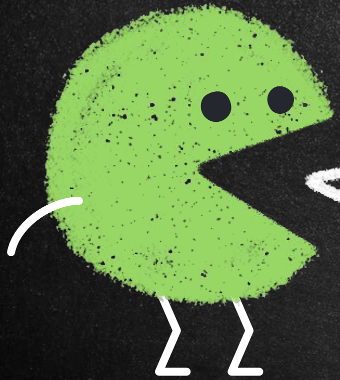
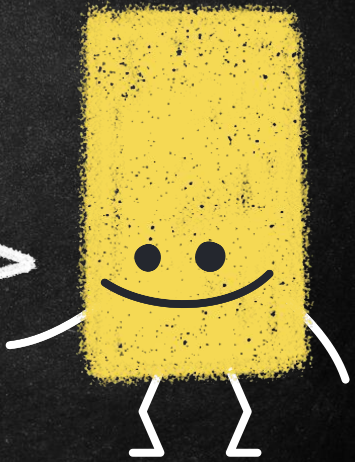
Introduction to Risk Management Science





Hello!

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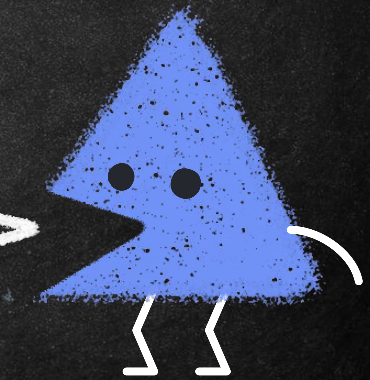
Department of Statistics

Content

- What is risk management
- Simple European Options
- Arbitrage



1.

What is risk management

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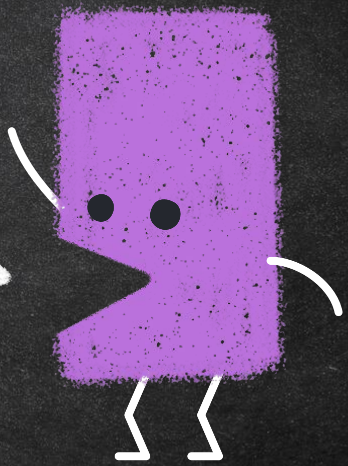
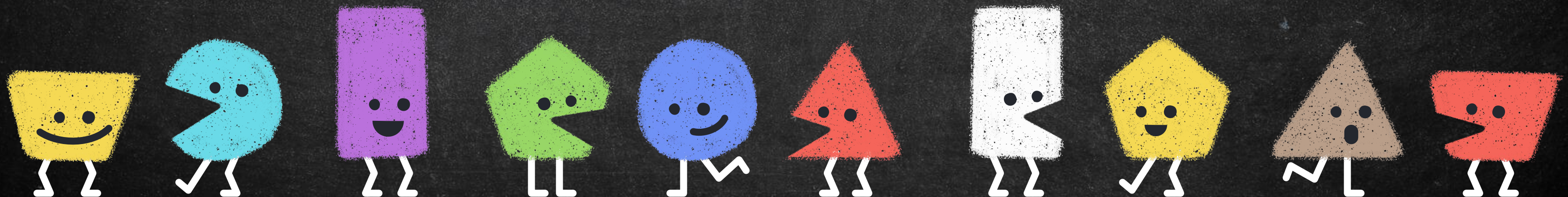
Broadly speaking, risk is defined as uncertainty of having a bad outcome.



Risk Management

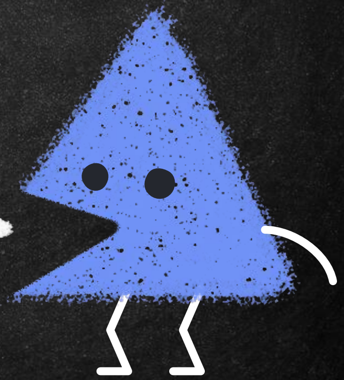
Risk Management means taking deliberate actions to shift the odds in your favour



Example

You work for a fire insurance company. How much reserves (cash) you need depends on how many houses will have fires in the coming year. Let's call this number H

- Your model H as being random, perhaps $H \sim N(100,100)$
- How much money do you prepare to reserve? (Suppose each fire house will get $1)



Example

Expected loss

On average there will be 100 houses burnt. Amongst the past observations, the numbers of house burned in each year range from 80 to 120

Probability of loss

Usually

(E(H)-2 sd(H),

E(H)+2 sd(H))

Covers approx. 95% of the possible situations

Risk

You may prepare the resources for 100 houses. But the uncertainty is that it may be in excess, or may not be enough; the risk refers to the variation from 80 to 120

