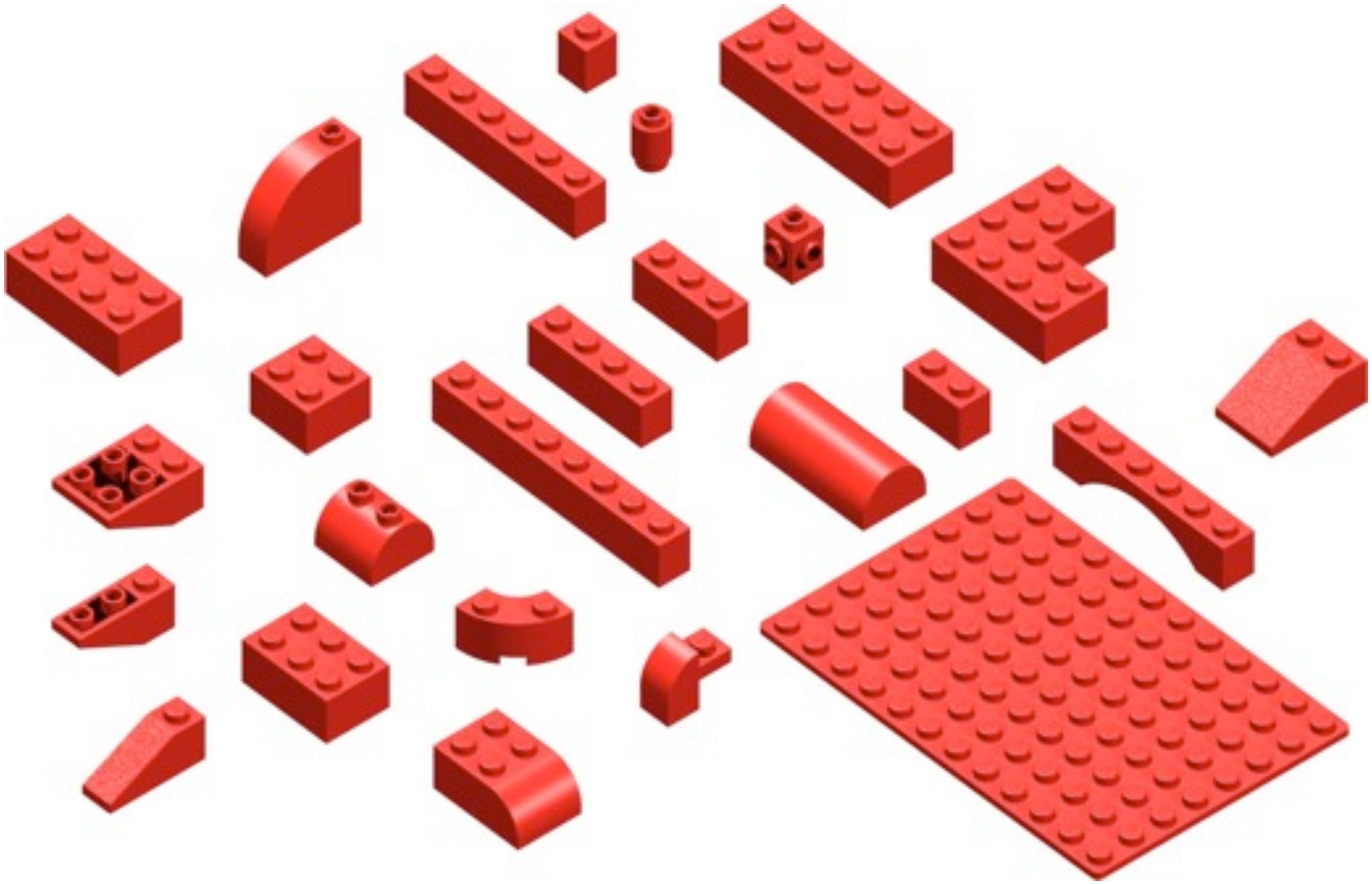
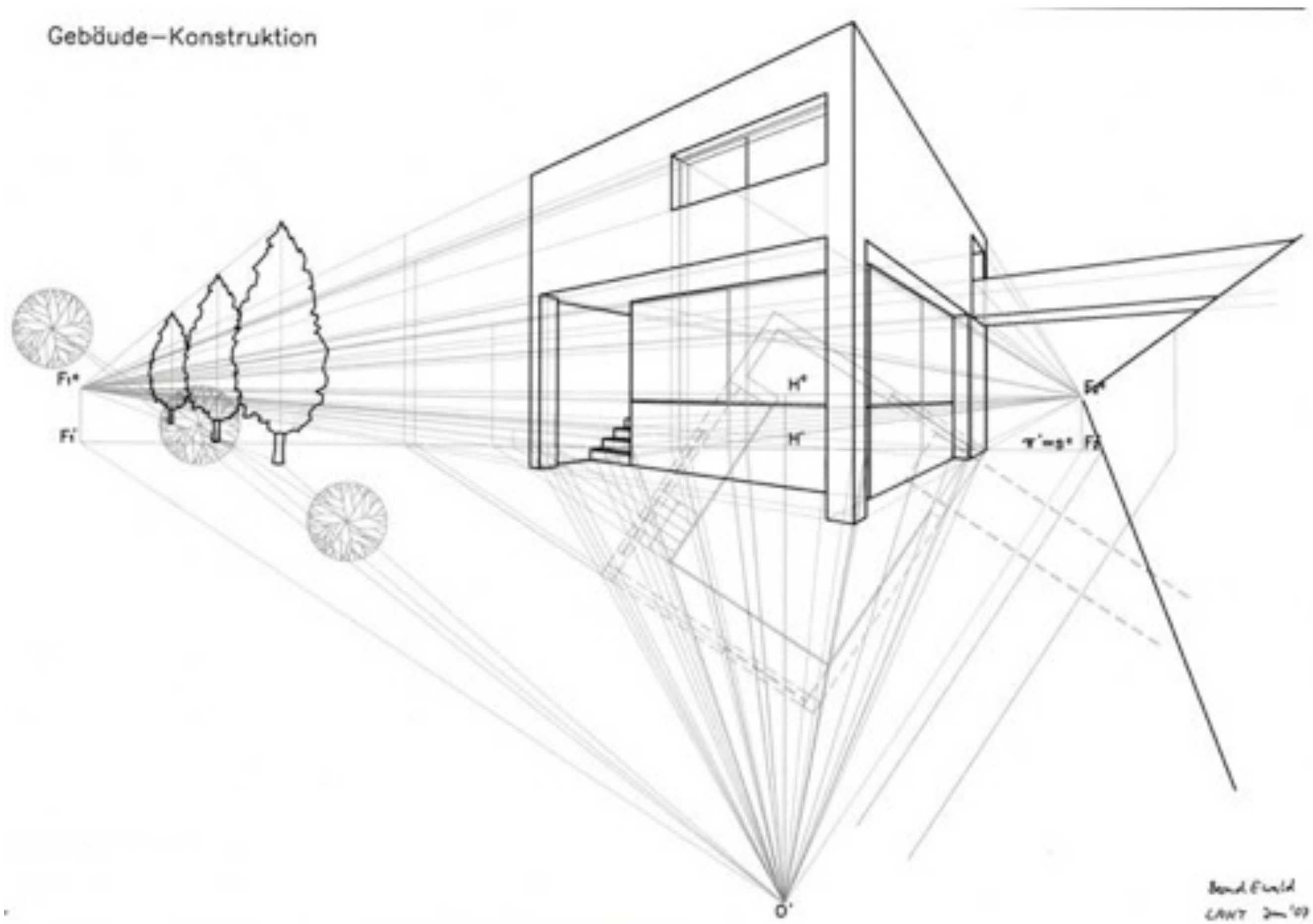
Commodity Trading Derivatives

