Tuesday, 17 March 2015
Econophysics

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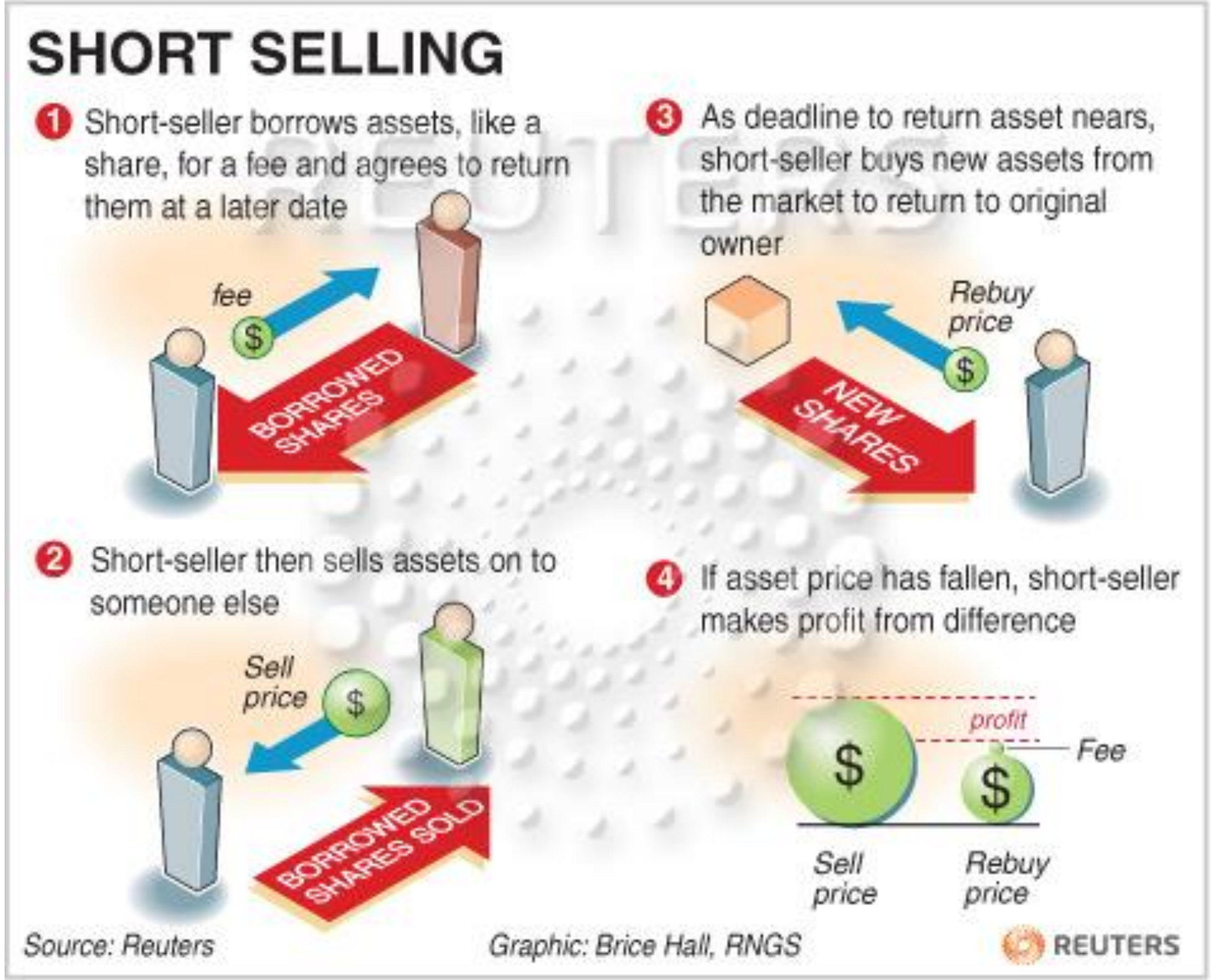
PART 1. DICTIONARY

- Long position
- Short position
- Risk-free interest rate [proxies: LIBOR, Government notes]

- **Short selling**

It is possible to have a negative number of stocks, or other financial instruments (bonds, futures, derivatives,).



PART 2. *Arbitrage*

Arbitrage: An opportunity for riskless profit

Example 2.1. (Trivial case) ***Apple stock*** *having different prices on two different stock exchanges.*

Trading strategy:

It is simple - buy the stock at the lower price and **immediately** sell at the higher price.

No arbitrage principle

(*efficient market hypothesis*)

"There are (almost) no arbitrage opportunities"

- This principle holds very approximately, and it allows us to price various instruments

No arbitrage principle: Everything is perfectly balanced.

- not exactly true
- market is not perfectly efficient

"Efficient market"

Real market is something more like this….

