財務工程 - Week8

https://cool.ntu.edu.tw/courses/1195

PecuLab peculiar change the world 蔡芸琤 (Peculiar)

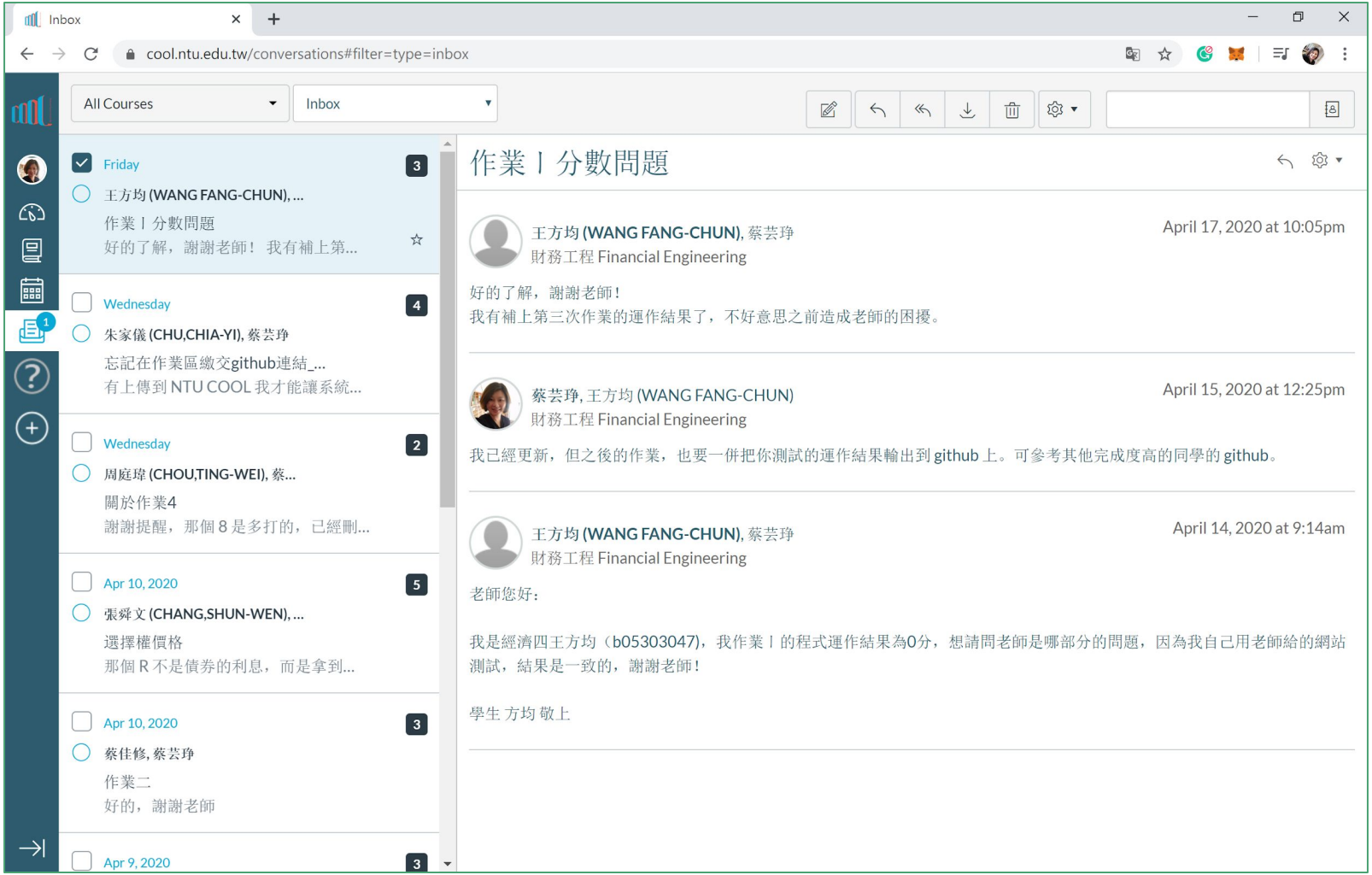
http://www.peculab.org/

https://www.facebook.com/pecu.tsai

東吳巨資 & 台大財金

Github 作業繳交列表

https://docs.google.com/spreadsheets/d/1ZGO3ciyAhqZerbG3wUZd9zhHIxgqh8mvHbw0sqpQGN4/edit?usp=sharing


