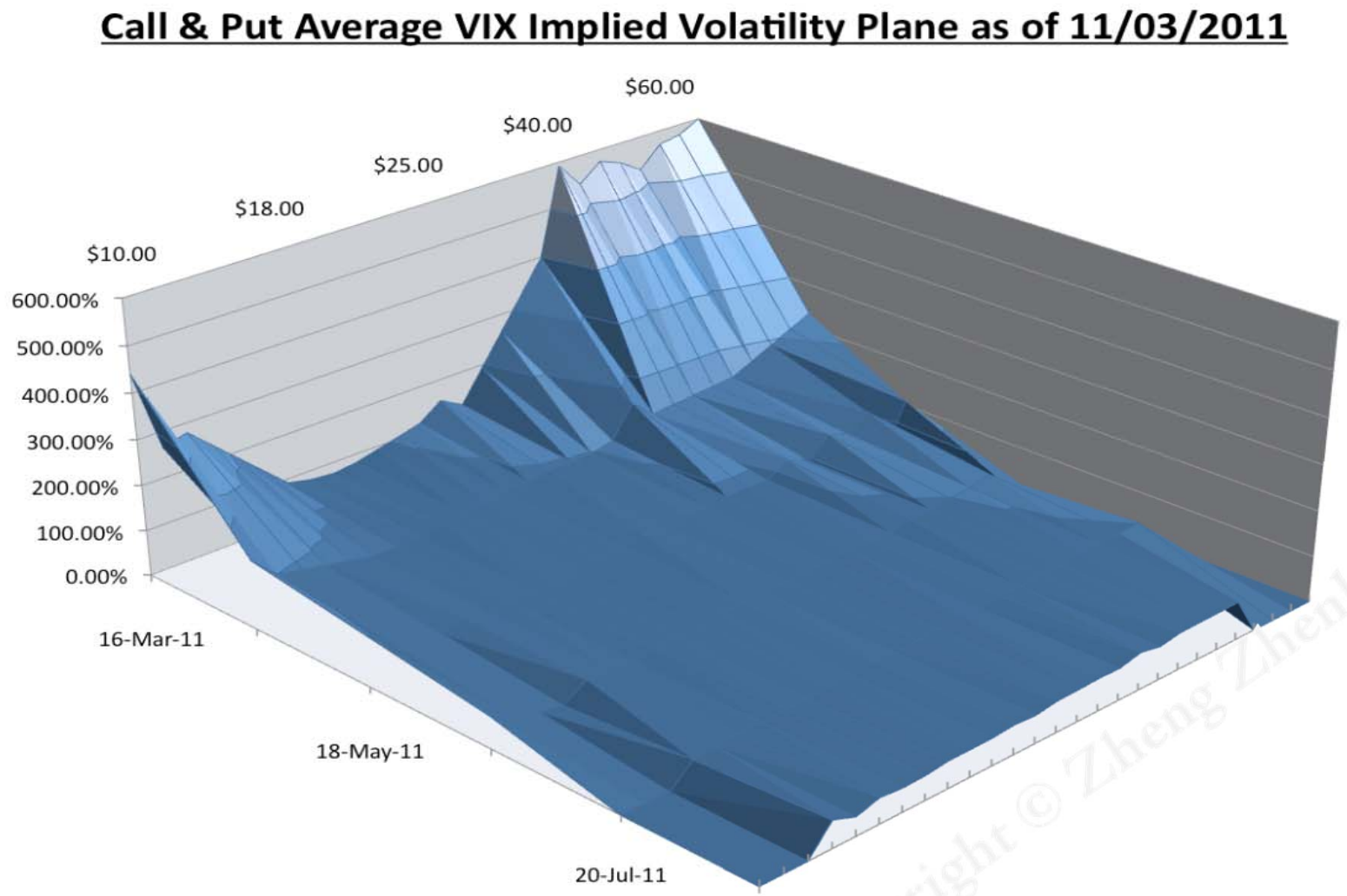
- 将波动率作为协议价格和期限的函数，就可以画出波动率曲面。

	K/S_0				
	0.90	0.95	1.00	1.05	1.10
1 mnth	14.2	13.0	12.0	13.1	14.5
3 mnth	14.0	13.0	12.0	13.1	14.2
6 mnth	14.1	13.3	12.5	13.4	14.3
1 year	14.7	14.0	13.5	14.0	14.8
2 year	15.0	14.4	14.0	14.5	15.1
5 year	14.8	14.6	14.4	14.7	15.0

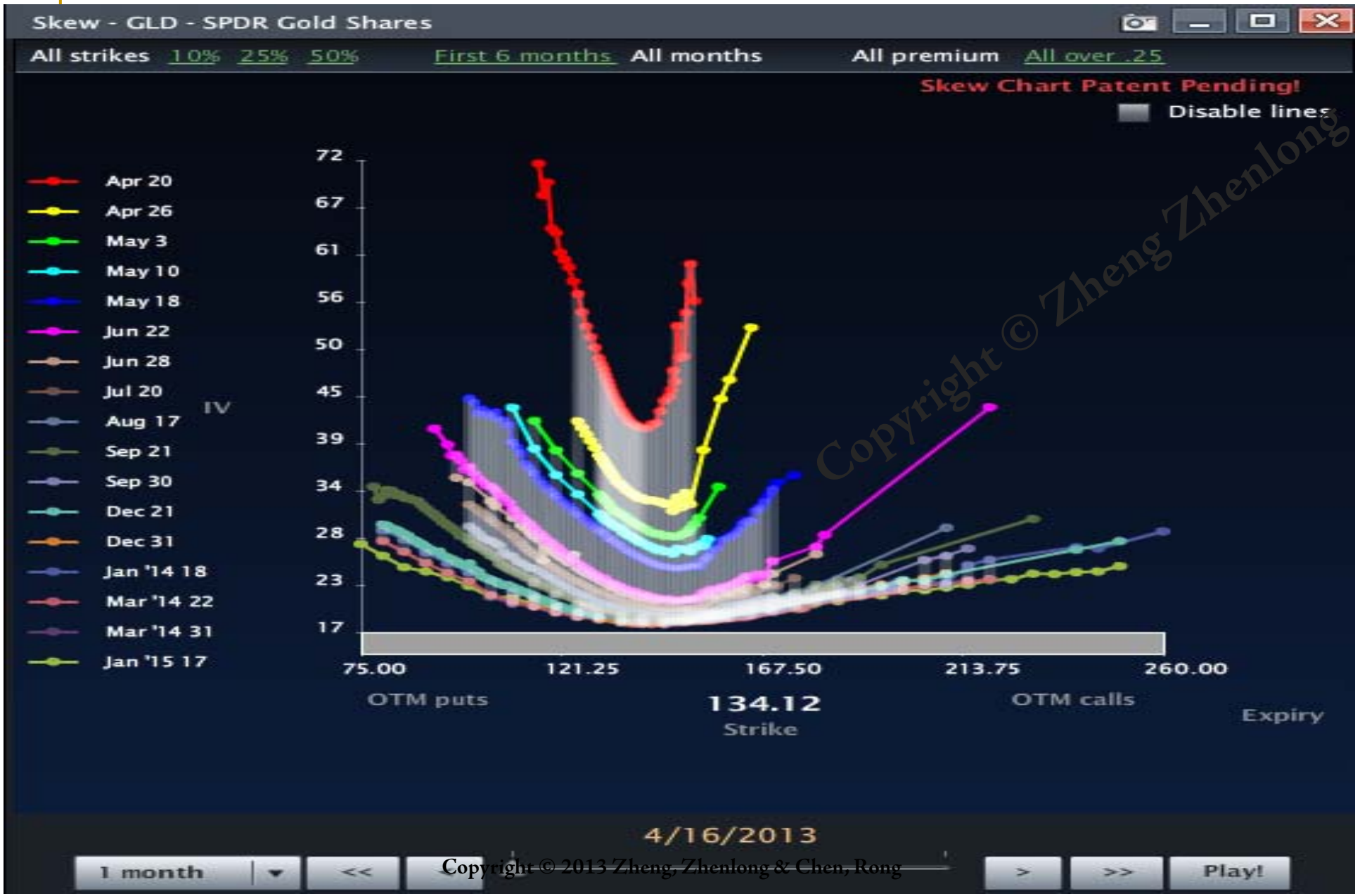
波动率曲面



现实世界中的波动率曲面

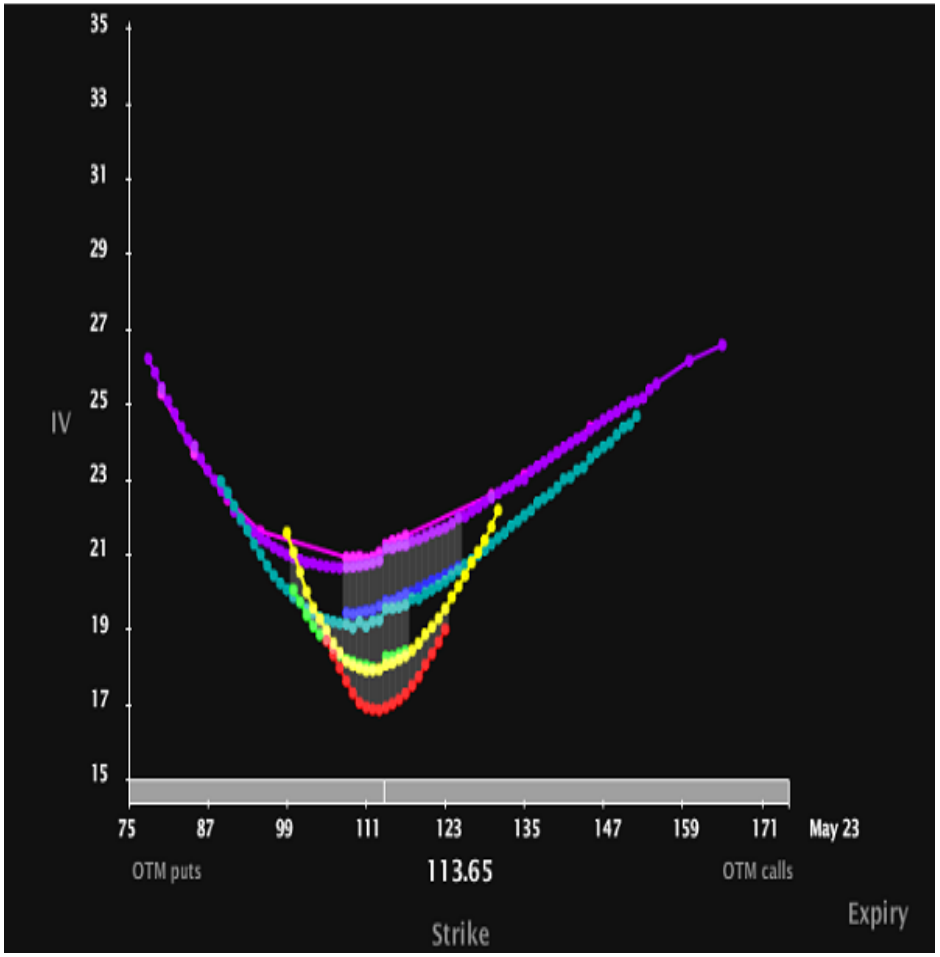


现实中的波动率曲面

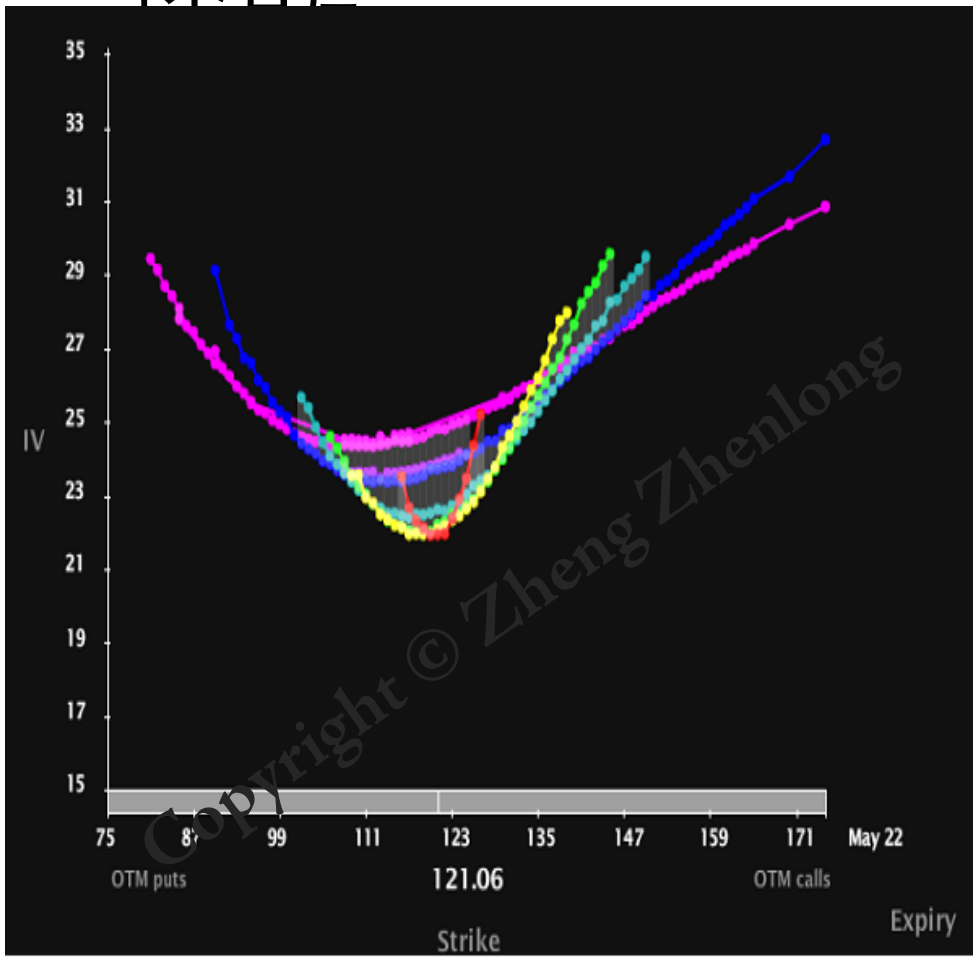


波动率曲面的变化

- 1个月前

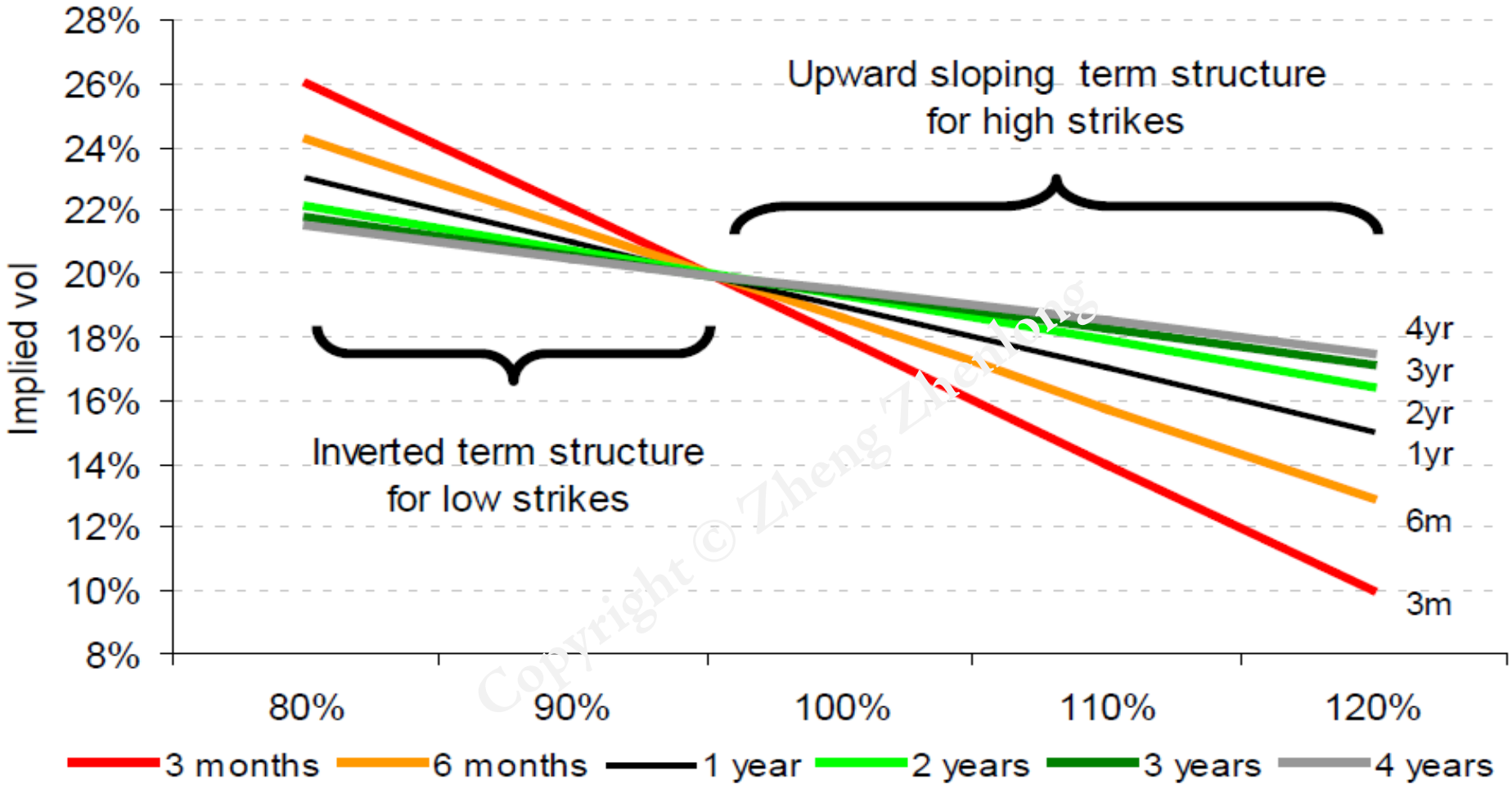


- 1个月后



股价指数的偏度与波动率期限结构

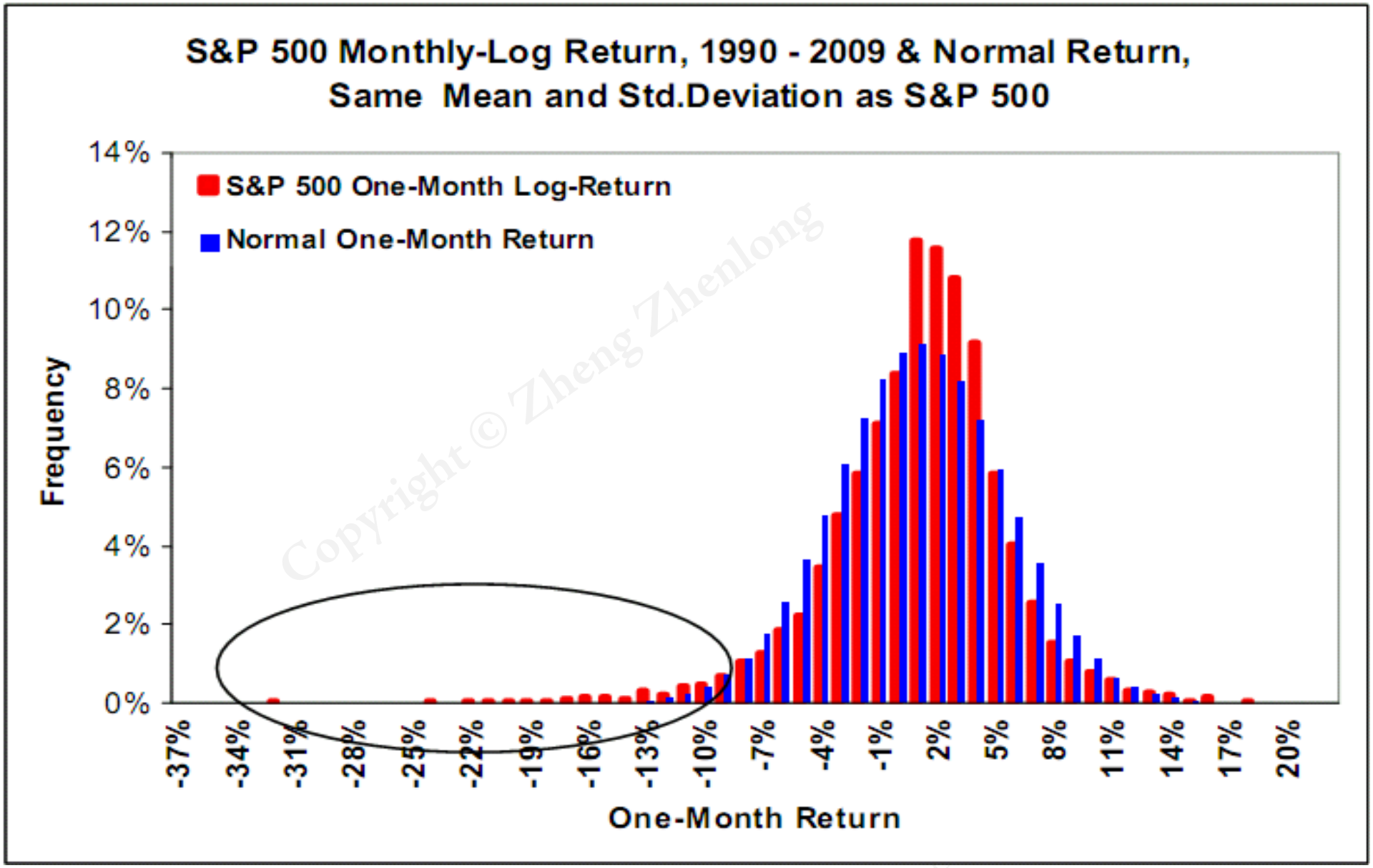
Figure 80. Skew for Options of Different Maturity



对偏度的深入研究

收益率分布的三阶矩——偏度

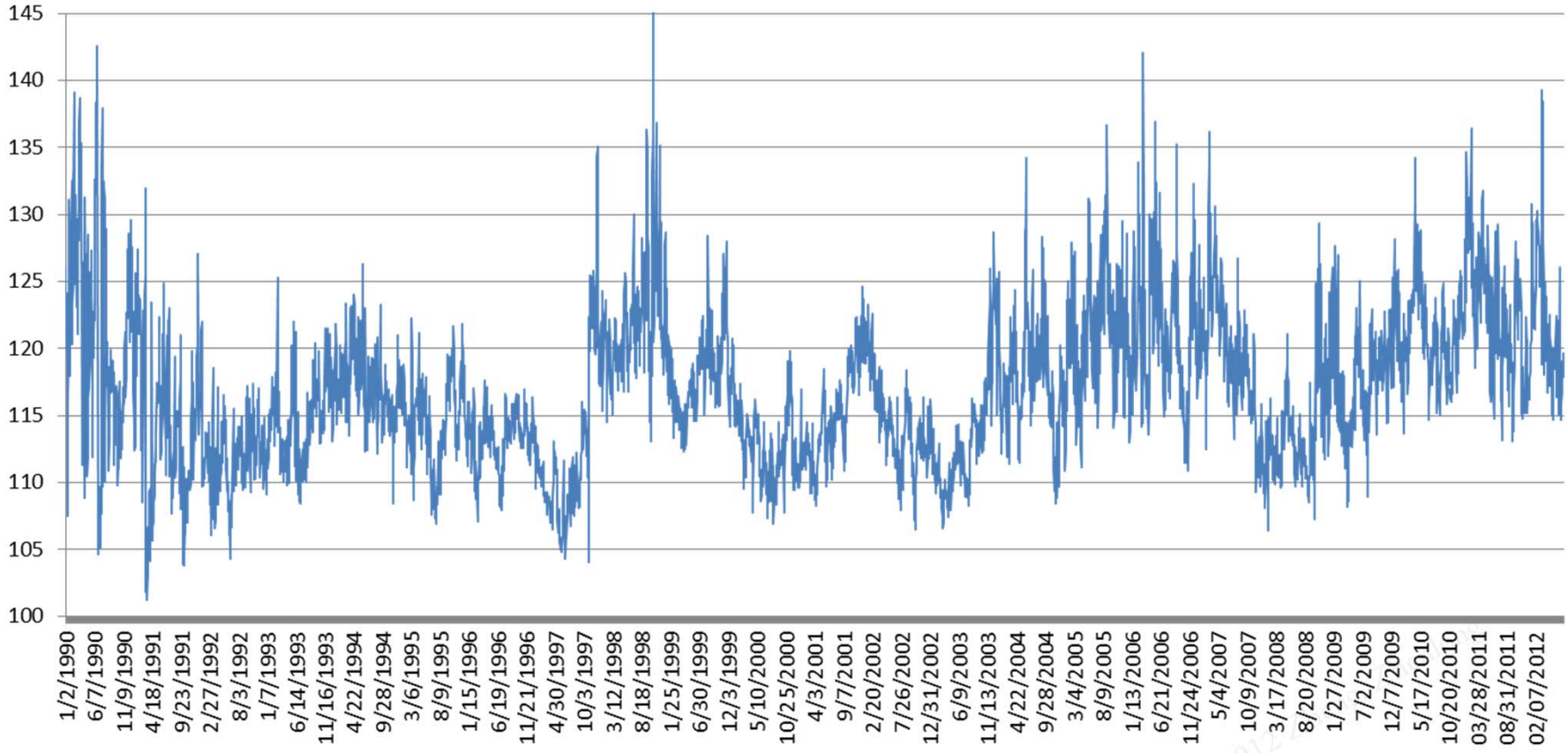
- 资产收益率的偏度是其三阶距特征，反映了该收益率分布的非对称性。预期偏度越小，资产价值下降的可能性越大。
- 关注点：预期偏度还是历史偏度？



如何度量偏度？

- 三阶矩
  - 偏度（Skewness）= $E[(\frac{R-\mu}{\sigma})^3]$
  - CBOE偏度指数（Skew）=100-10*偏度
    - 用无模型方法Bakshi,Madan(2000)从期权价格中提取。
- Delta偏度（如(25 delta put-25 delta call)/50 delta)
  - 该指标不受标的资产的波动率σ的影响。
- 协议价格偏度（如90%-110%，指$\ln\left(\frac{k}{F_0}\right)$隐含$\sigma$之差)
  - 偏度度量指标应该独立于标的资产的波动率σ。因此协议价格之间距离应该跟σ成正比。例如，如果σ为20%时选择90%-110%，则当σ为40%时，应该选择80%-120%。

S&P500偏度指数



S&P500对数收益率
低于均值2或3个标准差的概率

Estimated Risk Adjusted Probability		
SKEW	S&P 500 30-Day Log Return	
	2 Std. Dev	3 Std. Dev.
100	2.30%	0.15%
105	3.65%	0.45%
110	5.00%	0.74%
115	6.35%	1.04%
120	7.70%	1.33%
125	9.05%	1.63%
130	10.40%	1.92%
135	11.75%	2.22%
140	13.10%	2.51%
145	14.45%	2.81%

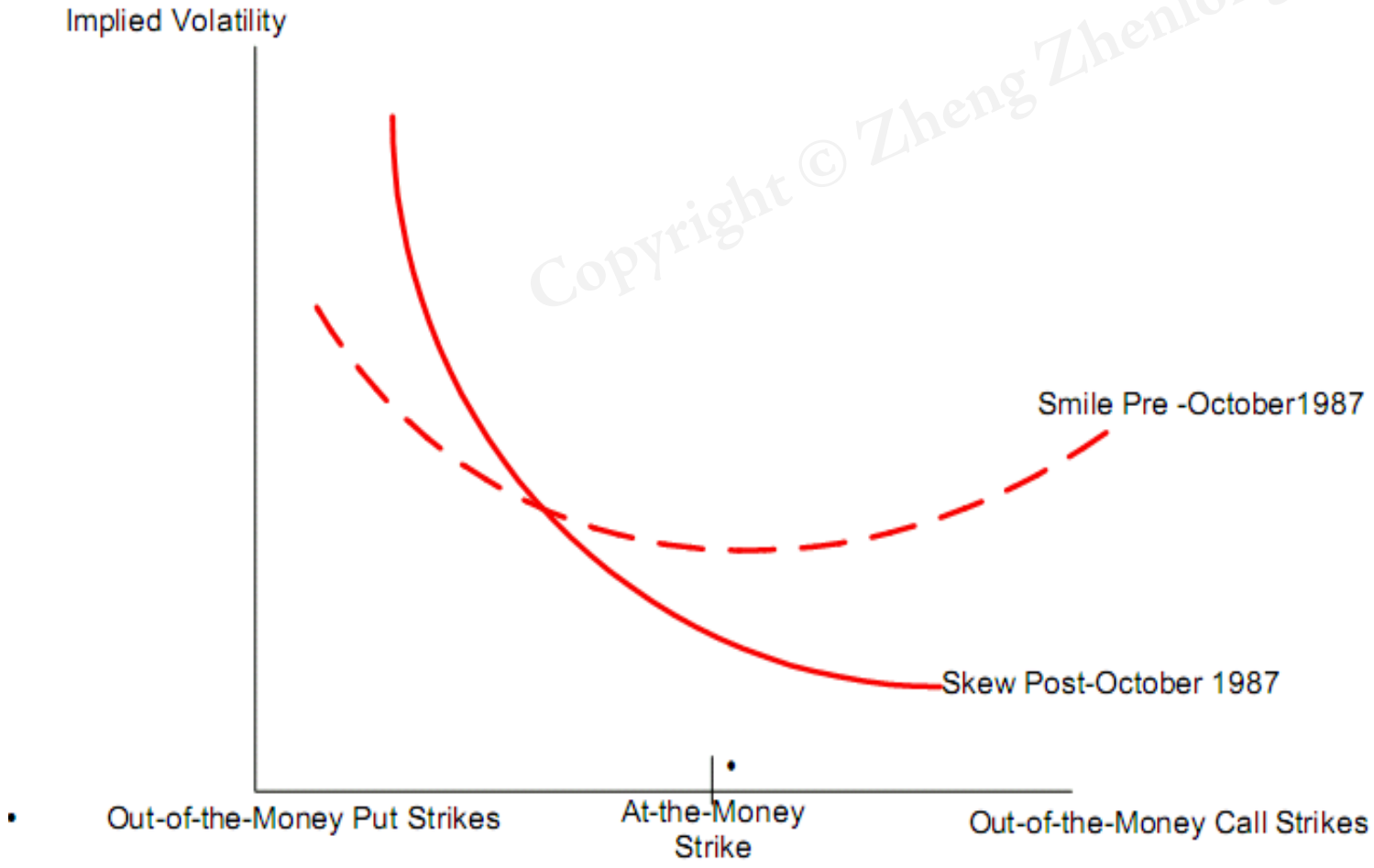
Source: CBOE

SKEW的历史频度

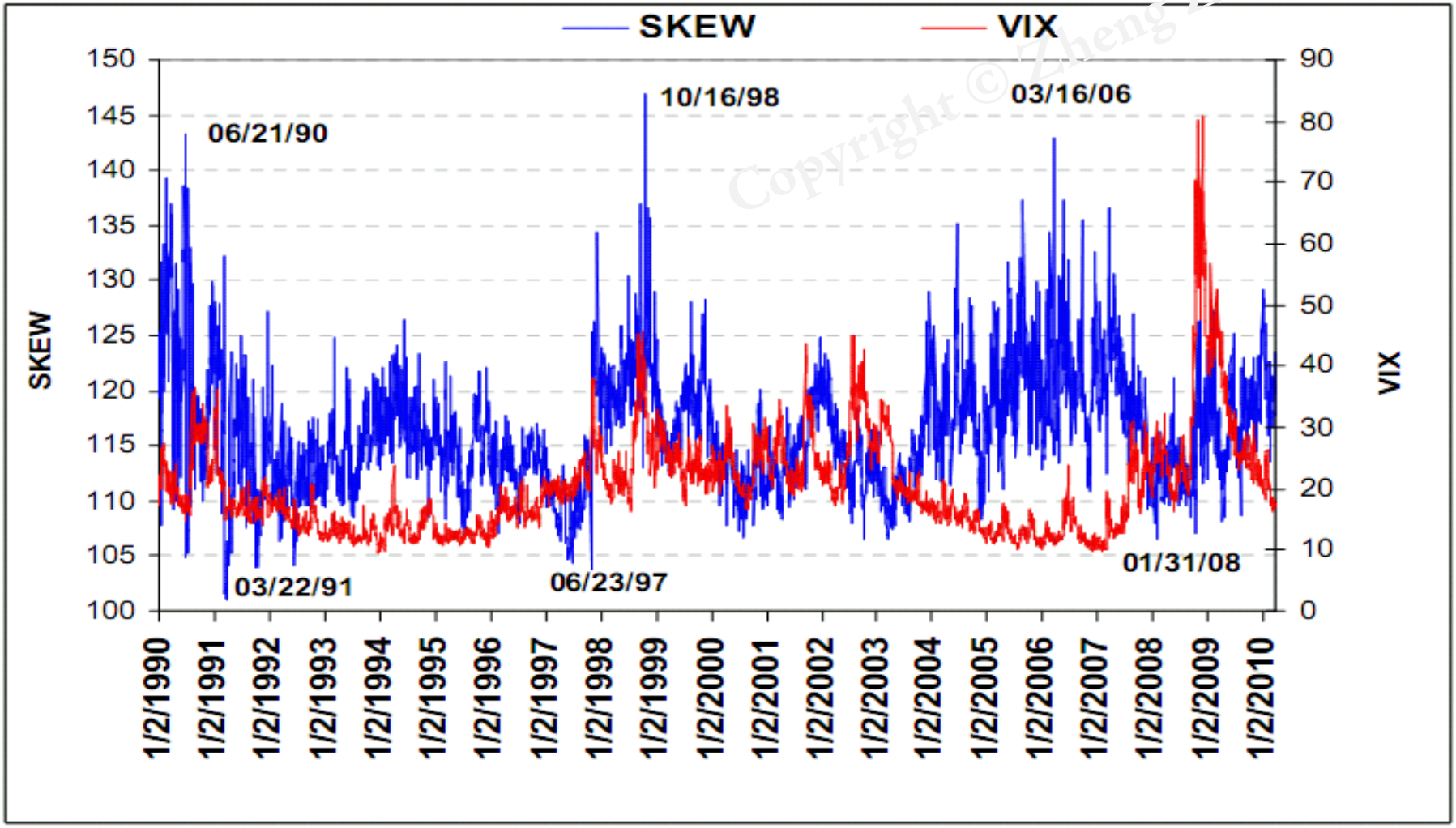
SKEW	Frequency 1990 - 2010	SKEW	Frequency 1990 - 2010
100.00	0.00%	127.50	3.07%
102.50	0.10%	130.00	1.55%
105.00	0.42%	132.50	0.79%
107.50	1.59%	135.00	0.40%
110.00	7.21%	137.50	0.30%
112.50	15.38%	140.00	0.10%
115.00	20.47%	142.50	0.02%
117.50	17.55%	145.00	0.04%
120.00	14.96%	147.50	0.02%
122.50	10.14%	150.00	0.00%
125.00	5.90%		

