Risk Modelling

Overview

2014

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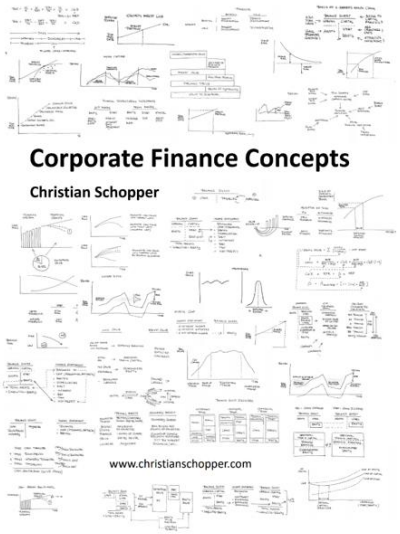

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Forward Rate Agreements

- A forward rate agreement is an off balance sheet instrument to make a settlement in the future
- In effect, you agree to pay or receive at a future date the difference between the agreed interest rate and the rate prevailing on the settlement date

Scenario

- A company wants to '**lock in' an interest rate of 12.5%** for three months' time and requests its bank to write an FRA agreement
- **On** the **settlement date**, interest rates have **fallen to 11.5%**

Start Date	1-Jun-01
Finish Date	1-Sep-01
Contract Rate	12,50%
Market Rate	11,50%
Contract Amount	1.000.000

Result

- Therefore the **client makes up the difference** on the contract
  - This is an indication of the cash flows on settlement
- Since, the eventual rate is below the contract rate, the **client pays** the settlement amount
- If the eventual rate were above the contract rate, then the client would receive the difference

The variables are:

- start date
- finish maturity date
- contract rate
- market rate
- contract amount.

The formula for calculating the settlement amount is:

$$Settlement_Amount = \frac{(L - f) * {}^{n}/Year * Contract_Amount}{1 + (L * {}^{n}/Year)}$$

where:

F = forward rate agreement amount
L = interest rate (LIBOR) current at the beginning of the period
N = number of days in the contract period
$Year$ = number of days in year.

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Forward Rate Agreements (cont´d)

Settlement Position

		Annual	183 days
Receive (+)	LIBOR under FRA	12,50%	6,27%
	Fixed FRA rate under FRA	-	
	Borrower		
Pay (-)	LIBOR to cash lender	(12,50%)	(6,27%)
	Fixed FRA rate under FRA	(1,00%)	(0,50%)
Net Position		**(1,00%)**	**(0,50%)**

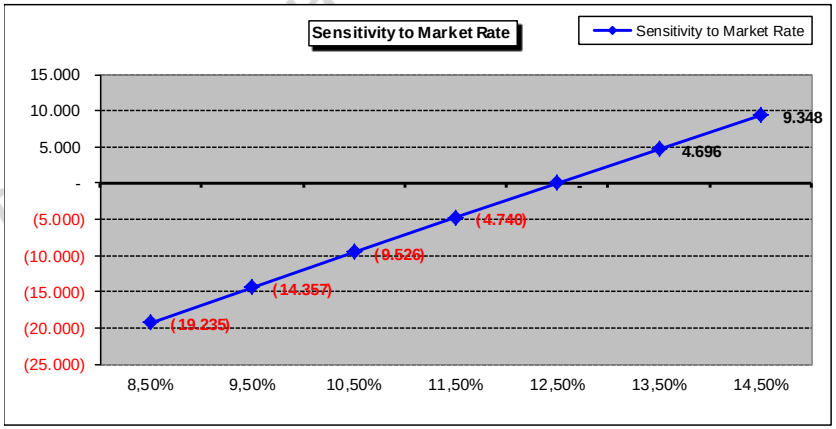
Inputs	
Start Date	**1-Jun-01**
Finish Date	**1-Dez-01**
Contract Rate	**12,50%**
Market Rate	**11,50%**
Contract Amount	**1.000.000**

Management Summary	
Days	**183 days**
Days in current year	**365 days**
Settlement	**(4.740,38)**
Payable	**Paid by Client**
Percentage	**(0,47%)**
Difference in rates	**(1,00%)**

Sensitivity to Market Rate

Units $0

Market Rate Interval	**1,00%**				**Slope: Change per 1%**		**4.763,60**
	8,50%	9,50%	10,50%	**11,50%**	12,50%	13,50%	14,50%
(4.740,38)	(19.235,06)	(14.357,26)	(9.525,92)	**(4.740,38)**	-	4.695,86	9.347,82
	Client	Client	Client	Client	Bank	Bank	Bank