Small disturbances and imperfections are always present

- Tiny deviations from the *no arbitrage* principle present an opportunity to make money (hedge funds, trading firms, investment banks)

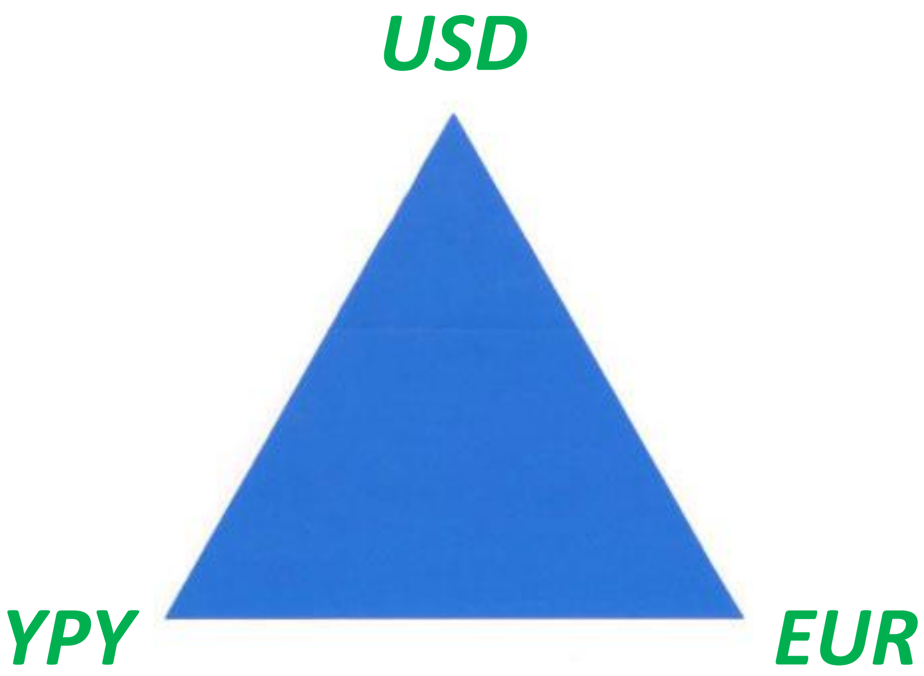
Large market disturbance

Hedge fund trader

A more interesting example…

Example 2.2. *Currency triangle.*

USD/EUR	**0.9423**
EUR/JPY	**128.74**
JPY/USD	**0.00828**



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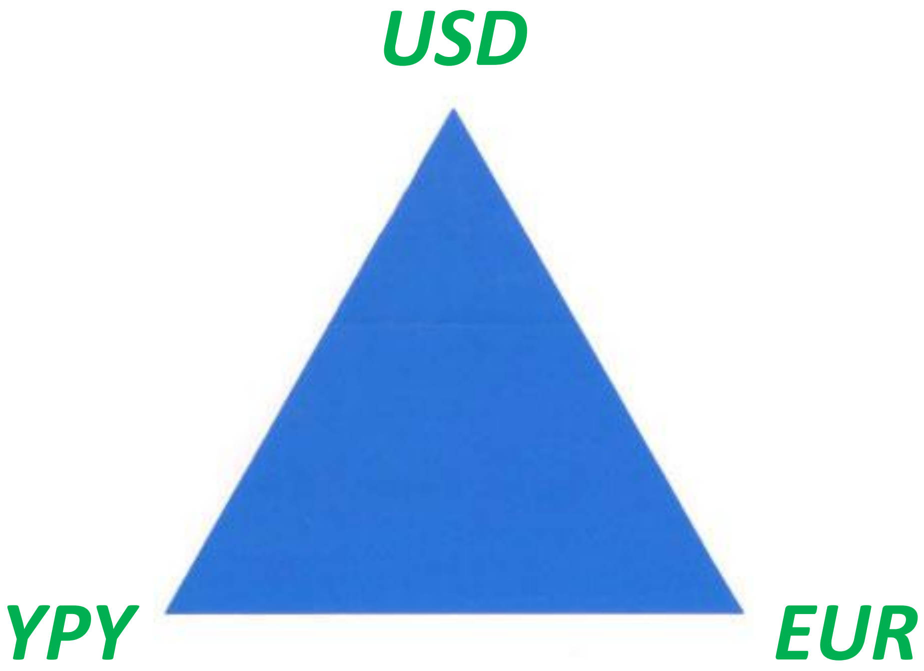

We start from $100 000.

A more interesting example…

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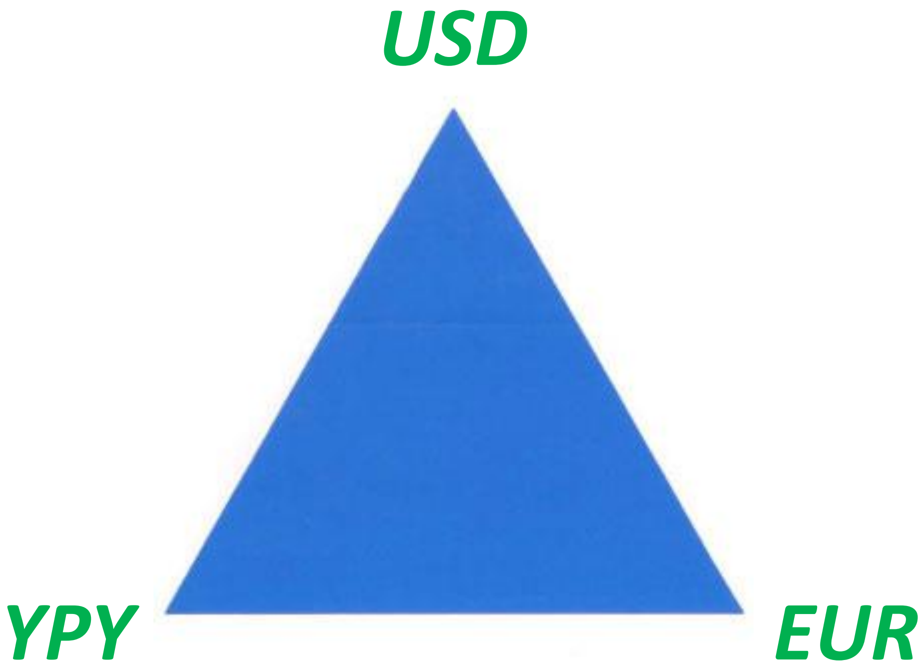