Source: CBOE

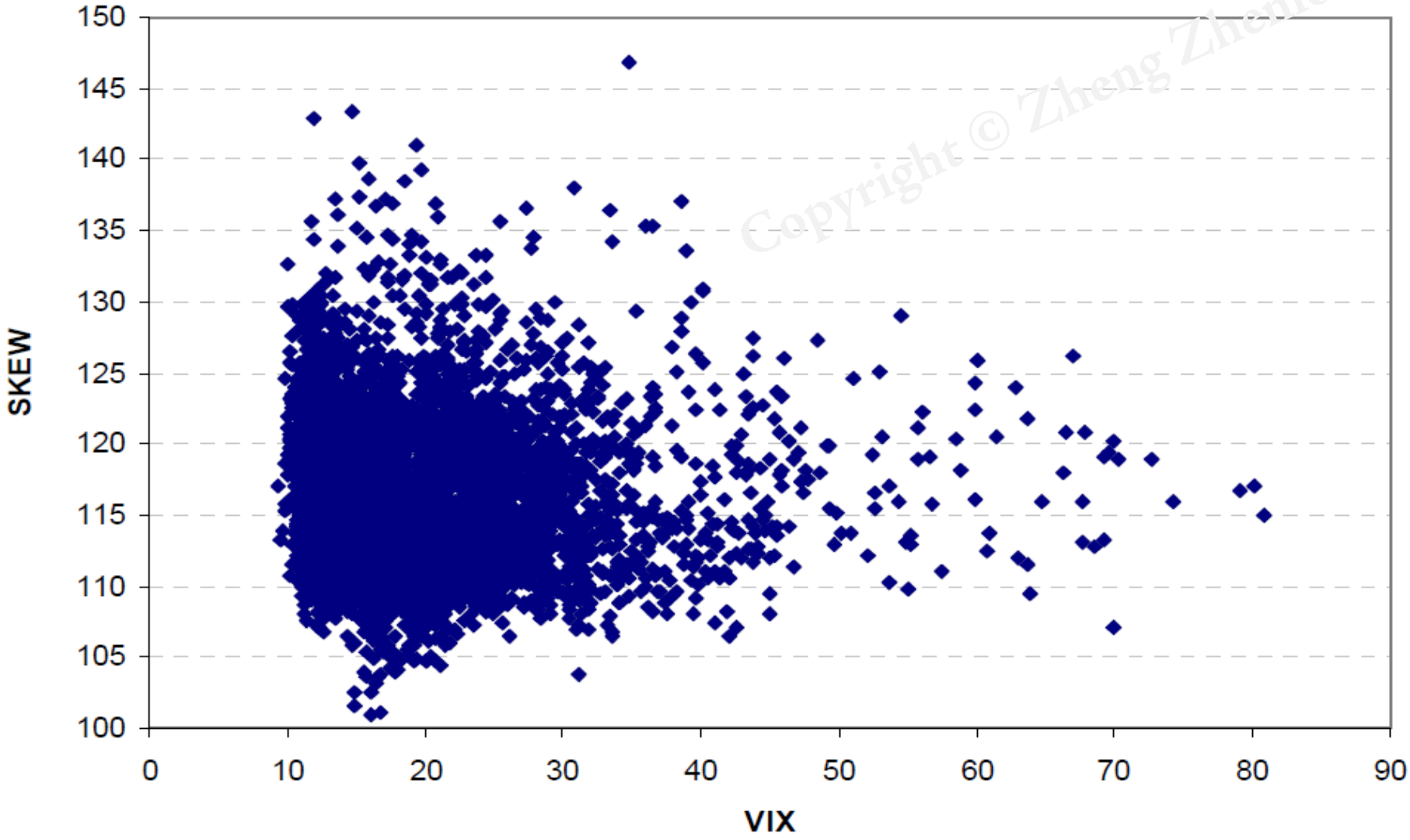
偏度与隐含波动率的关系



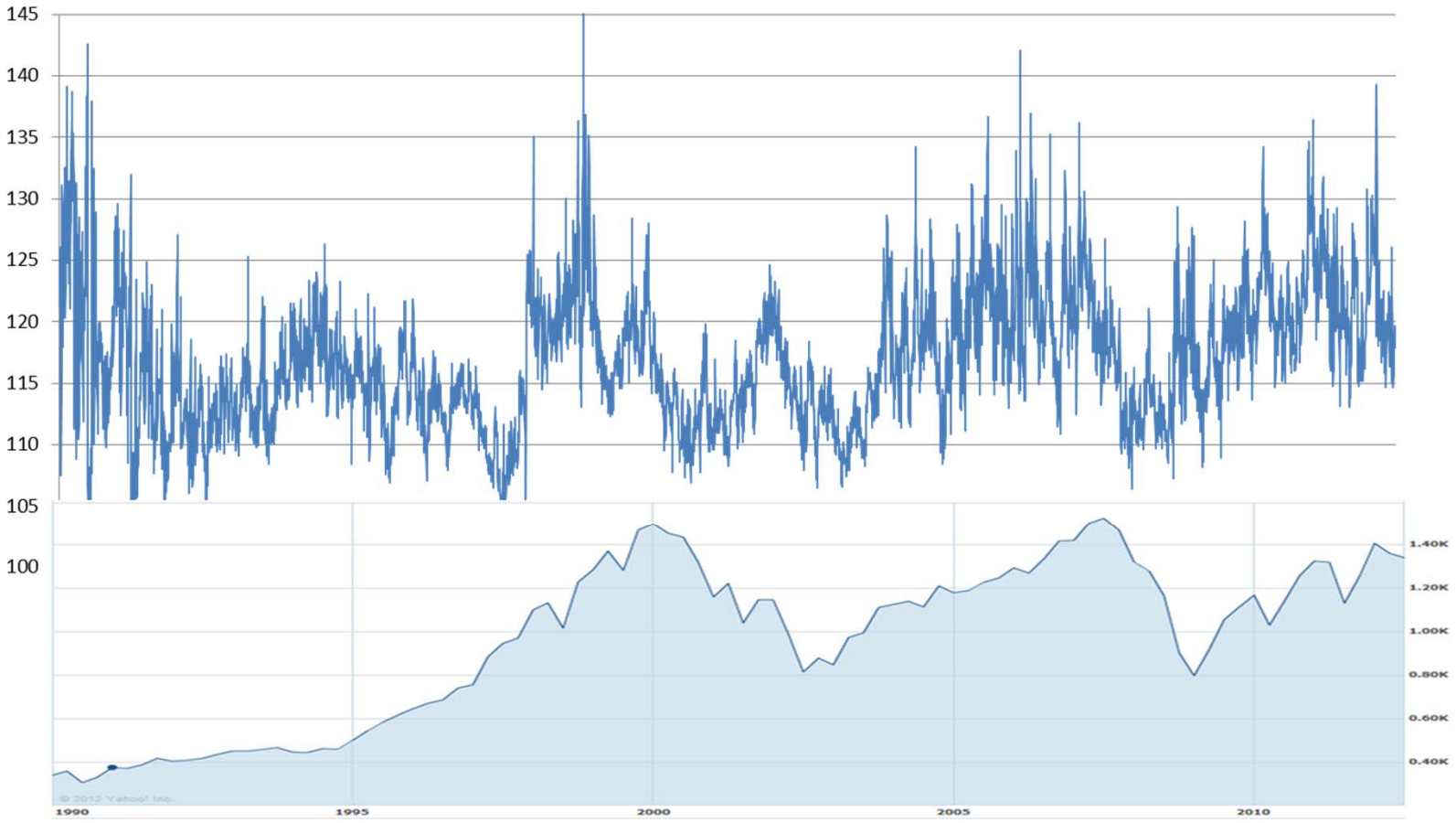
Skew and VIX (From CBOE)



SKEW与VIX散点图（1990－2010）



S&P500指数与其偏度指数



偏度的期限结构

- 偏度也随着期限的平方根衰减。这意味着$skew \times \sqrt{T}$基本稳定。

Figure 85. Skew by Maturity (with same skew when multiplied by square root of time)

Maturity	3 Months	6 Months	1 Year	2 Years	3 Years	4 Years
Time (years)	0.25	0.5	1	2	3	4
Square root of time	**0.5**	**0.71**	**1**	**1.41**	**1.73**	**2**
90% implied	22.0%	21.4%	21.0%	20.7%	20.6%	20.5%
100% implied	18.0%	18.6%	19.0%	19.3%	19.4%	19.5%
Skew (per 10% move spot)	**4.0%**	**2.8%**	**2.0%**	**1.4%**	**1.2%**	**1.0%**
Skew × square root of time	**2.0%**	**2.0%**	**2.0%**	**2.0%**	**2.0%**	**2.0%**

偏度的上下限

- 低协议价格的**put**价格应该低于高协议价格的。因此低协议价格的隐含波动率**最高**不能使低协议价格的put价格超过高协议价格的。这就是**偏度上限**。
- 同理，低协议价格的**call**价格应该高于高协议价格的。因此低协议价格的隐含波动率**最低**不能使低协议价格的call价格低于高协议价格的。这就是**偏度下限**。
- 例子：通过BS公式可以算出，1年期隐含波动率26.39%的99% put价格等于1年期隐含波动率25%的100% put价格。因此90%-100%或95%-105%偏度上限为13.9%。

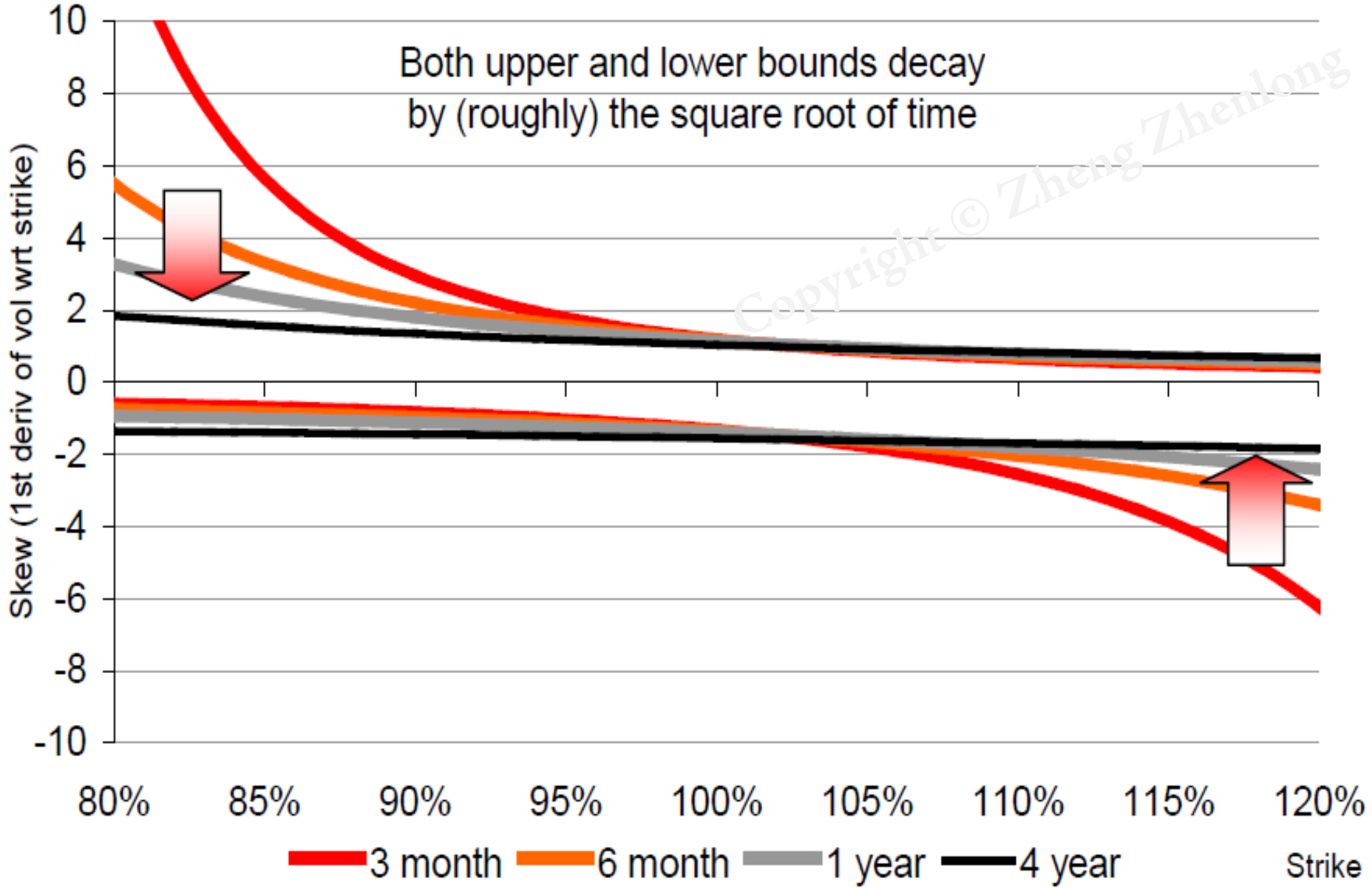
偏度上下限期限结构

- 局部偏度可以用波动率微笑的斜率x来表示。该斜率的上下限为：

$$\text{Lower bound} = -\sqrt{2\pi}.e^{\frac{d_1^2}{2}}\left[1-N(d_2)\right] \le x \le \sqrt{2\pi}.e^{\frac{d_1^2}{2}}.N(d_2) = \text{upper bound}$$

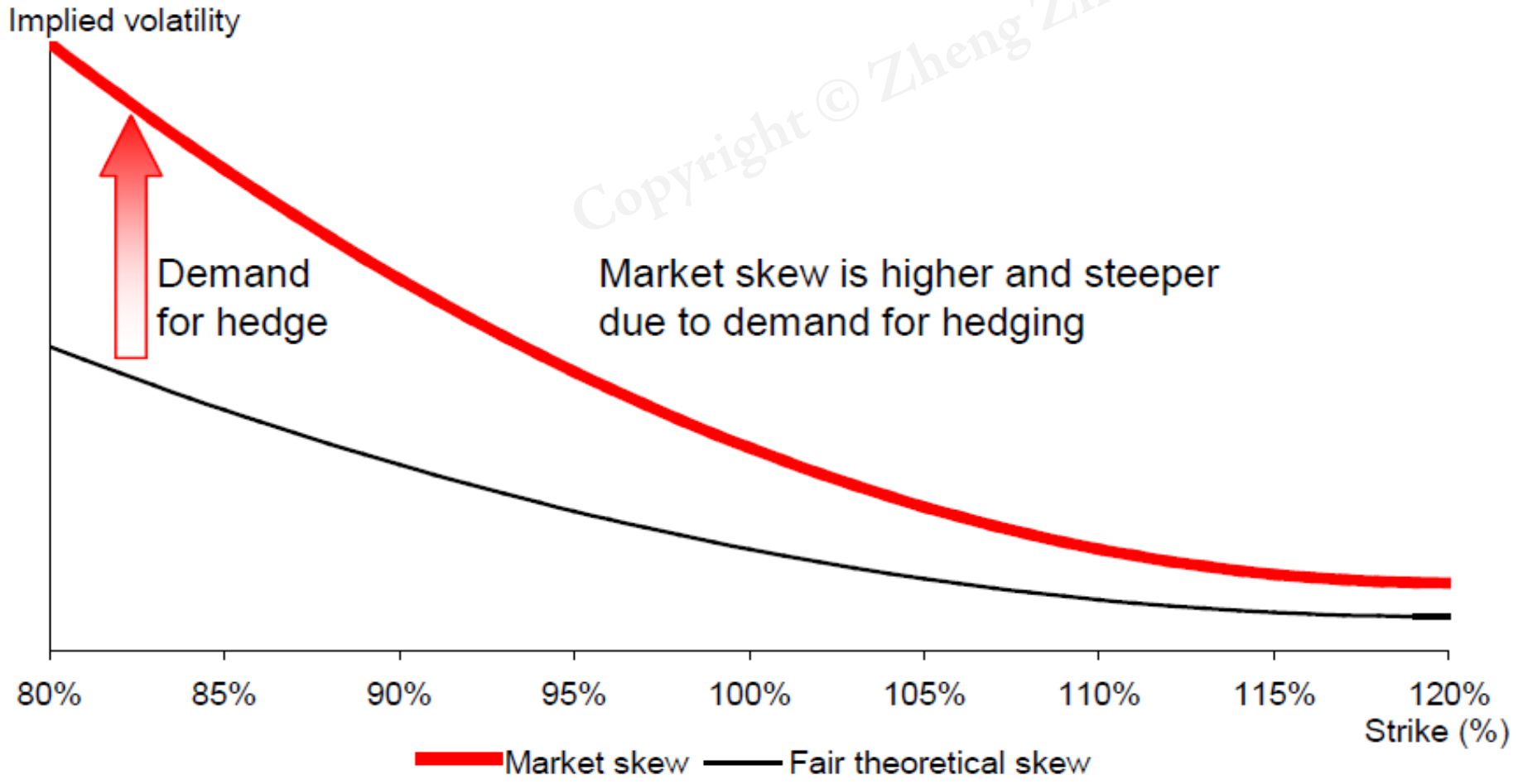
- 可以证明，该上下限随期限的平方根衰减。
- 由于偏度上下限随期限的平方根衰减，实际偏度也具有随期限的平方根衰减的特征。

Figure 120. Upper and Lower Bound for Skew (given 25% volatility)



市场上偏度的价格也是被高估

Figure 98. Market and Theoretical Skew



如何赚钱3：期权组合策略

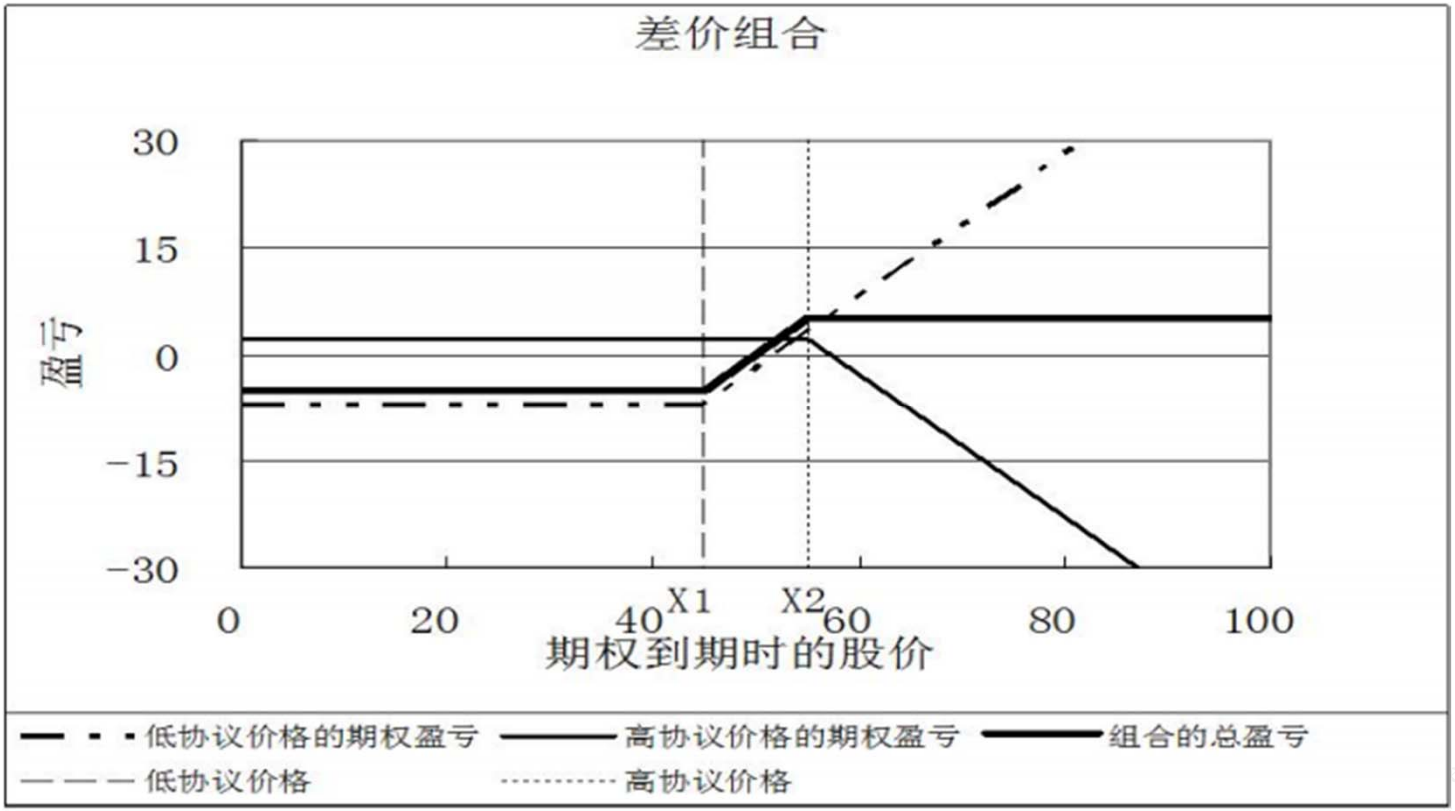
实践问题：如何制定交易策略？

- 期权组合的种类
  - 协议价格——差价组合（期限相同）
  - 期限——差期组合（协议价格相同）
  - 协议价格和期限同时不同——对角组合（同种期权）
  - 不同种类（call/put）——混合期权
  - 多头/空头——牛市/熊市、正向/反向、顶部/底部等等

差价组合

- 持有相同期限、不同协议价格的两个或多个同种期权头寸组合（即同是看涨期权，或者同是看跌期权）。
- 其主要类型
  - 牛市差价组合（买低卖高）
  - 熊市差价组合（买高卖低）
  - 蝶式差价组合等

牛市差价（Bull Spreads）组合

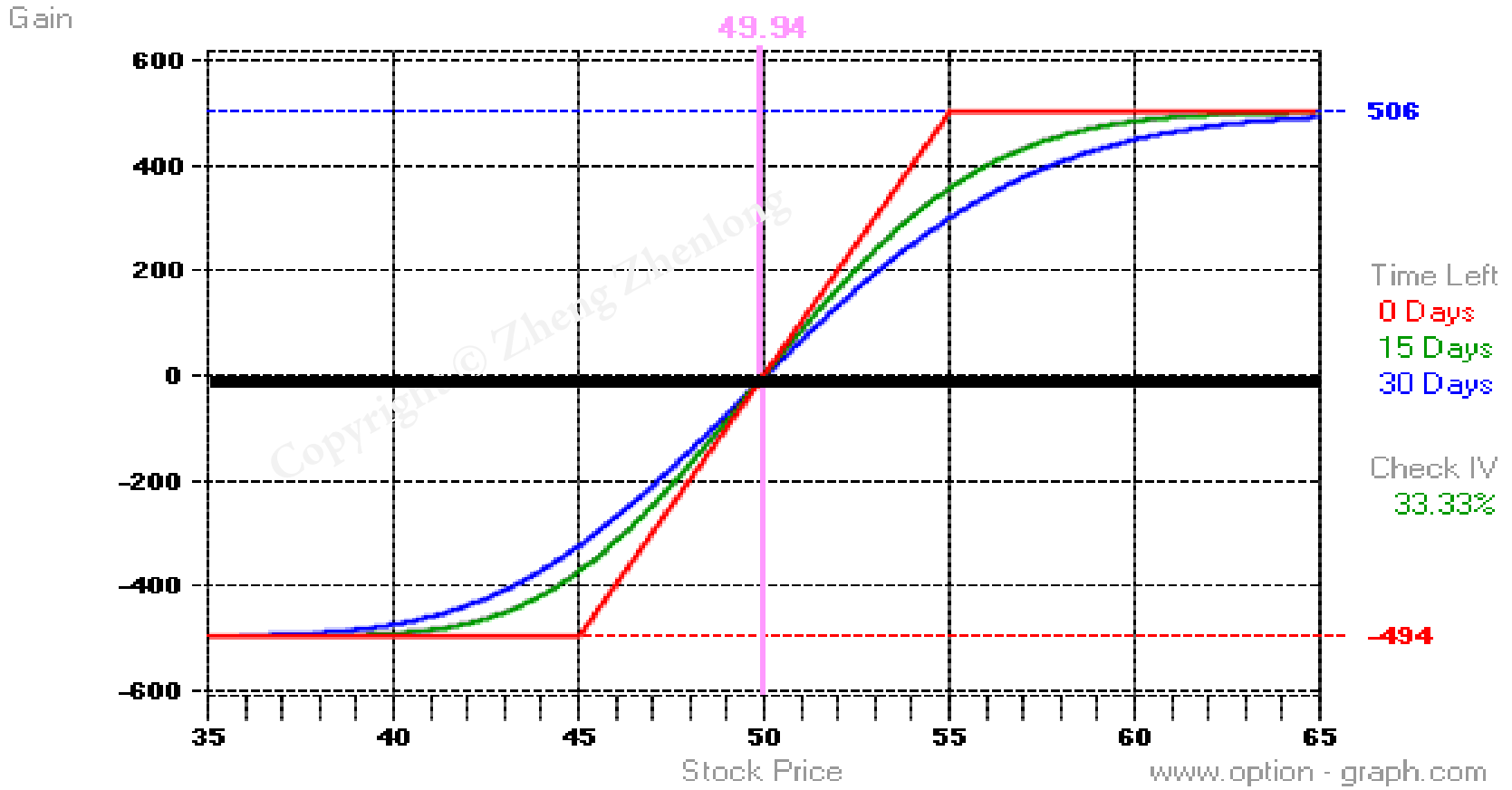


(a)看涨期权构造的牛市差价组合

盈亏均衡

Position Details : Bull Call to compare to Modified Bullish Butterfly

Stock at 50, 1 Short Call, 55 strike, 30 days, IV 33.33%, Option Price $0.45 =	$45.00	credit
Stock at 50, 1 Long Call, 45 strike, 30 days, IV 33.33%, Option Price $5.39 =	$539.00	debit
Total Position = $494.00 DEBIT		

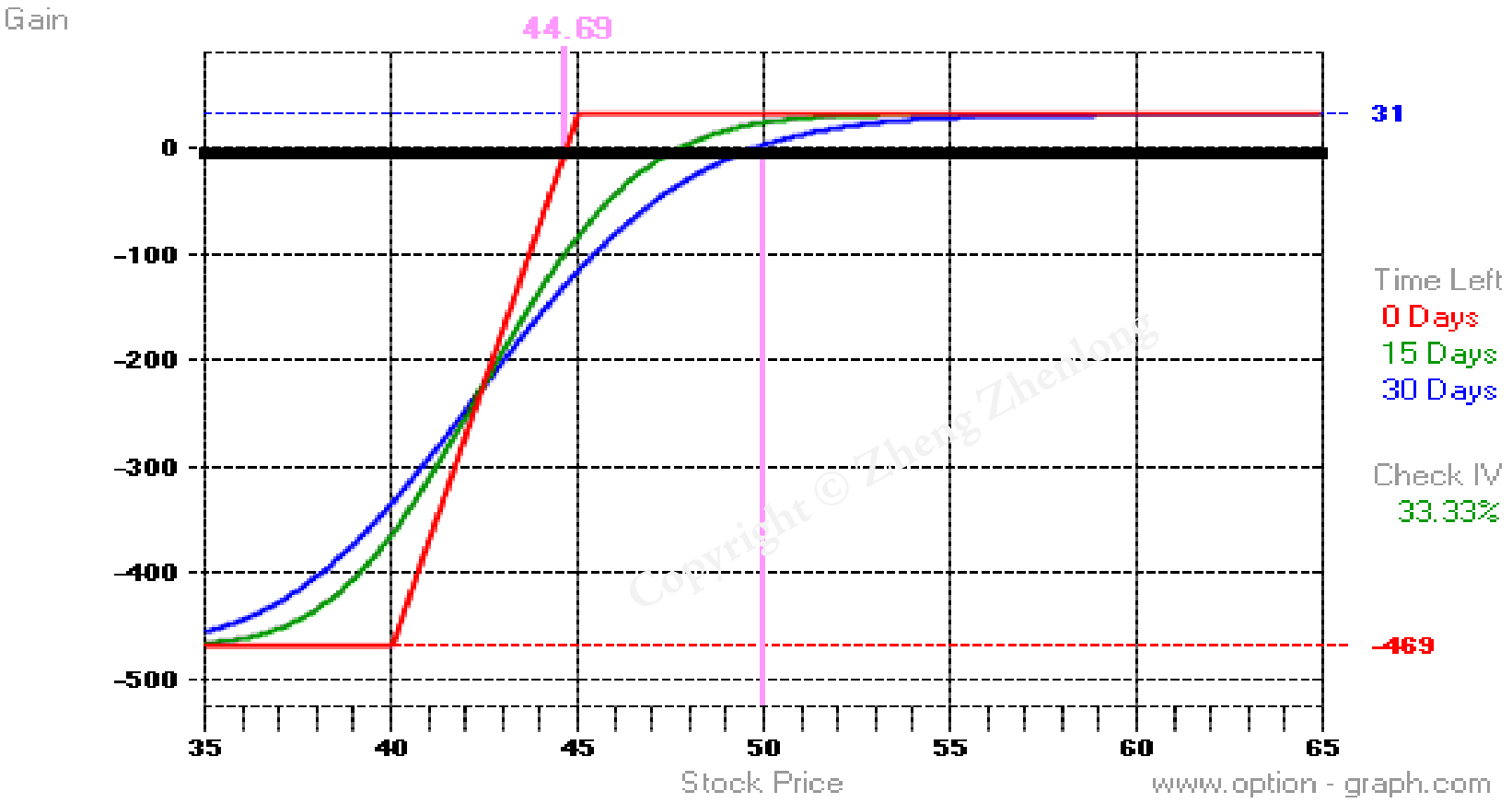


大概率中小奖

Position Details : Bull Call (2 strikes down to 1 strike down)

Stock at 50, 1 Long Call, 40 strike, 30 days, IV 33.33%, Option Price $10.08 =	$1,008.00	debit
Stock at 50, 1 Short Call, 45 strike, 30 days, IV 33.33%, Option Price $5.39 =	$539.00	credit