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Forward Rate Agreements (cont´d) - Examples

Forward Rates	
Inputs	
Start Date	1-Jul-14
Finish Date	1-Sep-14
Contract Rate	15,00%
Market Rate	17,00%
Contract Amount	3.000.000

Forward Rates	
Inputs	
Start Date	1-Jul-14
Finish Date	1-Sep-14
Contract Rate	15,00%
Market Rate	14,00%
Contract Amount	3.000.000

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Forward Rate Agreements (cont´d) - Examples

Forward Rates | Menu

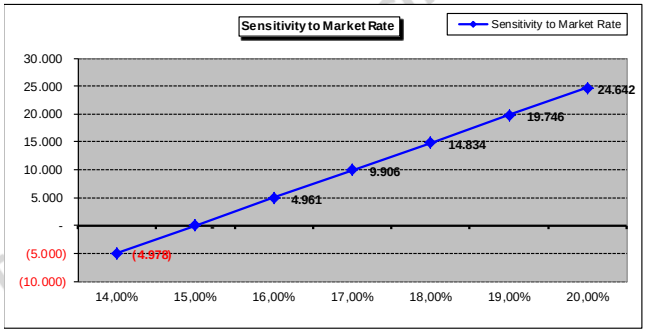
v1.0 1-Jan-2001

Inputs	
Start Date	1-Jul-14
Finish Date	1-Sep-14
Contract Rate	15,00%
Market Rate	17,00%
Contract Amount	3.000.000

Management Summary	
Days	62 days
Days in current year	365 days
Settlement	9.905,74
Payable	Paid by Bank
Percentage	0,33%
Difference in rates	2,00%

Sensitivity to Market Rate — Units $0

Market Rate Interval	1,00%				Slope: Change per 1%		4.936,61
	14,00%	15,00%	16,00%	17,00%	18,00%	19,00%	20,00%
9.905,74	(4.977,52)	-	4.961,06	9.905,74	14.834,11	19.746,27	24.642,29
	Client	Bank	Bank	Bank	Bank	Bank	Bank



Forward Rates | Menu

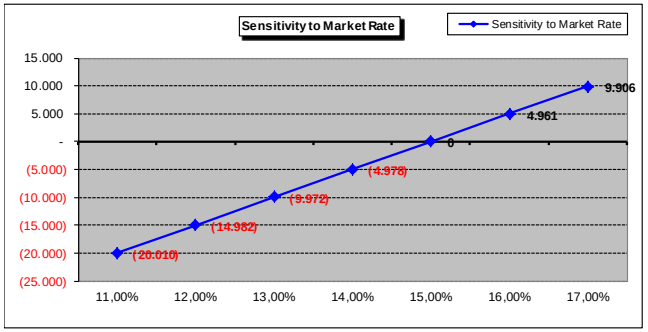
v1.0 1-Jan-2001

Inputs	
Start Date	1-Jul-14
Finish Date	1-Sep-14
Contract Rate	15,00%
Market Rate	14,00%
Contract Amount	3.000.000

Management Summary	
Days	62 days
Days in current year	365 days
Settlement	(4.977,52)
Payable	Paid by Client
Percentage	(0,17%)
Difference in rates	(1,00%)

Sensitivity to Market Rate — Units $0

Market Rate Interval	1,00%				Slope: Change per 1%		4.985,88
	11,00%	12,00%	13,00%	14,00%	15,00%	16,00%	17,00%
(4.977,52)	(20.009,68)	(14.982,28)	(9.971,59)	(4.977,52)	0,00	4.961,06	9.905,74
	Client	Client	Client	Client	Bank	Bank	Bank



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Swaps

- As an alternative to a forward rate agreement a swap could be used to fix interest
- In essence, a swap is an agreement between two parties to exchange interest rates and can include interest rates and more than one currency
- While an FRA allows you to fix specific periods, swaps allow more flexibility over longer periods and can reduce the cost of borrowing for both parties.