Inbox
cool.ntu.edu.tw/conversations#filter=type=inbox
All Courses
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Friday
3
王方均 (WANG FANG-CHUN), ...
作業 I 分數問題
好的了解，謝謝老師！ 我有補上第...
Wednesday
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朱家儀 (CHU,CHIA-YI), 蔡芸琤
忘記在作業區繳交github連結_...
有上傳到 NTU COOL 我才能讓系統...
Wednesday
2
周庭瑋 (CHOU,TING-WEI), 蔡...
關於作業4
謝謝提醒，那個 8 是多打的，已經刪...
Apr 10, 2020
5
張舜文 (CHANG,SHUN-WEN), ...
選擇權價格
那個 R 不是債券的利息，而是拿到...
Apr 10, 2020
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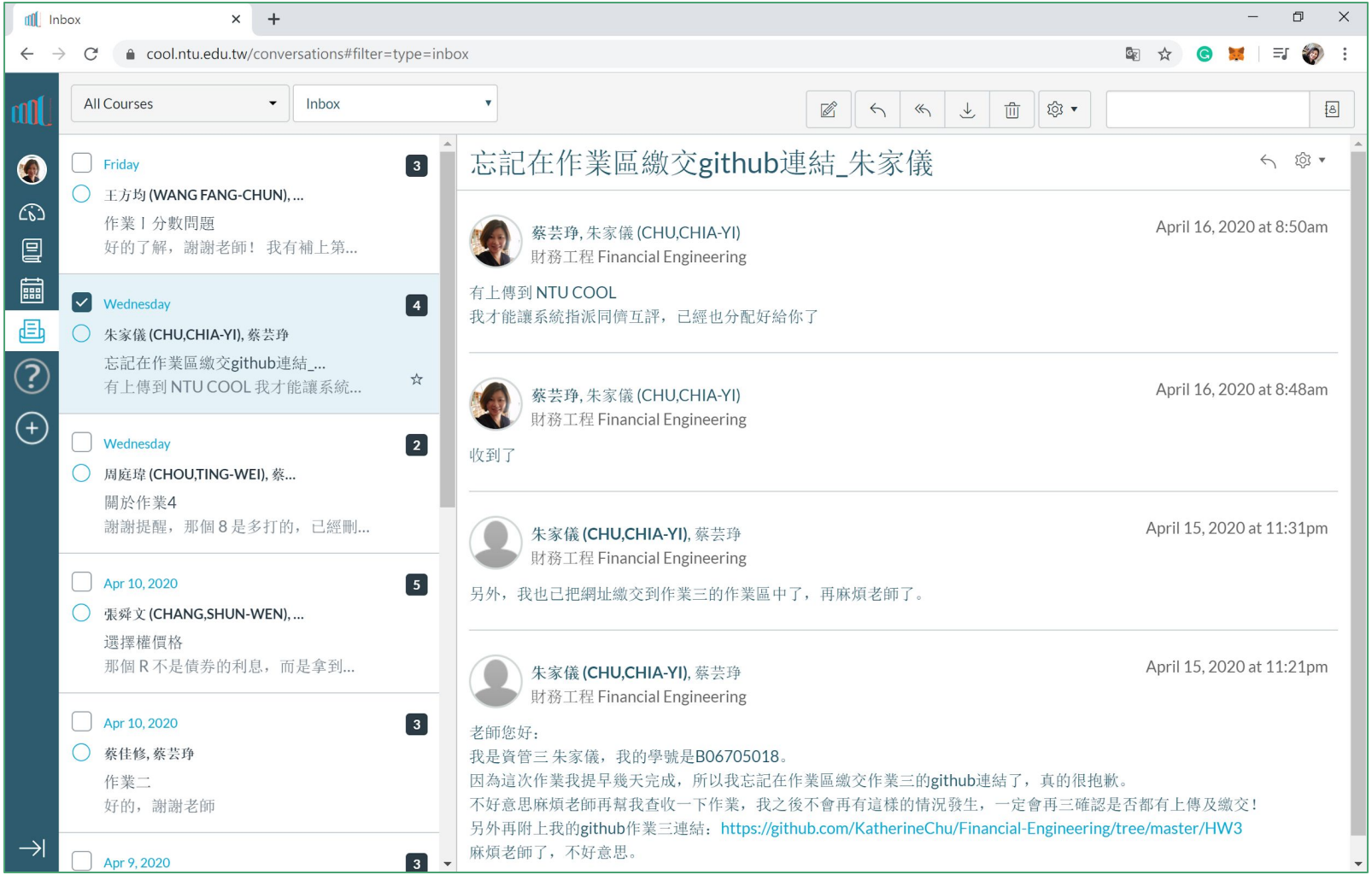
蔡佳修, 蔡芸琤
作業二
好的，謝謝老師
Apr 9, 2020
3
作業 I 分數問題
王方均 (WANG FANG-CHUN), 蔡芸琤
財務工程 Financial Engineering
April 17, 2020 at 10:05pm
好的了解，謝謝老師！
我有補上第三次作業的運作結果了，不好意思之前造成老師的困擾。
蔡芸琤, 王方均 (WANG FANG-CHUN)
財務工程 Financial Engineering
April 15, 2020 at 12:25pm
我已經更新，但之後的作業，也要一併把你測試的運作結果輸出到 github 上。可參考其他完成度高的同學的 github。
王方均 (WANG FANG-CHUN), 蔡芸琤
財務工程 Financial Engineering
April 14, 2020 at 9:14am
老師您好：
我是經濟四王方均（b05303047），我作業 I 的程式運作結果為0分，想請問老師是哪部分的問題，因為我自己用老師給的網站測試，結果是一致的，謝謝老師！
學生 方均 敬上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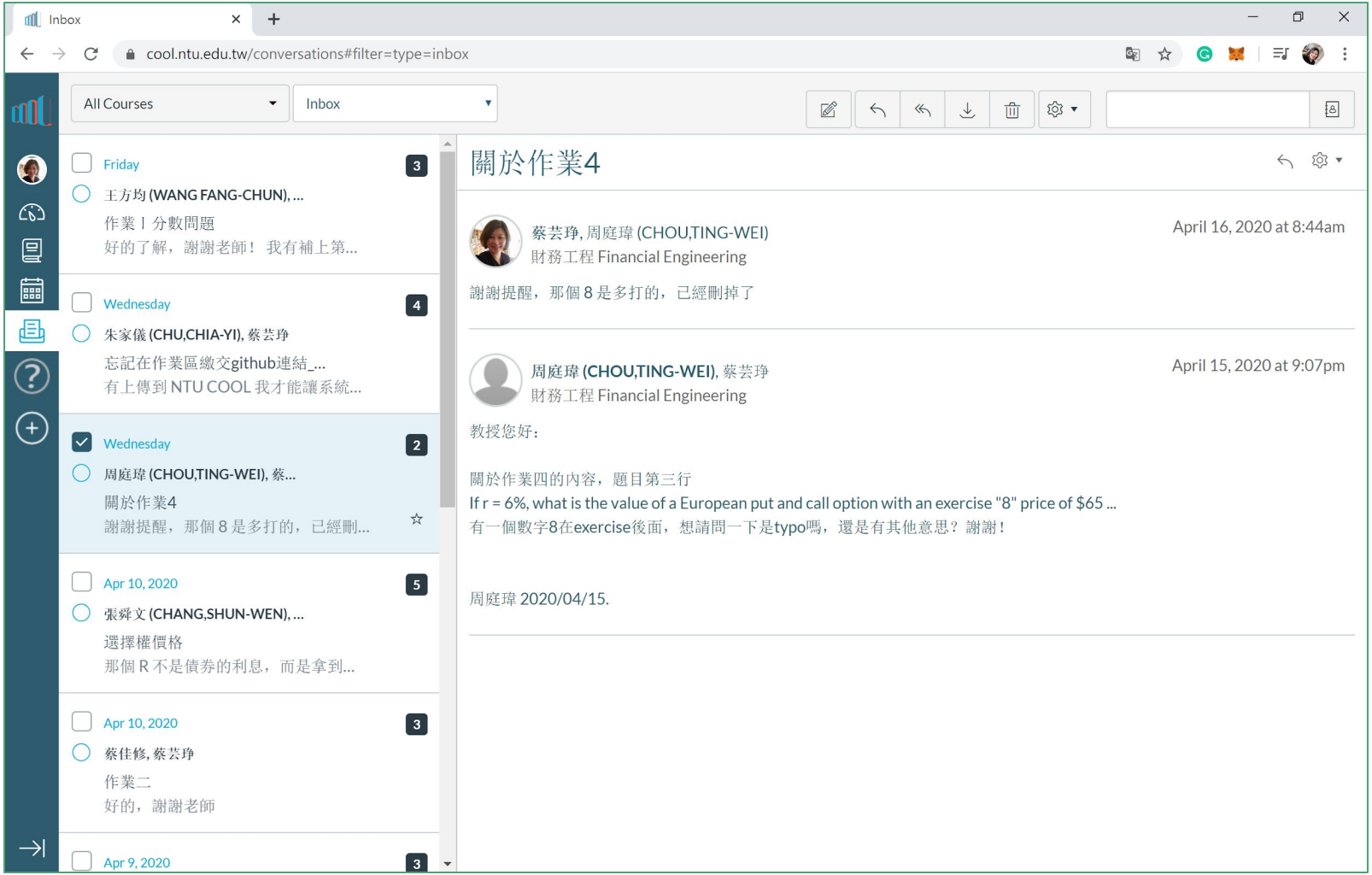
好的，謝謝老師
Apr 9, 2020
3
忘記在作業區繳交github連結_朱家儀
蔡芸琤, 朱家儀 (CHU,CHIA-YI)
財務工程 Financial Engineering
April 16, 2020 at 8:50am
有上傳到 NTU COOL
我才能讓系統指派同儕互評，已經也分配好給你了
蔡芸琤, 朱家儀 (CHU,CHIA-YI)
財務工程 Financial Engineering
April 16, 2020 at 8:48am
收到了
朱家儀 (CHU,CHIA-YI), 蔡芸琤
財務工程 Financial Engineering
April 15, 2020 at 11:31pm
另外，我也已把網址繳交到作業三的作業區中了，再麻煩老師了。
朱家儀 (CHU,CHIA-YI), 蔡芸琤
財務工程 Financial Engineering
April 15, 2020 at 11:21pm
老師您好：
我是資管三 朱家儀，我的學號是B06705018。
因為這次作業我提早幾天完成，所以我忘記在作業區繳交作業三的github連結了，真的很抱歉。
不好意思麻煩老師再幫我查收一下作業，我之後不會再有這樣的情況發生，一定會再三確認是否都有上傳及繳交！
另外再附上我的github作業三連結：https://github.com/KatherineChu/Financial-Engineering/tree/master/HW3
麻煩老師了，不好意思。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Apr 9, 2020
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關於作業4
蔡芸琤, 周庭瑋 (CHOU,TING-WEI)
財務工程 Financial Engineering
April 16, 2020 at 8:44am
謝謝提醒，那個 8 是多打的，已經刪掉了
周庭瑋 (CHOU,TING-WEI), 蔡芸琤
財務工程 Financial Engineering
April 15, 2020 at 9:07pm
教授您好:
關於作業四的內容，題目第三行
If r = 6%, what is the value of a European put and call option with an exercise "8" price of $65 ...
有一個數字8在exercise後面，想請問一下是typo嗎，還是有其他意思？謝謝！
周庭瑋 2020/04/15.