We start from $100 000.
Buy euros (convert dollars to euros): 94 230 EUR

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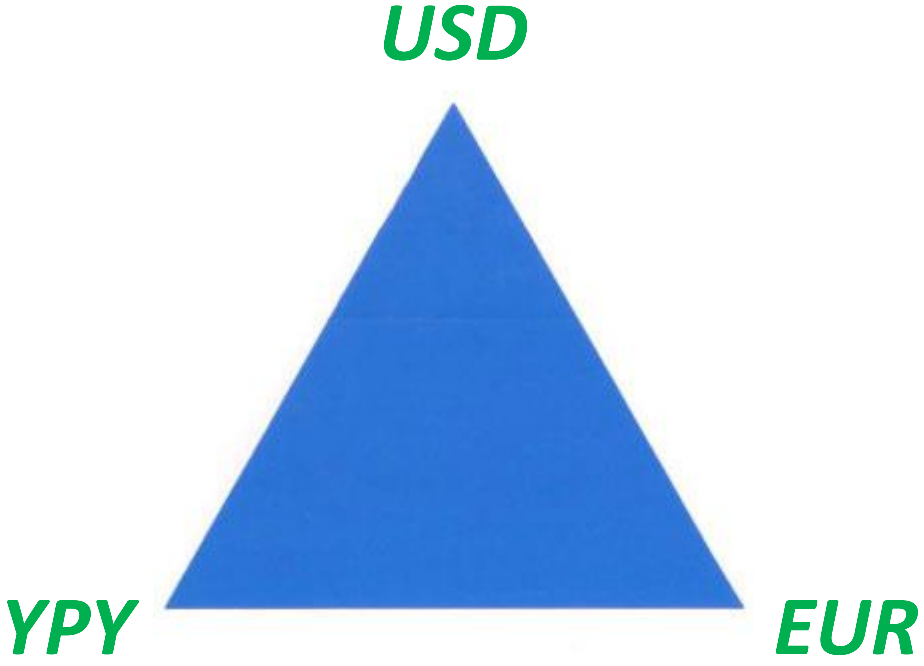

We start from $100 000.
Buy euros (convert dollars to euros): 94 230 EUR
Use those euros to buy Japanese Yen. We have: 12’ 131 170 YPY

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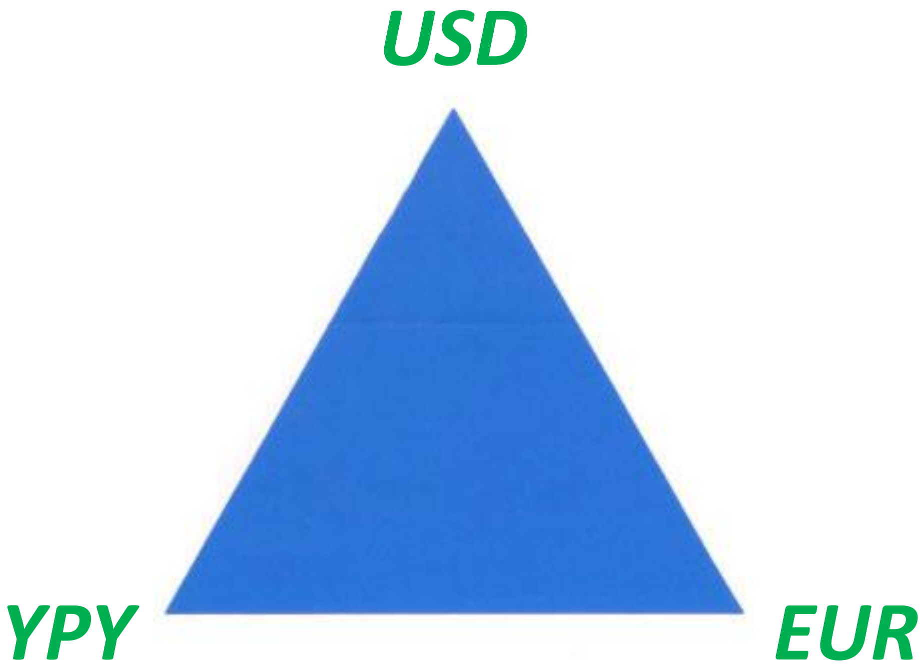

We start from $100 000.
Buy euros (convert dollars to euros): 94 230 EUR
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Convert Yens back to dollars: $100 446