- A swap involves no payment or exchange of principal: only the interest is exchanged. This is netted off rather than transferred gross

- There are often discrepancies in the pricing of different funding methods or pricing in different geographic markets, which can be shared by setting up a swap arrangement between the parties

Agreed Swap Rate	5,500%

	Fixed	Variable
AA	7,000%	2,000%
BB	8,750%	3,000%

Scenario

- Company **AA** can borrow at a **fixed rate of 7% <u>or</u> at base plus 2%**
- Company **BB** can borrow **fixed at 8.75% <u>or</u> at base plus 3%**
- **Discrepancy** of fixed 1.75% and variable 1% could be **shared** between the parties

- Hence, in this example, there is **0.75%** difference between the rates

Swap rate is the **fixed rate that receiver demands** in exchange for the uncertainty of having **to pay** the short-term (LIBOR / EURIBOR) **floating rate** over time

- At any given time, the market's forecast of what LIBOR will be in the future is reflected in the forward LIBOR curve
- At the time of the swap agreement, the total value of the swap's fixed rate flows will be equal to the value of **expected floating rate payments implied by the forward LIBOR curve**
- As forward expectations for LIBOR change, so will the fixed rate that investors demand to enter into new swaps
- Swaps are typically quoted in this **fixed rate**, or **alternatively** in the "**swap spread**," which is the difference between the swap rate and the U.S. Treasury bond yield (or equivalent local government bond yield for non-U.S. swaps) for the same maturity

- In most emerging markets with underdeveloped government bond markets, the swap curve is more complete than the treasury yield curve and is thus used as the benchmark curve

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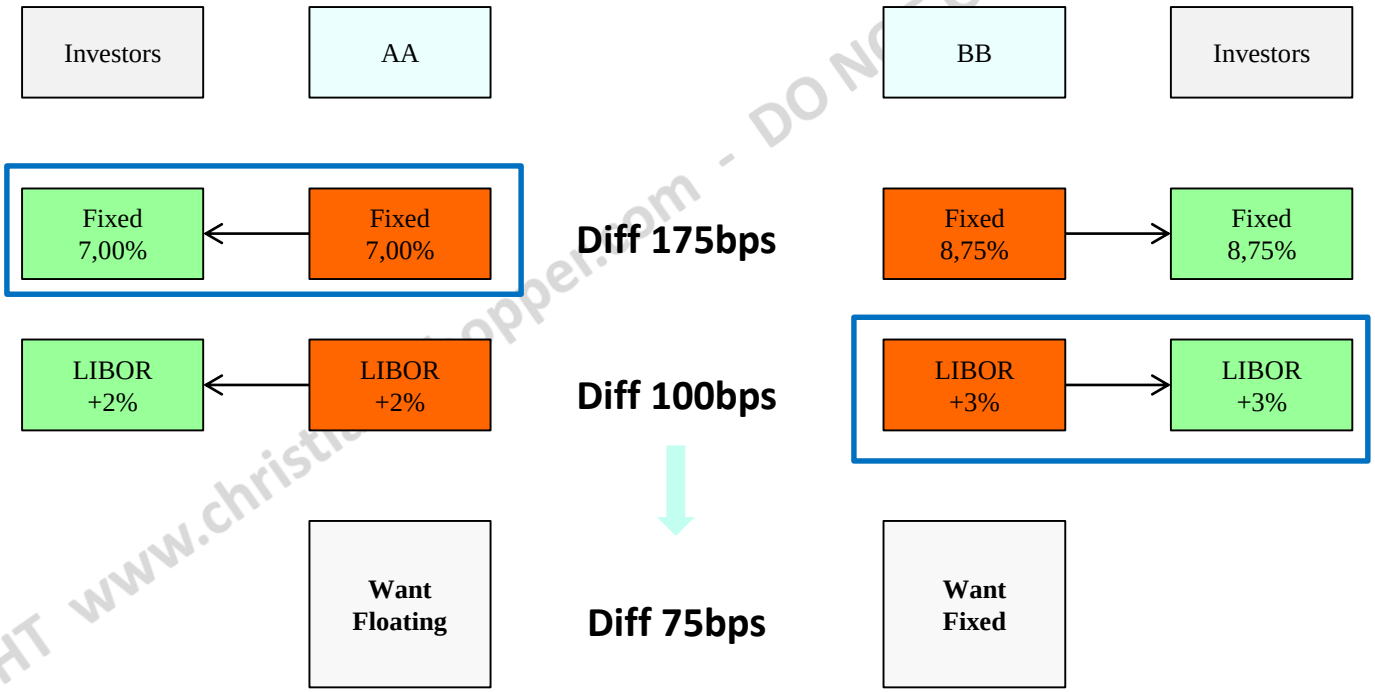
Swaps (cont´d)