18.4.2011

A Trading Lecture does not look like a set of components with a



… but rather like a set of perspectives to a single object.



Repetition Risk Categories

- Operational Risks
- Market Risk
- Credit Risk
- Reputational Risk

Derivatives (Definition)

- Definition: Trading instrument which relates on an observable underlying – often a tradable instrument itself (exception: e.g. weather derivatives). Derivatives are legally contracts of two parties.

- Purpose: ?

Purpose to trade derivatives

- Standardization ➔ Liquidity, costs
- Taylor made ➔ induvidual purpose
- Asymmetric Payout (Option)
- Risk Mitigation, Hedging
- Leverage, low cost of transfer
- Tax optimization
- …

Reputation of Derivatives

- „Derivatives are the weapons of mass destruction of the financial industry“ (Warren Buffett)
- Warren Buffett earned billions with structured derivatives in Swiss Re and Goldman Sachs

Categories of Derivatives

Types

- Forwards
- Futures
- Swaps
- Options,
  plain vanilla,
  Knock outs/ ins
  exotic
- Structured Products/ Combinations

Underlyings:

- Commodities
- FX
- Equities
- Interest Rates
- Credit Spreads

Legal Forms:

- Exchange Traded
- Over the Counter
- Prearranged Exchange Traded

- How large is the gross outstanding notional amount of derivatives (end 2008) in comparison with world GDP?

- How large is the net outstanding notional amount of derivatives (end 2008) in comparison with world GDP?

- Which is the most popular underlying?