Total Position = $469.00 DEBIT

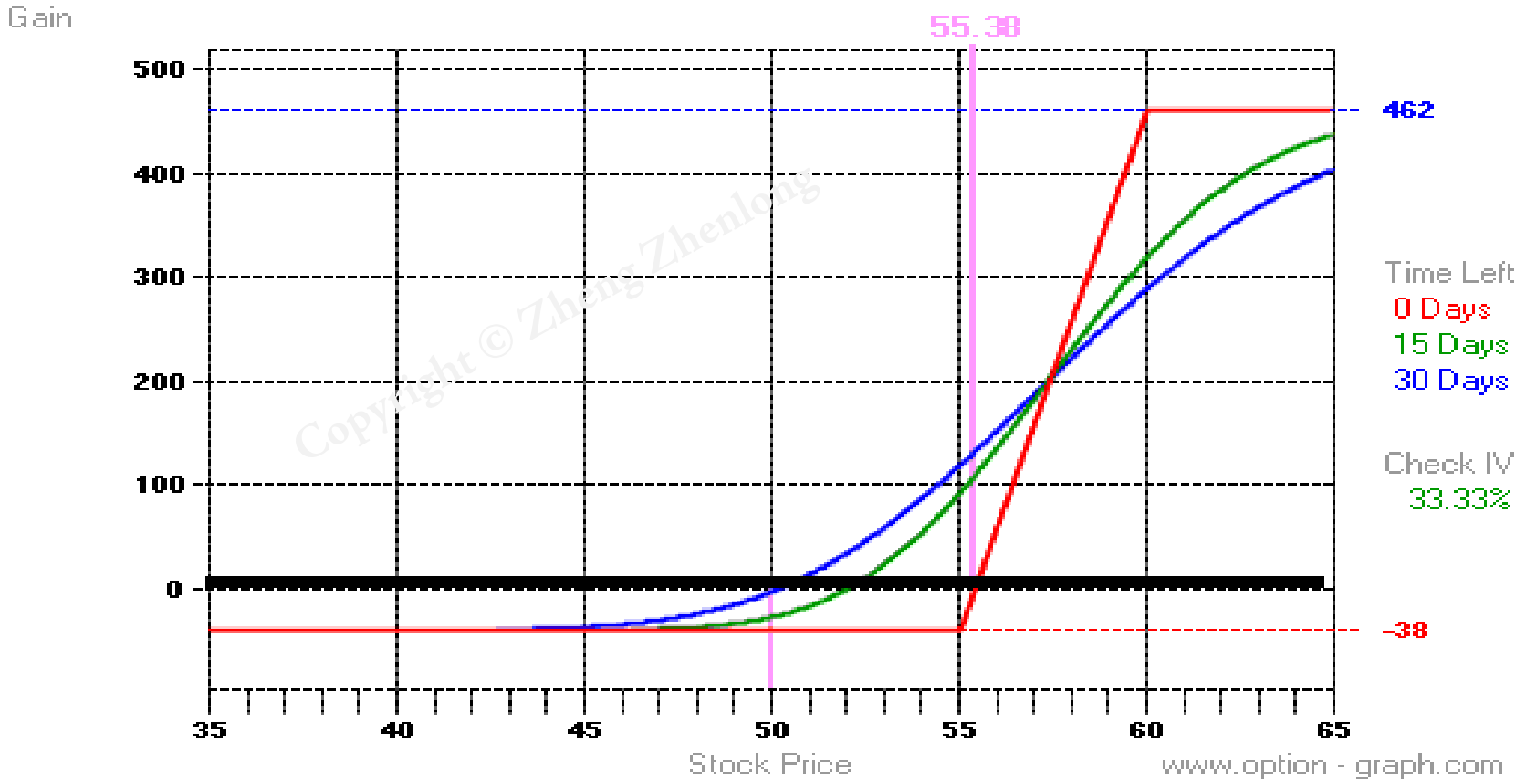


小概率中大奖

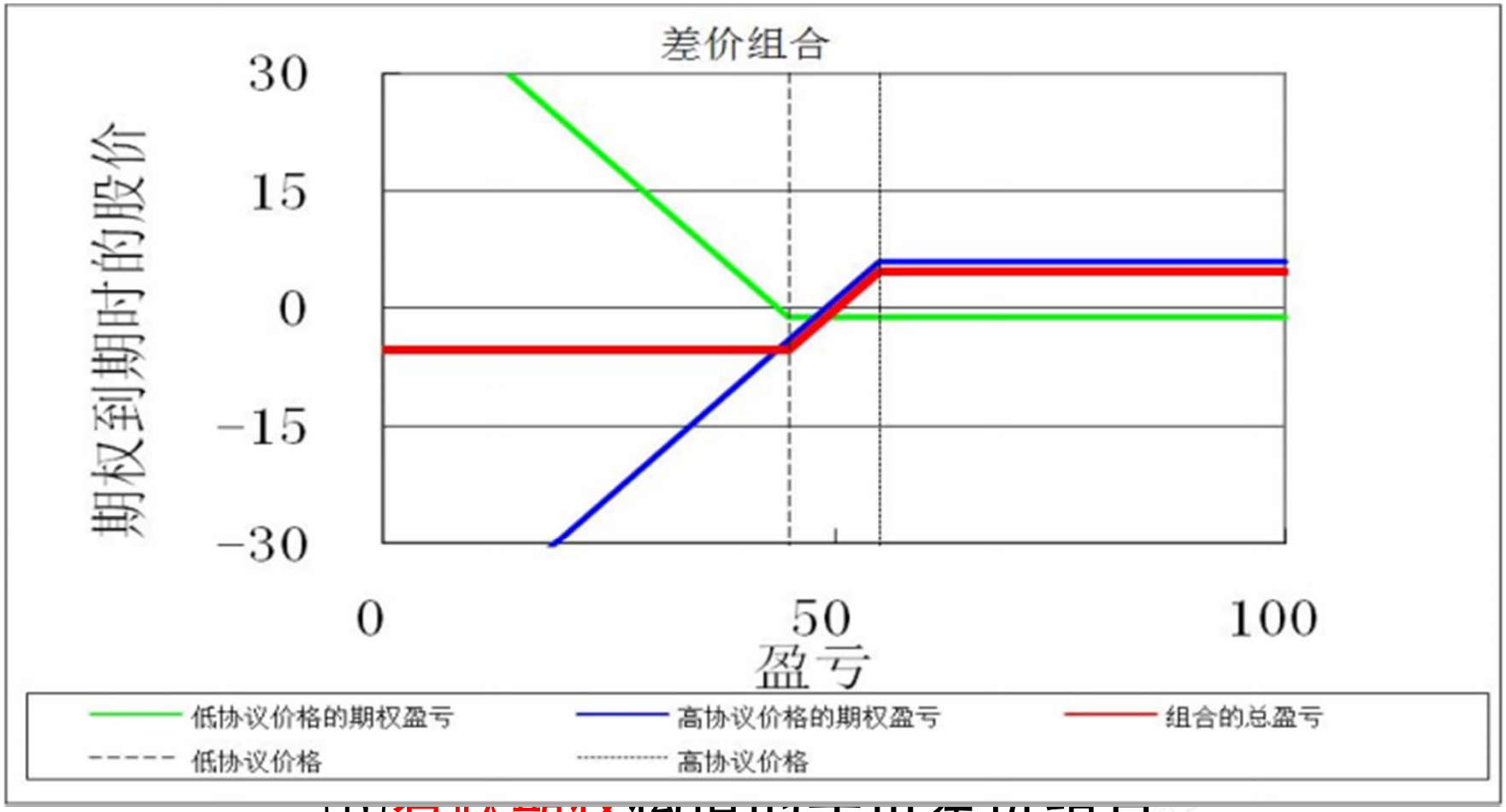
Position Details : Bull Call (1 strike up to 2 strikes up)

Stock at 50, 1 Long Call, 55 strike, 30 days, IV 33.33%, Option Price $0.45 =	$45.00	debit
Stock at 50, 1 Short Call, 60 strike, 30 days, IV 33.33%, Option Price $0.07 =	$7.00	credit

Total Position = $38.00 DEBIT



牛市差价（Bull Spreads）组合

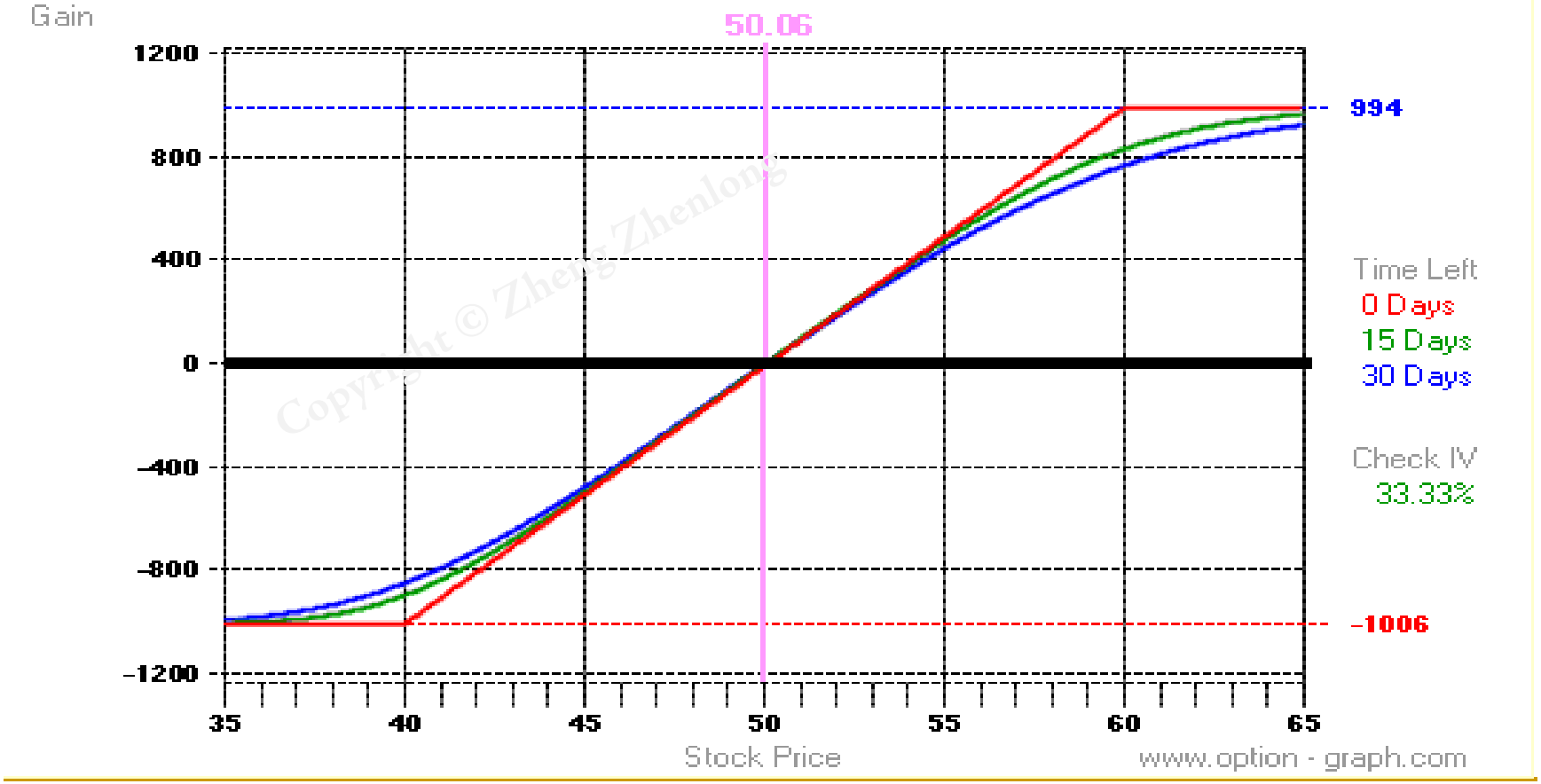


(b)看跌期权构造的牛市差价组合

盈亏均衡

Position Details : Bull Put (2 strikes down to 2 strikes up)

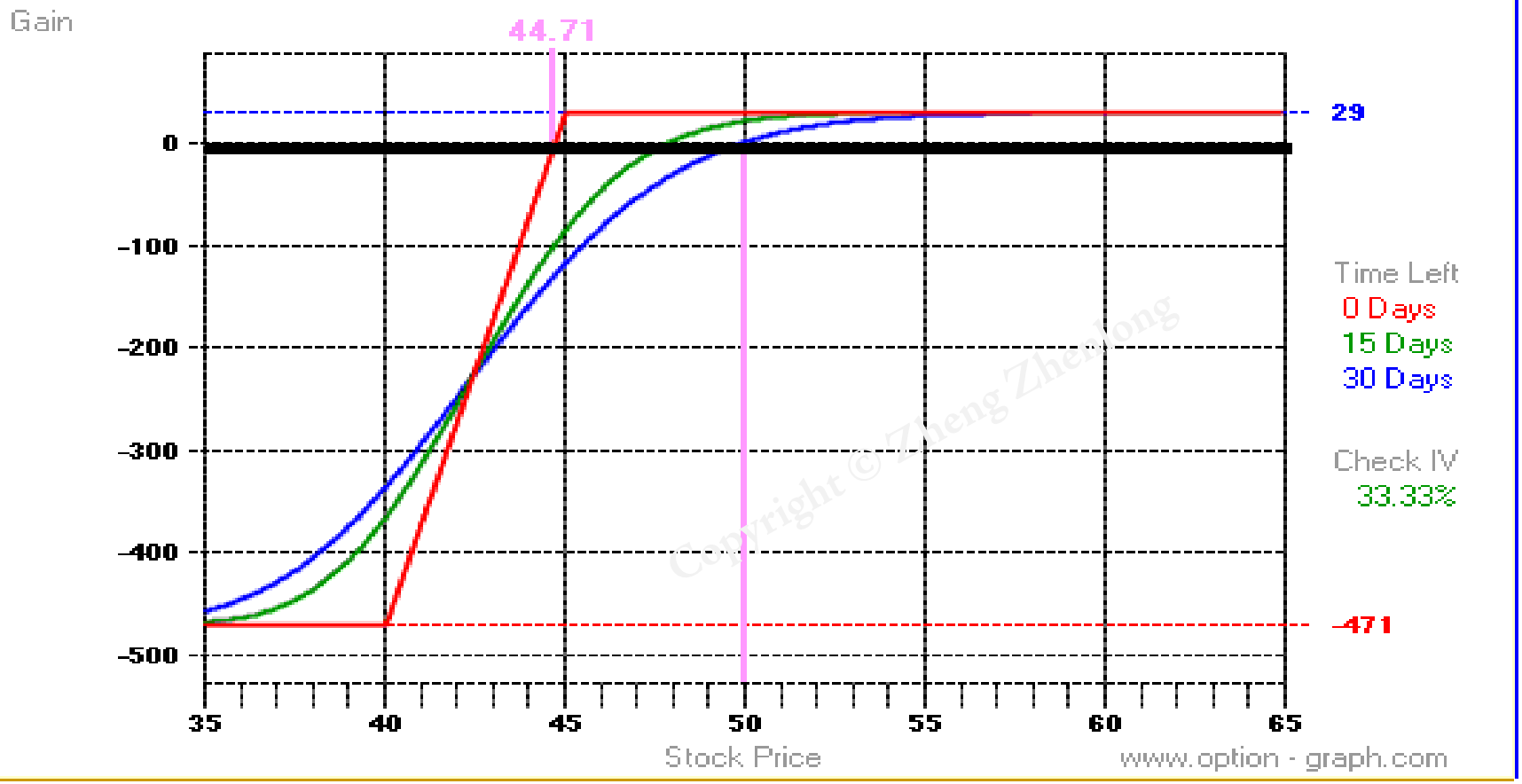
Stock at 50, 1 Long Put, 40 strike, 30 days, IV 33.33%, Option Price $0.02 =	$2.00	debit
Stock at 50, 1 Short Put, 60 strike, 30 days, IV 33.33%, Option Price $9.96 =	$996.00	credit
Total Position = $994.00 CREDIT		



大概率中小奖

Position Details : Bull Put (2 strikes down to 1 strike down)

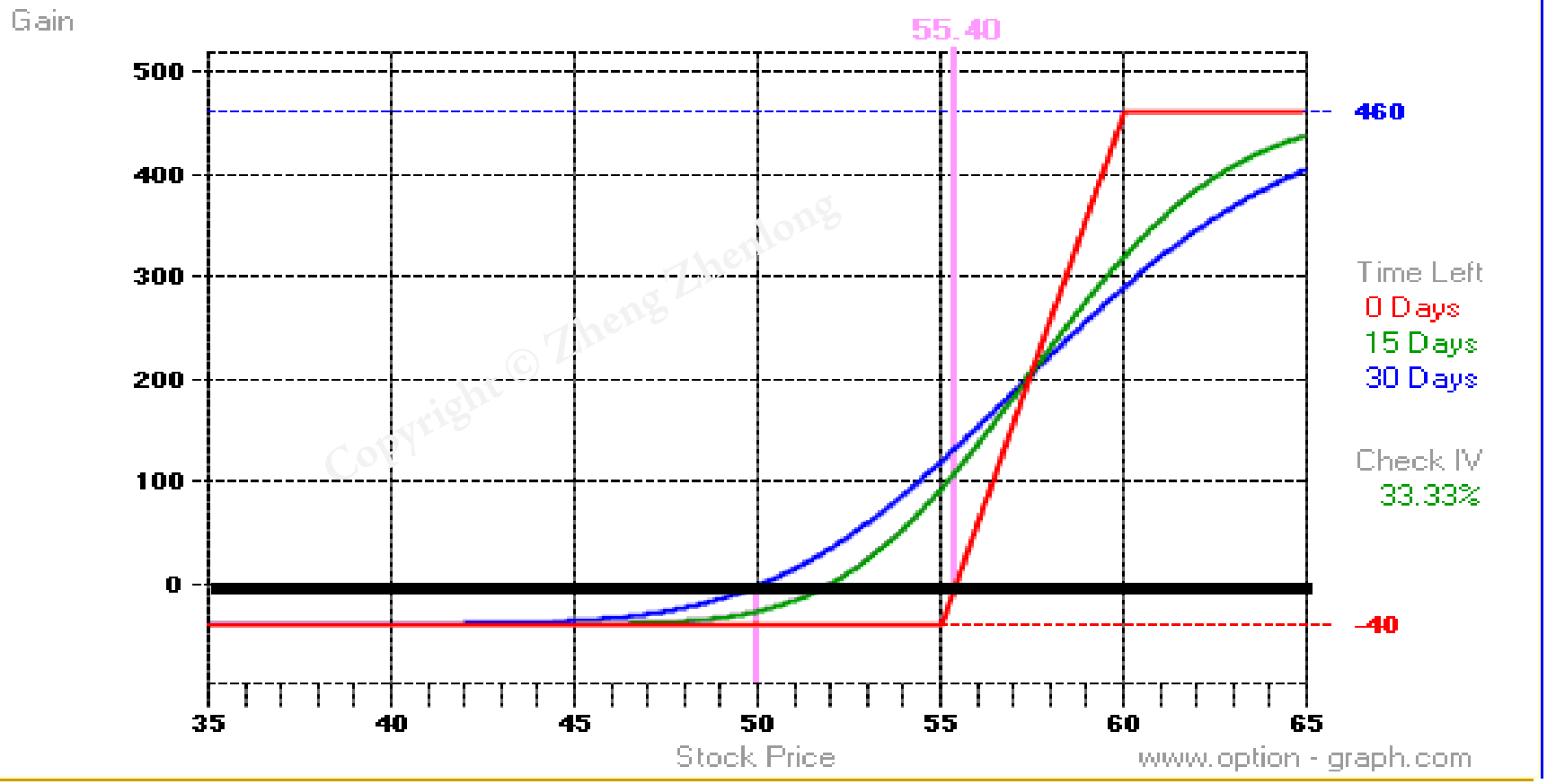
Stock at 50, 1 Long Put, 40 strike, 30 days, IV 33.33%, Option Price $0.02 =	$2.00	debit
Stock at 50, 1 Short Put, 45 strike, 30 days, IV 33.33%, Option Price $0.31 =	$31.00	credit
Total Position = $29.00 CREDIT		



小概率中大奖

Position Details : Bull Put (1 strike up to 2 strikes up)

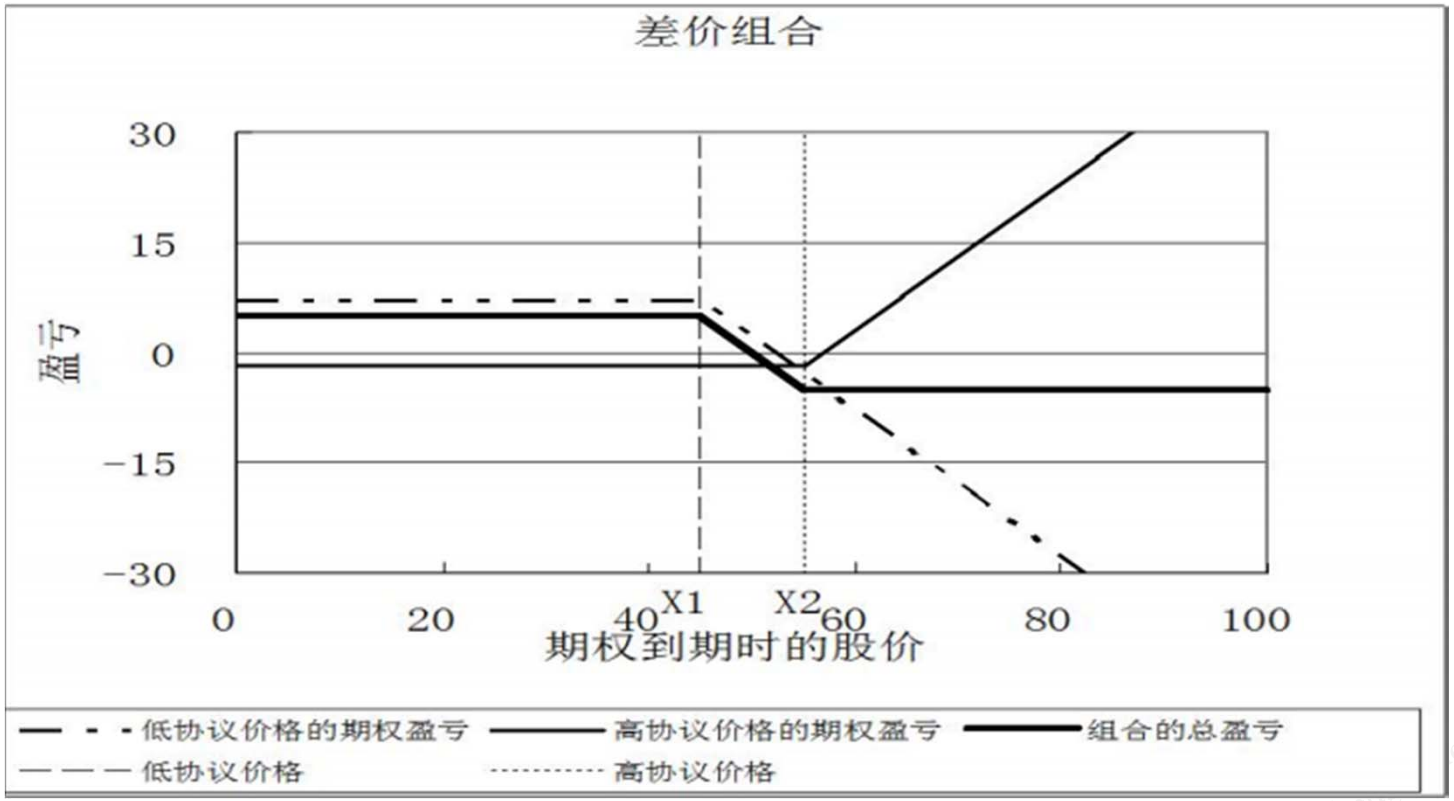
Stock at 50, 1 Long Put, 55 strike, 30 days, IV 33.33%, Option Price $5.36 =	$536.00	debit
Stock at 50, 1 Short Put, 60 strike, 30 days, IV 33.33%, Option Price $9.96 =	$996.00	credit
Total Position = $460.00 CREDIT		



- 怎样的情况下牛市差价组合有利？（为什么要构建？）
  - 预期价格上升幅度不大，降低初始成本
  - 在用看跌期权投机于上升预期之后进行保险

- 看涨期权和看跌期权的牛市差价组合
  - 看涨期权的牛市差价组合：期初现金流为负，但期末回报大于看跌期权的牛市差价组合
  - 看跌期权的牛市差价组合：期初现金流为正，但期末回报小于看涨期权的牛市差价组合（因为是进行看涨投机并进行一定的保险）

熊市差价（Bear Spreads）组合

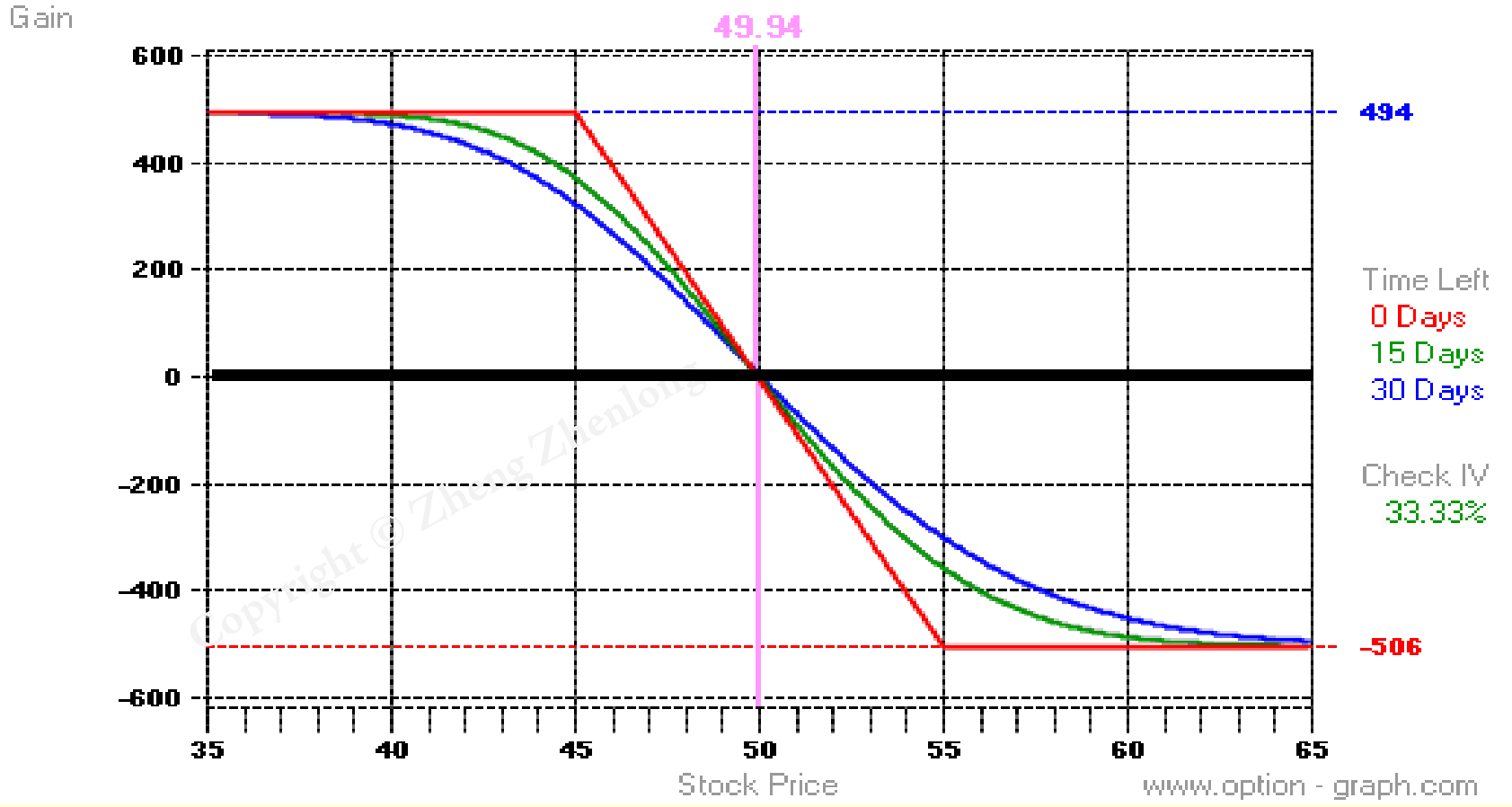


(a)看涨期权构造的熊市差价组合

盈亏均衡

Position Details : Bear Call (1 strike down to 1 strike up)

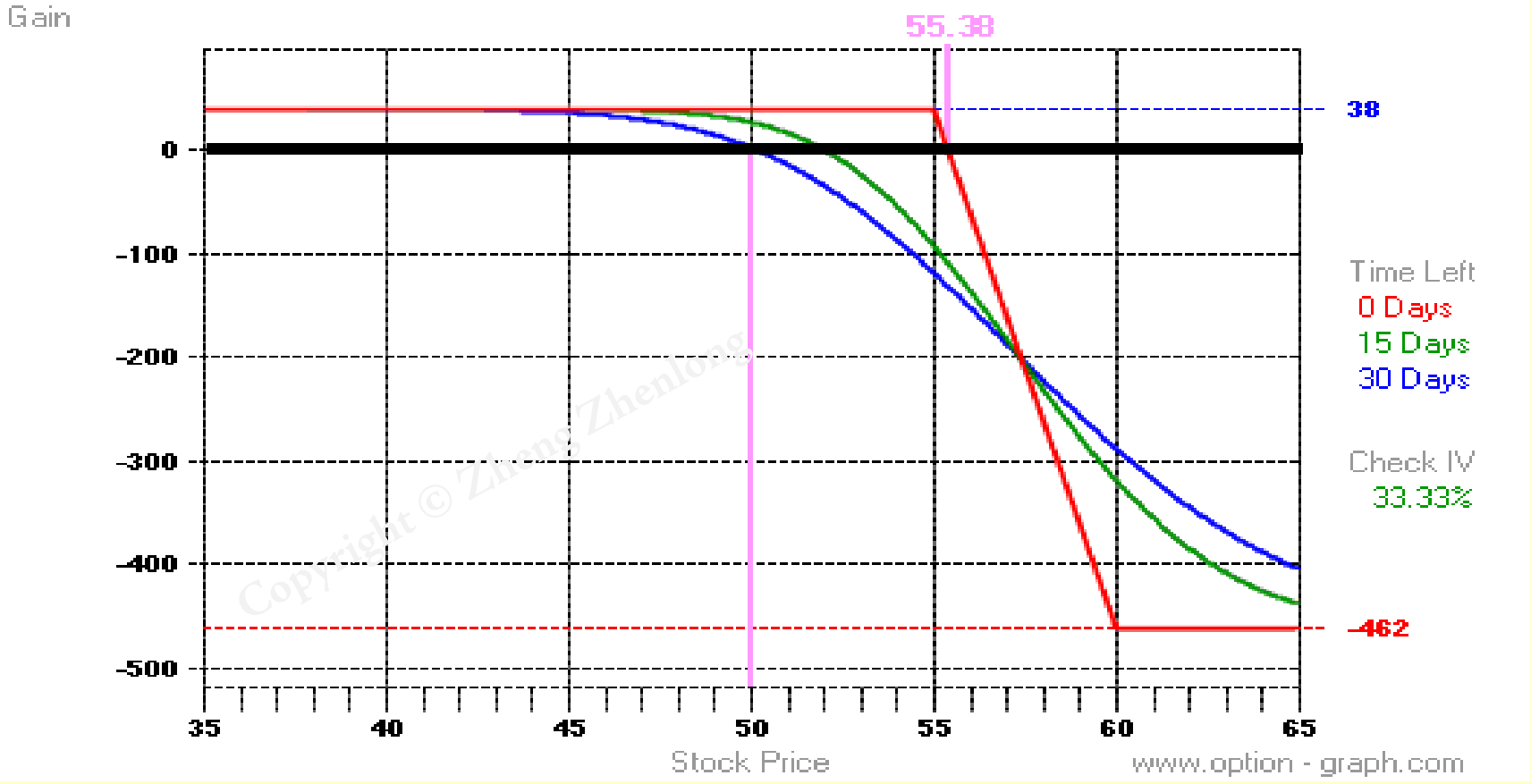
Stock at 50, 1 Long Call, 55 strike, 30 days, IV 33.33%, Option Price $0.45 =	$45.00	debit
Stock at 50, 1 Short Call, 45 strike, 30 days, IV 33.33%, Option Price $5.39 =	$539.00	credit
Total Position = $494.00 CREDIT		



大概率中小奖

Position Details : Bear Call (1 strike up to 2 strikes up)

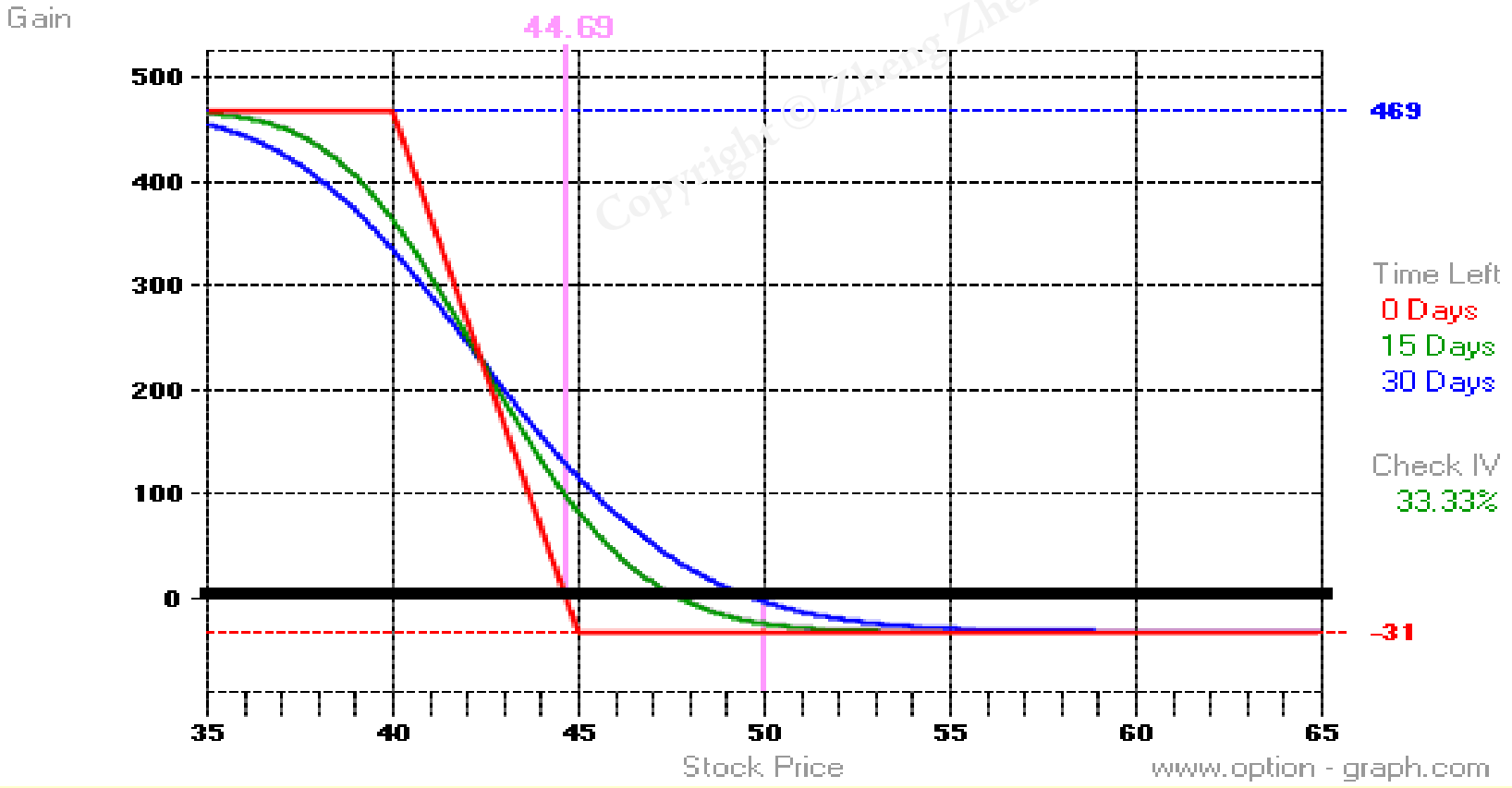
Stock at 50, 1 Long Call, 60 strike, 30 days, IV 33.33%, Option Price $0.07 =	$7.00	debit
Stock at 50, 1 Short Call, 55 strike, 30 days, IV 33.33%, Option Price $0.45 =	$45.00	credit
Total Position = $38.00 CREDIT		