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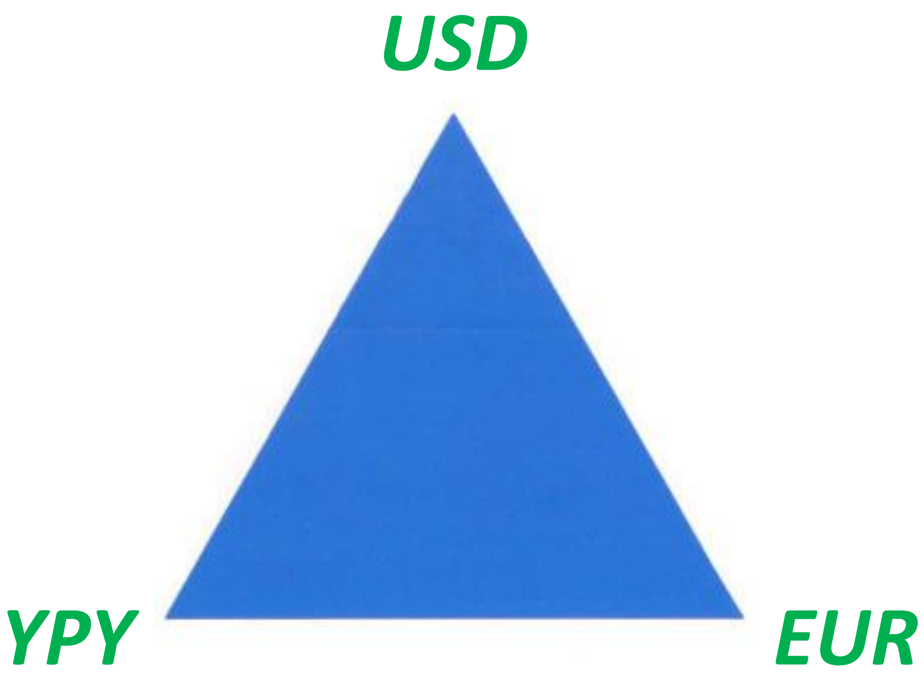


We start from $100 000.
Buy euros (convert dollars to euros): 94 230 EUR
Use those euros to buy Japanese Yen. We have: 12’ 131 170 YPY
Convert Yens back to dollars: $100 446
Riskless profit: $446

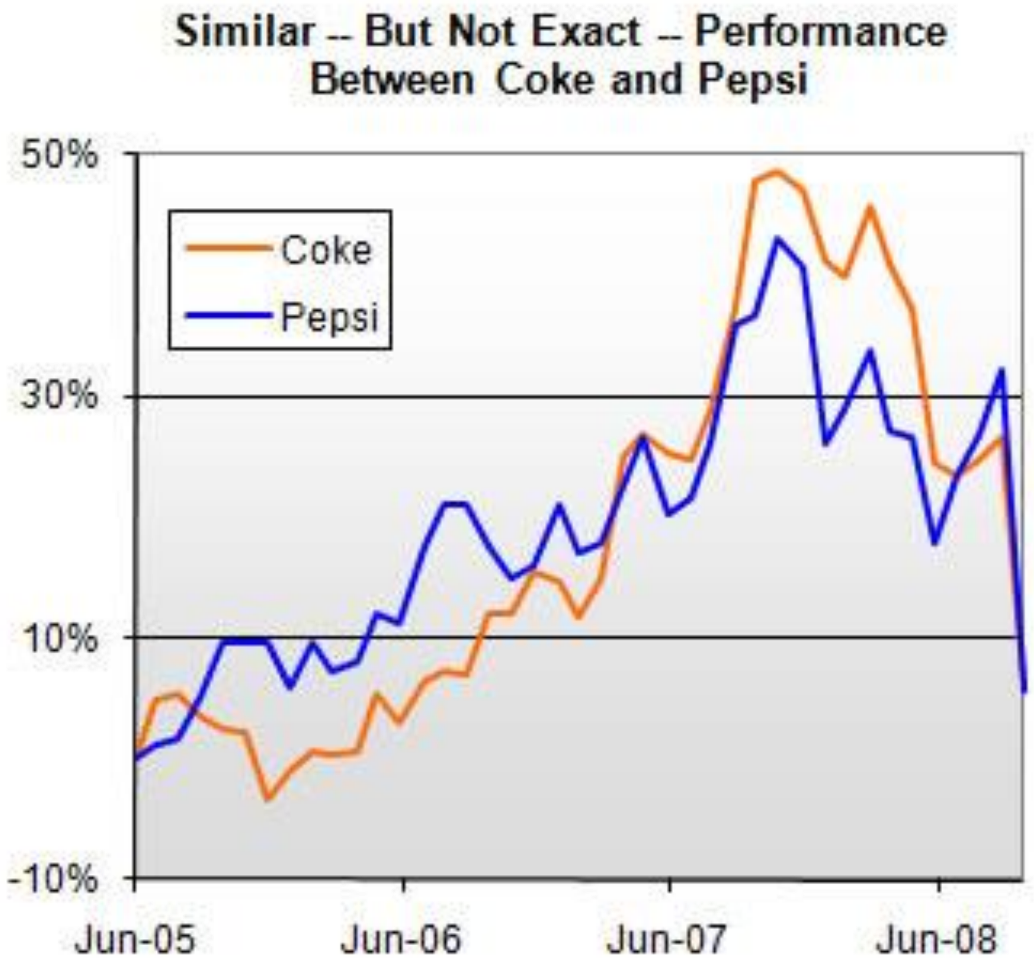
Example 2.3. Put-call parity

$$c + Ke^{-rT} = p + S_0$$

c- price of ***European call option***
p- price of ***European put option***
K- "strike" price (fixed parameter, will talk about it later)
T-time to maturity of (both) options
S-price of an underlying stock

If put-call parity is broken, we have an arbitrage opportunity.
This is correct in theory.
If you see this relation broken in practice, should you immediately execute a trade?

Example 2.4. Pairs trading



Styles of trading

- **Discretionary trading** (fundamental value of a company, looking for fundamentally underpriced or overpriced companies)

- **Systematic trading** (quantitative, predictive signals)

--Trend prediction & trend following, low and medium frequency trading

-- HF trading

PART 3. **Pricing of financial instruments.**

How do we determine the fair price of a bond, stock, option or an exotic derivative?