HW4

- A stock is currently priced at $75 and has a σ of 0.35.
- It will pay two $1 dividends in 1 month and 4 months.
- If r = 6%, what is the value of a European put and call option with an exercise price of $65 maturing in 6 months?

$$D = \$1\, e^{-0.06\,(\frac{1}{12})} + \$1\, e^{-0.06\,(\frac{4}{12})} \cong \$1.9752.$$

Thus, $\hat{S} = S - D \cong \$75 - \$1.9752 \cong \$73.02.$

$$\begin{aligned} d_1 &= \frac{\ln(\widehat{S}/X) + (\mathrm{r} + \frac{1}{2}\sigma^2)\,\tau}{\sigma\sqrt{\tau}} \\ &\cong \frac{\ln(73.02/65.00) + (0.06 + \frac{1}{2}0.35^2)\,\frac{6}{12}}{0.35\sqrt{\frac{6}{12}}} \\ &\cong 0.715 \\ d_2 &= d_1 - \sigma\sqrt{\tau} \\ &\cong 0.715 - 0.35\sqrt{\frac{6}{12}} \\ &\cong 0.468. \end{aligned}$$

$N(-0.715) \cong 0.2373$ and $N(-0.468) \cong 0.3199$, so

$$\begin{aligned} p &= Xe^{-\mathrm{r}\,\tau}\,N(-d_2) - \widehat{S}\,N(-d_1) \\ &\cong \$65\, e^{-0.06\,(\frac{6}{12})}\,(0.3199) - \$73.02\,(0.2373) \\ &\cong \$20.179 - \$17.328 \\ &\cong \$2.85. \end{aligned}$$

主題： GBM 公式推導細節 & Ito

cool.ntu.edu.tw/courses/1195/discussion_topics/11457

財務工程 (ECON5106) › 課程內容 › GBM 公式推導細節 & Ito's Paper

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Symphony
myNTU 服務整合
設定

編輯

GBM 公式推導細節 & Ito's Paper

蔡芸琤

4月15日 15:53

所有班別

https://en.wikipedia.org/wiki/Geometric_Brownian_motion

For an arbitrary initial value S_0 the above SDE has the analytic solution (under Itô's interpretation):