Total outstanding derivatives (end 2008, BIS): $683‘000‘000‘000‘000 =

Forward

- Trade between a buyer and a seller where delivery and payments to predefined conditions take place in some defined time in the future, not necessarily simultaneously.
- If in the period till delivery/ payment market price move, one party profits, the other losses.
- The party which profits run then a **credit risk**, since it can never be sure, whether the losing party is able to honor the

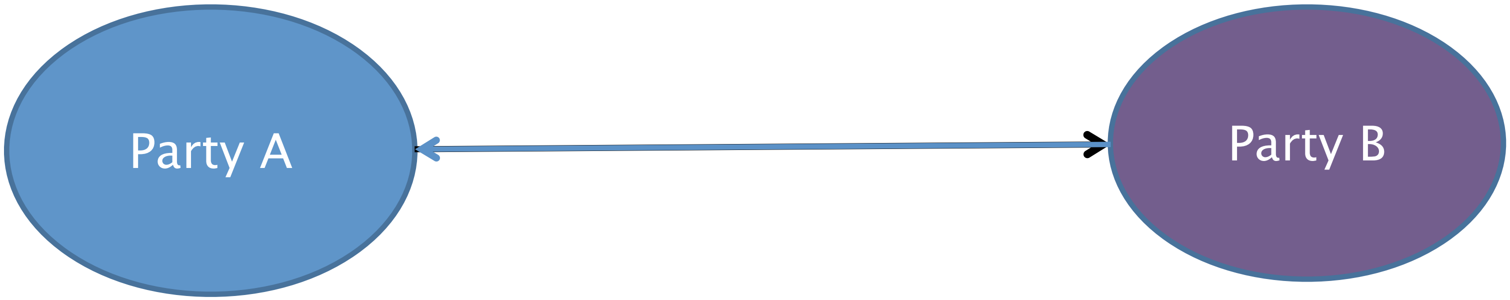
Swaps

- Interest Rate Swaps
- Currency Swaps
- Total Return Swaps

- Universal Concept based on observables

Example Interest Rate Swap

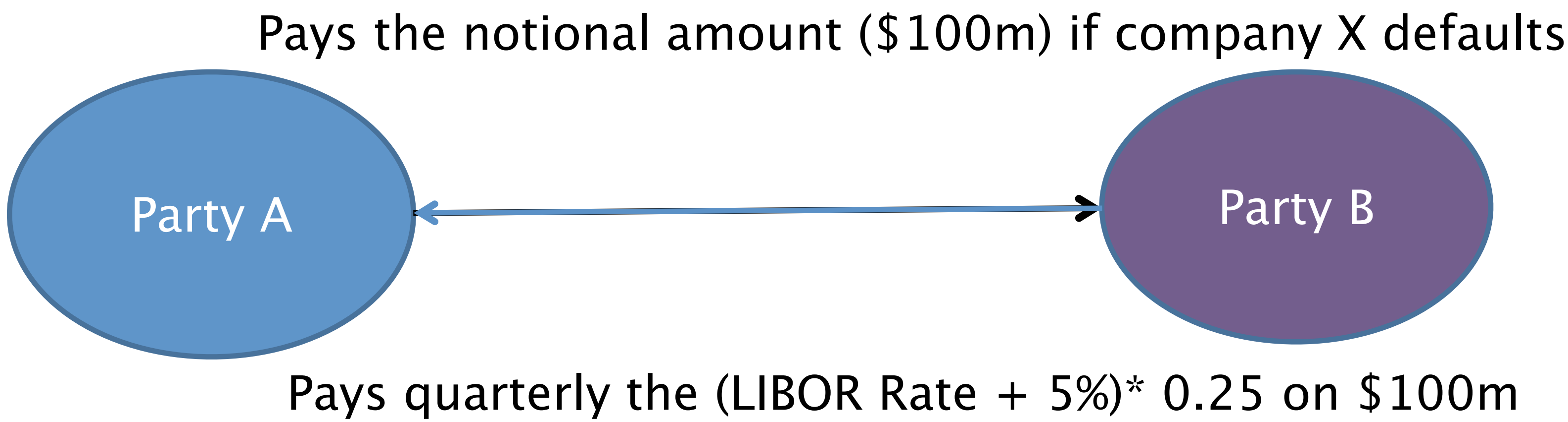
Pays annually 4% of notional $100m



Pays quarterly the LIBOR Rate * 0.25 on $100m

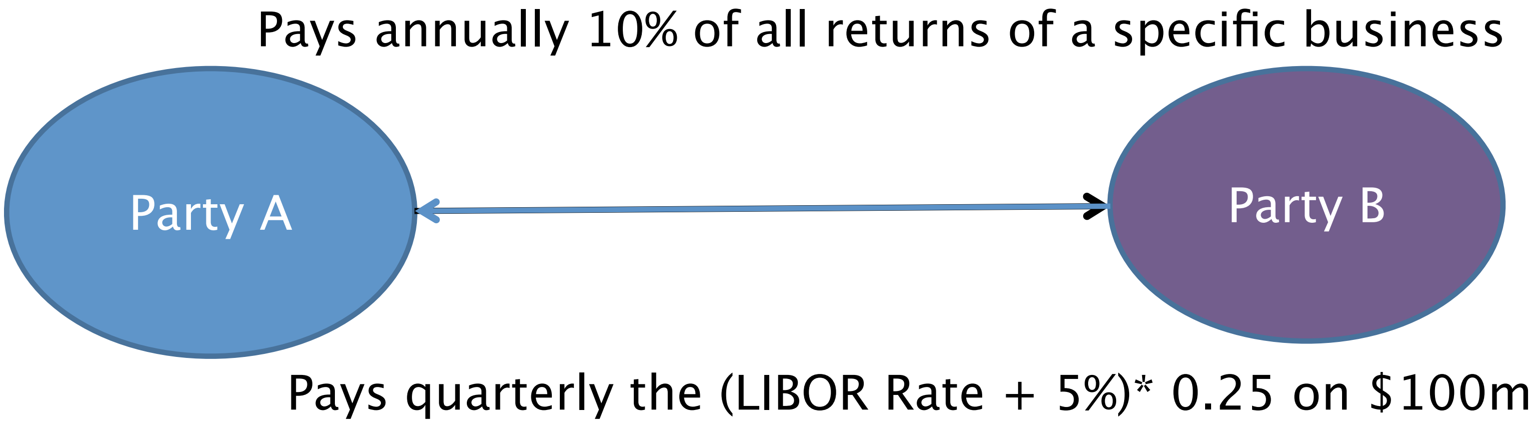
Only Interest Rates are exchanged

Example Credit Swap



Party B can unload ist exposure to X, Party A becomes a secret creditor of X

Example Total Return Swap



Only beneficary ownership!