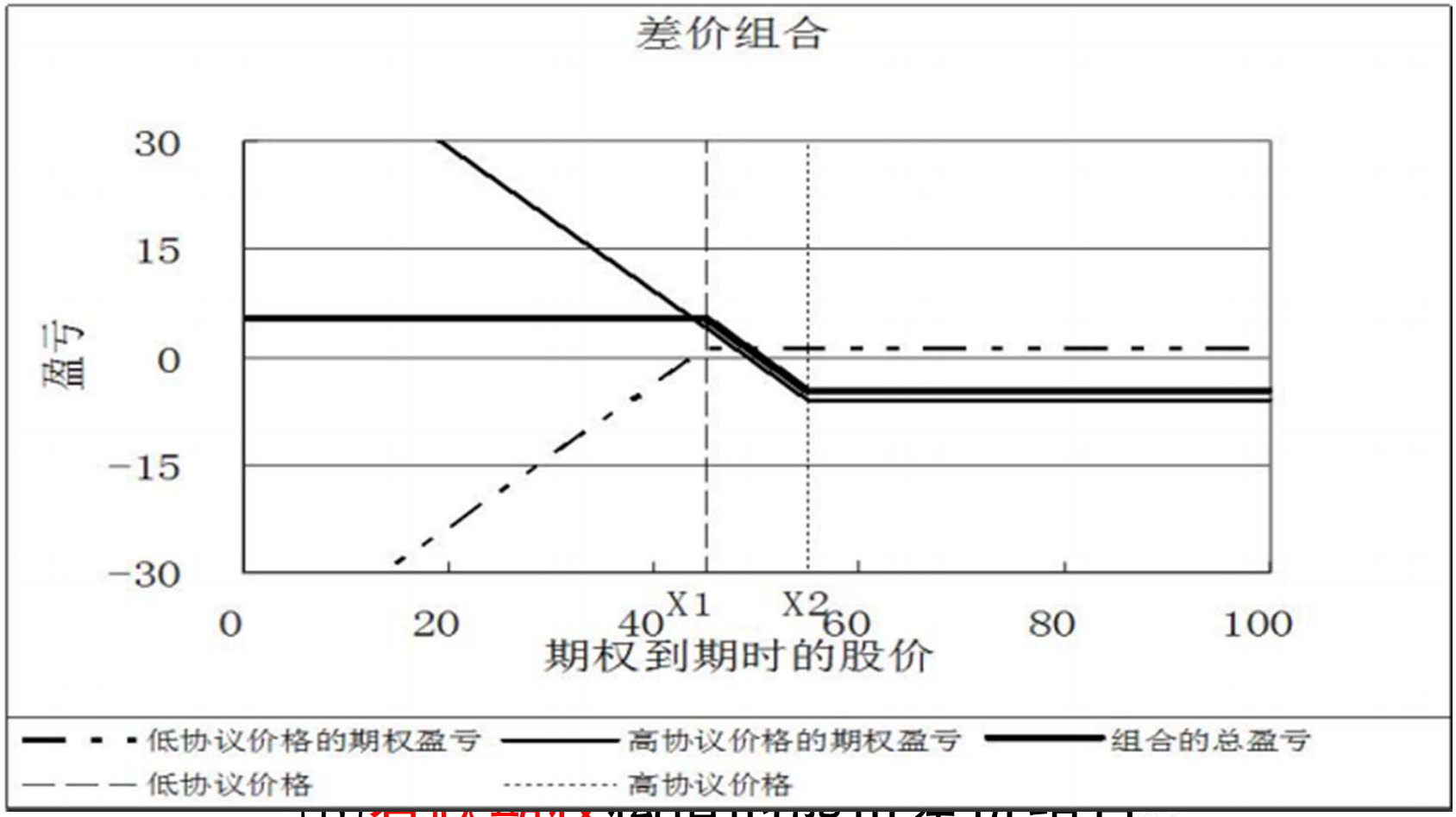
小概率中大奖

Position Details : Bear Call (2 strikes down to 1 strike down)

Stock at 50, 1 Long Call, 45 strike, 30 days, IV 33.33%, Option Price $5.39 =	$539.00	debit
Stock at 50, 1 Short Call, 40 strike, 30 days, IV 33.33%, Option Price $10.08 =	$1,008.00	credit
Total Position = $469.00 CREDIT		



熊市差价（Bear Spreads）组合



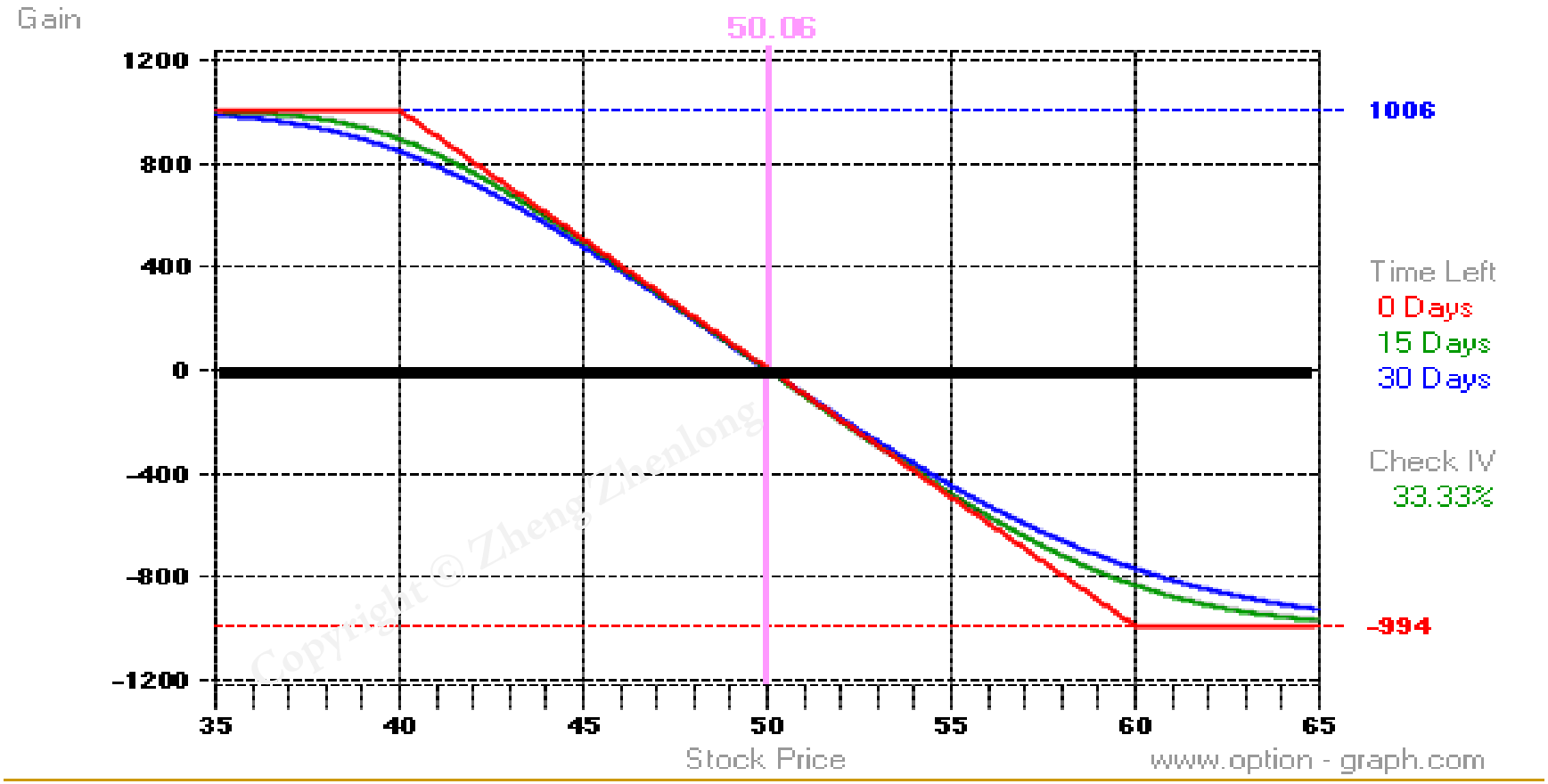
(b)看跌期权构造的熊市差价组合

均衡盈亏

Position Details : Bear Put (2 strikes down to 2 strikes up)

Stock at 50, 1 Long Put, 60 strike, 30 days, IV 33.33%, Option Price $9.96 =	$996.00	debit
Stock at 50, 1 Short Put, 40 strike, 30 days, IV 33.33%, Option Price $0.02 =	$2.00	credit

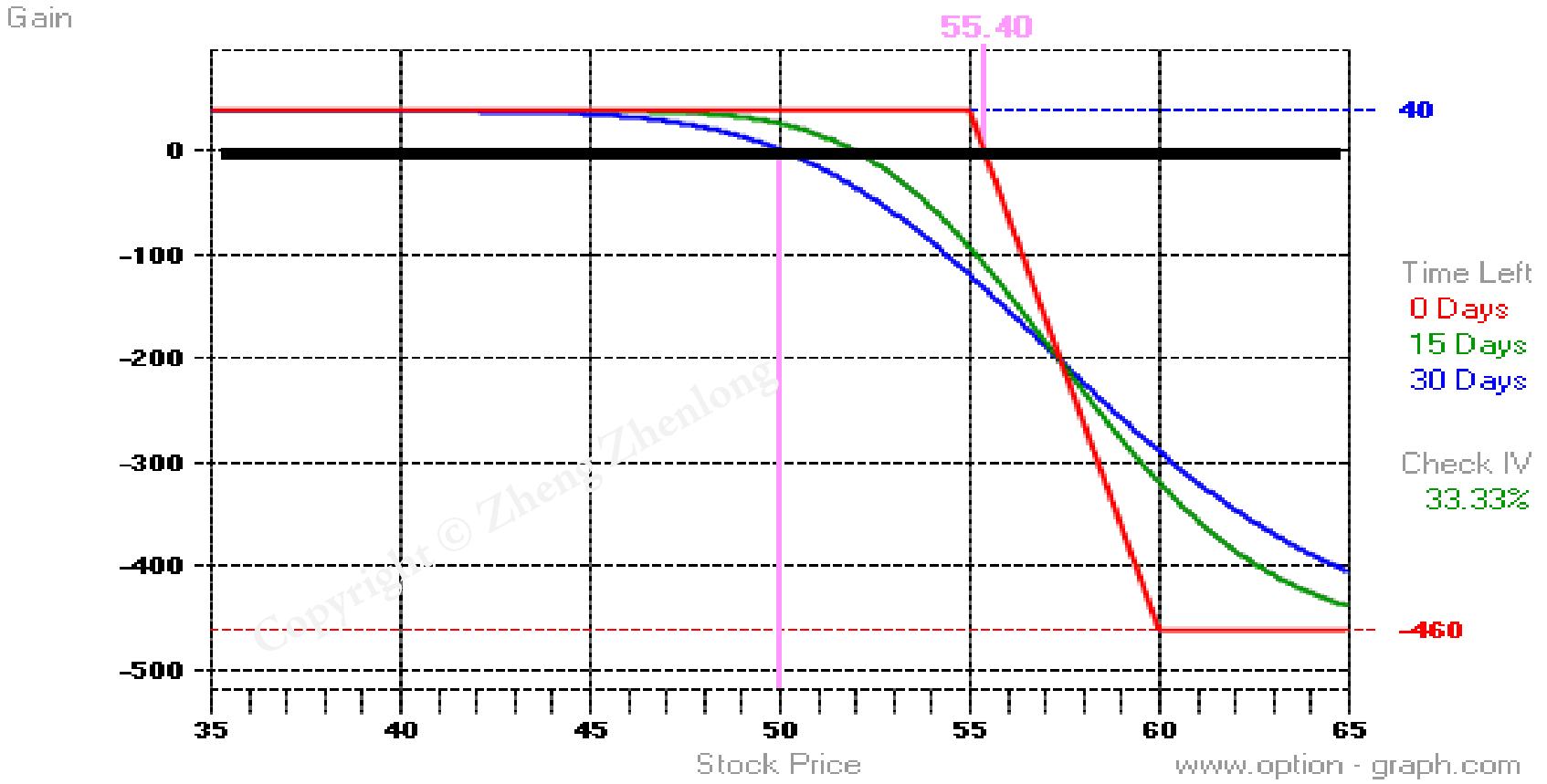
Total Position = $994.00 DEBIT



大概率中小奖

Position Details : Bear Put (1 strike up to 2 strikes up)

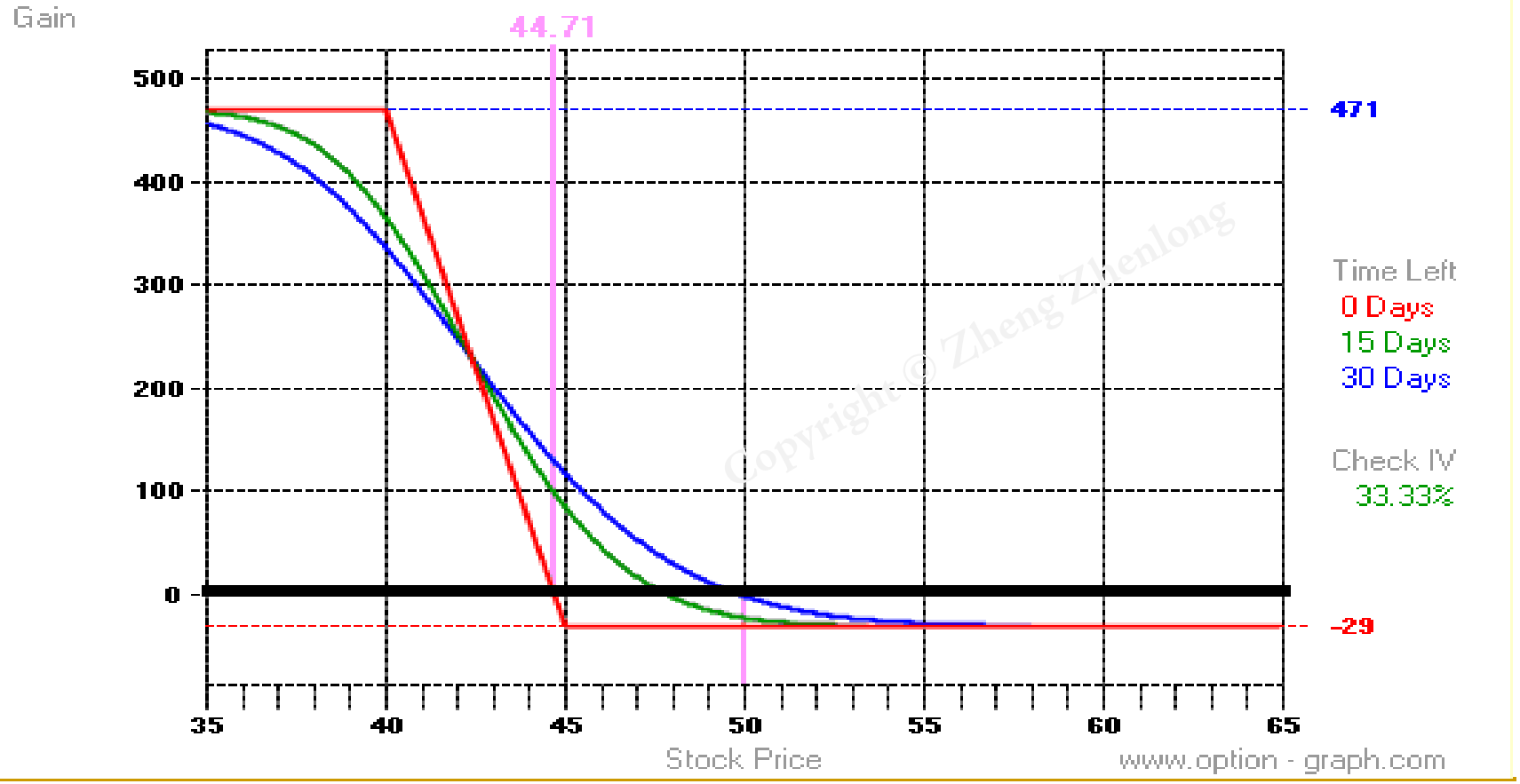
Stock at 50, 1 Long Put, 60 strike, 30 days, IV 33.33%, Option Price $9.96 =	$996.00	debit
Stock at 50, 1 Short Put, 55 strike, 30 days, IV 33.33%, Option Price $5.36 =	$536.00	credit
Total Position = $460.00 DEBIT		



小概率中大奖

Position Details : Bear Put (2 strikes down to 1 strike down)

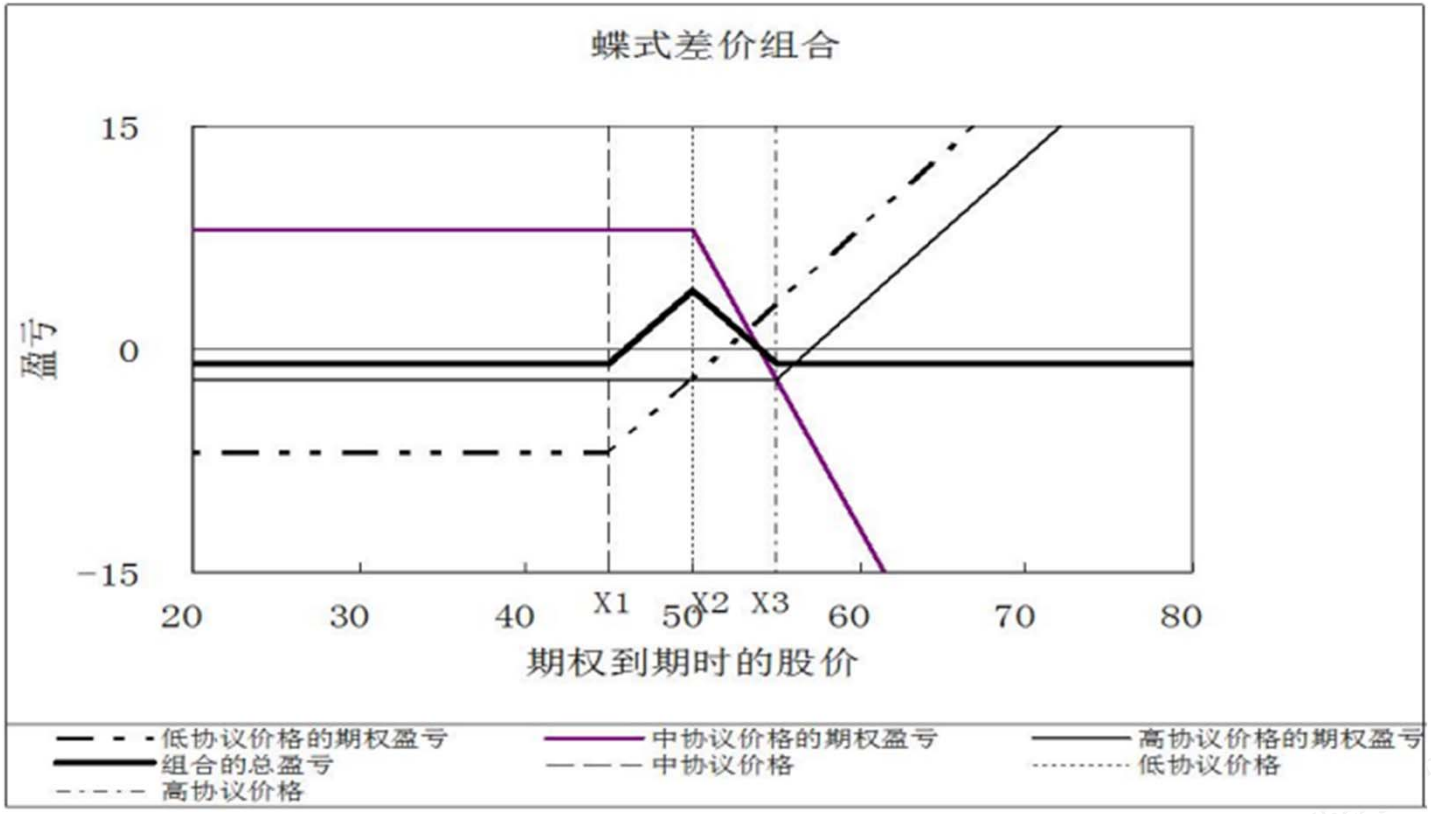
Stock at 50, 1 Long Put, 45 strike, 30 days, IV 33.33%, Option Price $0.31 =	$31.00	debit
Stock at 50, 1 Short Put, 40 strike, 30 days, IV 33.33%, Option Price $0.02 =	$2.00	credit
Total Position = $29.00 DEBIT		



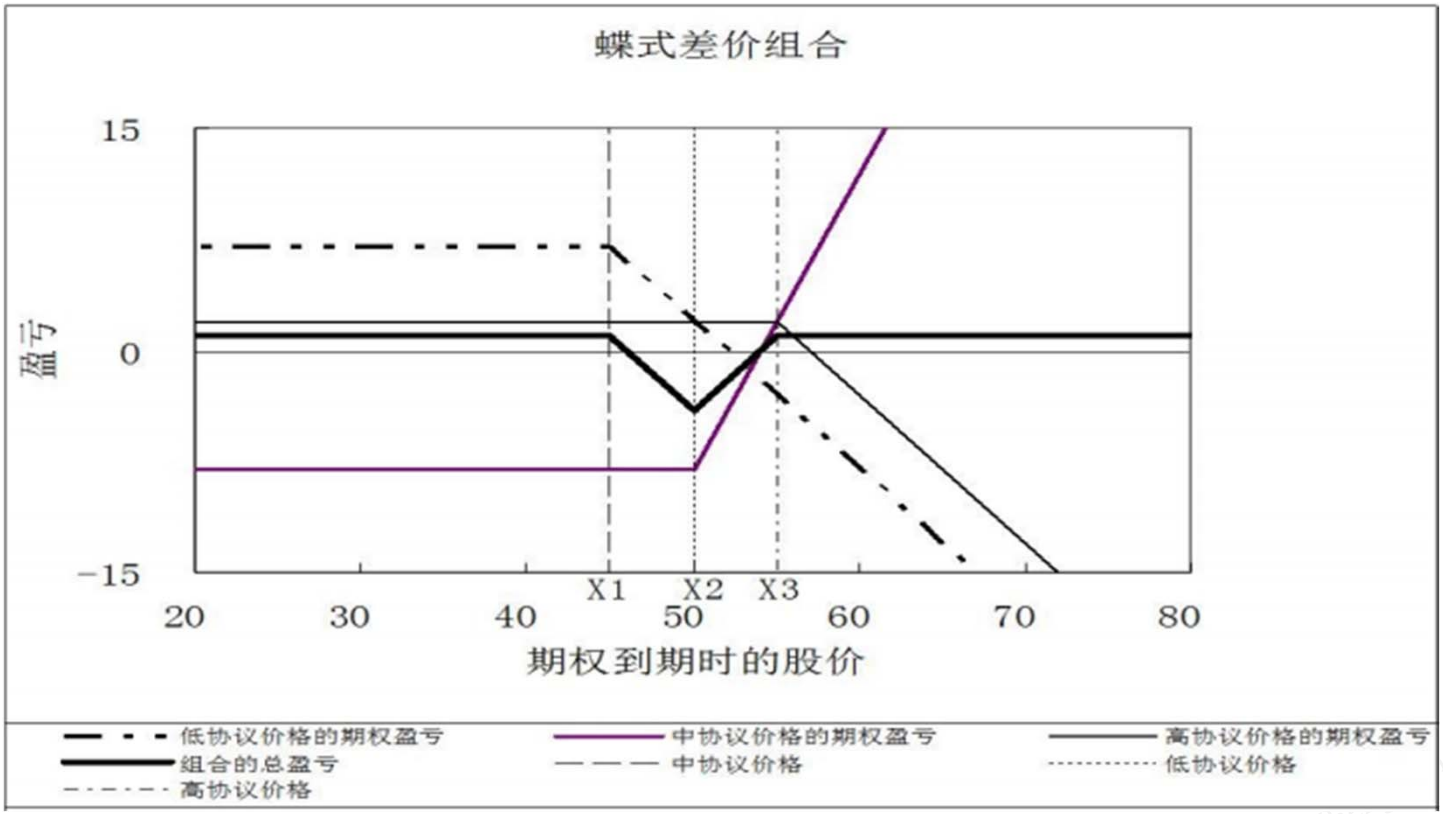
- 怎样的情况下熊市差价组合有利？（为什么要构建？）
  - 预期价格下跌幅度不大，降低初始成本
  - 在用看涨期权构造看跌预期投机时，进行保险

- 看涨期权的熊市差价组合和看跌期权的熊市差价组合的差别在于，前者在期初有正的现金流，后者在期初则有负的现金流，但后者的期末回报大于前者。
- 熊市差价组合刚好跟牛市差价组合相反，两者的图形刚好以 X 轴对称。

蝶式差价组合（Butterfly Spreads）



(a)看涨期权的正向蝶式差价组合



(b)看涨期权的反向蝶式差价组合

- 蝶式差价组合由四份具有相同期限、不同协议价格的同种期权头寸组成。
- 若 $X_1 < X_2 < X_3$，且 $X_2 = (X_1 + X_3)/2$，则蝶式差价组合有如下四种：

- 看涨期权的正向蝶式差价组合：由协议价格分别为 X_1 和 X_3 的看涨期权多头和两份协议价格为 X_2 的看涨期权空头组成
- 看涨期权的反向蝶式差价组合：由协议价格分别为 X_1 和 X_3 的看涨期权空头和两份协议价格为 X_2 的看涨期权多头组成

- 看跌期权的正向蝶式差价组合：由协议价格分别为 X_1 和 X_3 的看跌期权多头和两份协议价格为 X_2 的看跌期权空头组成
- 看跌期权的反向蝶式差价组合：由协议价格分别为 X_1 和 X_3 的看跌期权空头和两份协议价格为 X_2 的看跌期权多头组成

- 无论用看涨还是看跌期权组合，正向和反向结果都相同，并且初始投资也相同。（如何证明？）
- 为何构建蝶式差价组合：预期价格会在一定的区间内波动

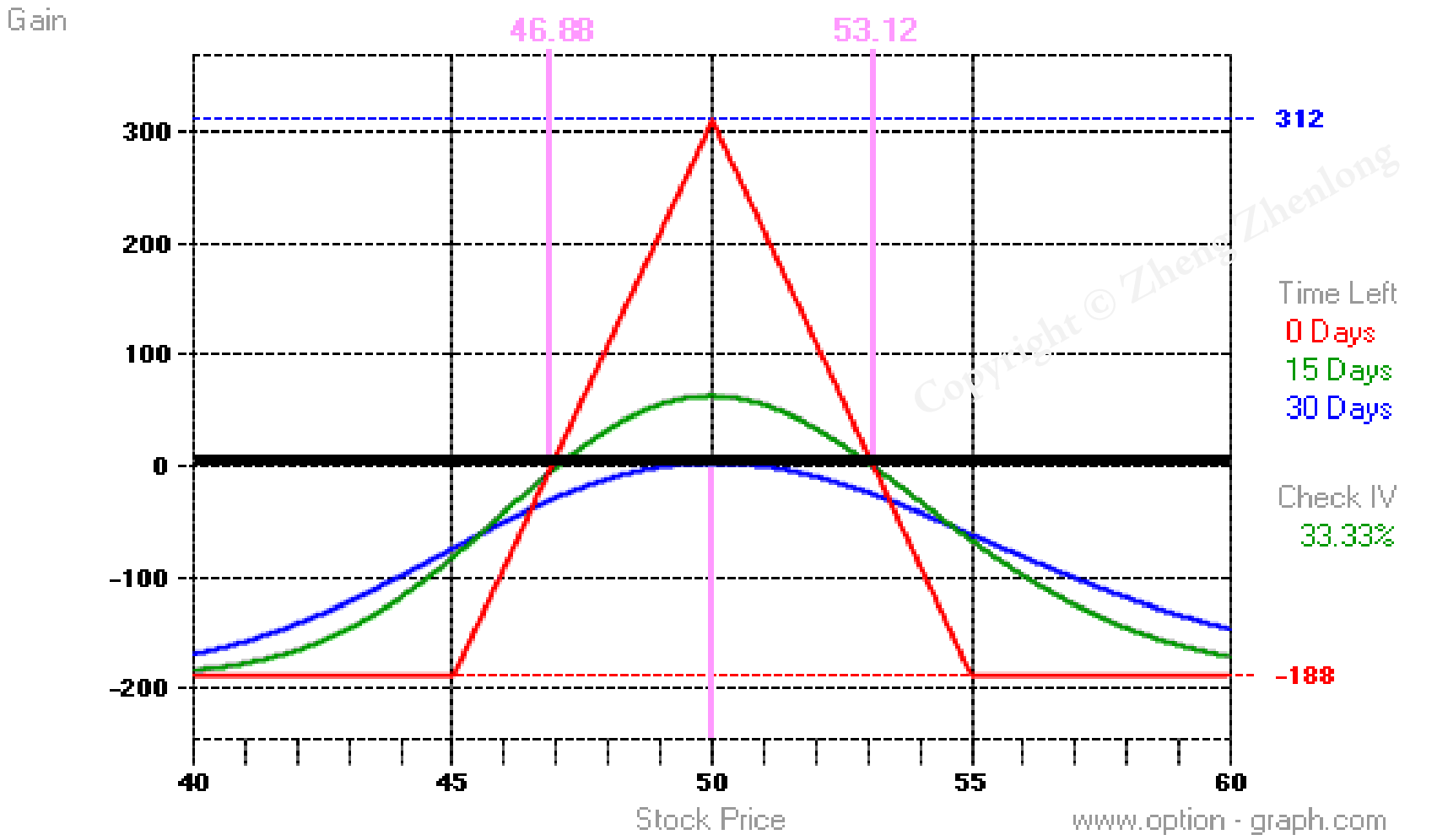
看涨期权正向蝶式差价组合的盈亏状况表

S_T 的范围	c_1 盈亏	2 份 c_2 盈亏
$S_T \leqslant X_1$	$0 - c_1$	$0 + 2c_2$
$X_1 < S_T \leqslant X_2$	$S_T - X_1 - c_1$	$0 + 2c_2$
$X_2 < S_T \leqslant X_3$	$S_T - X_1 - c_1$	$2X_2 - 2S_T + 2c_2$
$S_T \geqslant X_3$	$S_T - X_1 - c_1$	$2X_2 - 2S_T + 2c_2$
c_3 的盈亏	总盈亏	
$0 - c_3$	$2c_2 - c_1 - c_3$	
$0 - c_3$	$S_T - X_1 + 2c_2 - c_1 - c_3$	
$0 - c_3$	$X_3 - S_T + 2c_2 - c_1 - c_3$	
$S_T - X_3 - c_3$	$2c_2 - c_1 - c_3$	

Position Details : Butterfly with all Calls

Stock at 50, 1 Short Call, 50 strike, 30 days, IV 33.33%, Option Price $1.98 =	$198.00	credit
Stock at 50, 1 Short Call, 50 strike, 30 days, IV 33.33%, Option Price $1.98 =	$198.00	credit
Stock at 50, 1 Long Call, 55 strike, 30 days, IV 33.33%, Option Price $0.45 =	$45.00	debit
Stock at 50, 1 Long Call, 45 strike, 30 days, IV 33.33%, Option Price $5.39 =	$539.00	debit