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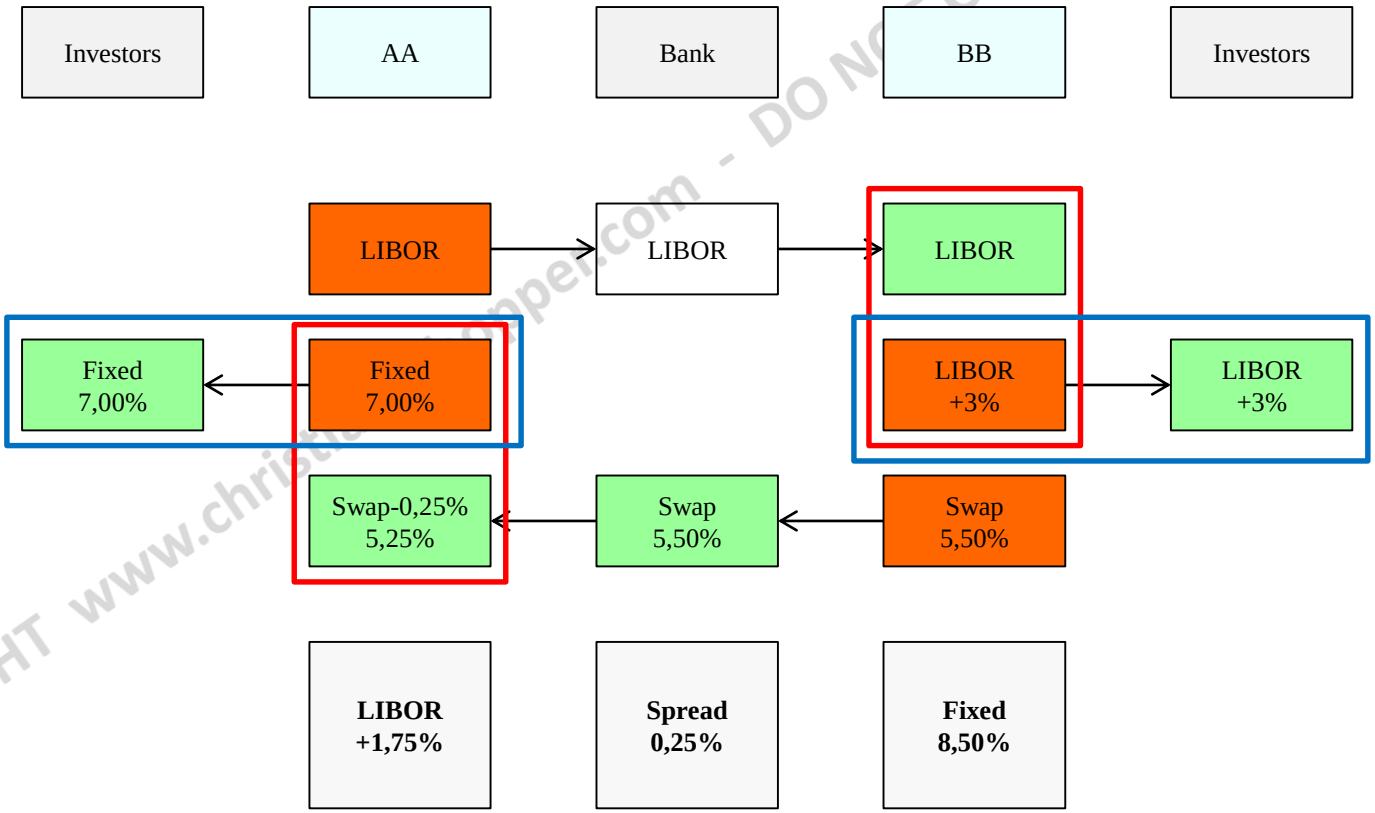

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Swaps (cont´d)

Agreed Swap Rate	5,500%

	Fixed	Variable
AA	7,000%	2,000%
BB	8,750%	3,000%
Variance on risk premiums	1,750%	1,000%
Total Benefit to be Shared	0,750%	
Benefit Split	0,250%	0,250%
Bank Margin	0,250%	

Scenario (cont´d)

- Company **AA** may **prefer** the **floating** rate and Company **BB** the **fixed** rate
- By sharing some of the interest difference, the parties can reduce their cost of borrowing
- In the transaction, the bank acts as an intermediary and the contracts are dealt with separately

Result

- Company **AA** and Company **BB both receive a gain of 0.25%** over their variable or fixed amounts
- Company AA pays base plus the bank's margin of 0.25% and receives base plus 2%
- This is a 1.75% margin to be paid over base
- The net position is a 0.25% gain.
- Company BB pays the bank the fixed rate of 8.5% which is 0.25% less than the fixed rate of 8.75%
- The gain of 0.75% is therefore split evenly between the two companies and the bank
  - Both borrowers have reduced their net cost of borrowing and the intermediary has also earned a margin