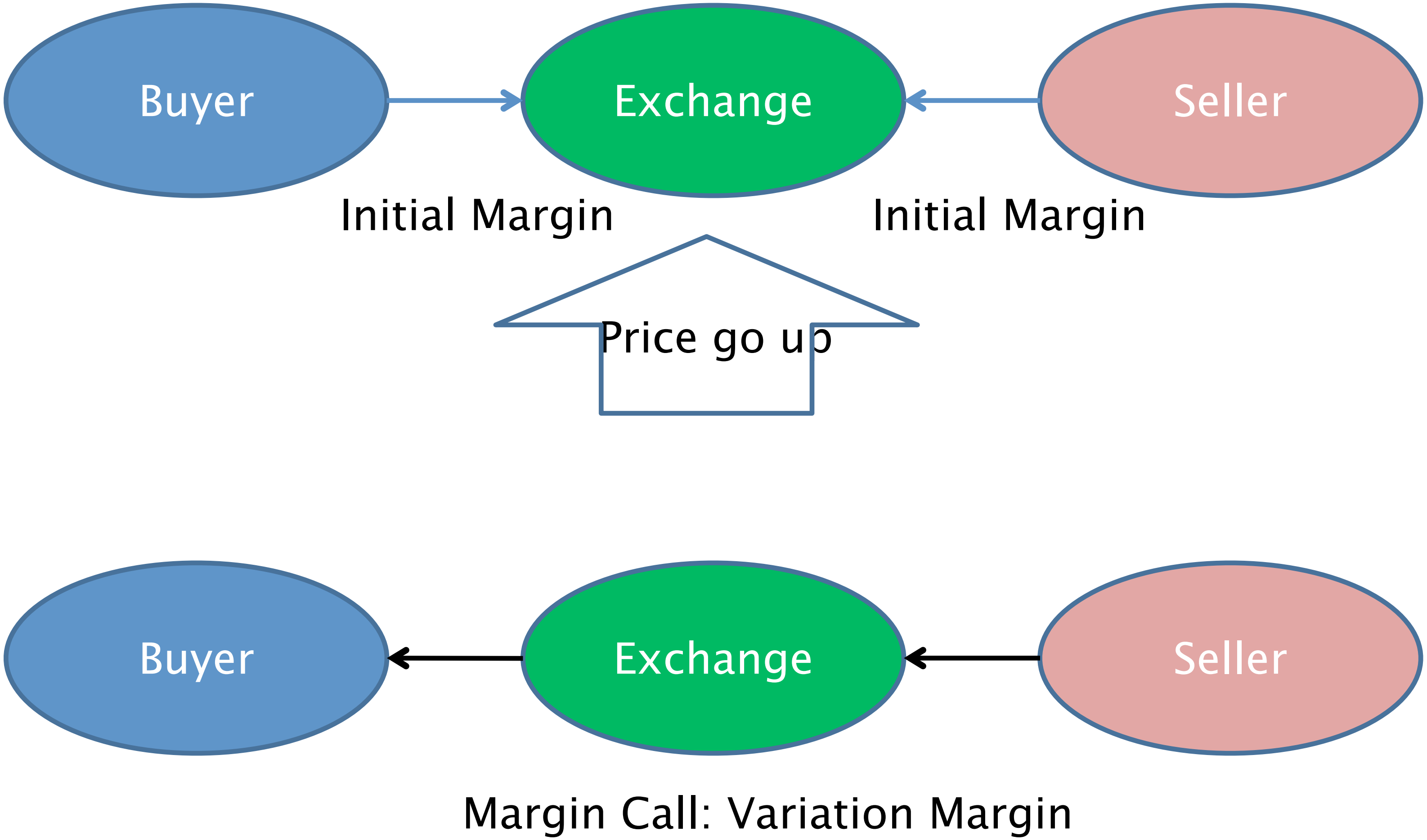
Swaps

- A truly bilateral contract
- During the lifetime valued by both parties separately. If one party want to leave, a common price will be evaluated
- Flexible