Total Position = $188.00 DEBIT

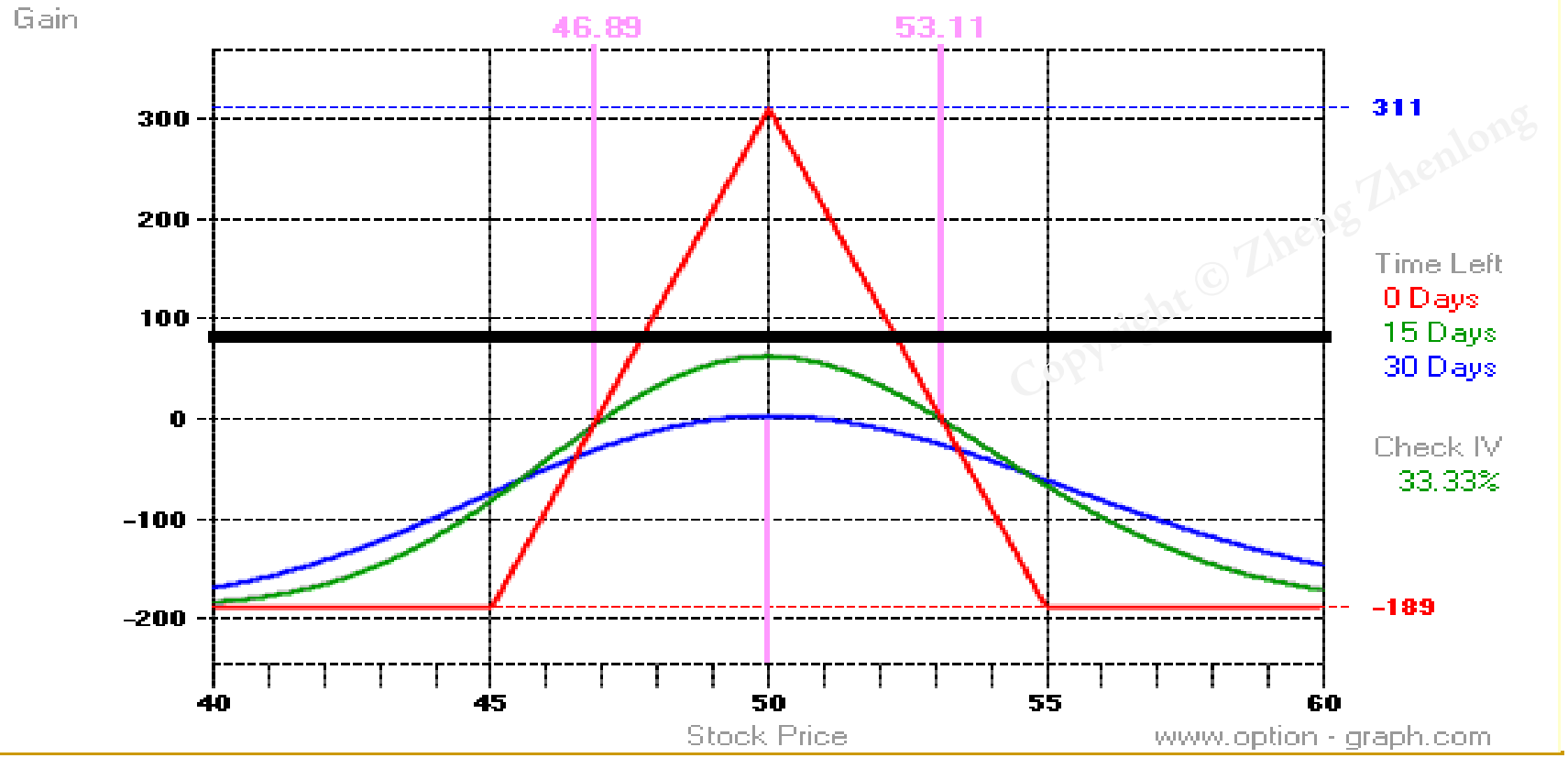


看跌期权的正向蝶式差价组合

Position Details : Butterfly with all Puts

Stock at 50, 1 Short Put, 50 strike, 30 days, IV 33.33%, Option Price $1.89 =	$189.00	credit
Stock at 50, 1 Short Put, 50 strike, 30 days, IV 33.33%, Option Price $1.89 =	$189.00	credit
Stock at 50, 1 Long Put, 55 strike, 30 days, IV 33.33%, Option Price $5.36 =	$536.00	debit
Stock at 50, 1 Long Put, 45 strike, 30 days, IV 33.33%, Option Price $0.31 =	$31.00	debit

Total Position = $189.00 DEBIT

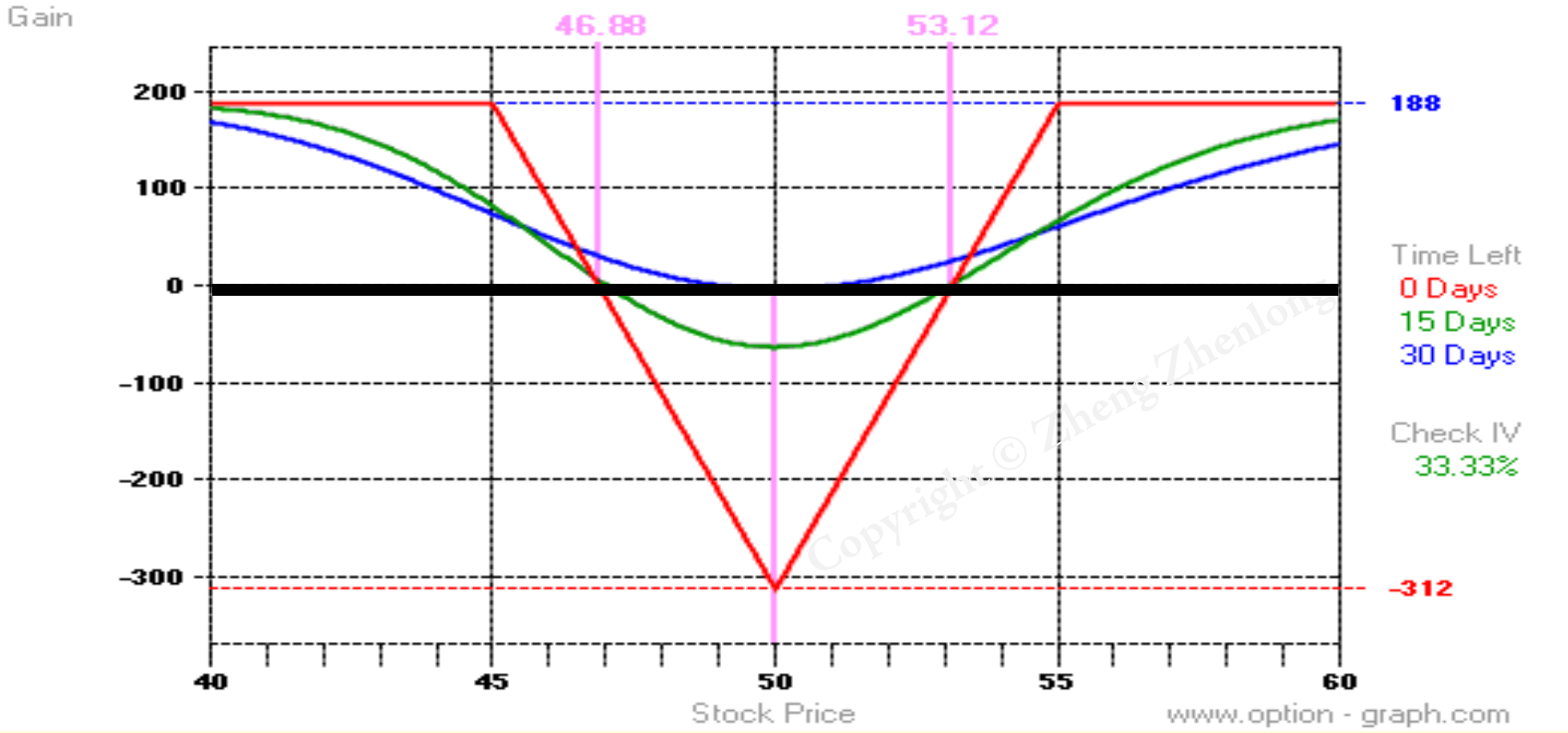


看涨期权的反向蝶式差价组合

Position Details : Reverse Butterfly with all Calls

Stock at 50, 1 Long Call, 50 strike, 30 days, IV 33.33%, Option Price $1.98 =	$198.00	debit
Stock at 50, 1 Long Call, 50 strike, 30 days, IV 33.33%, Option Price $1.98 =	$198.00	debit
Stock at 50, 1 Short Call, 55 strike, 30 days, IV 33.33%, Option Price $0.45 =	$45.00	credit
Stock at 50, 1 Short Call, 55 strike, 30 days, IV 33.33%, Option Price $5.39 =	$539.00	credit

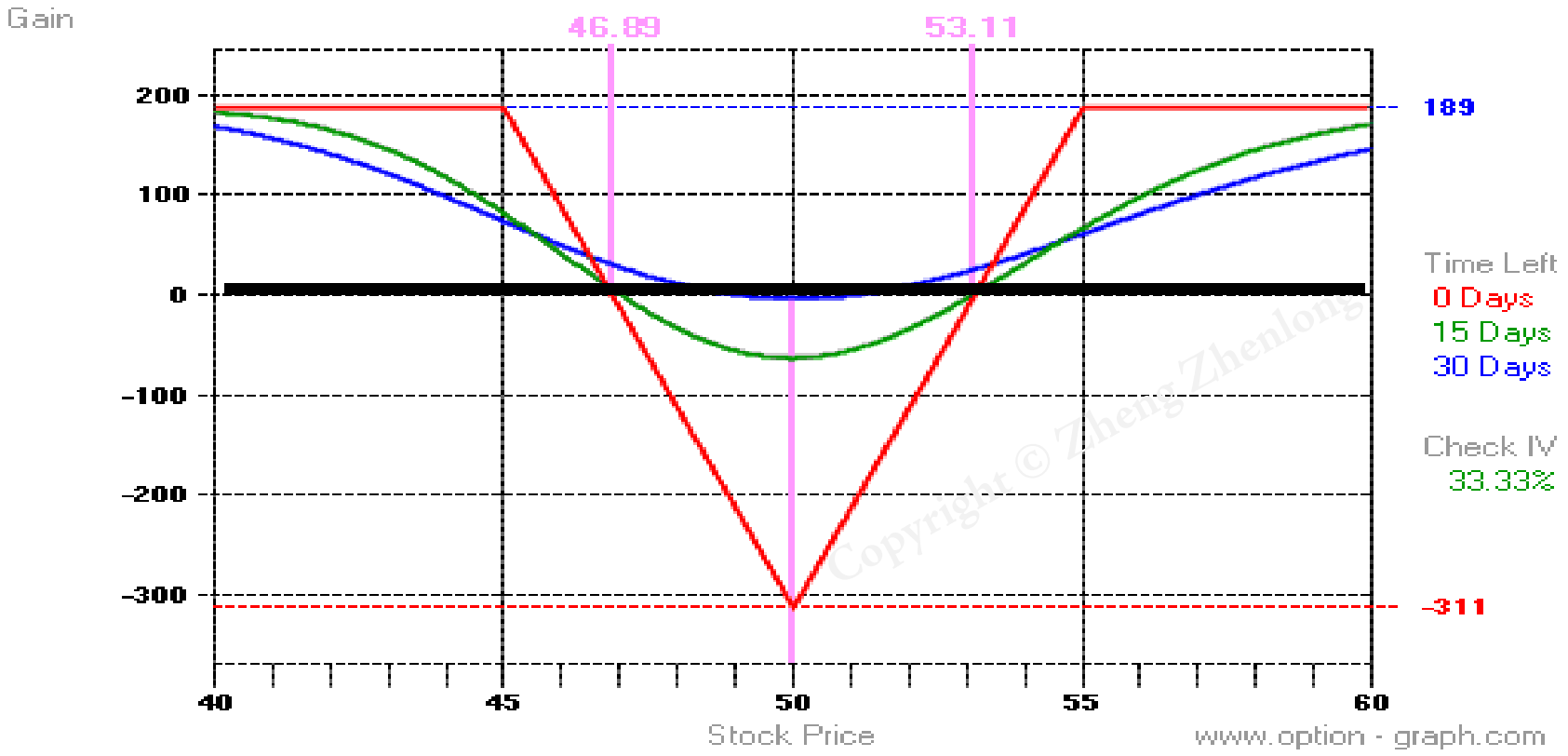
Total Position = $188.00 CREDIT



看跌期权的反向蝶式差价组合

Position Details : Reverse Butterfly with all Puts

Stock at 50, 1 Long Put, 50 strike, 30 days, IV 33.33%, Option Price $1.89 =	$189.00	debit
Stock at 50, 1 Long Put, 50 strike, 30 days, IV 33.33%, Option Price $1.89 =	$189.00	debit
Stock at 50, 1 Short Put, 55 strike, 30 days, IV 33.33%, Option Price $5.36 =	$536.00	credit
Stock at 50, 1 Short Put, 45 strike, 30 days, IV 33.33%, Option Price $0.31 =	$31.00	credit
Total Position = $189.00 CREDIT		



差期（Calendar Spreads）组合

- 差期组合：两份相同协议价格、不同期限的同种期权的不同头寸组成
- 差期组合的四种类型
  - 正向差期组合（买长卖短）
    - 一份看涨期权多头与一份期限较短的看涨期权空头的组合，称看涨期权的正向差期组合。
    - 一份看跌期权多头与一份期限较短的看跌期权空头的组合，称看跌期权的正向差期组合。

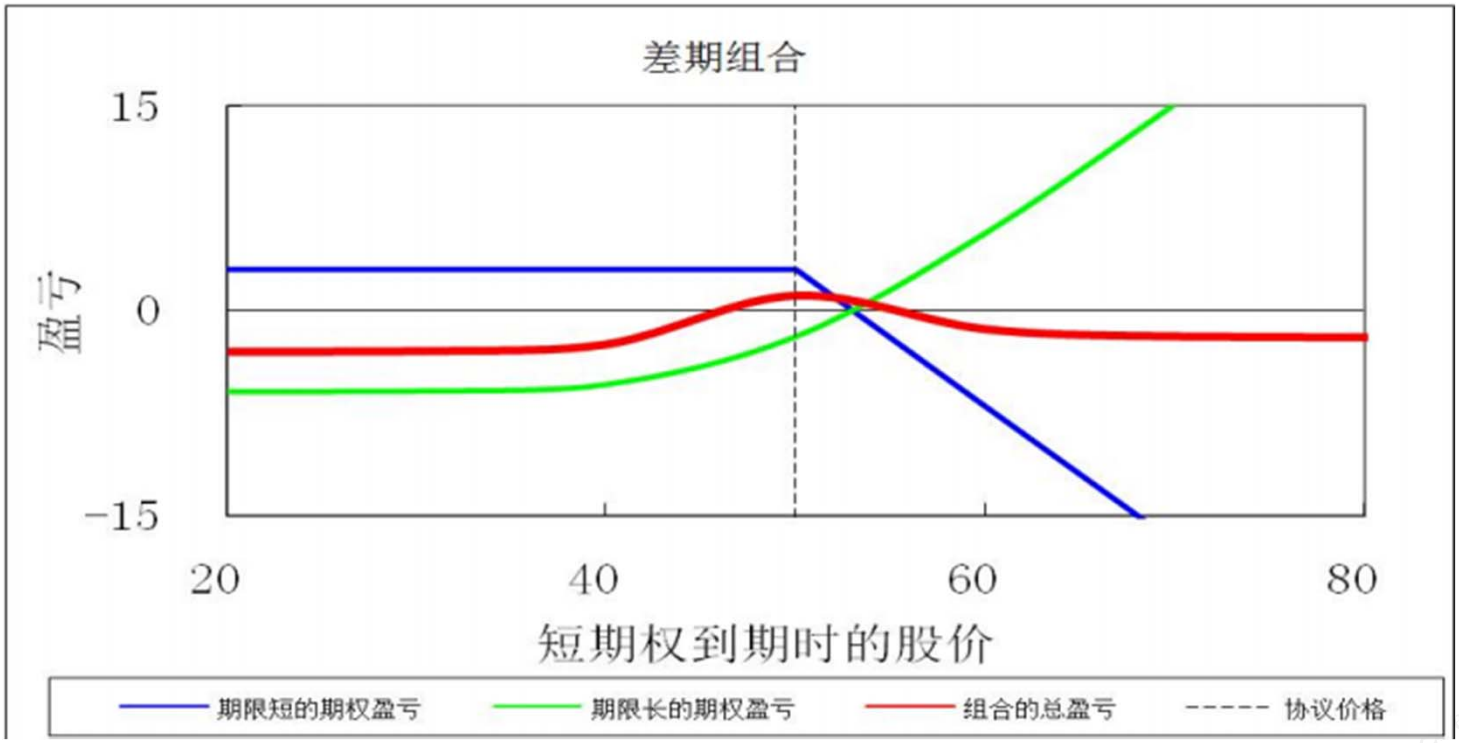
- 反向差期组合（买短卖长）
  - 一份看涨期权多头与一份期限较长的看涨期权空头的组合，称看涨期权的反向差期组合。
  - 一份看跌期权多头与一份期限较长的看跌期权空头的组合，称看跌期权的反向差期组合。

看涨期权的正向差期组合的盈亏状况表

表 13.2 看涨期权的正向差期组合的盈亏状况

S_T 的范围	看涨期权多头的盈亏	看涨期权空头的盈亏	总盈亏
$S_T \to \infty$	趋近 $S_T - Xe^{-r(T^*-T)} - c_1$	$X - S_T + c_2$	趋近 $X - Xe^{-r(T^*-T)} + c_2 - c_1$
$S_T = X$	$X - Xe^{-r(T^*-T)} + c_{1T} - c_1$	c_2	$X - Xe^{-r(T^*-T)} + c_{1T} + c_2 - c_1$
$S_T \to 0$	趋近 $-c_1$	c_2	趋近 $c_2 - c_1$

看涨期权的正向差期组合 Profit

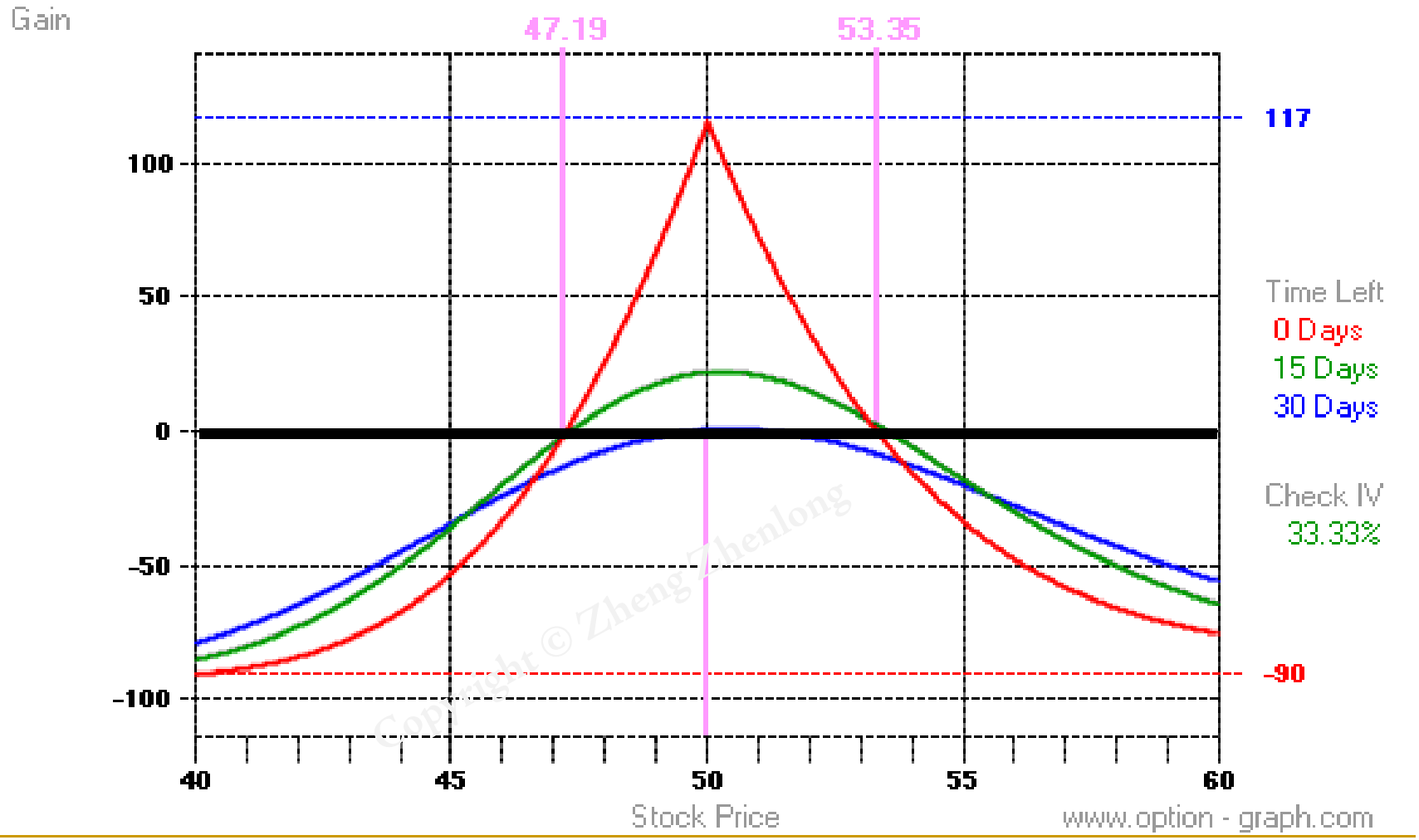


看涨期权构造的正向差期组合

Position Details : Calendar Call, ATM

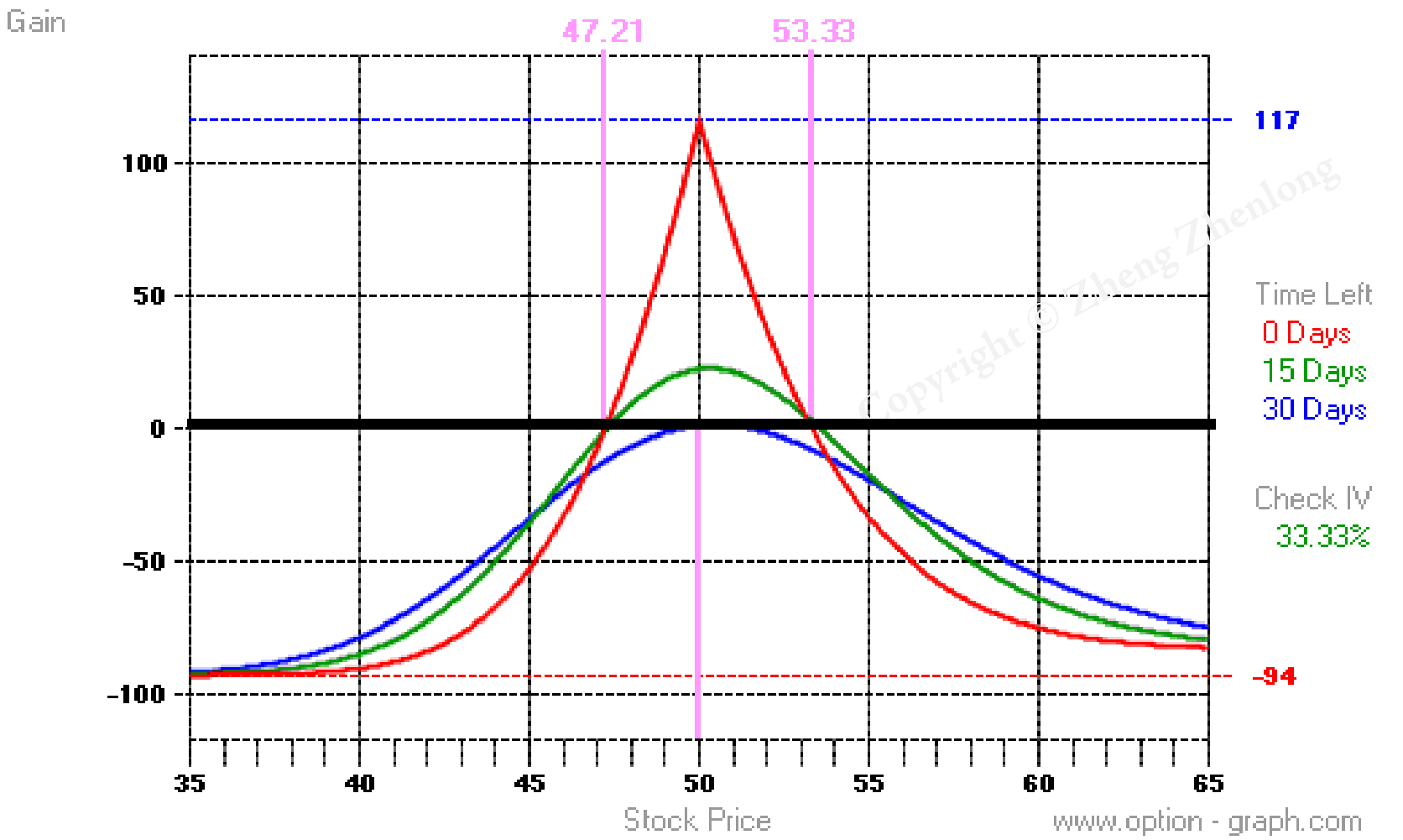
Stock at 50, 1 Long Call, 50 strike, 65 days, IV 33.33%, Option Price $2.91 =	$291.00	debit
Stock at 50, 1 Short Call, 50 strike, 30 days, IV 33.33%, Option Price $1.98 =	$198.00	credit

Total Position = $93.00 DEBIT



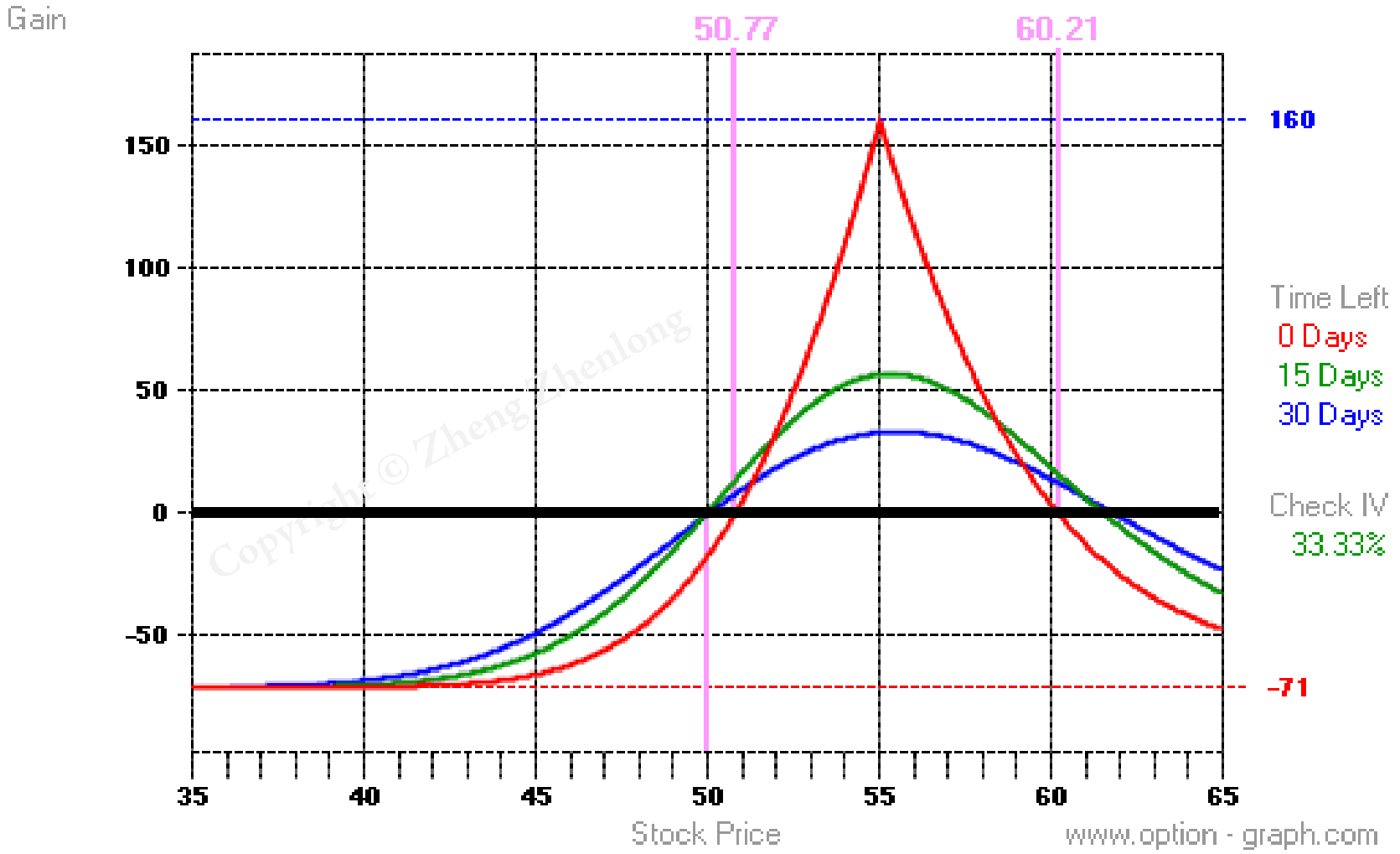
Position Details : Calendar Put, ATM

Stock at 50, 1 Long Put, 50 strike, 65 days, IV 33.33%, Option Price $2.73 =	$273.00	debit
Stock at 50, 1 Short Put, 50 strike, 30 days, IV 33.33%, Option Price $1.89 =	$189.00	credit
Total Position = $84.00 DEBIT		



Position Details : Calendar Call, OTM

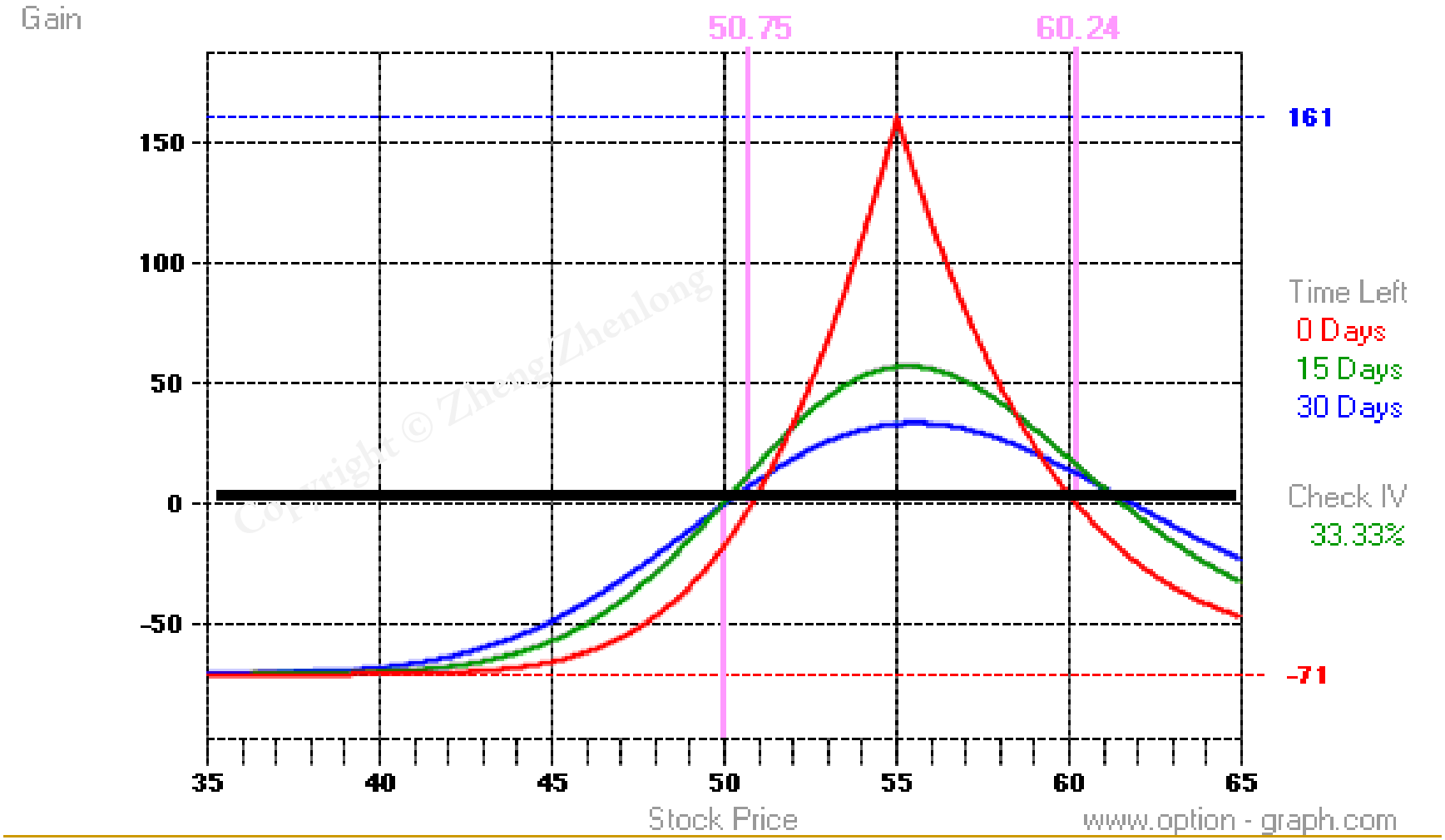
Stock at 50, 1 Long Call, 55 strike, 65 days, IV 33.33%, Option Price $1.16 =	$116.00	debit
Stock at 50, 1 Short Call, 55 strike, 30 days, IV 33.33%, Option Price $0.45 =	$45.00	credit
Total Position = $71.00 DEBIT		