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Swaps (cont´d)

Company: AA
Issues fixed and receives floating

Company AA Pays LIBOR to Bank	-
Investors receive Fixed Rate 0.007%	(7,000%)
Receives Swap Rate less Margin	5,250%
Sum: Total Payable for Floating Rate	(1,750%)
Total Gain over Variable	0,250%

Company: BB
Issues floating and receives fixed

Bank Pays LIBOR to Company BB	-
Investors receive LIBOR + 0.003%	(3,000%)
Company BB pays Bank Swap Rate	(5,500%)
Sum: Total Payable for Fixed Rate	(8,500%)
Total Gain over Fixed	0,250%

Total Variance A + B	0,500%
Total Bank Gain (	0,250%

Cash Flows (Cash In = Positive, Cash Out = Negative)

	AA	Dealer	BB
Investor receives fixed rate of 0.007%	(7,000%)		
Dealer receives LIBOR + 0.003%			(3,000%)
Bank pays AA swap rate - margin	5,250%	(5,250%)	
BB pays swap rate including margin		5,500%	(5,500%)
AA notionally pays LIBOR	-	-	
Bank notionally pays BB LIBOR		-	-
Total	(1,750%)	0,250%	(8,500%)
Cost without swap (fixed and floating)	2,000%		8,750%
Cost with swap	1,750%	0,250%	(8,500%)
Total Gain to each Party	0,250%	0,250%	0,250%

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Swaps (cont´d)

- **The benefits to each party depend on the differential and overall interest rates**
- **Benefits are sensitive to fixed and variable rates for each party**

Sensitivity Table AA: Fixed Across and Variable Rate Down

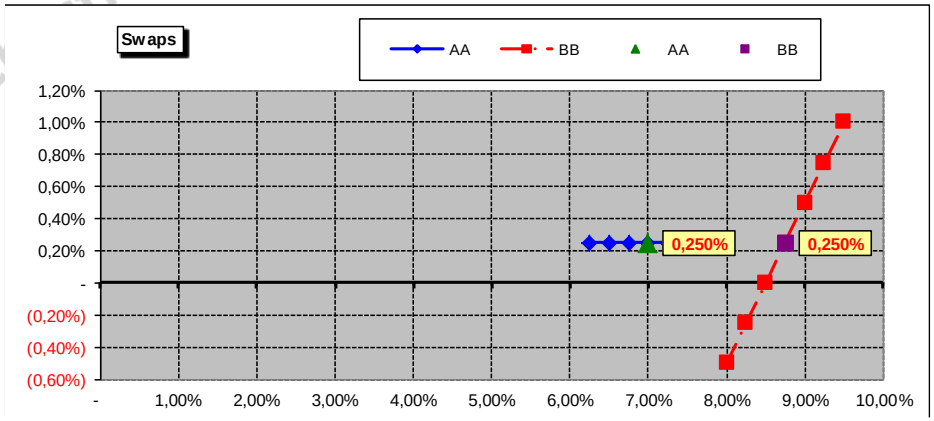
LIBOR - Across	**0,250%**
AA - Down	**0,250%**

Units $0

0,25%	6,25%	6,50%	6,75%	**7,00%**	7,25%	7,50%	7,75%
4,75%	(0,5000%)	(0,5000%)	(0,5000%)	(0,5000%)	(0,5000%)	(0,5000%)	(0,5000%)
5,00%	(0,2500%)	(0,2500%)	(0,2500%)	(0,2500%)	(0,2500%)	(0,2500%)	(0,2500%)
5,25%	-	-	-	-	-	-	-
5,50%	**0,2500%**	**0,2500%**	**0,2500%**	**0,2500%**	**0,2500%**	**0,2500%**	**0,2500%**
5,75%	0,5000%	0,5000%	0,5000%	0,5000%	0,5000%	0,5000%	0,5000%
6,00%	0,7500%	0,7500%	0,7500%	0,7500%	0,7500%	0,7500%	0,7500%
6,25%	1,0000%	1,0000%	1,0000%	1,0000%	1,0000%	1,0000%	1,0000%