- Exchange of Market Risk with Credit Risk

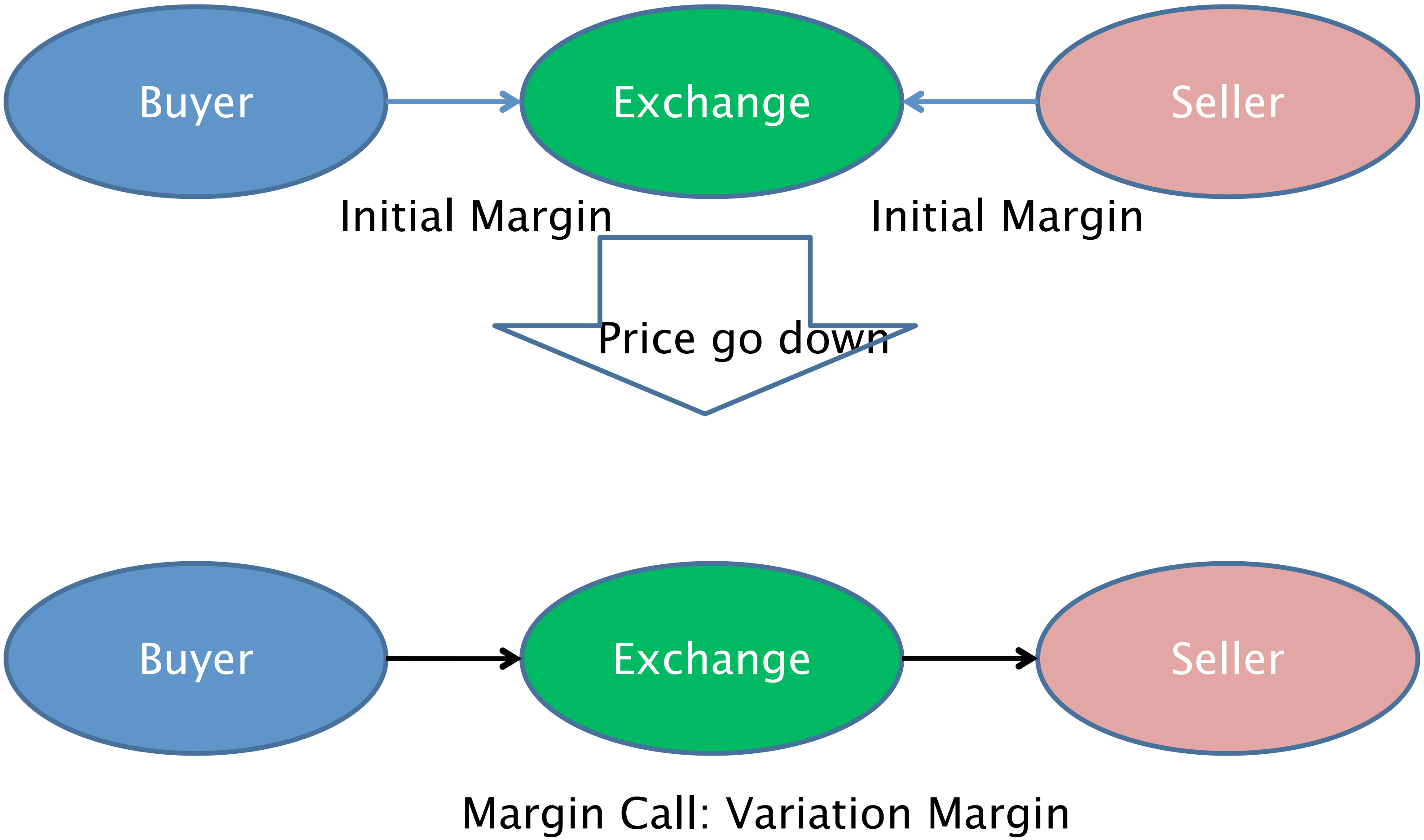
Futures

- Most traded derivatives
- Only the exchanges
- Minimizes Credit Risks through daily (sometimes intraday!) margining
- Full Transparency