No arbitrage principle

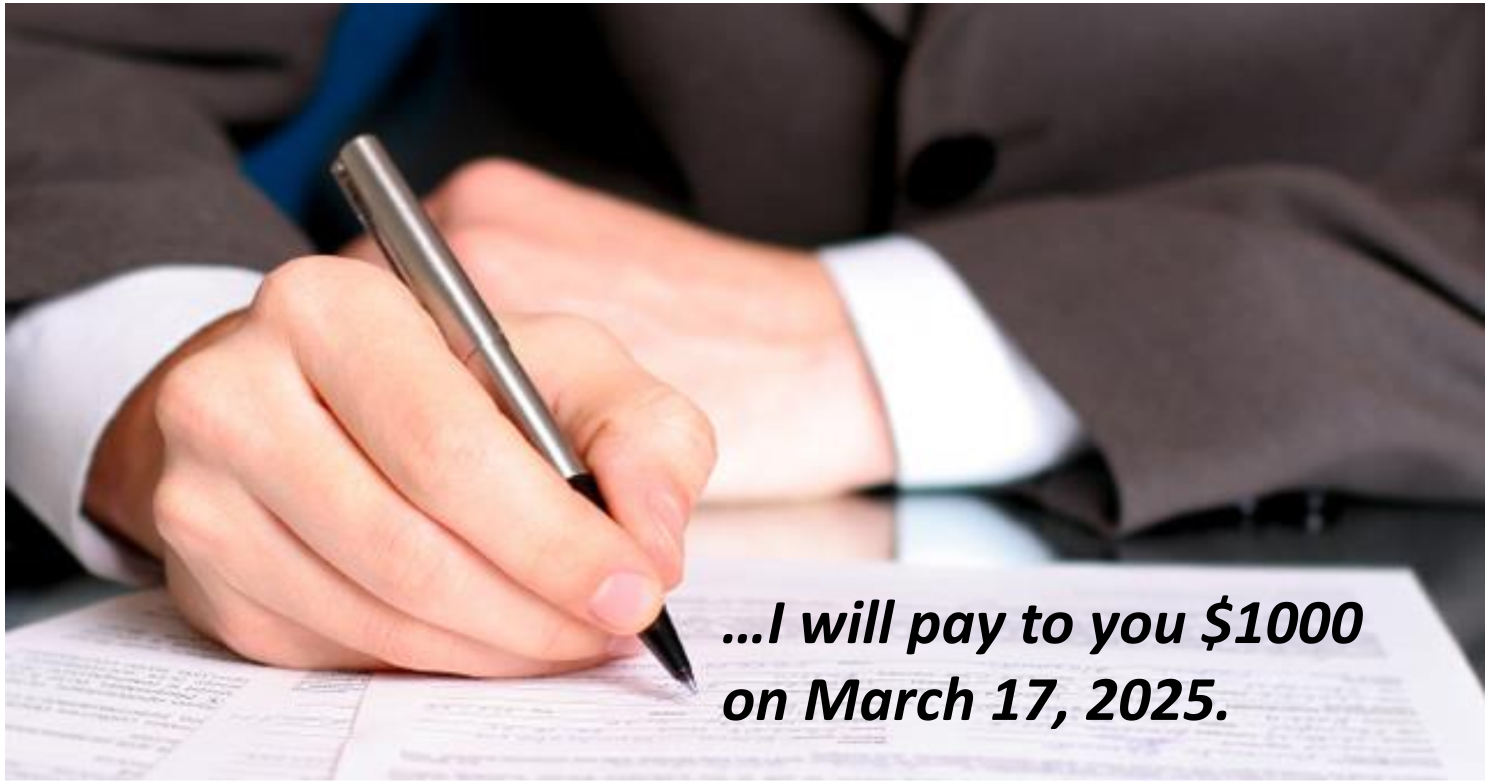
(***efficient market hypothesis***)

"There are (almost) no arbitrage opportunities"

- This principle holds very approximately, and it allows us to price various instruments

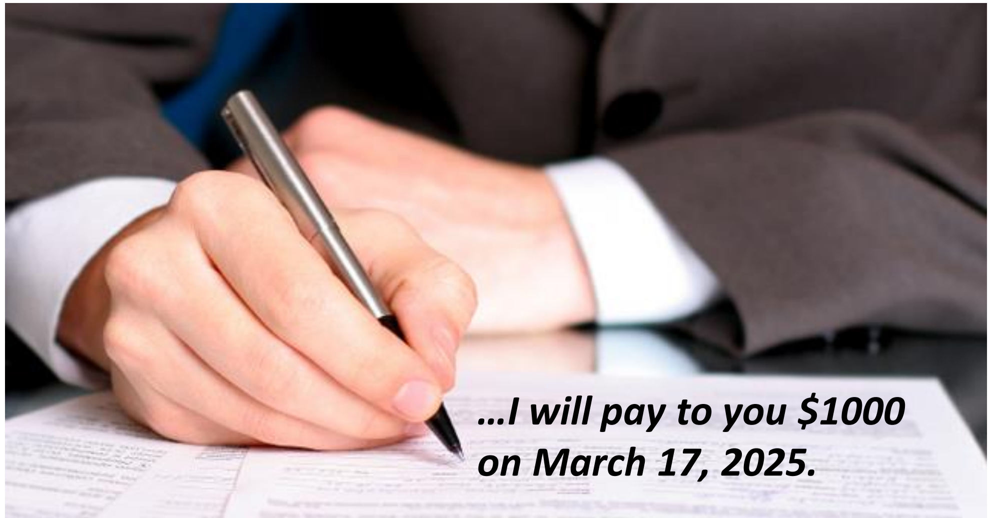
Example 3.1 :

INSTRUMENT 1.: **Individual cash flow** paid in the future (model for a **bond** without a coupon)



Q: How much would you pay for this piece of paper?