以上為第六週第三十頁的 GBM 公式的推導過程。提供大家參考。

以下為 Ito 的完整論述內容，我們在課堂中簡化了這些過程，直接拿結論來使用，若有興趣了解的同學，可自行參考。

https://projecteuclid.org/download/pdf_1/euclid.pja/1195572786

https://archive.org/details/onstochasticdiff029540mbp/page/n19/mode/2up

GBM.png

搜尋條目或作者

未讀

回覆

For an arbitrary initial value S_0 the above SDE has the analytic solution (under Itô's interpretation):

$$S_t = S_0 \exp\left(\left(\mu - \frac{\sigma^2}{2}\right)t + \sigma W_t\right).$$

The derivation requires the use of Itô calculus. Applying Itô's formula leads to

$$d(\ln S_t) = (\ln S_t)' dS_t + \frac{1}{2}(\ln S_t)'' \, dS_t \, dS_t = \frac{dS_t}{S_t} - \frac{1}{2}\frac{1}{S_t^2} \, dS_t \, dS_t$$

where $dS_t \, dS_t$ is the quadratic variation of the SDE.

$$dS_t \, dS_t = \sigma^2 \, S_t^2 \, dt + 2\sigma S_t^2 \mu \, dW_t \, dt + \mu^2 \, S_t^2 \, dt^2$$

When $dt \to 0$, dt converges to 0 faster than dW_t, since $dW_t^2 = O(dt)$. So the above infinitesimal can be simplified by

$$dS_t \, dS_t = \sigma^2 \, S_t^2 \, dt$$

Plugging the value of dS_t in the above equation and simplifying we obtain

$$\ln \frac{S_t}{} = \left(\mu - \frac{\sigma^2}{} \right) t + \sigma W_t$$

風險管理 (Risk Management)

風險管理(risk management)

1. 是一個管理過程，包括對風險的定義、測量、評估和發展因應風險的策略。
2. 目的是將可避免的風險、成本及損失極小化。
3. 理想的風險管理，事先已排定優先次序，可以優先處理引發最大損失及發生機率最高的事件，其次再處理風險相對較低的事件。
4. 風險可能來自各種來源，包括**金融市場的不確定性**，項目失敗的威脅(在設計，開發，生產或維持生命週期的任何階段)，法律責任，信用風險，事故，自然原因和災難，故意攻擊來自對手，或根本原因不確定或不可預測的事件。
5. 實際狀況中，因為風險與發生機率通常不一致，所以難以決定處理順序。故須衡量兩者比重，做出最合適的決定。
6. 把資源用於風險管理可能會減少運用在其他具有潛在報酬之活動的資源；**理想的風險管理正是希望以最少的資源化解最大的危機**。

Risk management means selecting and maintaining portfolios with defined exposure to risks. Derivatives are essential to risk management.

農夫 怕小麥價格下跌

麵粉工廠 怕小麥價格上漲

賣出小麥期貨避險

買進小麥期貨避險

Hedging (避險)


JANUARY
FEBRUARY
MARCH
APRIL
Batt
Inc

Delta Hedge

- The delta (hedge ratio) of a derivative f is defined as

$$\Delta \triangleq \frac{\partial f}{\partial S}.$$

- Thus

$$\Delta f \approx \Delta \times \Delta S$$

  for relatively small changes in the stock price, ΔS.

- A delta-neutral portfolio is hedged as it is immunized against small changes in the stock price.

- A trading strategy that dynamically maintains a delta-neutral portfolio is called delta hedge.

- Delta changes with the stock price.
- A delta hedge needs to be rebalanced periodically in order to maintain delta neutrality.
- In the limit where the portfolio is adjusted continuously, "perfect" hedge is achieved and the strategy becomes self-financing.

Implementing Delta Hedge

- We want to hedge N *short* derivatives.
- Assume the stock pays no dividends.
- The delta-neutral portfolio maintains $N \times \Delta$ shares of stock plus B borrowed dollars such that

$$-\boxed{N \times f} + \boxed{N \times \Delta \times S} - \boxed{B} = 0.$$

- At next rebalancing point when the delta is Δ', buy $N \times (\Delta' - \Delta)$ shares to maintain $N \times \Delta'$ shares.
- Delta hedge is the discrete-time analog of the continuous-time limit and will rarely be self-financing.

- A hedger is *short* 10,000 European calls.
- $S = 50$, $\sigma = 30\%$, and $r = 6\%$.
- This call's expiration is four weeks away, its strike price is \$50, and each call has a current value of $f = 1.76791$.
- As an option covers 100 shares of stock, $N = 1{,}000{,}000$.
- The trader adjusts the portfolio weekly.
- The calls are replicated well if the cumulative cost of trading *stock* is close to the call premium's FV.

Option Price Calculator

不安全 | option-price.com/index.php

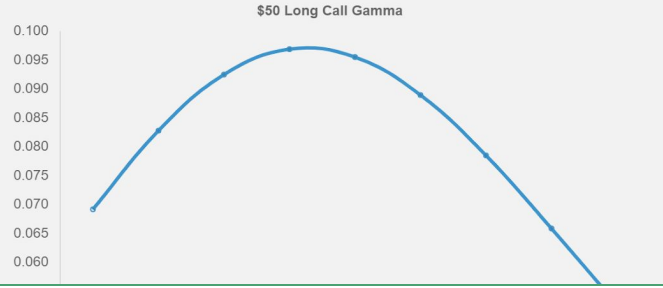
Option Calculator | Implied Volatility | Strategies | Custom | Matrix | About

Underlying Price	50
Exercise Price	50
Days Until Expiration	28
Interest Rates	6
Dividend Yield	0
Volatility	30
Rounding	3
Graph Increment	1

Calculate

	Call Option	Put Option
Theoretical Price	1.77	1.541
Delta	0.539	-0.461
Gamma	0.096	0.096
Vega	0.055	0.055
Theta	-0.034	-0.025
Rho	0.019	-0.019

Long Call | Long Call Gamma



τ	S	Option value f	Delta Δ	Change in delta	No. shares bought $N\times(5)$	Cost of shares $(1)\times(6)$	Cumulative cost $\mathrm{FV}(8')+(7)$
	(1)	(2)	(3)	(5)	(6)	(7)	(8)
4	50	1.7679	0.53856	—	538,560	26,928,000	26,928,000
3	51	2.1058	0.64036	0.10180	101,795	5,191,545	32,150,634
2	53	3.3509	0.85578	0.21542	215,425	11,417,525	43,605,277
1	52	2.2427	0.83983	−0.01595	−15,955	−829,660	42,825,960
0	54	4.0000	1.00000	0.16017	160,175	8,649,450	51,524,853

The total number of shares is 1,000,000 at expiration (trading takes place at expiration, too).