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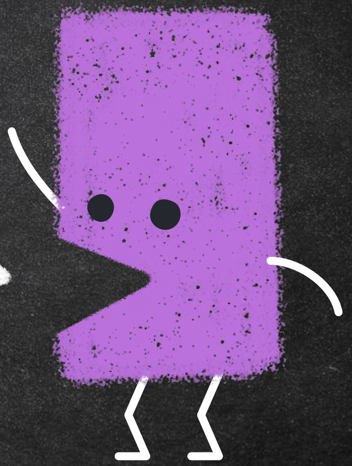
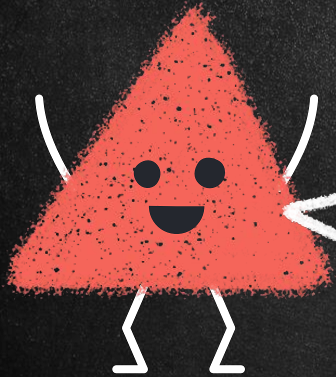
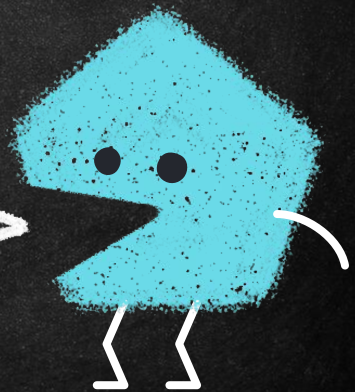
Risk is uncertainty (variation), not expected loss, not probability of loss!



2.

Simple european options (欧洲期权)





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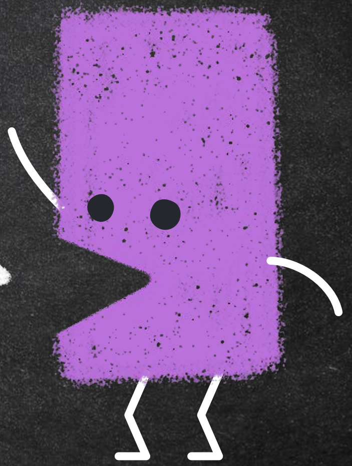
Options(期权) are financial derivatives(金融衍生品） that give the buyers the right but not the obligation to buy or sell an asset at an agreed-upon price and date.



Basic Concepts

Underlying Asset （標的物）

Financial assets upon which a derivative's price is based.

Strike Price （履約價格）

A strike price is the set price at which a derivative contract can be bought or sold when it is exercised.

Basic Concepts

Expiration Date

（履約日期）

The last date on which the holder of the option may exercise it according to its terms

European options

（歐洲期權）

A version of an options contract that limits rights exercise to only the day of expiration