Individual cash flow paid in the future (model for a **bond** without a coupon)



$$PV = \frac{FV}{(1+i)^n}$$

PV- present value
FV-future value

Riskless interst rate: 3%

Bond price P:

$$P = \frac{M}{(1+i)^N}$$

M- face value ($1000)

Today's value of The cash flow: **$ 737**

This must be the price, otherwise (for a higher or lower price) there is an arbitrage opportunity.

Example 3.2 : **What would you rather have?**

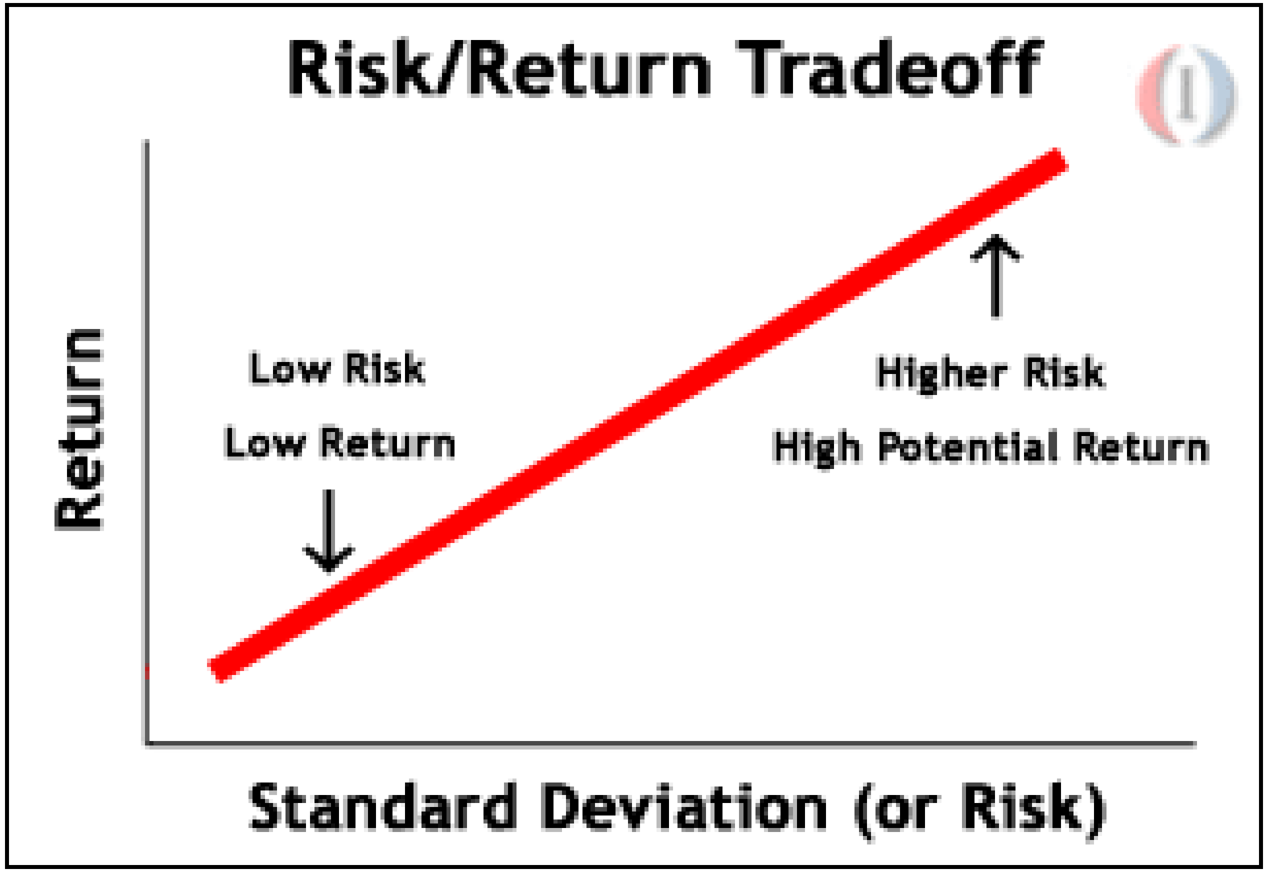
A) 400 dollars

B) A ticket for the following game: You roll a dice once, if the result is greater than 3, you receive $800, otherwise you win $0.

C) A ticket for the following game: You roll a dice once, and you get [the number of points on the dice] * $100.
If you are not satisfied with your roll, you have a right to decline the prize and roll one more (last) time.

We've just learnt about the ***risk aversion***.

-Is there any risk that I will not get my money?
-Or a risk to not get the *expected* value?



If the risk is higher, an investor will buy the instrument only if its ***expected profit*** is significantly above the risk-free interest rate.

Stocks: typically around 7% yearly.

Example 3.3 : ***Assume there exists a stock the expected return of which is only 3%? Risk-free interest rate is also 3%.***

Assume today's value $1000.

March 17, 2016. expected value: $1030

Would anyone want to buy this stock?

Would the trading of this stock stop?

What would happen?