- As $\Delta = 0.538560$

$$N \times \Delta = 538,560$$

shares are purchased for a total cost of

$$538{,}560 \times 50 = 26{,}928{,}000$$

dollars to make the portfolio delta-neutral.

- The trader finances the purchase by borrowing

$$B = N \times \Delta \times S - N \times f = 25{,}160{,}090$$

dollars net.

- At 3 weeks to expiration, the stock price rises to \$51.
- The new call value is $f' = 2.10580$.
- So before rebalancing, the portfolio is worth

$$-N \times f' + 538{,}560 \times 51 - Be^{0.06/52} = 171{,}622.$$

- A delta hedge does not replicate the calls perfectly; it is not self-financing as \$171,622 can be withdrawn.
- The magnitude of the tracking error—the variation in the net portfolio value—can be mitigated if adjustments are made more frequently.
- In fact, the tracking error over *one* rebalancing act is positive about 68% of the time, but its expected value is essentially zero.
- The tracking error at maturity is proportional to vega.

- In practice tracking errors will cease to decrease beyond a certain rebalancing frequency.
- With a higher delta $\Delta' = 0.640355$, the trader buys

$$N \times (\Delta' - \Delta) = 101,795$$

shares for \$5,191,545.

- The number of shares is increased to $N \times \Delta' = 640,355$.

- The cumulative cost is

$$26{,}928{,}000 \times e^{0.06/52} + 5{,}191{,}545 = 32{,}150{,}634.$$

- The portfolio is again delta-neutral.

- At expiration, the trader has 1,000,000 shares.
- They are exercised against by the in-the-money calls for \$50,000,000.
- The trader is left with an obligation of

$$51{,}524{,}853 - 50{,}000{,}000 = 1{,}524{,}853,$$

which represents the replication cost.

- Compared with the FV of the call premium,

$$1{,}767{,}910 \times e^{0.06\times 4/52} = 1{,}776{,}088,$$

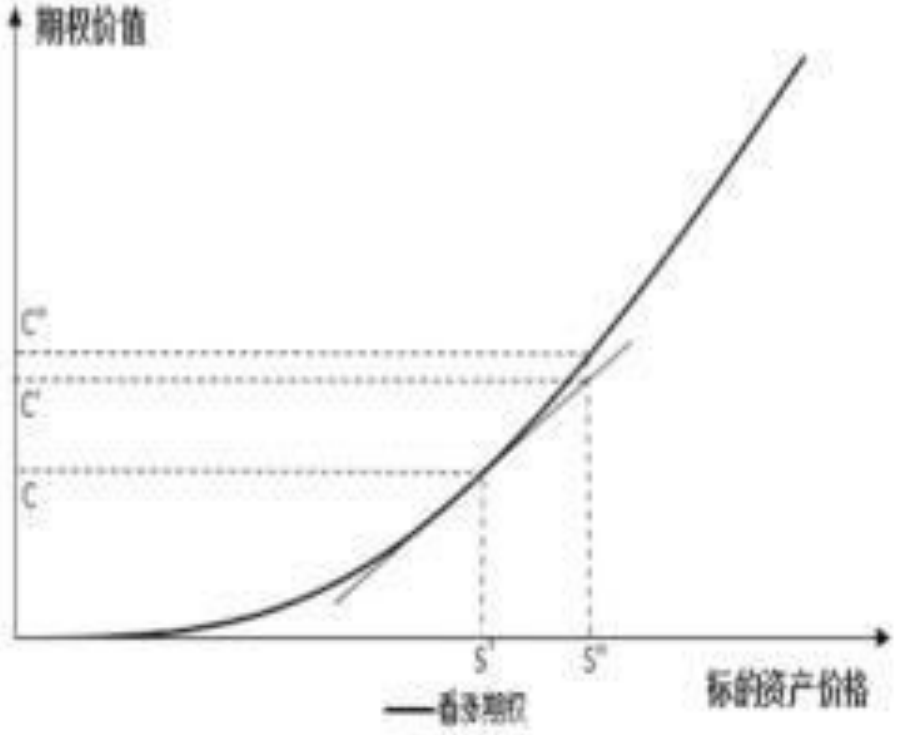
the net gain is $1{,}776{,}088 - 1{,}524{,}853 = 251{,}235$.

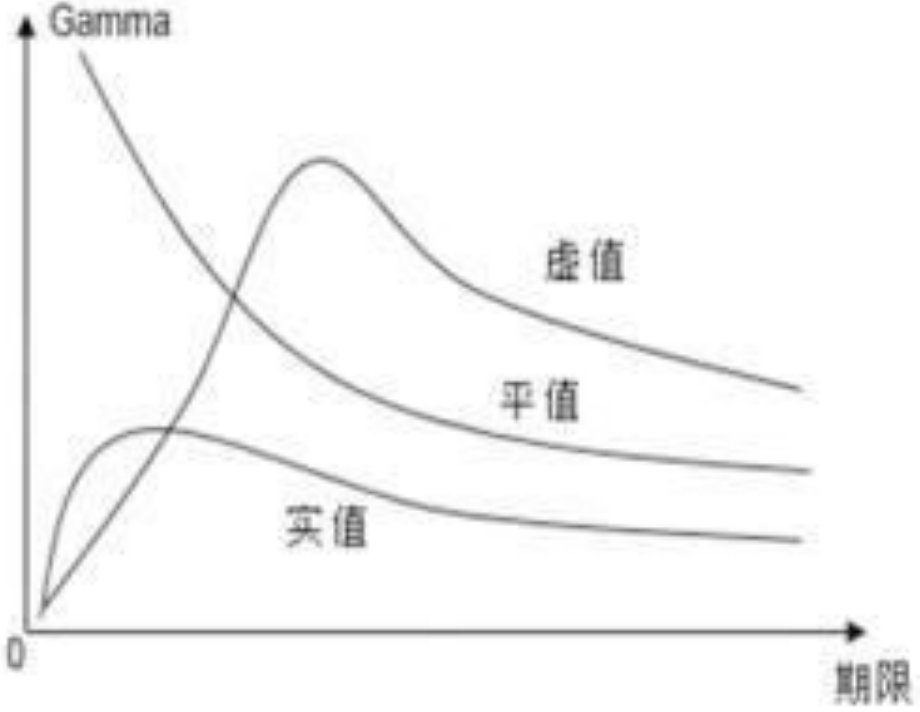
Tracking Error Revisited (避險誤差)