Scheme (I)


Buyer
Exchange
Seller
Initial Margin
Initial Margin
Price go up
Buyer
Exchange
Seller
Margin Call: Variation Margin

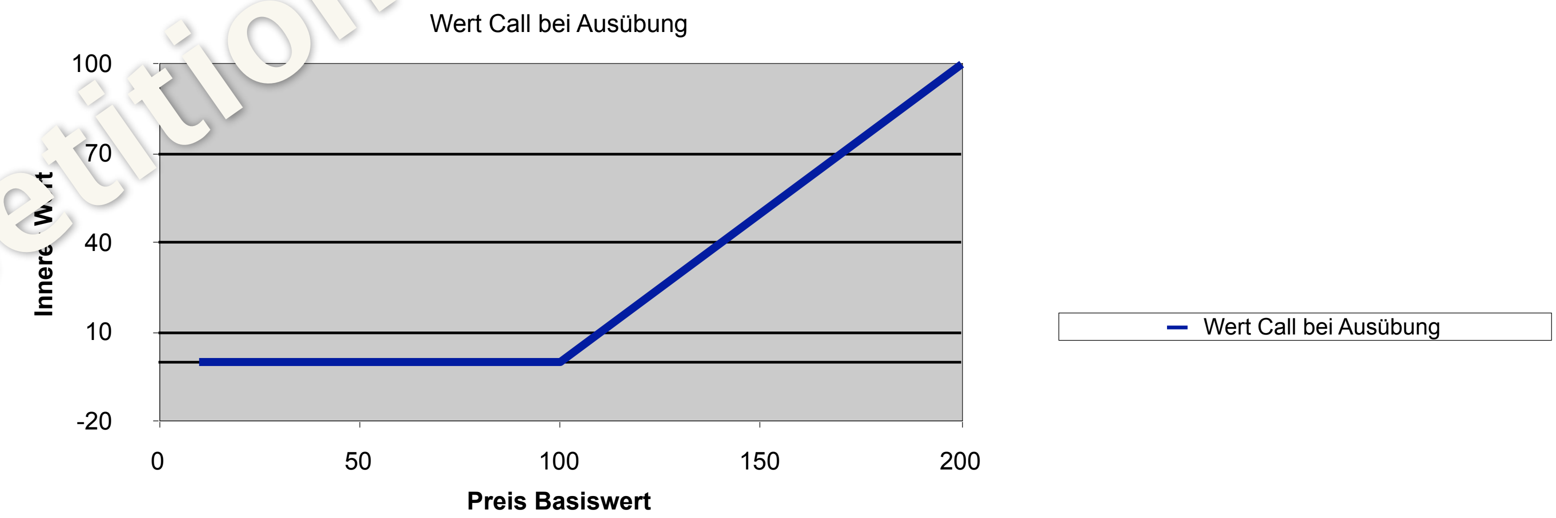
Scheme (II)



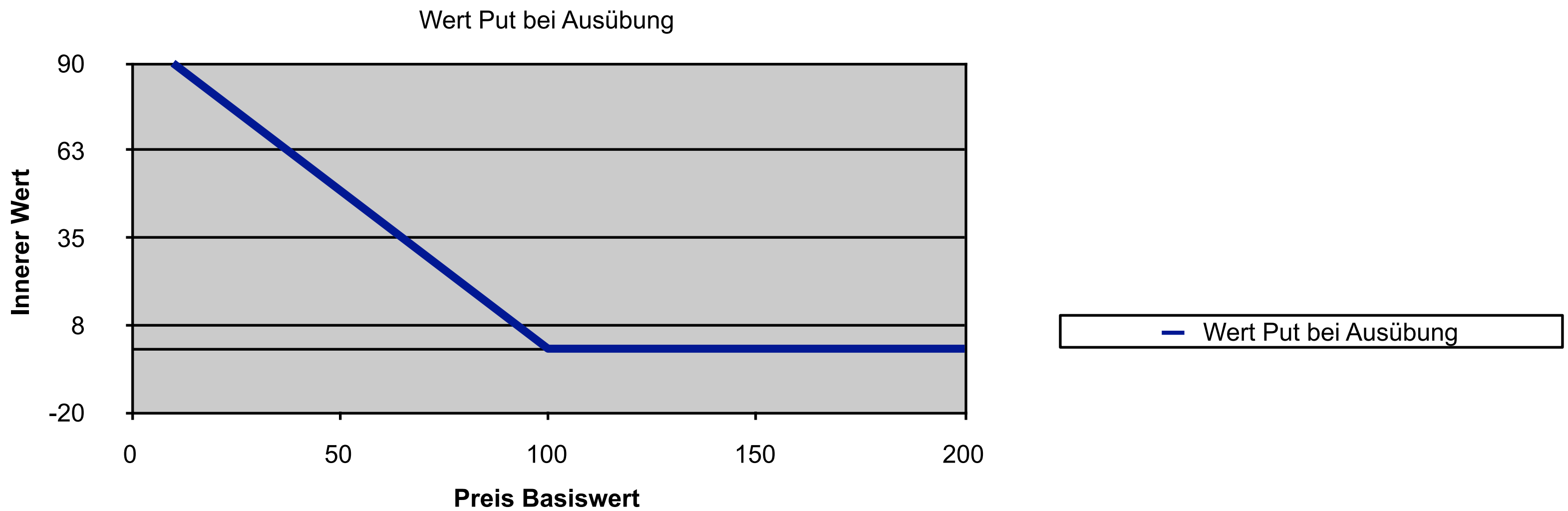
Buyer
Exchange
Seller
Initial Margin
Initial Margin
Price go down
Buyer
Exchange
Seller
Margin Call: Variation Margin