Basic Concepts

Call Options

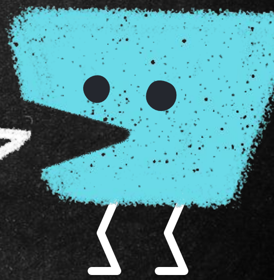
（看漲期權）

買進一定數量標的物的權利

Put Options

（看跌期權）

賣出一定數量標的物的權利



Basic Concepts

Long: 買期權

Short: 賣期權

Call: 買資產

Put: 賣資產

S_t: 履約日期標的物價格

K: 履約價格

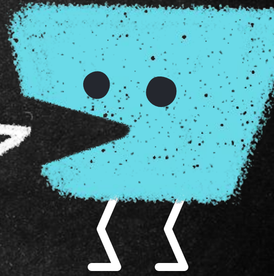
Pay-off（收入）

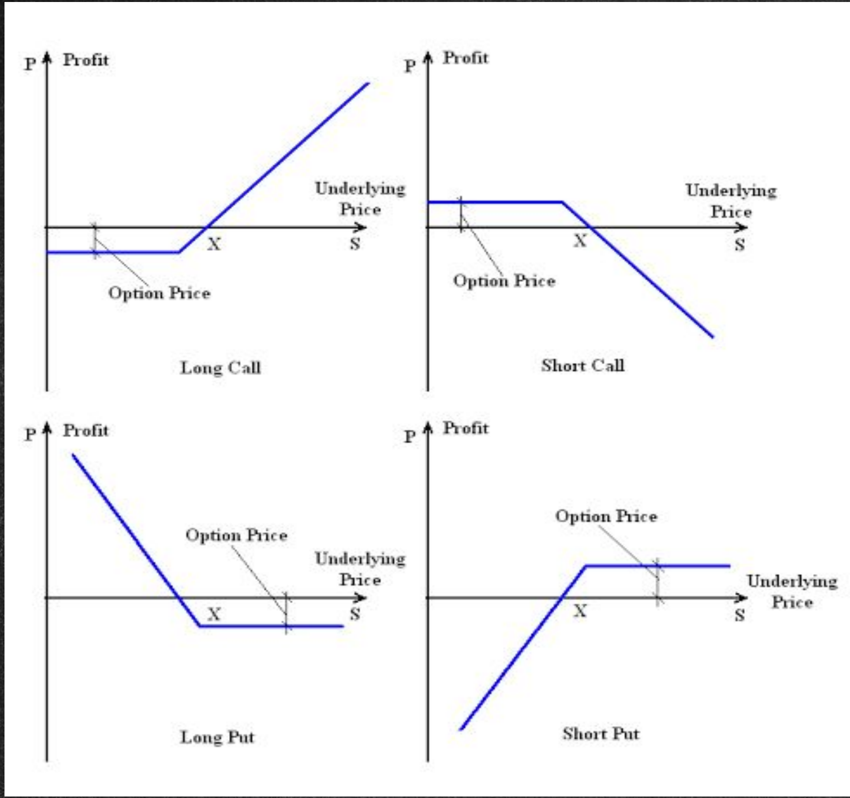
Long Call: $Max(0, S_t – K)$

Long Put: $Max(0, K – S_t)$

Short Call: $–Max(0, S_t – K)$

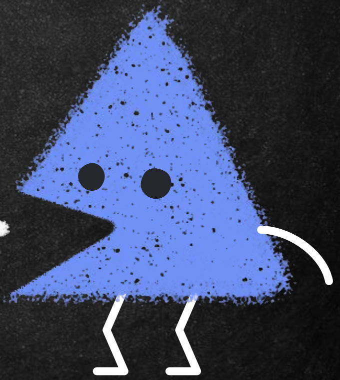
Short Put: $–Max(0, K – S_t)$





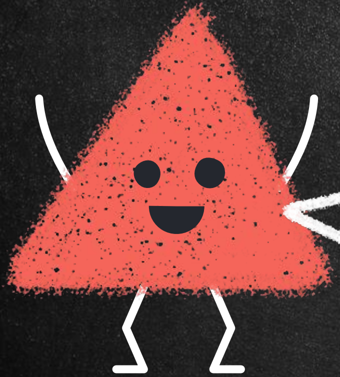
Profit GRAPH

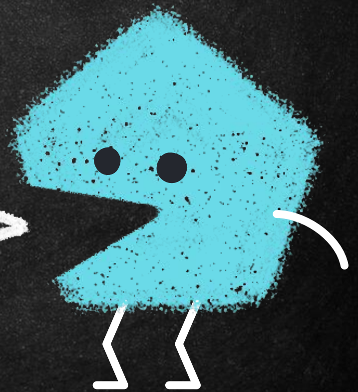
Long: 買期權 Short: 賣期權 Call: 買資產 Put: 賣資產



3.

Arbitrage (套利)

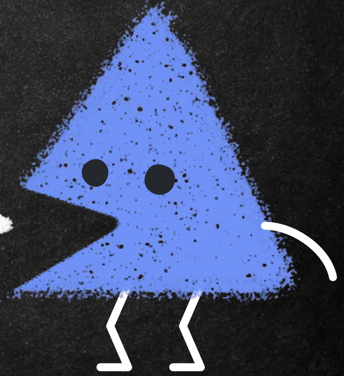




Example 1

	Strike Price K	Price
Call 1	75	11
Call 2	80	5

如何空手套白狼？？



Example 1

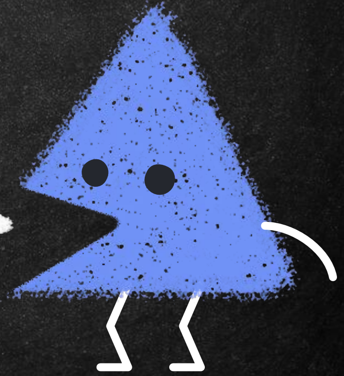
	Strike Price K	Price
Call 1	75	11
Call 2	80	5

賣call 1, 買call 2

Time 0: 11 – 5 = 6

Time 1: Max(0, S_1–80)–Max(0, S_1–75)