Position Details : Calendar Put, ITM

Stock at 50, 1 Long Put, 55 strike, 65 days, IV 33.33%, Option Price $5.96 =	$596.00	debit
Stock at 50, 1 Short Put, 55 strike, 30 days, IV 33.33%, Option Price $5.36 =	$536.00	credit

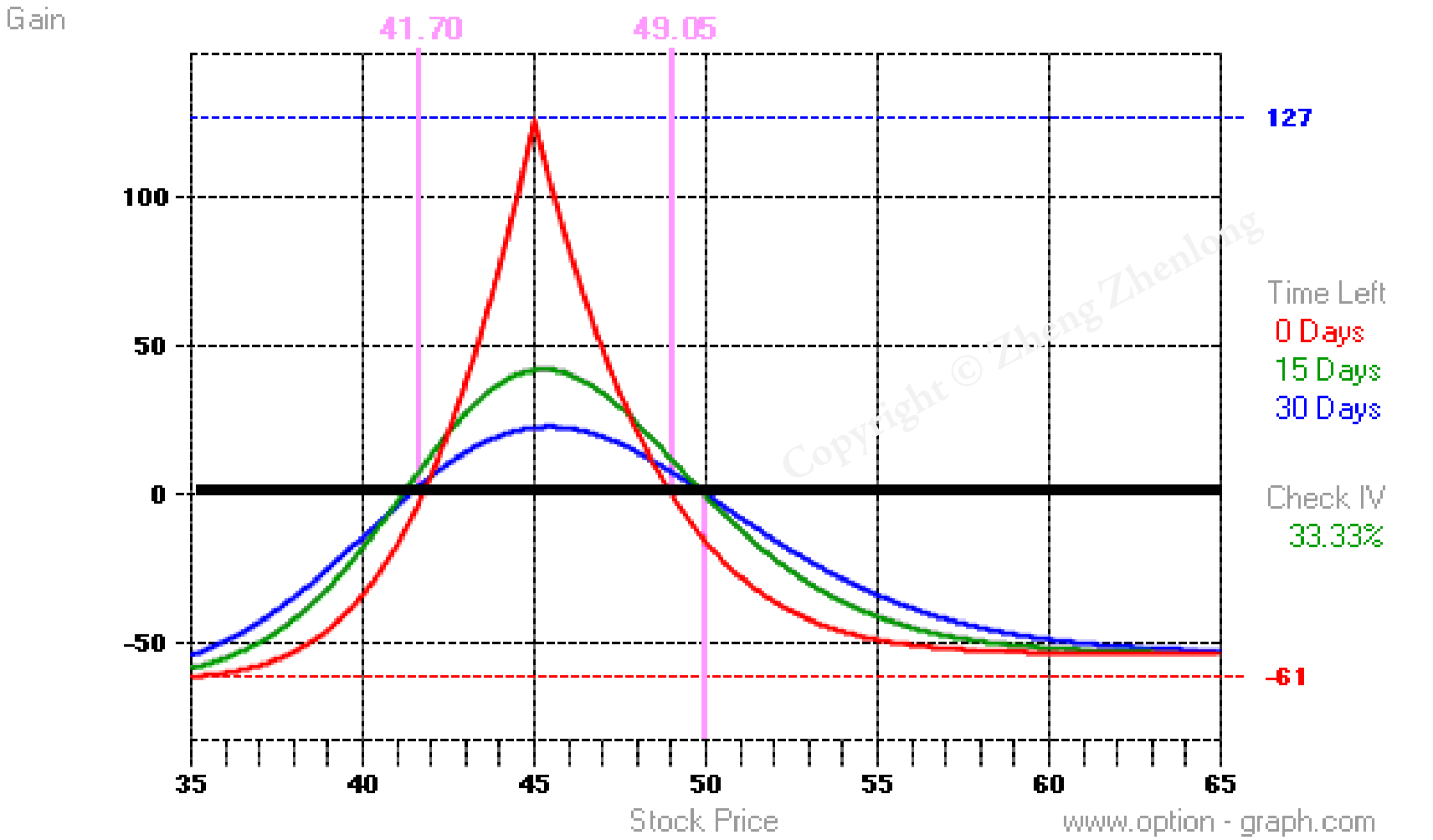
Total Position = $60.00 DEBIT



Position Details : Calendar Call, ITM

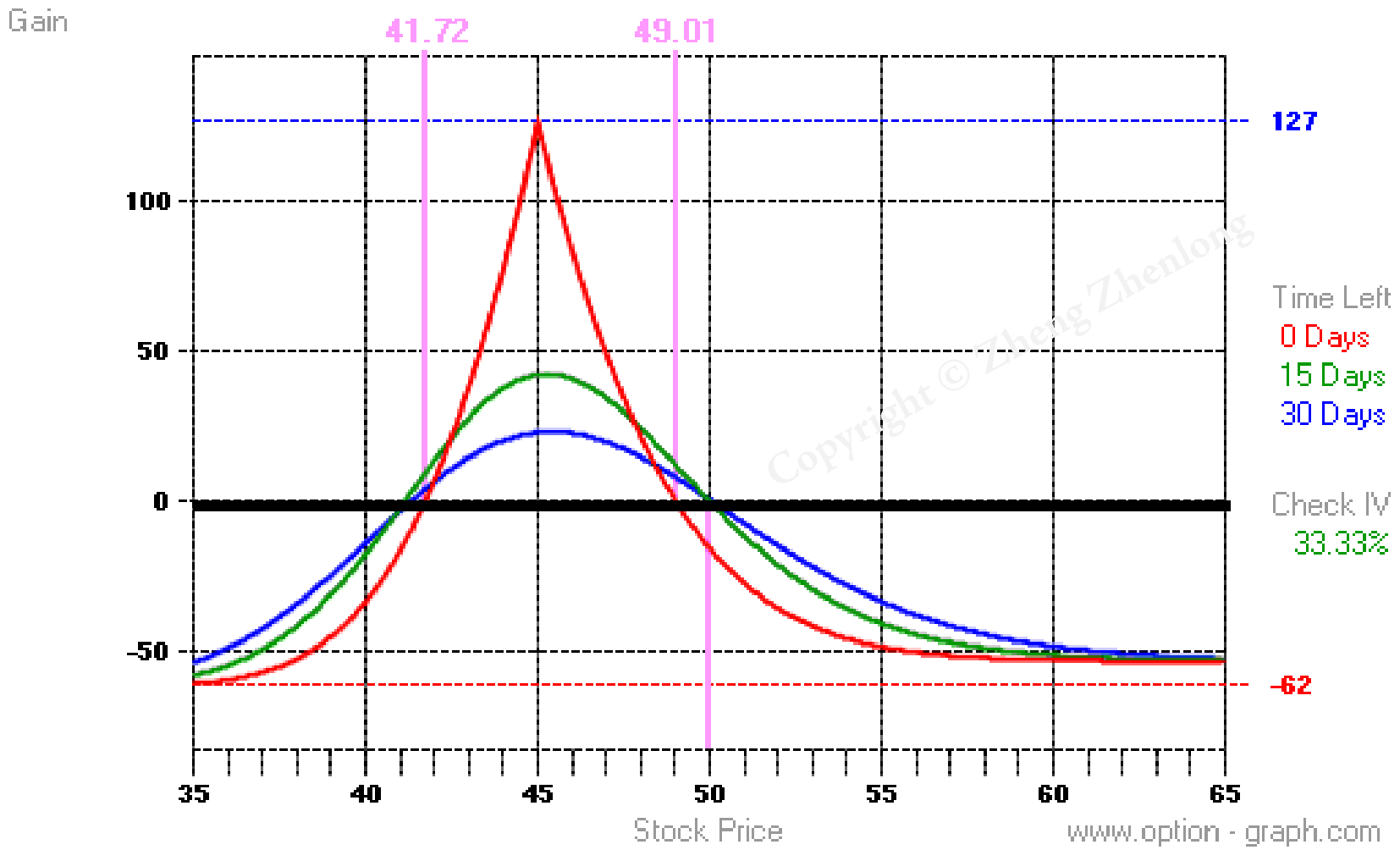
Stock at 50, 1 Long Call, 45 strike, 65 days, IV 33.33%, Option Price $6.01 =	$601.00	debit
Stock at 50, 1 Short Call, 45 strike, 30 days, IV 33.33%, Option Price $5.39 =	$539.00	credit

Total Position = $62.00 DEBIT



Position Details : Calendar Put, OTM

Stock at 50, 1 Long Put, 45 strike, 65 days, IV 33.33%, Option Price $0.85 =	$85.00	debit
Stock at 50, 1 Short Put, 45 strike, 30 days, IV 33.33%, Option Price $0.31 =	$31.00	credit
Total Position = $54.00 DEBIT		



对角（Diagonal Spreads）组合

- 对角组合（Diagonal Spreads）
  - 两份协议价格不同（X_1 和 X_2，且 $X_1 < X_2$）、期限也不同（T 和 T*，且 T < T*）的同种期权的不同头寸组成。
  - 它有八种类型
    - 看涨/看跌
    - 牛市/熊市——买低卖高/买高卖低
    - 正向/反向——买长卖短/买短卖长

对角组合的八种类型

- 看涨期权的牛市正向对角组合
  - 由看涨期权的（X_1，T^*）多头加（X_2，T）空头组合组成
- 看涨期权的熊市反向对角组合
  - 由看涨期权的（X_1，T^*）空头加（X_2，T）多头组成的组合。其盈亏图与 1 刚好相反。

- 看涨期权的熊市正向对角组合
  - 由看涨期权的（X_2，T^*）多头加（X_1，T）空头组成的组合。
- 看涨期权的牛市反向对角组合。
  - 由看涨期权的（X_2，T^*）空头加（X_1，T）多头组成的组合，其盈亏图与 3 刚好相反。

- 看跌期权的牛市正向对角组合。
  - 由看跌期权的（X_1，T^*）多头加（X_2，T）空头组成的组合。
- 看跌期权的熊市反向对角组合。
  - 由看跌期权的（X_1，T^*）空头加（X_2，T）多头组成的组合，其盈亏图与 5 刚好相反。

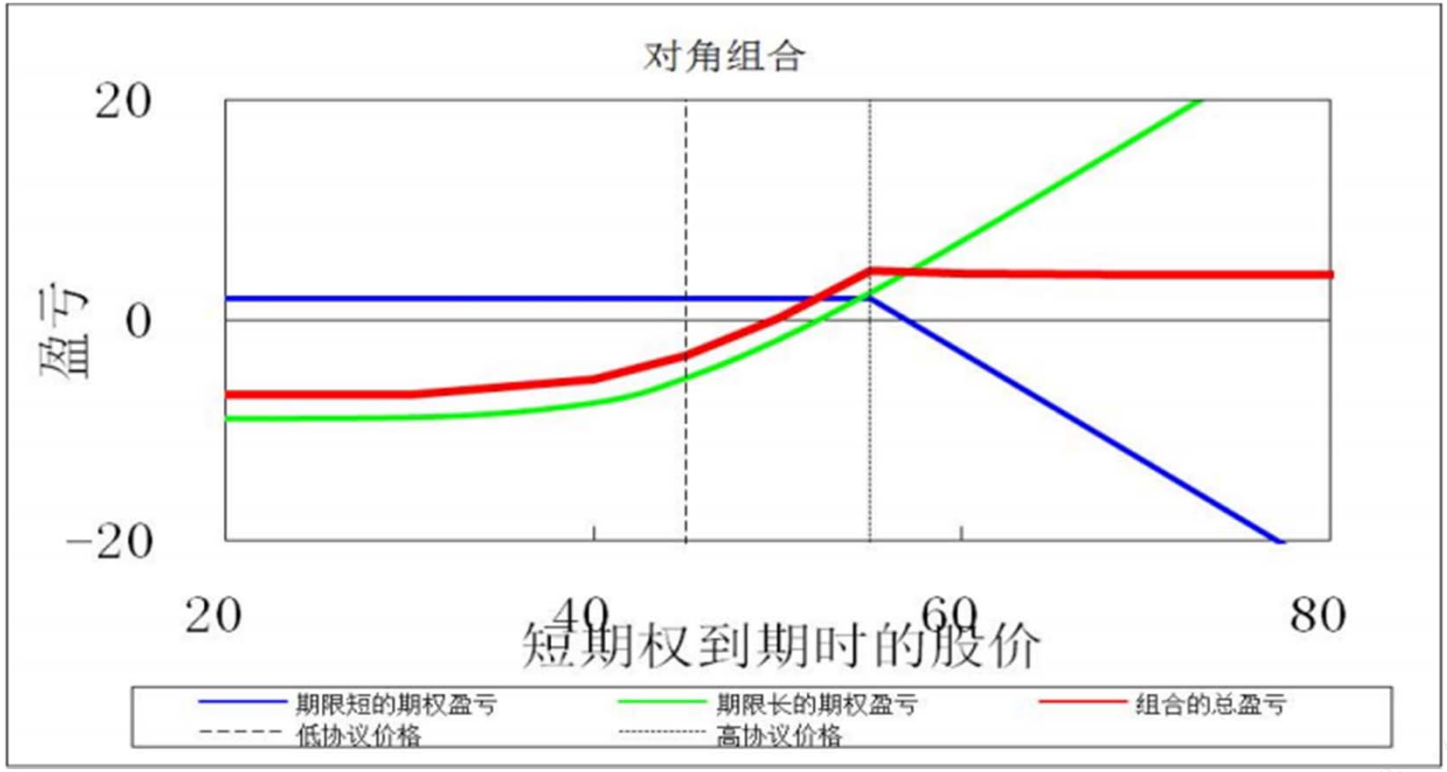
- 看跌期权的熊市正向对角组合。
  - 由看跌期权的（X_2，T^*）多头加（X_1，T）空头组成的组合。
- 看跌期权的牛市反向对角组合。
  - 由看跌期权的（X_2，T^*）空头加（X_1，T）多头组成的组合，其盈亏图与 7 刚好相反。

看涨期权的牛市正向对角组合

- 由看涨期权的（X_1,T*）多头加（X_2,T）空头组合组成

S_T 的范围	(X_1, T^*) 多头的盈亏	(X_2, T) 空头的盈亏	总盈亏
$S_T \to \infty$	趋近 $S_T - X_1 e^{-r(T^*-T)} - c_1$	$X_2 - S_T + c_2$	趋近 $X_2 - X_1 e^{-r(T^*-T)} + c_2 - c_1$
$S_T = X_2$	$X_2 - X_1 e^{-r(T^*-T)} + c_{1T} - c_1$	c_2	$X_2 - X_1 e^{-r(T^*-T)} + c_2 - c_1 + c_{1T}$
$S_T \to 0$	趋近 $-c_1$	c_2	趋近 $c_2 - c_1$

看涨期权的牛市正向对角组合 Profit



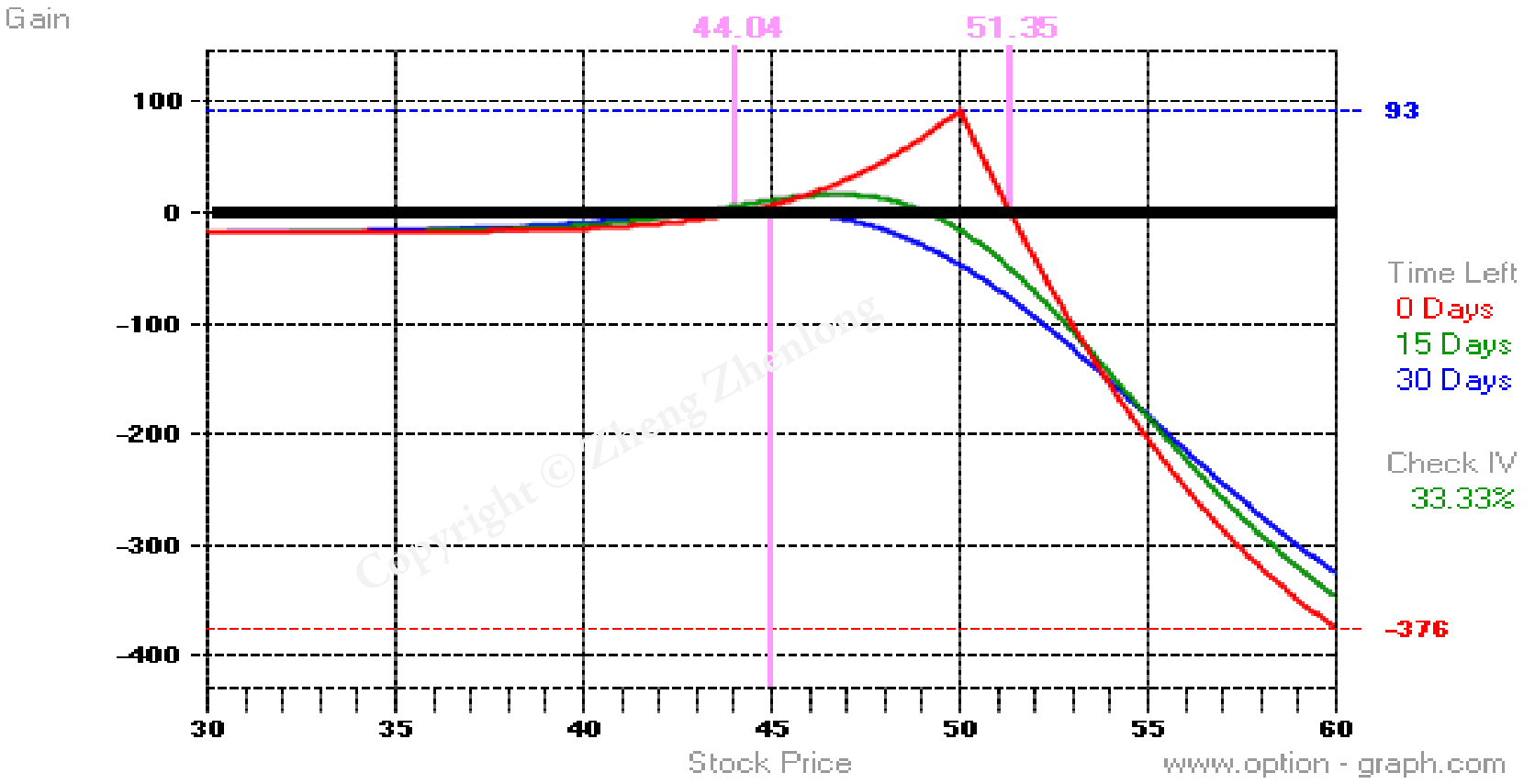
看涨期权的牛市正向对角组合

看涨期权的熊市正向对角组合 Profit

Position Details : Bear Call Diagonalized by 2 months

Stock at $45.00, 1 Long Call, 55 strike, 93 days, IV 33.33%, Option Price $0.51 =	$51.00	debit
Stock at $45.00, 1 Short Call, 50 strike, 30 days, IV 33.33%, Option Price $0.34 =	$34.00	credit

Total Position = $17.00 DEBIT

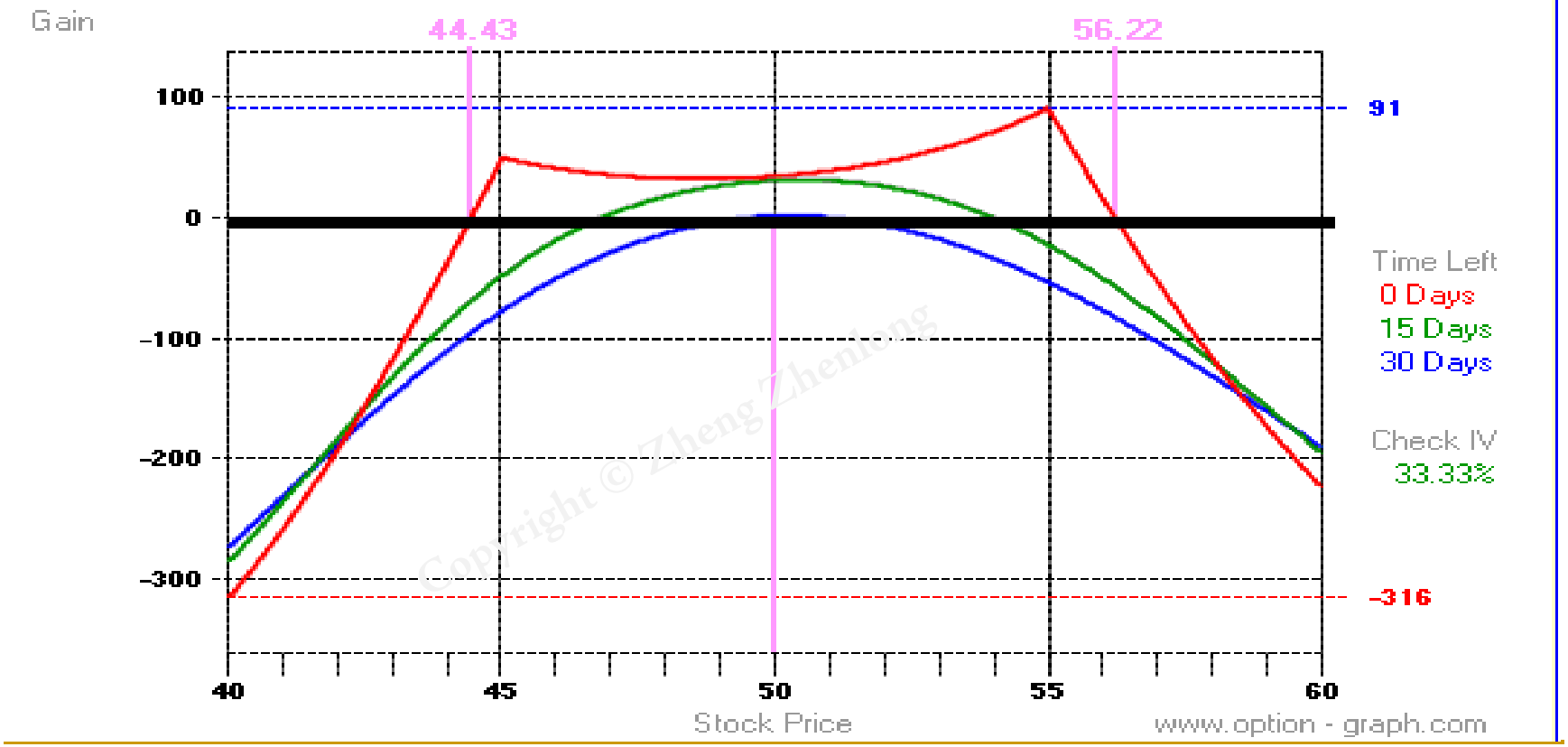


双对角组合：空头协议价格不同

Position Details : Double Diagonal with short strikes different

Stock at 50, 1 Short Call, 55 strike, 30 days, IV 33.33%, Option Price $0.45 =	$45.00	credit
Stock at 50, 1 Short Put, 45 strike, 30 days, IV 33.33%, Option Price $0.31 =	$31.00	credit
Stock at 50, 1 Long Call, 60 strike, 65 days, IV 33.33%, Option Price $0.38 =	$38.00	debit
Stock at 50, 1 Long Put, 40 strike, 65 days, IV 33.33%, Option Price $0.15 =	$15.00	debit

Total Position = $23.00 CREDIT

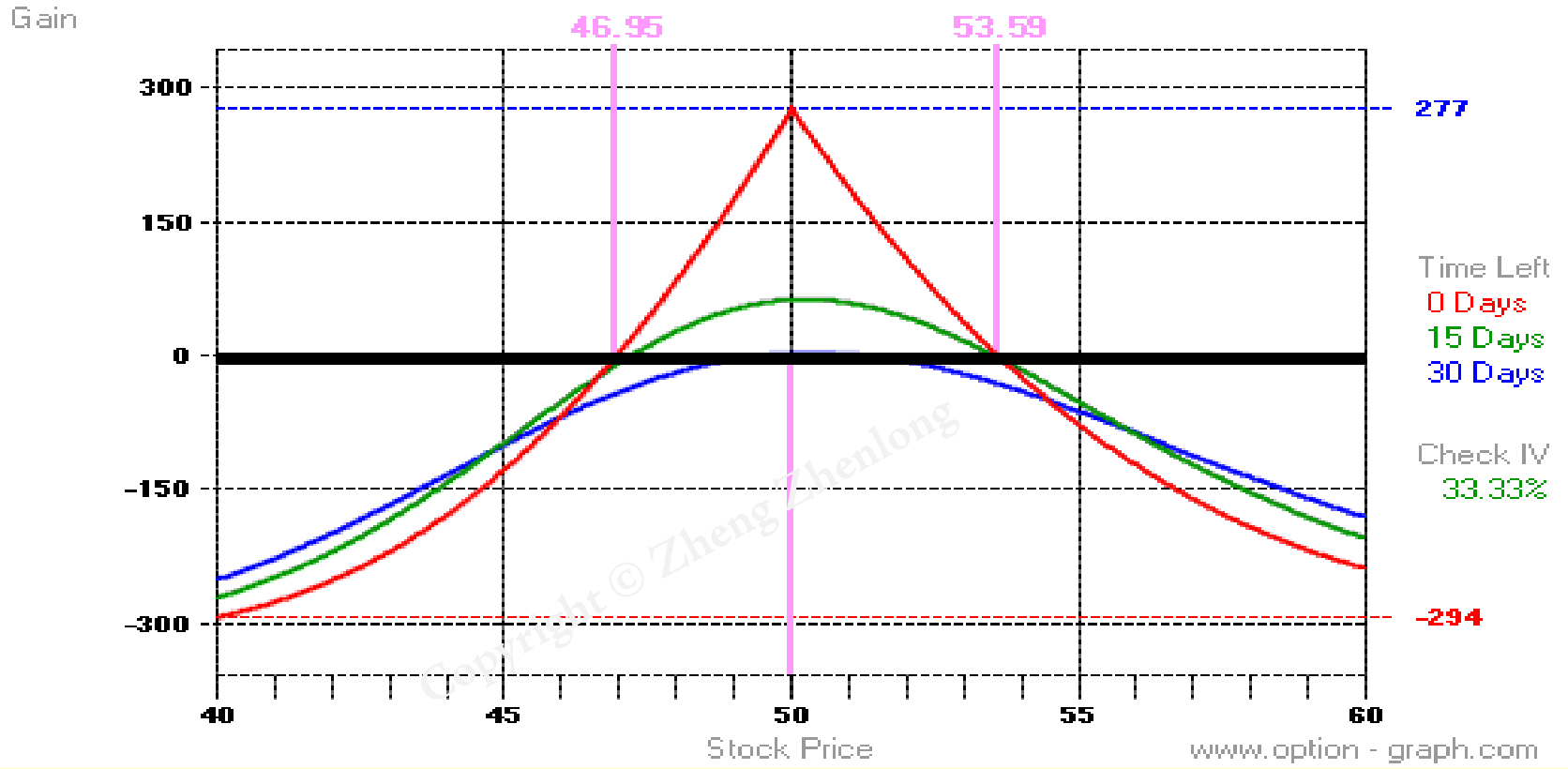


双对角组合：空头协议价格相同

Position Details : Double Diagonal using same short strike

Stock at 50, 1 Short Call, 50 strike, 30 days, IV 33.33%, Option Price $1.98 =	$198.00	credit
Stock at 50, 1 Short Put, 50 strike, 30 days, IV 33.33%, Option Price $1.89 =	$189.00	credit
Stock at 50, 1 Long Call, 55 strike, 65 days, IV 33.33%, Option Price $1.16 =	$116.00	debit
Stock at 50, 1 Long Put, 45 strike, 65 days, IV 33.33%, Option Price $0.85 =	$85.00	debit

Total Position = $186.00 CREDIT

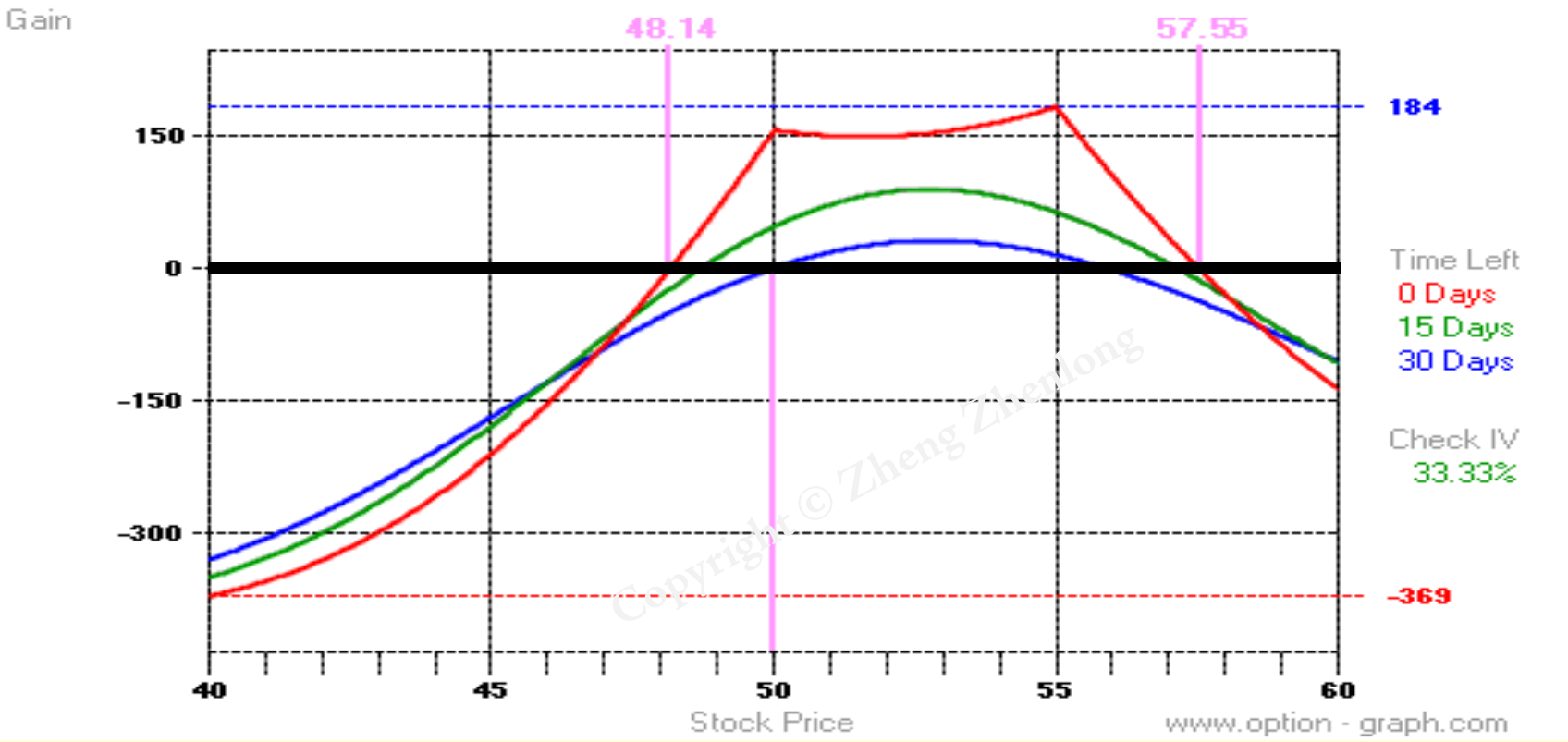


双对角组合：牛市正向

Position Details : Double Diagonal, bullish

Stock at 50, 1 Short Call, 55 strike, 30 days, IV 33.33%, Option Price $0.45 =	$45.00	credit
Stock at 50, 1 Short Put, 50 strike, 30 days, IV 33.33%, Option Price $1.89 =	$189.00	credit
Stock at 50, 1 Long Call, 60 strike, 65 days, IV 33.33%, Option Price $0.38 =	$38.00	debit
Stock at 50, 1 Long Put, 45 strike, 65 days, IV 33.33%, Option Price $0.85 =	$85.00	debit