Plain Vanilla Option

- A Call is the right to BUY the underlying instrument at the expiration date at the STRIKE price. The value at expiration is the greater of (price of the underlying the that date minus strike price) and zero
- A Put is the right to SELL the underlying instrument at the expiration date at the STRIKE price. The value at expiration is the greater of (strike price minus price of the underlying the that date) and zero



Wert Call bei Ausübung
100
70
40
10
-20
Innerer Wert
0
50
100
150
200
Preis Basiswert
Wert Call bei Ausübung



Wert Put bei Ausübung
90
63
35
8
-20
Innerer Wert
0
50
100
150
200
Preis Basiswert
Wert Put bei Ausübung

Probabilistic Approach

- What is the value of call strike 3 on a dice, one roll?

➔ Know Probability Distribution!

Probabilistic Approach

- Sum of all payout multiplied by there probability over all events:

  0*1/6 + 0*1/6 + 0*1/6 + 1*1/6 + 2*1/6 + 3*1/6

Arbitrage Free Approach

- Situation A: An Asset will be worth either 20% more or 10% less, tomorrow
- Situation B: An Asset will be worth either 10% more or 40% less, tomorrow
- Which Call at-the-money (Strike today's price) is more valuable?

- Idea from Didier Cossin, IMD

Pricing the Calls

- Assumption: one can buy or sell both underlyings and call freely and without fees or interest rate (the later make no substantial difference). Assume Price underlying 100.
- Suppose the price at the current market is very low, buy 1000 calls and sell Δ * 1000 underlyings, such that in both cases you receive the <u>same profit</u>.
- If you manage to do so, you can make a sure profit as long the price is too low.

Case A

- Price Underlying 100, Price Call C
- Buy 1000 Calls – pay 1000*C
- sell Δ * 1000 underlyings – receive Δ * 100’000
- Upper Case Profit=1000*(20–C)–Δ*20’000
- Lower Case Profit=1000*(–C) + Δ*10’000

Case B

- Price Underlying 100, Price Call C
- Buy 1000 Calls - pay 1000*C
- sell Δ * 1000 underlyings - receive Δ * 100'000
- Upper Case Profit=1000*(10-C)-Δ*10'000
- Lower Case Profit=1000*(-C) + Δ*40'000

General Case

- Price Underlying 100 can be either X up (100+X) or Y down (100–Y), Price Call C
- Buy 1000 Calls – pay 1000*C
- sell Δ * 1000 underlyings – receive Δ * 100’000
- Upper Case Profit=1000*(X–C)– Δ*X*1000
- Lower Case Profit=1000*(–C) + Δ*Y*1000
- Equal if $\Delta = X/(X+Y)$

Discussion (I)

- Option prices Volatility not expectation!

  (TAI????)

- Independent of probabilistic view? Check X>0 and Y<0. ➔

  Case B: The fact that the current price is much closer to the upper case than to the lower case implies that the

Discussion (II)

- Probabilistic View p:= probability that price increases (upper case) / 1-p:= probability that price decreases (lower case)
- Case A: $p*120 + (1-p)*90 = 100$
  ➔ $p = 1/3$; $1-p= 2/3$
- Case B: $p*110 + (1-p)*60 = 100$
  ➔ $p = 4/5$; $1-p= 1/5$