Tracking Error Revisited (避險誤差)

當標的價格變化較大時，僅僅使用Delta會產生較大的估計誤差，此時需要引入另一個希臘字母Gamma。期權指標中的Gamma是指交易組合中Delta變化與標的資產價格變化的比率，它用來反映標的資產價格變化時Delta變化的速度，也可以看作為期權價格隨著標的資產價格變化的加速度。

原文網址：https://kknews.cc/finance/38va468.html


期权价值
C''
C'
C
S'
S''
标的资产价格
看涨期权


Gamma
虚值
平值
实值
0
期限

Tracking Error Revisited (避險誤差)

從左圖可以看出，當標的價格從S′增加到S″，Delta中性策略所設定的期權價格從C變成C′，實際上，期權價格發生的變化是從C增加至C″。因此，當投資者在做套期保值時，期權價格與股票價格之間的關係（即曲線的曲度）會在操作結果中引起誤差。圖形的彎曲程度越大，誤差就越大，Gamma正是此曲度的度量值。在圖中，Gamma就是切線之上的曲線部分，投資者在進行期權交易時，必需了解Gamma的風險，消除這類誤差。

原文網址：https://kknews.cc/finance/38va468.html

- Define the dollar gamma as $S^2\Gamma$.
- The change in value of a delta-hedged *long* option position after a duration of Δt is proportional to the dollar gamma.
- It is about

$$(1/2)S^2\Gamma[\,(\Delta S/S)^2 - \sigma^2\Delta t\,].$$

  - $(\Delta S/S)^2$ is called the daily realized variance.

- In our particular case,

$$S = 50, \Gamma = 0.0957074, \Delta S = 1, \sigma = 0.3, \Delta t = 1/52.$$

- The estimated tracking error is

$$-(1/2)\times 50^2 \times 0.0957074 \times \left[(1/50)^2 - (0.09/52) \right] = 159,205.$$

- It is very close to our earlier number of 171,622.
- Delta hedge is also called gamma scalping.

Option Price Calculator

不安全 | option-price.com/index.php

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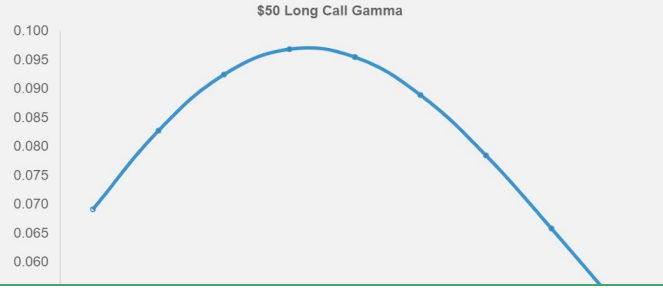


Option Greeks

https://medium.com/stockswipe-trade-ideas/option-greeks-not-greek-anymore-9e883273e6e6

Greek	Measures	Affected by	Affects
Delta	Impact of underlying price move (per $1)	Time until expiration, volatility, gamma, price	Option Price
Gamma	Impact of underlying price move (per $1)	Time until expiration, volatility, price	Delta
Theta	Impact of passage of time (per day)	Time until expiration, price, volatility	Option Price
Vega	Impact of volatility change (per 1%)	Time until expiration, volatility	Option Price
Rho	Impact of interest rate change(per 1%)	Interest rate, time until expiration	Option Price

Greek letter	*Call option*	*Put option*
Delta	$e^{-qT}N(d_1)$	$e^{-qT}[N(d_1)-1]$
Gamma	$\dfrac{N'(d_1)e^{-qT}}{S_0\sigma\sqrt{T}}$	$\dfrac{N'(d_1)e^{-qT}}{S_0\sigma\sqrt{T}}$
Theta	$-S_0N'(d_1)\sigma e^{-qT}/(2\sqrt{T})$ $+qS_0N(d_1)e^{-qT}-rKe^{-rT}N(d_2)$	$-S_0N'(d_1)\sigma e^{-qT}/(2\sqrt{T})$ $-qS_0N(-d_1)e^{-qT}+rKe^{-rT}N(-d_2)$
Vega	$S_0\sqrt{T}N'(d_1)e^{-qT}$	$S_0\sqrt{T}N'(d_1)e^{-qT}$
Rho	$KTe^{-rT}N(d_2)$	$-KTe^{-rT}N(-d_2)$

- Γ值對 Delta Hedging 調整投資組合的頻率有影響：
  - Γ值大時，Δ變動迅速，因此在做 Delta Hedging 時，調整投資組合須較頻繁。
  - Γ值小時，Δ變動較緩，因此在做 Delta Hedging 時，調整投資組合須較不頻繁。
- 當投資組合的 Γ=0 時，稱此投資組合為Γ中立。
- 使投資組合Γ中立，主要是用來規避標的資產的大幅變動。
  - Δ=0 ➔ 股價變動
  - Γ=0 ➔ 股價大幅變動

Delta-Gamma Hedge

- Delta hedge is based on the first-order approximation to changes in the derivative price, Δf, due to changes in the stock price, ΔS.
- When ΔS is not small, the second-order term, gamma $\Gamma \stackrel{\Delta}{=} \partial^2 f / \partial S^2$, helps (theoretically).
- A delta-gamma hedge is a delta hedge that maintains zero portfolio gamma, or gamma neutrality.
- To meet this extra condition, one more security needs to be brought in.