利潤 : 至少 1



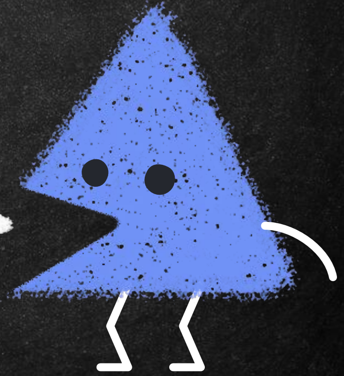
Example 2

	Strike Price K	Price
Call 1	55	12

S_0 = 70, i = 0.1(年利率), 現在距離履約日期還有六個月

Tips: 若現在有現金a, 六個月後它可以通過無風險投資變為 $a*e^{i/2}$

如何空手套白狼？？

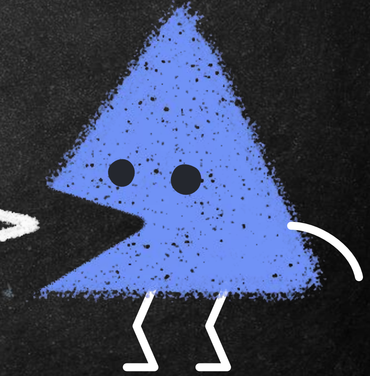


Example 2

	Strike Price K	Price
Call 1	55	12

S_0= 70, i = 0.1(年利率), 現在距離履約日期還有六個月
Tips: 若現在有現金a，六個月後它可以通過無風險投資變為$a*e^{i/2}$

- Time 0: 賣1個標的物，買一個call 1，把剩餘的錢 70–12 = 58存入銀行
- Time 1: 把標的物給買家，取出存入銀行的錢



$\max(S_1-55, 0)-S_1+58*e^{0.1/2} \geq 5.97 > 0$

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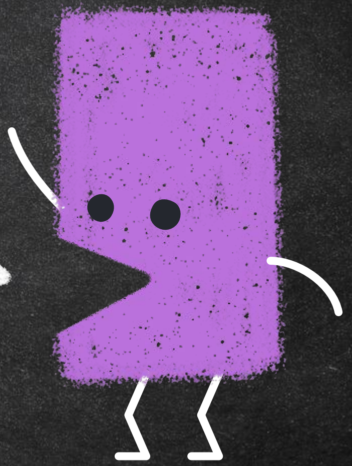
Arbitrage opportunities cannot last for long. The market is called efficient if no arbitrage opportunity exists.



Put-Call Parity

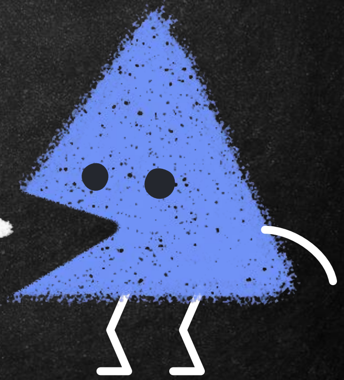
Lemma:

如果兩個資產的價值在T時間相等，則在(0, T)任意時間他們的價值相等

考慮如下兩個資產組合：

A: long 1 call 和現金 $K*e^{-rT}$

B: long 1 put 和一個標的資產



Put-Call Parity

A: long 1 call 和現金 K^*e^{-rT}

B: long 1 put 和一個標的資產

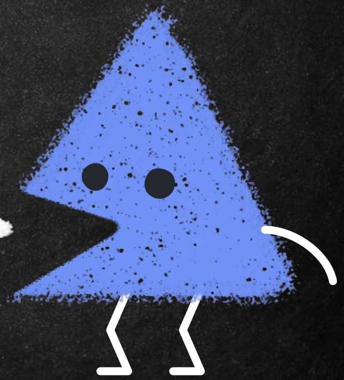
Time 1:

A: $\max(S_T-K,0) + Ke^{-rT}e^{rT}$

$=\max(S_T,K)$

B: $\max(K-S_T,0) + S_T = \max(S_T, K)$

Hence, A = B



Put-Call Parity

A: long 1 call 和現金 $K*e^{-rT}$

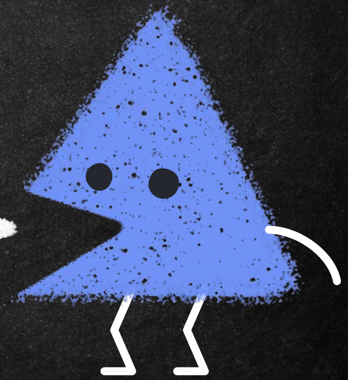
B: long 1 put 和一個標的資產

Hence, by the lemma, Time t, $t \in (0,T)$:

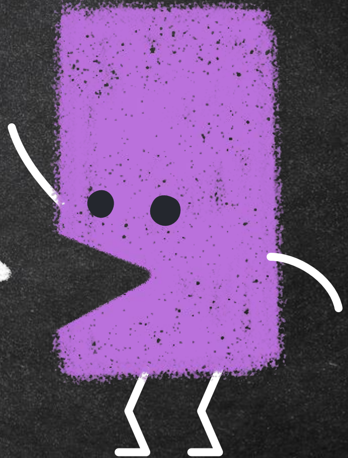
A: $c + K*e^{-r(T-t)}$

B: $p + S_t$

Hence, A = B, $c + K*e^{-r(T-t)} = p + S_t$



Put-call Parity is useful in option pricing.



Thanks!

Any questions?