Total Position = $111.00 CREDIT

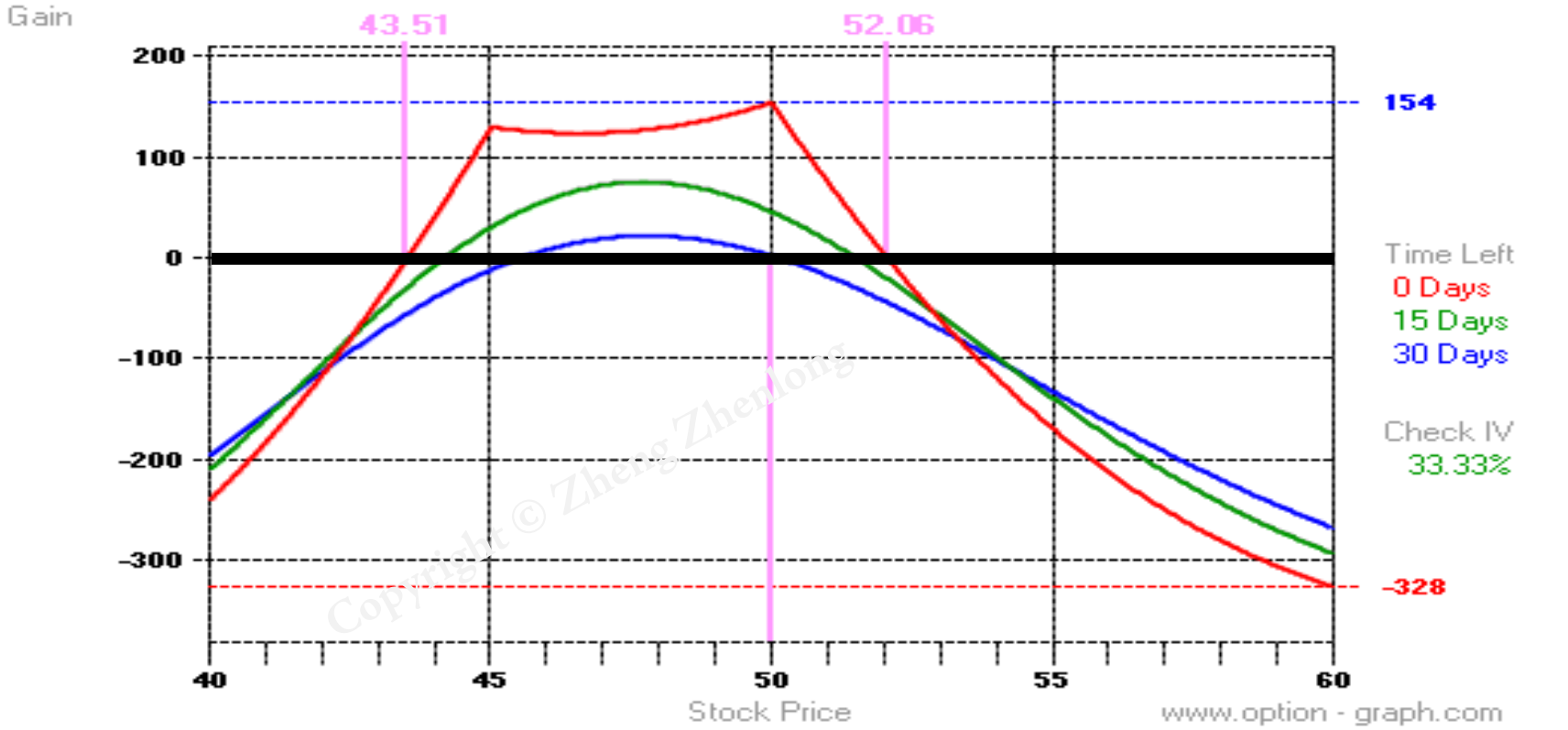


双对角组合：熊市正向

Position Details : Double Diagonal, bearish

Stock at 50, 1 Short Call, 50 strike, 30 days, IV 33.33%, Option Price $1.98 =	$198.00	credit
Stock at 50, 1 Short Put, 45 strike, 30 days, IV 33.33%, Option Price $0.31 =	$31.00	credit
Stock at 50, 1 Long Call, 55 strike, 65 days, IV 33.33%, Option Price $1.16 =	$116.00	debit
Stock at 50, 1 Long Put, 40 strike, 65 days, IV 33.33%, Option Price $0.15 =	$15.00	debit

Total Position = $98.00 CREDIT



混合期权

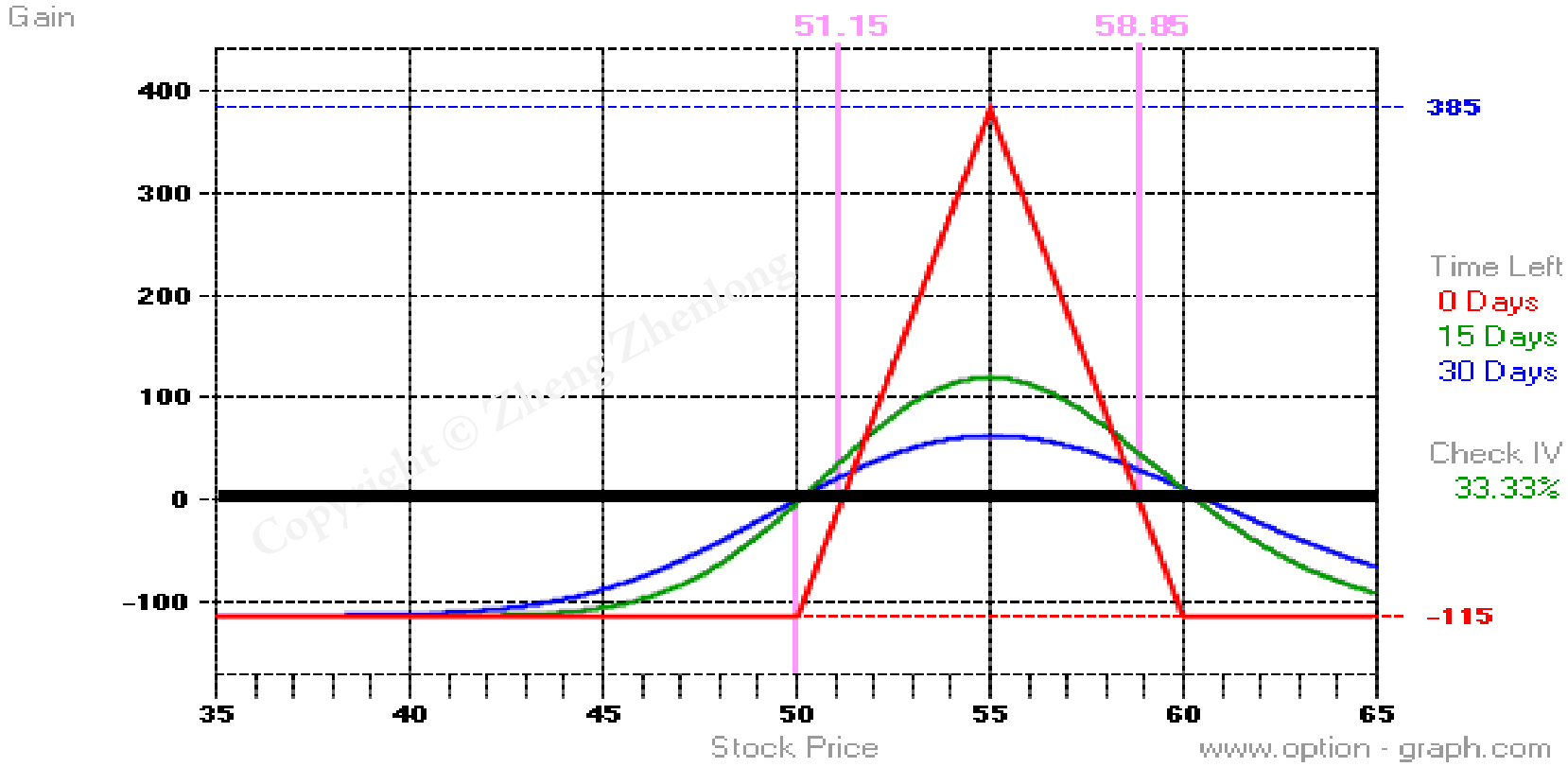
- 混合期权
  - 由不同种的期权——看涨和看跌组成的组合
  - 协议价格、期限、多空、份数等可以相同或不同
  - 底部/顶部——多头/空头

正向蝶式差价组合：看涨+看跌

Position Details : Butterfly, Bullish

Stock at 50, 1 Short Call, 55 strike, 30 days, IV 33.33%, Option Price $0.45 =	$45.00	credit
Stock at 50, 1 Short Put, 55 strike, 30 days, IV 33.33%, Option Price $5.36 =	$536.00	credit
Stock at 50, 1 Long Call, 60 strike, 30 days, IV 33.33%, Option Price $0.07 =	$7.00	debit
Stock at 50, 1 Long Put, 50 strike, 30 days, IV 33.33%, Option Price $1.89 =	$189.00	debit

Total Position = $385.00 CREDIT

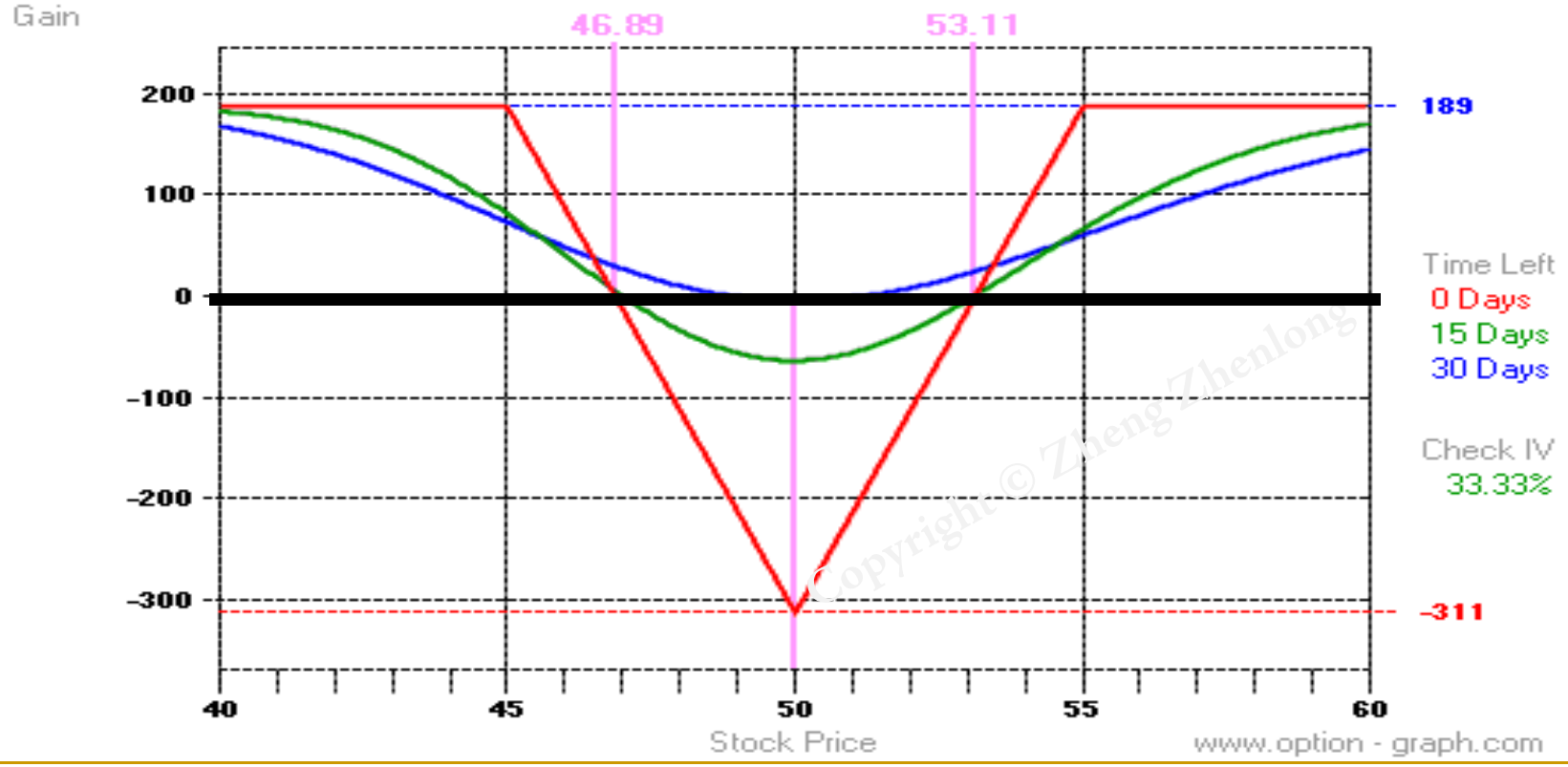


反向蝶式差价组合：看涨＋看跌

Position Details : Butterfly, Reverse

Stock at 50, 1 Long Call, 50 strike, 30 days, IV 33.33%, Option Price $1.98 =	$198.00	debit
Stock at 50, 1 Long Put, 50 strike, 30 days, IV 33.33%, Option Price $1.89 =	$189.00	debit
Stock at 50, 1 Short Call, 55 strike, 30 days, IV 33.33%, Option Price $0.45 =	$45.00	credit
Stock at 50, 1 Short Put, 45 strike, 30 days, IV 33.33%, Option Price $0.31 =	$31.00	credit

Total Position = $311.00 DEBIT

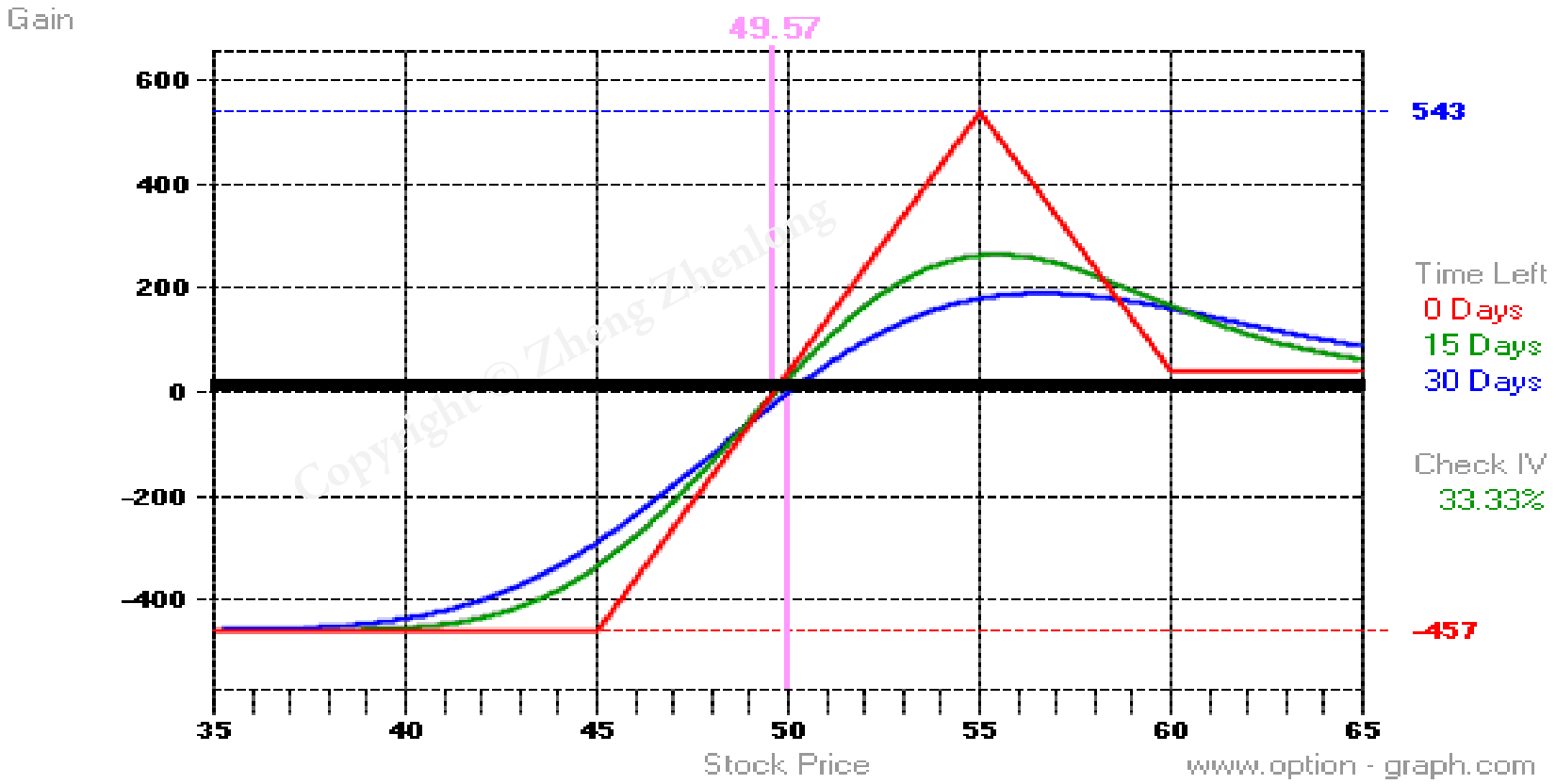


牛市蝶式差价：看涨+看跌

Position Details : Butterfly, Modified Bullish

Stock at 50, 1 Short Call, 55 strike, 30 days, IV 33.33%, Option Price $0.45 =	$45.00	credit
Stock at 50, 1 Short Put, 55 strike, 30 days, IV 33.33%, Option Price $5.36 =	$536.00	credit
Stock at 50, 1 Long Call, 60 strike, 30 days, IV 33.33%, Option Price $0.07 =	$7.00	debit
Stock at 50, 1 Long Put, 45 strike, 30 days, IV 33.33%, Option Price $0.31 =	$31.00	debit

Total Position = $543.00 CREDIT

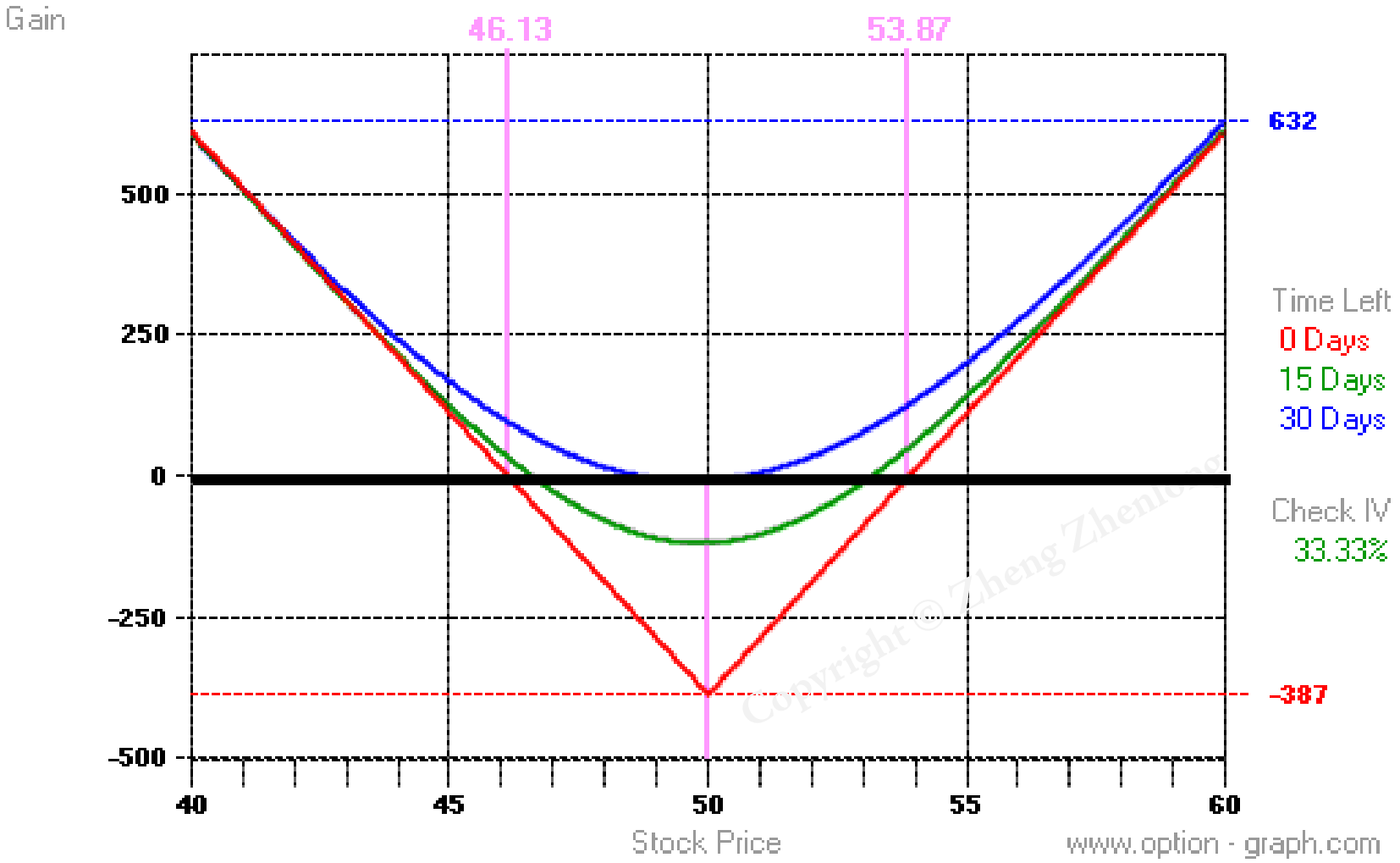


- 跨式组合（Straddle）
  - 由具有相同协议价格、相同期限的一份看涨期权和一份看跌期权组成
  - 底部跨式组合：两份多头组成
  - 顶部跨式组合：两份空头组成

Position Details : Straddle Purchase

Stock at 50, 1 Long Call, 50 strike, 30 days, IV 33.33%, Option Price $1.98 =	$198.00	debit
Stock at 50, 1 Long Put, 50 strike, 30 days, IV 33.33%, Option Price $1.89 =	$189.00	debit

Total Position = $387.00 DEBIT



- 条式组合（Strip）
  - 由具有相同协议价格、相同期限的一份看涨期权和两份看跌期权组成
  - 条式组合也分底部和顶部两种，前者由多头构成，后者由空头构成
  - 具有不对称性，底部条式适合投资者预测价格变化较大，且下跌的可能大于上涨可能的情形

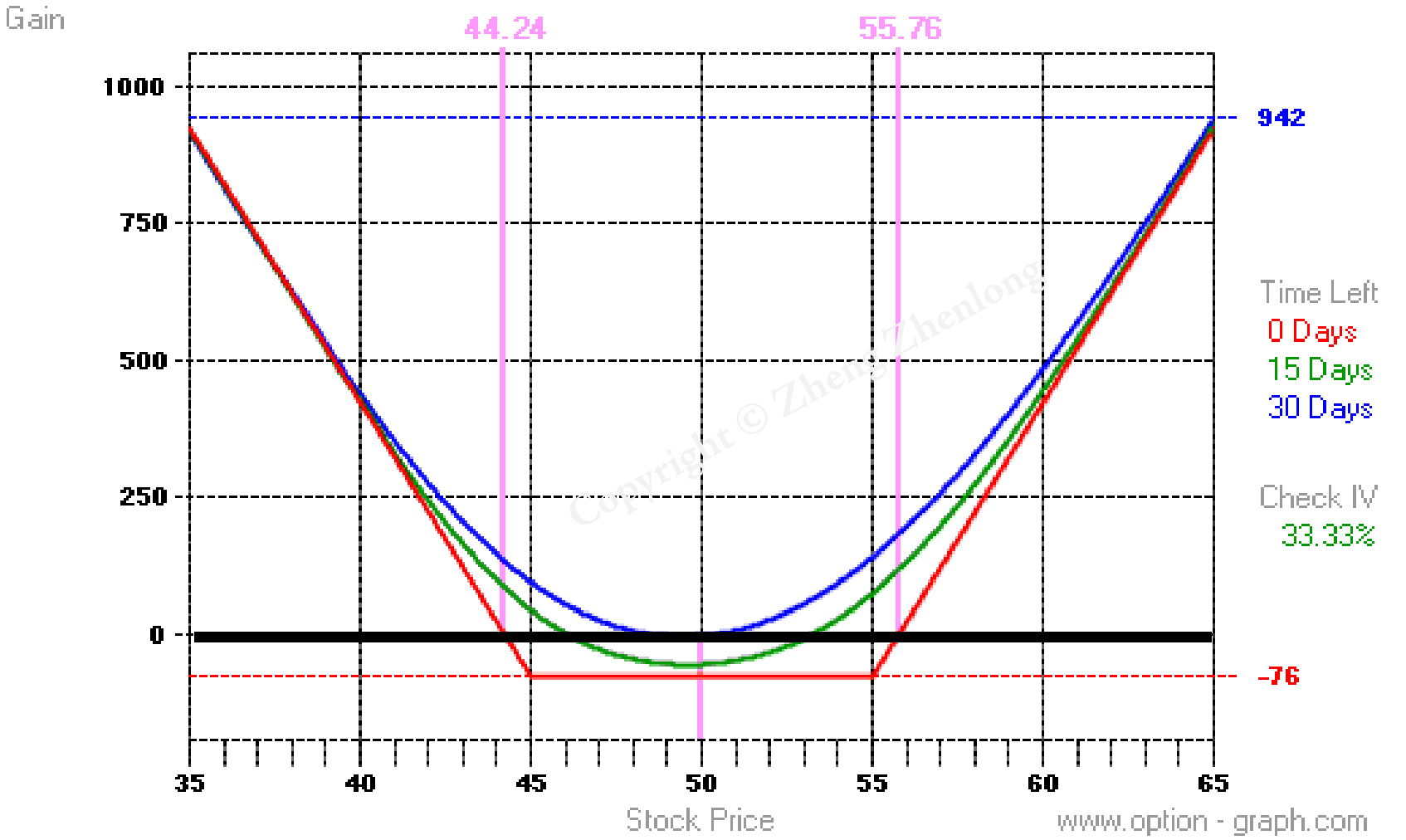
- 带式组合（Strap）
  - 由具有相同协议价格、相同期限的资产的两份看涨期权和一份看跌期权组成
  - 带式组合也分底部和顶部两种，前者由多头构成，后者由空头构成
  - 具有不对称性，适应于投资者预测价格变化较大，且上升的可能大于下跌可能的情形

- 宽跨式组合（Strangle）
  - 由相同到期日但协议价格不同的一份看涨期权和一份看跌期权组成，其中看涨期权的协议价格高于看跌期权
  - 宽跨式组合也分底部和顶部，前者由多头组成，后者由空头组成

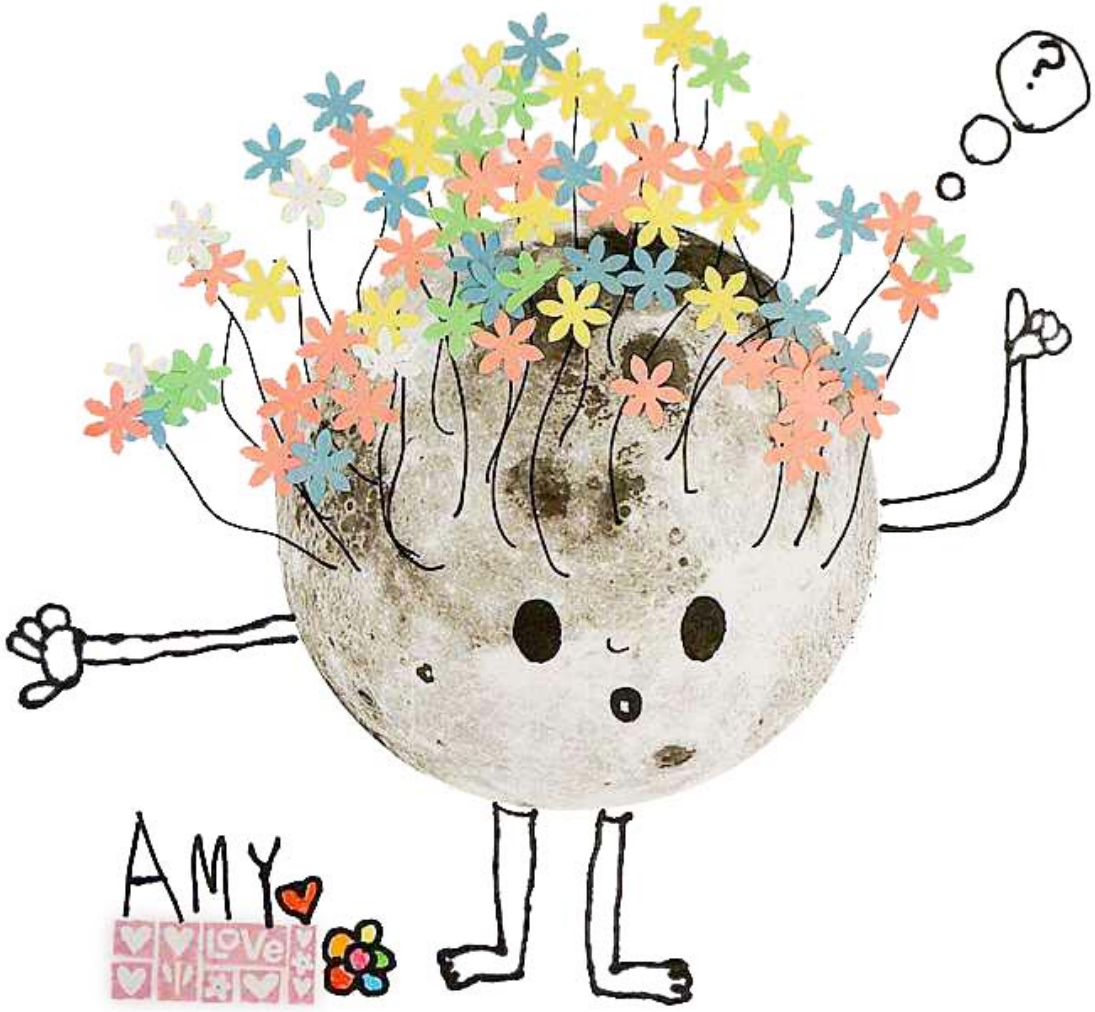
Position Details : Strangle Purchase

Stock at 50, 1 Long Call, 55 strike, 30 days, IV 33.33%, Option Price $0.45 =	$45.00	debit
Stock at 50, 1 Long Put, 45 strike, 30 days, IV 33.33%, Option Price $0.31 =	$31.00	debit

Total Position = $76.00 DEBIT



Any Questions ?