- Suppose we want to hedge short calls as before.
- A hedging call f_2 is brought in.
- To set up a delta-gamma hedge, we solve

$$\begin{aligned} -N \times f + n_1 \times S + n_2 \times f_2 - B &= 0 \quad \text{(self-financing)}, \\ -N \times \Delta + n_1 + n_2 \times \Delta_2 - 0 &= 0 \quad \text{(delta neutrality)}, \\ -N \times \Gamma + 0 + n_2 \times \Gamma_2 - 0 &= 0 \quad \text{(gamma neutrality)}, \end{aligned}$$

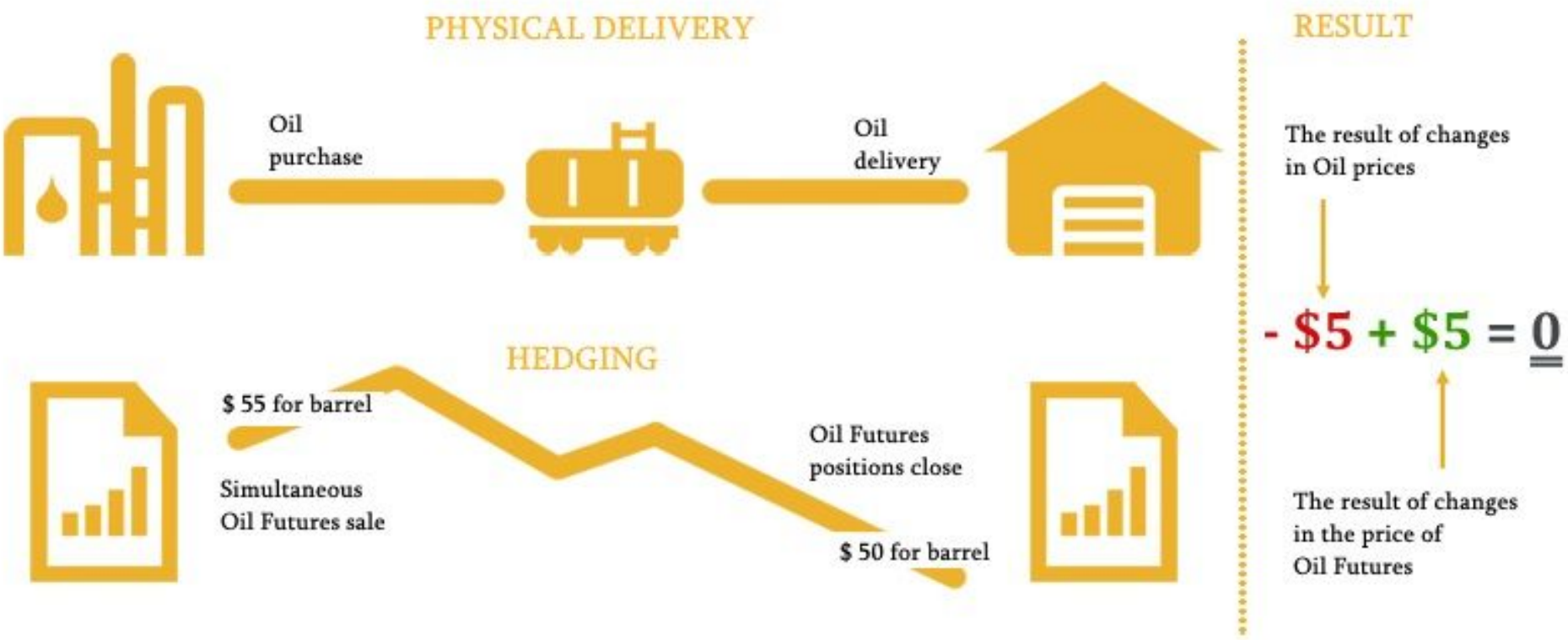
  for n_1, n_2, and B.

  – The gammas of the stock and bond are 0.

- See the numerical example on pp. 231–232 of the text.

Other Hedges

- If volatility changes, delta-gamma hedge may not work well.
- An enhancement is the delta-gamma-vega hedge, which also maintains vega zero portfolio vega.
- To accomplish this, one more security has to be brought into the process.
- In practice, delta-vega hedge, which may not maintain gamma neutrality, performs better than delta hedge.



https://www.renesource.com/en/services/hedging-and-risk-management

電力企業和電力販賣企業就可以規避風險，坐收利潤

讓電力和天然氣這個在全世界都被政府管制的產業自由化，然後將它變成和糧食期貨一樣進行期權交易。這樣一來，電力和天然氣就會成為金融交易的工具，大量的金融資本就會進來，電力企業和電力販賣企業就可以規避風險，坐收利潤。從長期看，美國一旦建立這個體系，全世界就會效仿，逐步建立以美國為首的能源交易中心，然後理所當然地用經濟手段去控制世界能源市場，避免美國未來的能源問題。而這個計劃得以建立的基礎就是電力市場的自由化，只有促使全球電力和能源市場開放，擁有足夠的電力企業或其他能源企業，這個市場才能確立。一旦這個計劃得以實現，Enron公司作為先行者就會理所當然地成為全球第一霸主。