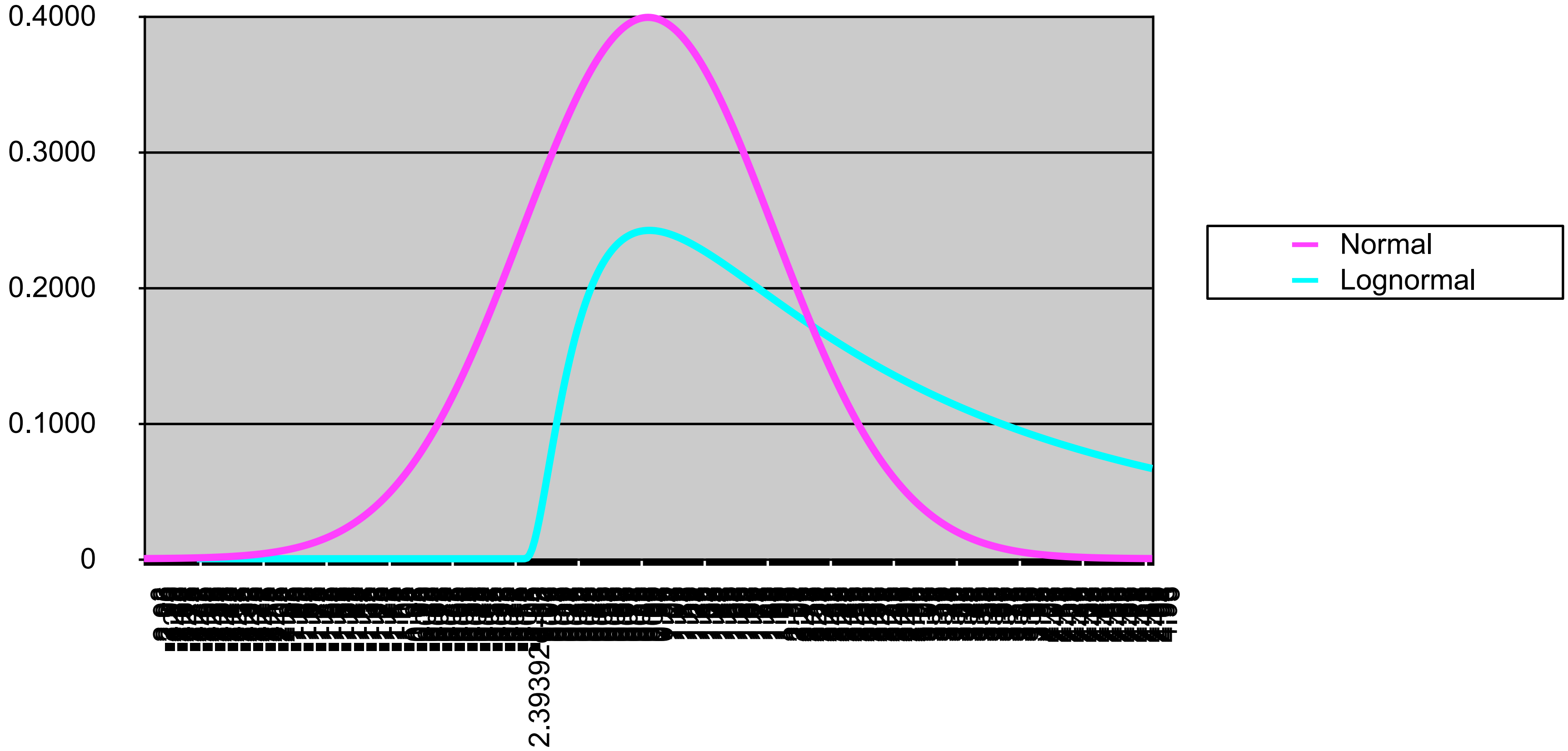
Probability = Model for

- Randomness ⇔Uncertainty
- Few thing are truly random, lots of influence are not detectable in reasonable time

Conclusion on Options

- Often used for leverage
- Volatility is the main element in Options
- There are arbitrage among options, Buy call, sell put replaces forward buying
- Arbitrage free price is equivalent probilistic pricing

Most Models are based on lognormal probability



Black Scholes Formula

$C = S * \mathrm{erf}(d_1) - K * e^{-rt} * \mathrm{erf}(d_1 - \sigma \sqrt{t})$

Where $d_1 \quad = \quad (\ln(S/(K^* e^{-rt)}) + 0.5 * t * \sigma^2) / \sigma \sqrt{t}$

C: Price Call

S: Forward Price Underlying

K: Strike

$K * e^{-rt}$: today‘s price of Strike

t: time to expiration

σ: implied volatility

Δ = Hedge Ratio

$\Delta =$ erf (d_1)

whereas $d_1 = (\ln(S/(K^* \, e^{-rt)}) + 0.5 \, {}^*t^*\sigma^2) \,/\, \sigma \sqrt{t}$

Price Call / Delta vs. Preis Underlying