Example 3.3 : Stock (model)

A stock pays dividends D_i periodically,

$$V_0 = \frac{D_1}{1+k} + \frac{D_2}{(1+k)^2} + \frac{D_3}{(1+k)^3} + \frac{D_4}{(1+k)^4} + \cdots$$

$$V_0 = \textit{stock value},\quad D_1 = \textit{dividend yr 1},\quad D_2 = \textit{yr 2} \ldots,$$

$$k = \textit{require return}$$

The “required return” k is significantly higher then the riskless rate

Options

- **Call option (European):**

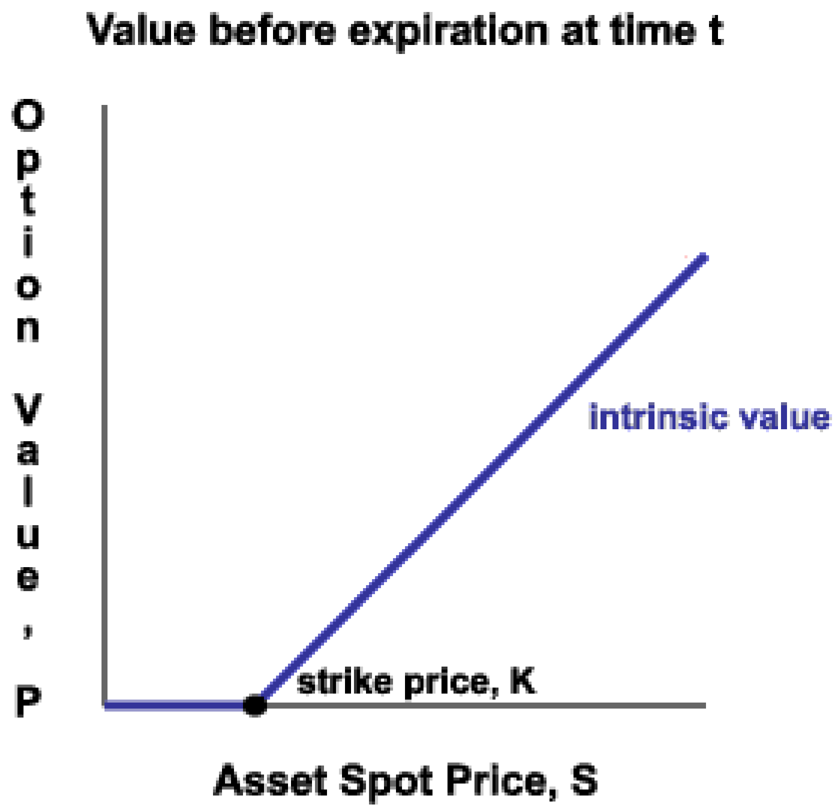
-Tied to a specific asset, for example a stock.

K- “strike price”

S- stock value

T-time to maturity

The option gives the owner the ***right*** to buy the stock for price K at some specified time T. The owner does not need to execute this right.



Options

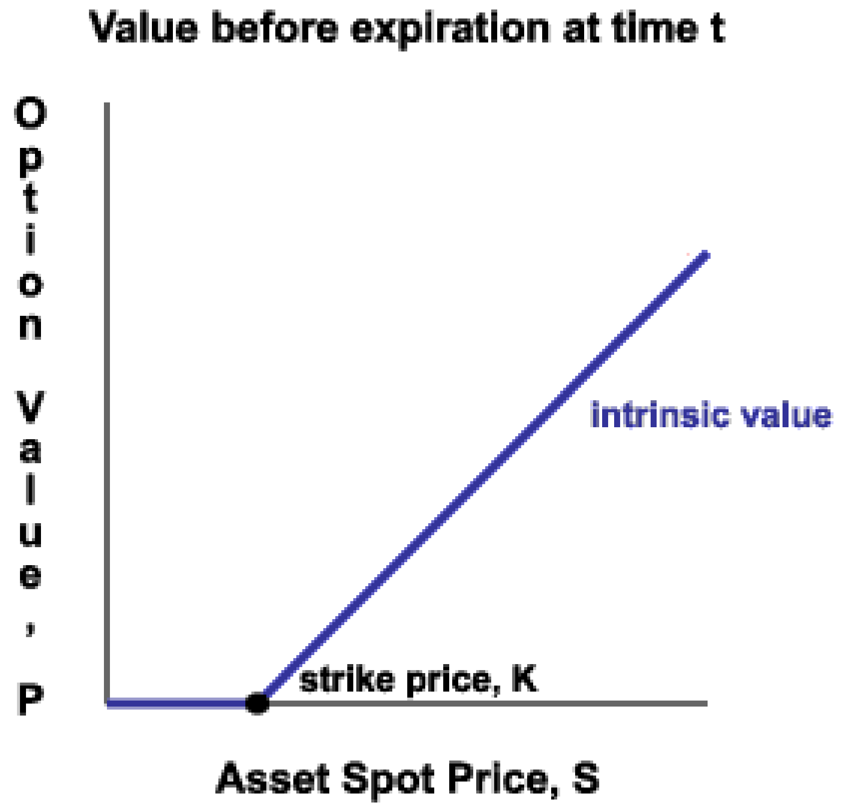
- **Call option (European):**

Payoff **at maturity**

(a European option can only be exercised at the maturity):

If S>K, then this option provides a profit of S-K dollars.

If S<=K, the option is worth 0.