https://www.epochtimes.com/b5/3/12/17/n431327.htm


非凡新聞
Next on 呼風喚雨的超級資金
淡馬錫控股內幕

2016/11/03, 財經

美國商業醜聞的重要紀錄片——《安隆風暴》（Enron: The Smartest Guys in the Room）

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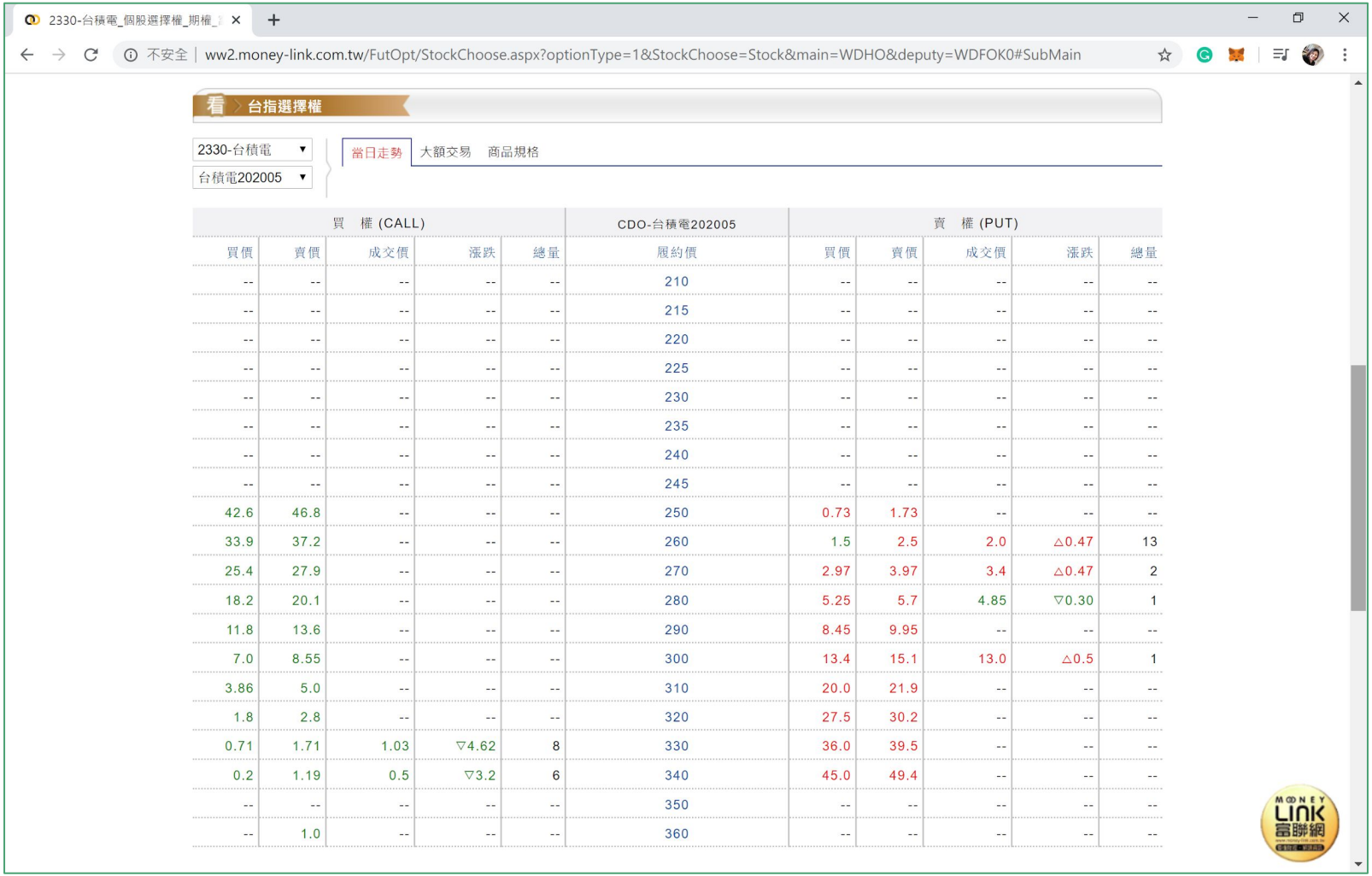
用選擇權幫股票買保險

日期：2017-05-04

每當大盤接近萬點時，投資者相當期待可以一舉衝破這歷史屏障，但也居高思危擔心這是高點，這種既期待又怕受傷害的心情，可真是折磨人！

當然，膽小一點的也可以選擇停利出場，但要是股市持續往上漲，不就失去這波大好機會。如果市場上可以買到一紙保單，條件是當投資標的跌到某個價位以下，保險公司就會理賠虧損部位，這樣投資就可以穩操勝算了。只是市面上卻找不到一家保險公司發行這類型的保單，不過別灰心，透過買入選擇權的賣權(Put)，就可以達到跟買保險一樣的效果。

例如投資一檔台積電股票，若要替這檔股票保險，只要買入台積電股票選擇權(CDO)的賣權，履約價選擇比當時的股價低一點，因為履約價就相當於保險金額，當選擇權到期時，只要台積電股價低於履約



買 權 (CALL)					CDO-台積電202005	賣 權 (PUT)				
買價	賣價	成交價	漲跌	總量	履約價	買價	賣價	成交價	漲跌	總量
--	--	--	--	--	210	--	--	--	--	--
--	--	--	--	--	215	--	--	--	--	--
--	--	--	--	--	220	--	--	--	--	--
--	--	--	--	--	225	--	--	--	--	--
--	--	--	--	--	230	--	--	--	--	--
--	--	--	--	--	235	--	--	--	--	--
--	--	--	--	--	240	--	--	--	--	--
--	--	--	--	--	245	--	--	--	--	--
42.6	46.8	--	--	--	250	0.73	1.73	--	--	--
33.9	37.2	--	--	--	260	1.5	2.5	2.0	△0.47	13
25.4	27.9	--	--	--	270	2.97	3.97	3.4	△0.47	2
18.2	20.1	--	--	--	280	5.25	5.7	4.85	▽0.30	1
11.8	13.6	--	--	--	290	8.45	9.95	--	--	--
7.0	8.55	--	--	--	300	13.4	15.1	13.0	△0.5	1
3.86	5.0	--	--	--	310	20.0	21.9	--	--	--
1.8	2.8	--	--	--	320	27.5	30.2	--	--	--
0.71	1.71	1.03	▽4.62	8	330	36.0	39.5	--	--	--
0.2	1.19	0.5	▽3.2	6	340	45.0	49.4	--	--	--
--	--	--	--	--	350	--	--	--	--	--
--	1.0	--	--	--	360	--	--	--	--	--

https://ww2.money-link.com.tw/FutOpt/StockChoose.aspx?optionType=1&StockChoose=Stock&main=WDHO&deputy=WDFOK0#SubMain

Q and A