投机和套保策略

套保策略比较

Figure 11. Protection Strategies

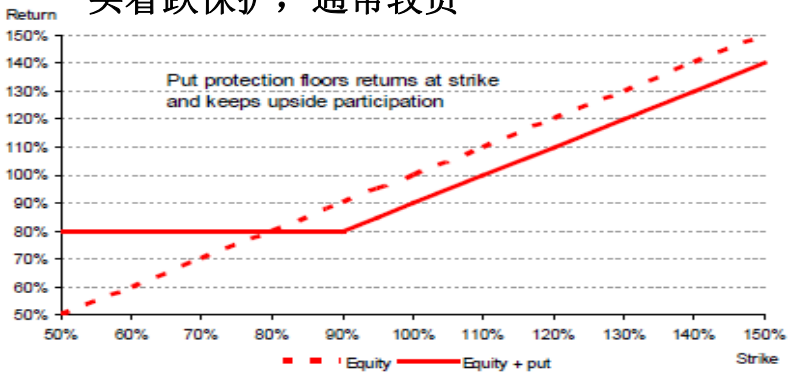
保护程度

上方是否有限

完全

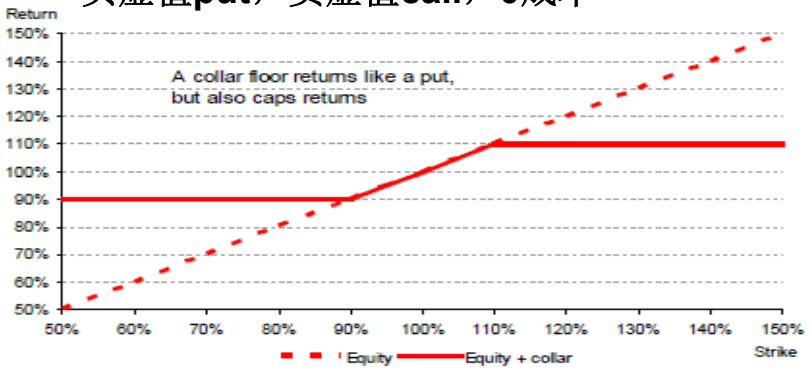
买看跌保护，通常较贵

无限



买虚值put，卖虚值call，0成本

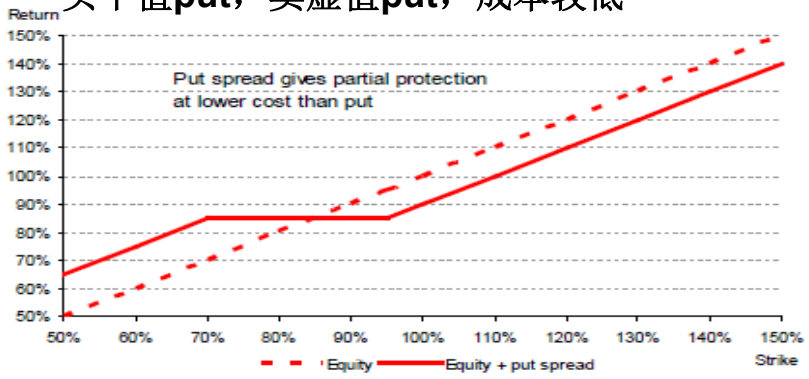
有限



部分

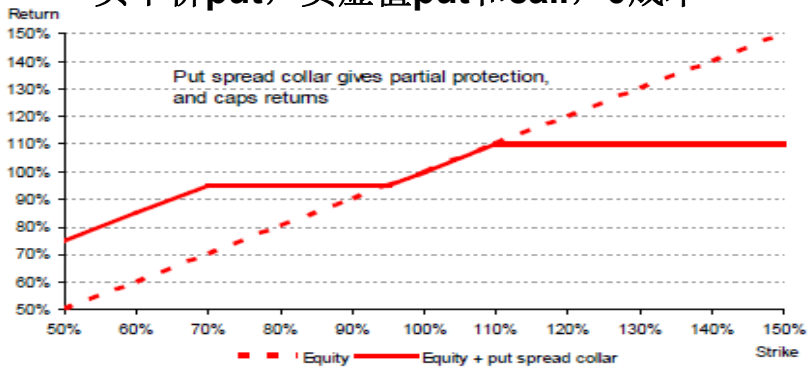
买平值put，卖虚值put，成本较低

无限



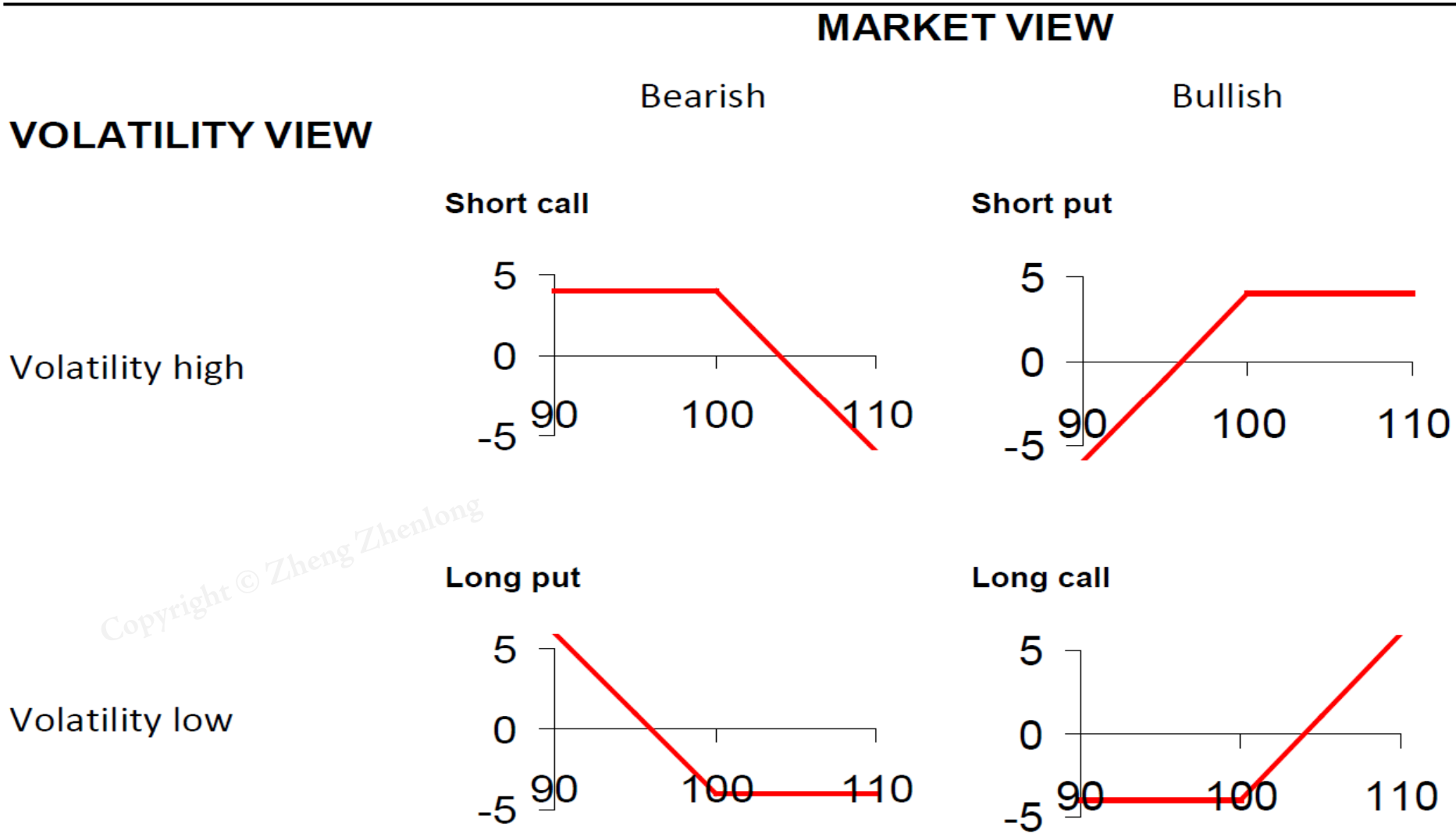
买平价put，卖虚值put和call，0成本

有限



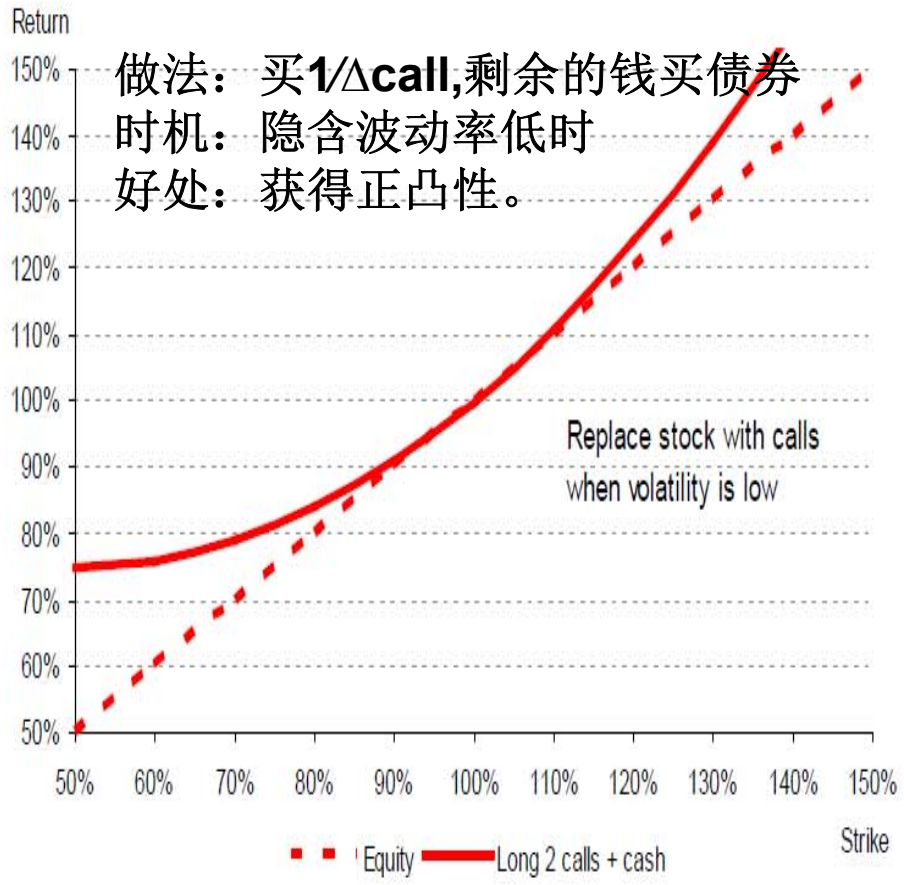
用期权进行投机：方向与波动率

Figure1. Option Strategy for Different Market and Volatility Views



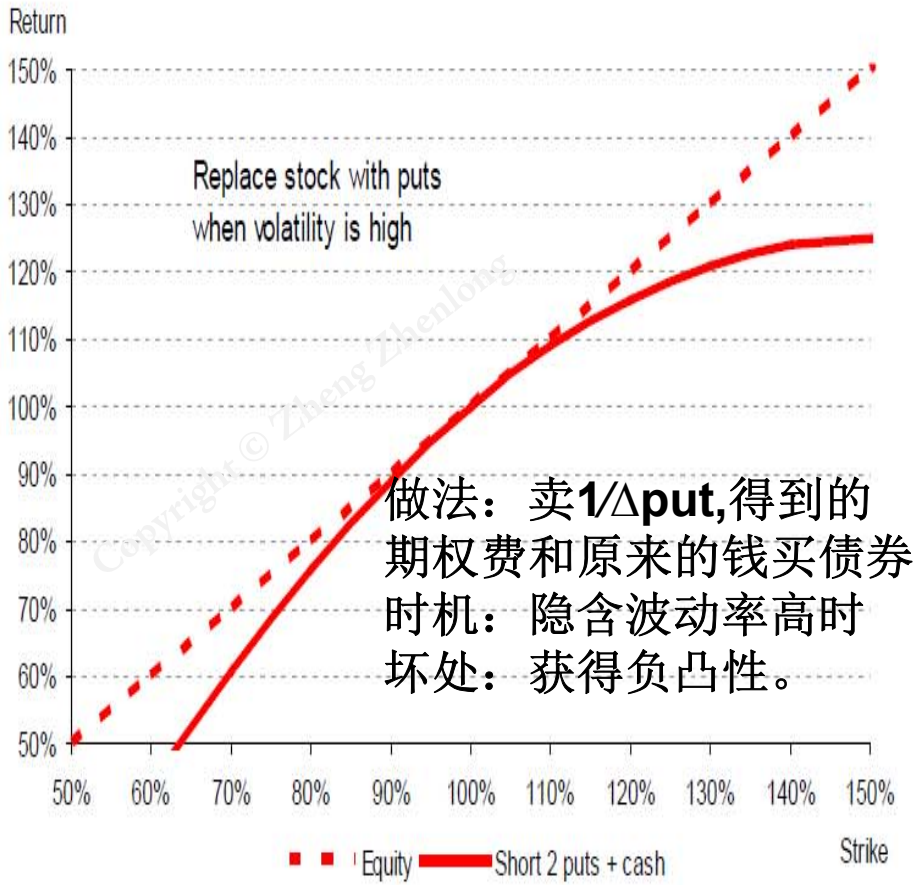
当你看涨时，可以用期权代替买股票

Figure 3. Stock Replacing with Calls



做法：买1/Δcall,剩余的钱买债券
时机：隐含波动率低时
好处：获得正凸性。

Stock Replacing with Puts



做法：卖1/Δput,得到的期权费和原来的钱买债券
时机：隐含波动率高时
坏处：获得负凸性。

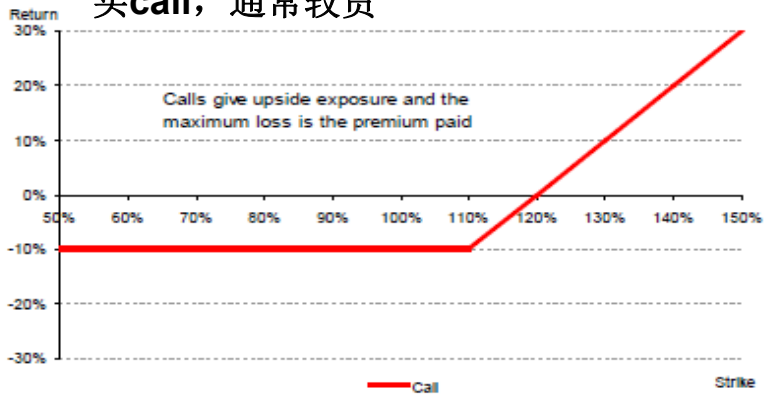
Source: Santander Investment Bolsa estimates.

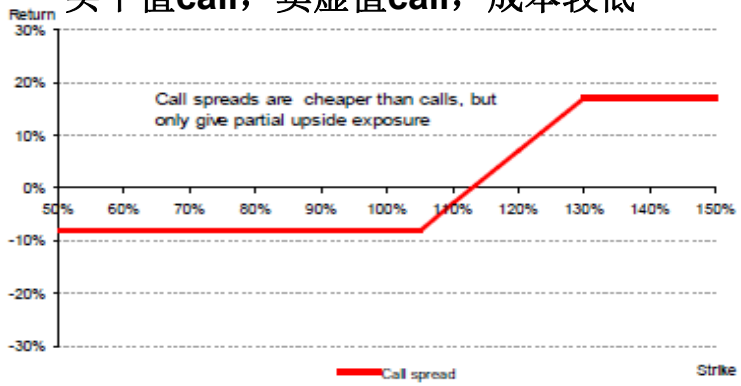
投机策略比较

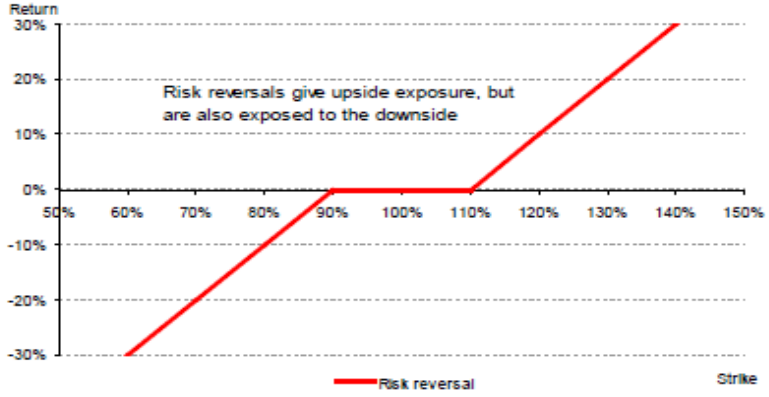
Figure 17. Upside Participation Strategies

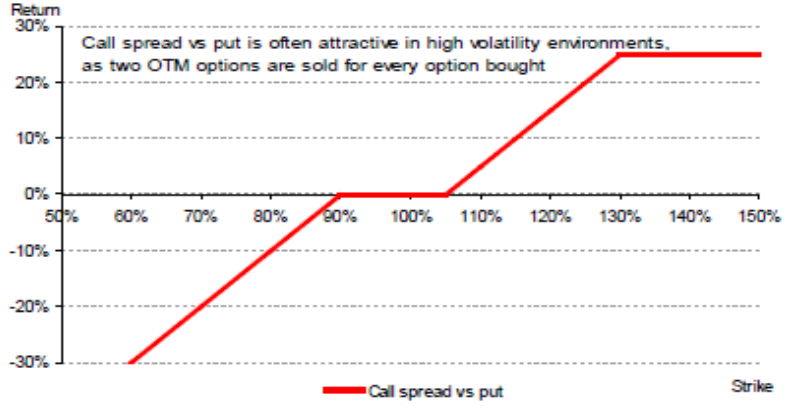
上升潜力

下方是否有限	完全	部分
有限	买call，通常较贵	买平值call，卖虚值call，成本较低
无限	买虚值call，卖虚值put，0成本	买平价call，卖虚值put和call，0成本



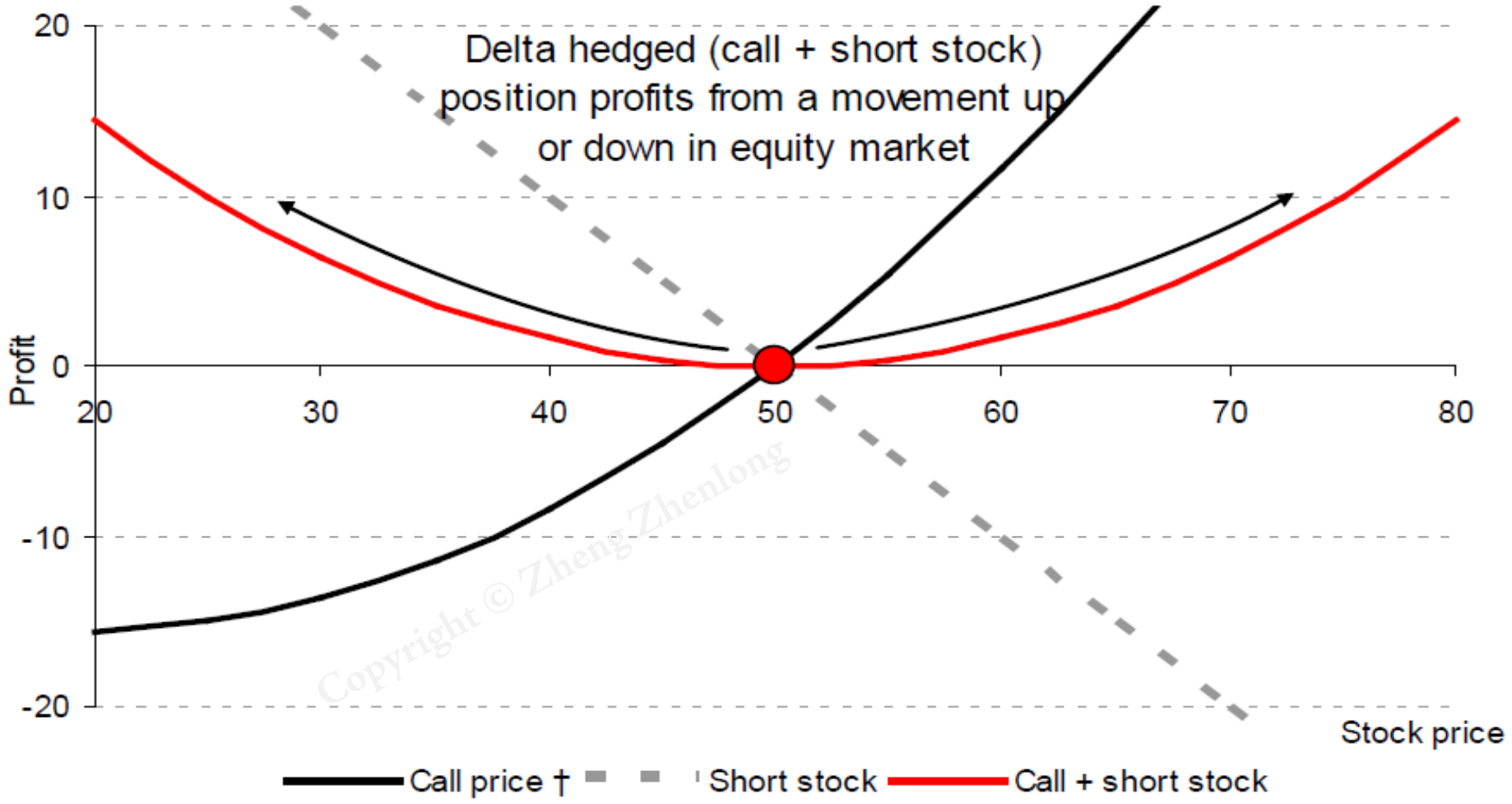






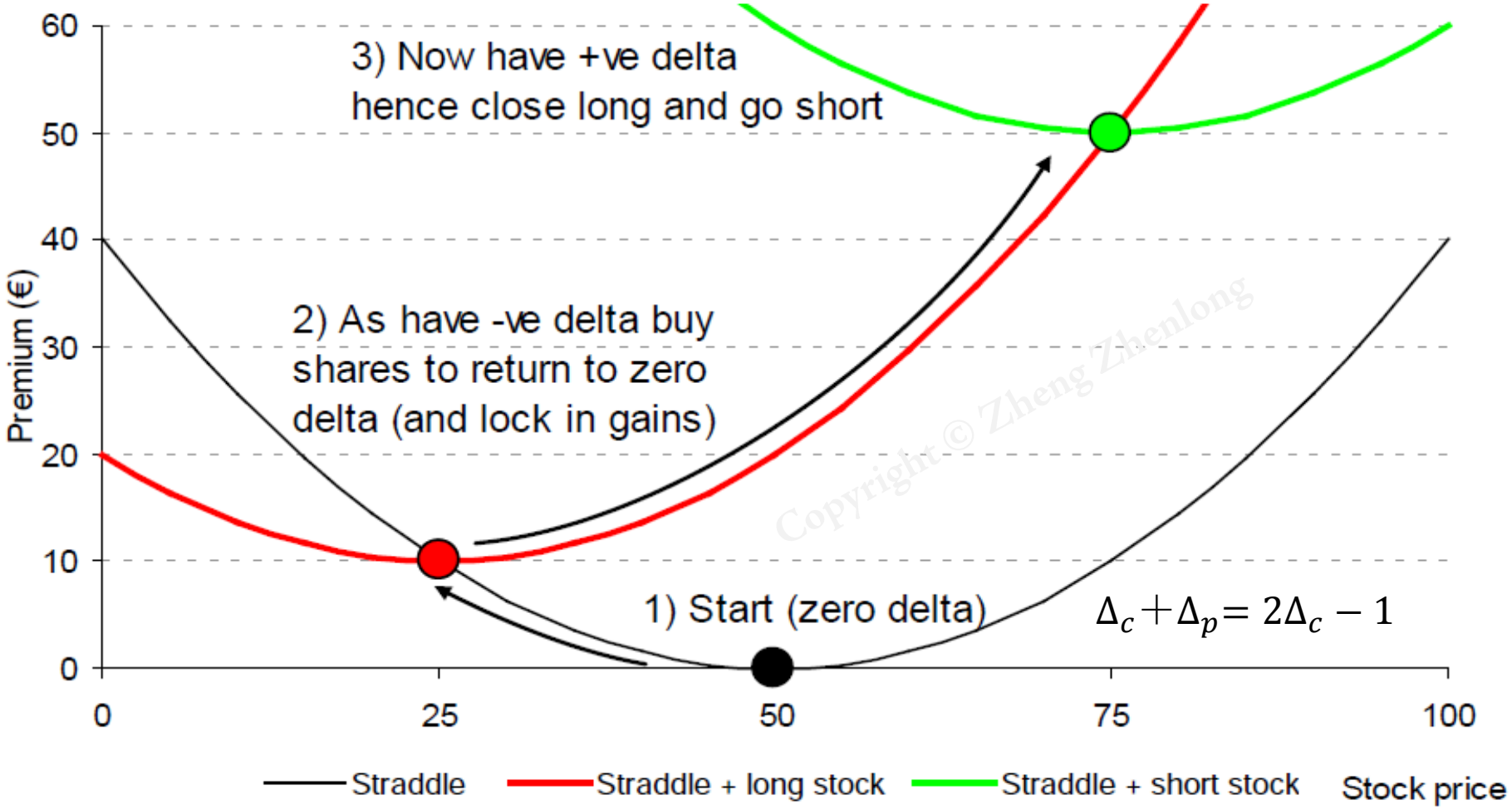
通过Δ中性投机于市场波动

Figure 24. Delta-Hedged Call



通过动态调整锁定利润（适用于动荡的市场）

Figure 25. Locking in Gains through Delta Hedging



13.4期权组合盈亏图的算法

期权组合盈亏图的算法

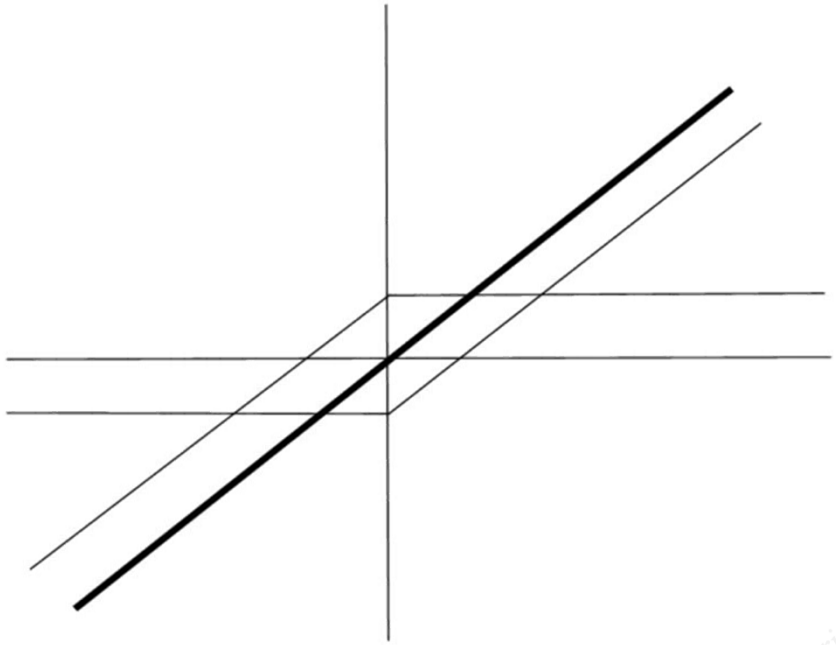
- 期权组合的盈亏可以通过符号的方法形象化的表示
- 符号规则：
  - 期权交易的结果在盈亏图上出现负斜率：（–1）
  - 期权交易的结果在盈亏图上出现正斜率：（+1）
  - 期权交易的结果在盈亏图上是水平状：（0）

- 各种基本头寸的盈亏状态
  - 看涨多头：$(0, +1)$
  - 看涨空头：$(0, -1)$
  - 看跌多头：$(-1, 0)$
  - 看跌空头：$(+1, 0)$
  - 标的资产多头：$(+1, +1)$
  - 标的资产空头：$(-1, -1)$

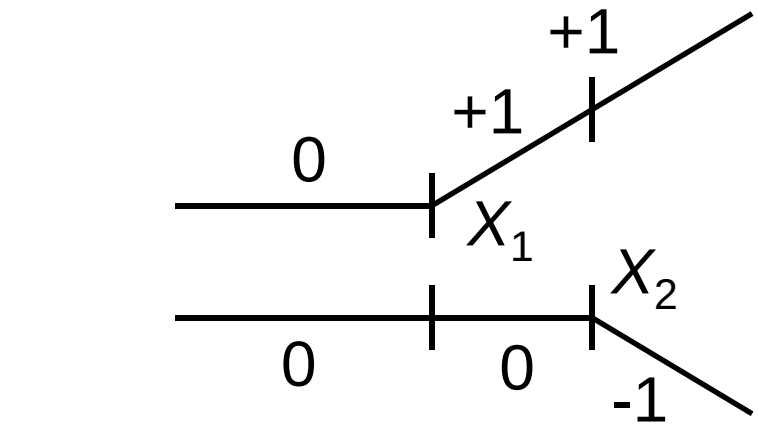
标的资产多头的组合分解图

- 看涨多头＋看跌空头＝标的资产多头：

$$(0, +1) + (+1, 0) = (+1, +1)$$



例子：看涨期权的牛市差价组合



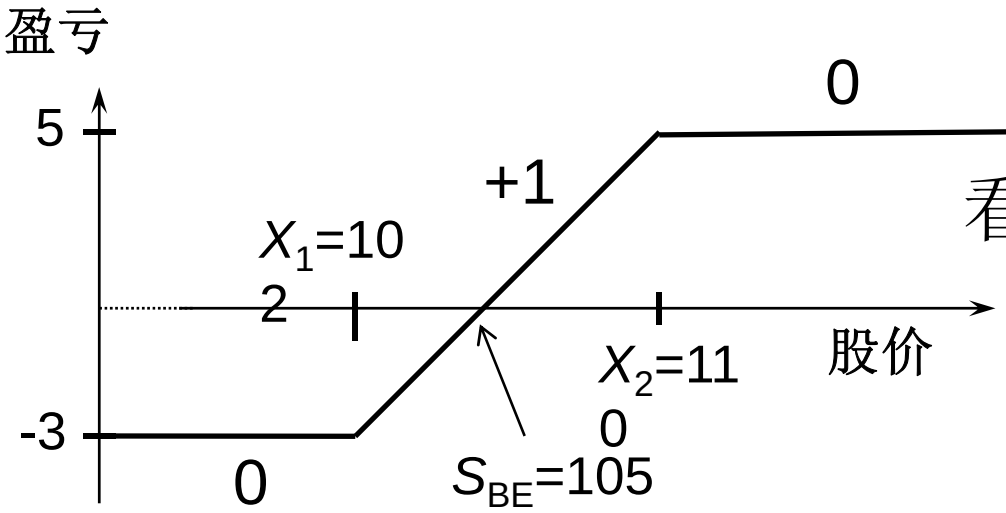
买入看涨期权 (X_1)

加上

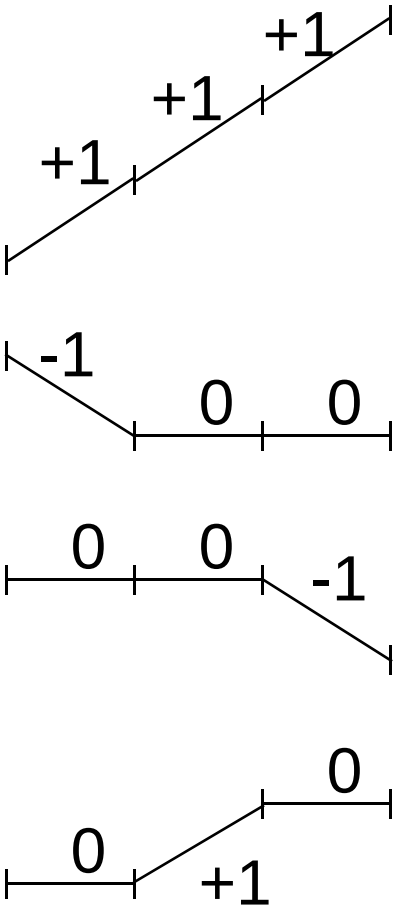
卖出看涨期权 ($X_2 > X_1$)

等于

看涨期权牛市差价组合



例子：Equity Collar



Long Stock

plus

Long Put

plus

Short Call

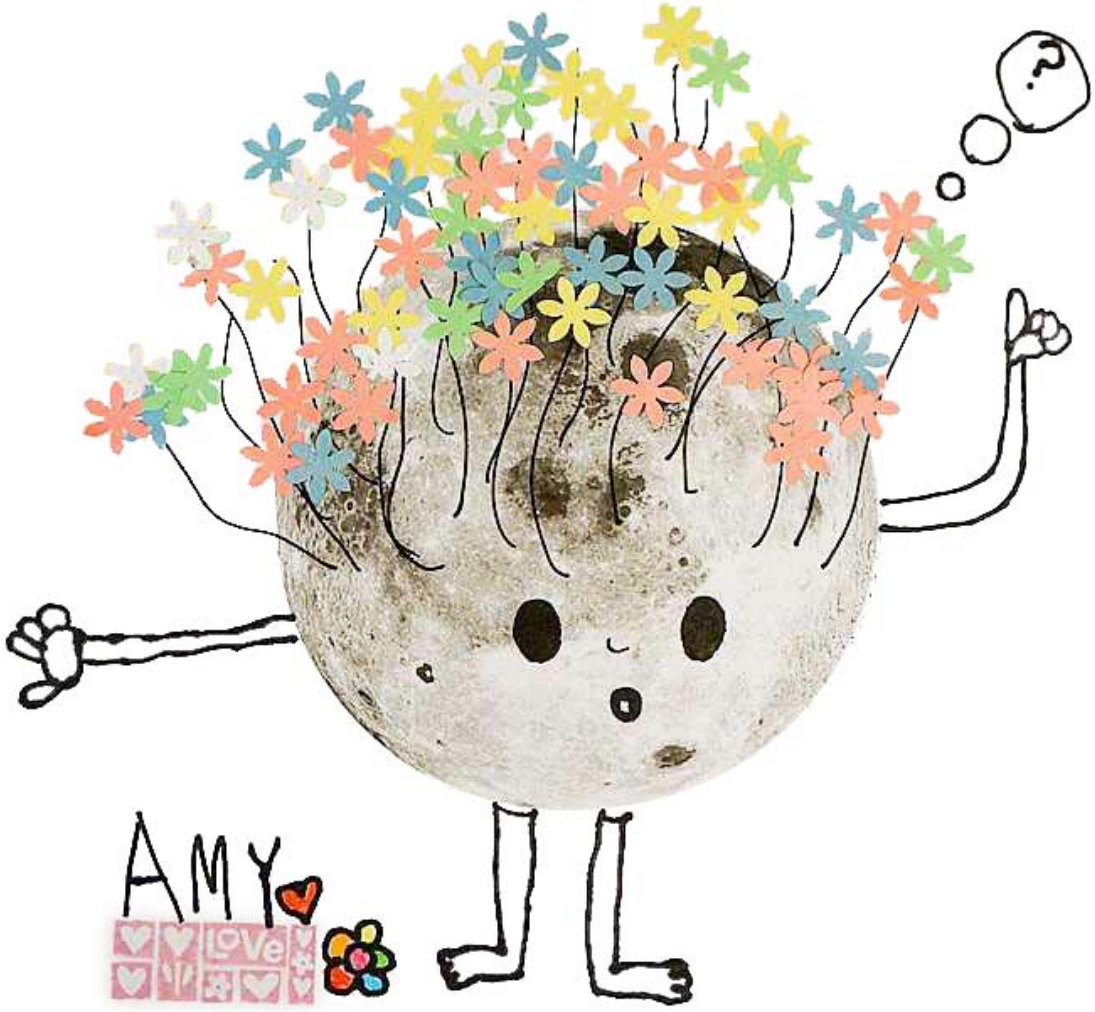
equals

Equity Collar

本讲参考资料

- 郑振龙和陈蓉，《金融工程》（第三版），高等教育出版社，2012：第13章
- John C. Hull, Options, Futures and other derivatives, 8th ed., Pearson, 2012: Ch11
- Guy Cohen, the Bible of Options Strategies,2005
- Sheldon Natenburg, Option Volatility & Pricing: Advanced Trading Strategies, 1994.
- http://efinance.org.cn/本科课程金融工程
- http://efinance.org.cn/硕士生课程金融工程
- http://option-info.com/optionstrategies.htm

Any Questions ?



http://efinance.org.cn
zlzheng@xmu.edu.cn
aronge@xmu.edu.cn