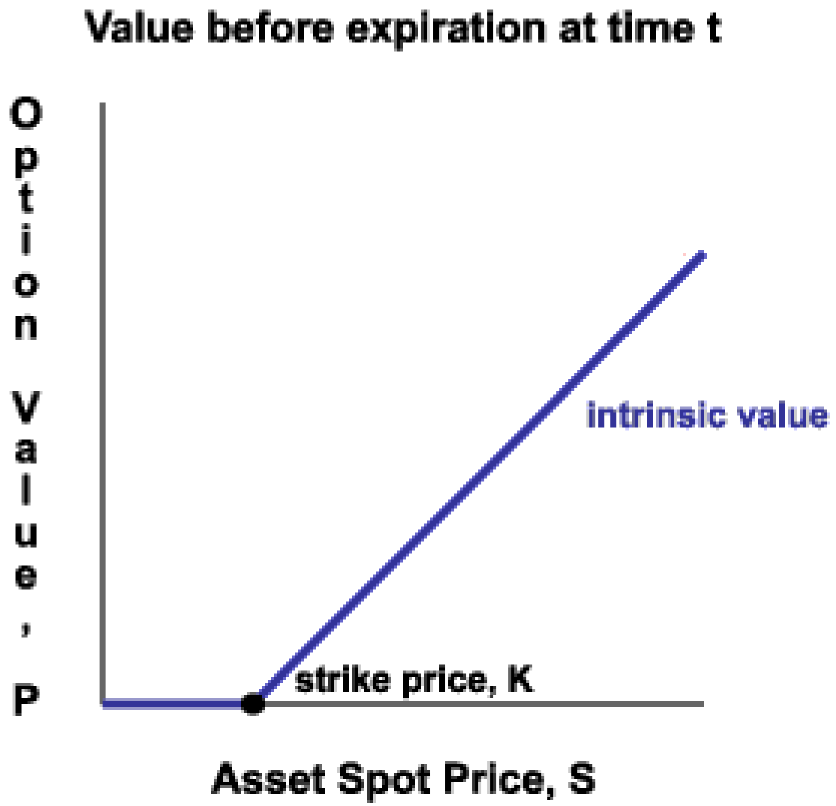


Example 3.4
European call option

Today is March 17, 2015.
The price of Apple stock is **S=$127**.

Data table:
Sep 21, 2012: Apple stock price was $100.
Jul 5, 2013: Apple stock price was $60.
Today's price: $127

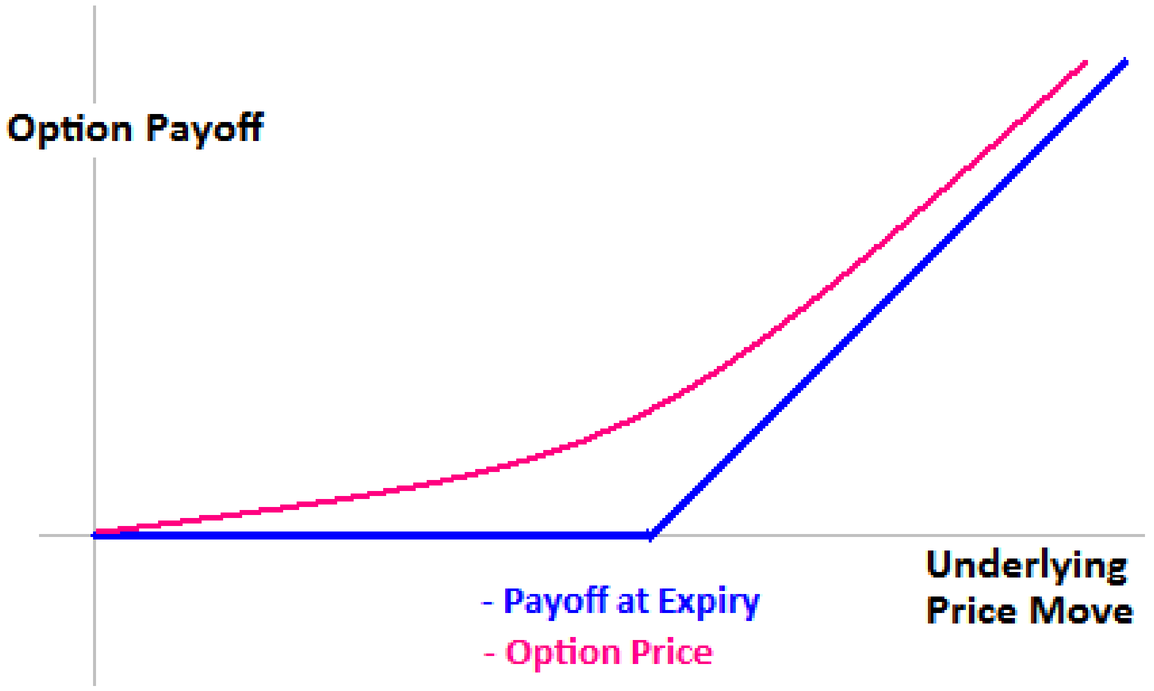
-There is an option on the Apple stock, that gives you the right to buy the Apple stock for **K=$140** on March 17, 2016.



- Obviously S<K. Is this option worth $0?
- Give your *personal estimate*, how much would you be willing to pay for this option?
- How do investment banks determine the price of such an instrument?

(we are going to talk about this next time)

Current (spot) price of European call (if the stock does not pay dividends) is higher then its intrinsic value.



Options

- **Put option (European):**

-Tied to a specific asset, for example a stock.

K- “strike price”

S- stock value

T-time to maturity

The option gives the owner the ***right*** to SELL the stock for price K at some specified time T.

The owner does not need to execute this right.