Sensitivity Table BB: Fixed Across Variable Rate Down

0,25%	8,00%	8,25%	8,50%	**8,75%**	9,00%	9,25%	9,50%
4,75%	**0,2500%**	0,5000%	0,7500%	1,0000%	1,2500%	1,5000%	1,7500%
5,00%	-	**0,2500%**	0,5000%	0,7500%	1,0000%	1,2500%	1,5000%
5,25%	(0,2500%)	-	**0,2500%**	0,5000%	0,7500%	1,0000%	1,2500%
5,50%	(0,5000%)	(0,2500%)	-	**0,2500%**	0,5000%	0,7500%	1,0000%
5,75%	(0,7500%)	(0,5000%)	(0,2500%)	-	**0,2500%**	0,5000%	0,7500%
6,00%	(1,0000%)	(0,7500%)	(0,5000%)	(0,2500%)	-	**0,2500%**	0,5000%
6,25%	(1,2500%)	(1,0000%)	(0,7500%)	(0,5000%)	(0,2500%)	-	**0,2500%**



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Swaps (cont´d) - Example

Agreed Swap Rate	3,200%

	Fixed	Variable
AA	3,500%	1,900%
BB	6,300%	2,750%
Variance on risk premiums	2,800%	0,850%
Total Benefit to be Shared	1,950%	
Benefit Split	0,700%	0,700%
Bank Margin	0,550%	

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Swaps (cont´d) - Example

Company: AA
Issues fixed and receives floating

Company AA Pays LIBOR to Bank	-
Investors receive Fixed Rate 0.004%	(3,500%)
Receives Swap Rate less Margin of 001%	2,650%
Sum: Total Payable for Floating Rate	(0,850%)
Total Gain over Variable at 002%	1,050%

Company: BB
Issues floating and receives fixed

Bank Pays LIBOR to Company BB	-
Investors receive LIBOR + 0.003%	(2,750%)
Company BB pays Bank Swap Rate	(3,200%)
Sum: Total Payable for Fixed Rate	(5,950%)
Total Gain over Fixed at 006%	0,350%

Total Variance A + B	1,400%
Total Bank Gain 0.002% - 0.001%	0,550%

Cash Flows (Cash In = Positive, Cash Out = Negative)

	AA	Dealer	BB
Investor receives fixed rate of 0.004%	(3,500%)		
Dealer receives LIBOR + 0.003%			(2,750%)
Bank pays AA swap rate - margin	2,650%	(2,650%)	
BB pays swap rate including margin		3,200%	(3,200%)
AA notionally pays LIBOR	-	-	
Bank notionally pays BB LIBOR		-	-
Total	(0,850%)	0,550%	(5,950%)
Cost without swap (fixed and floating)	1,900%		6,300%
Cost with swap	0,850%	0,550%	(5,950%)
Total Gain to each Party	1,050%	0,550%	0,350%

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Swaps (cont´d) - Example

Sensitivity Table AA: Fixed Across and Variable Rate Down

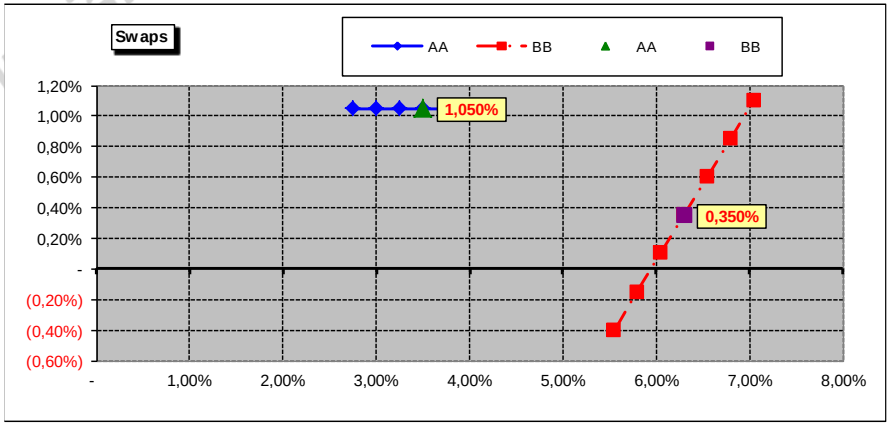
LIBOR - Across	**0,250%**
AA - Down	**0,250%**

Units $0

1,05%	2,75%	3,00%	3,25%	**3,50%**	3,75%	4,00%	4,25%
2,45%	0,3000%	0,3000%	0,3000%	0,3000%	0,3000%	0,3000%	0,3000%
2,70%	0,5500%	0,5500%	0,5500%	0,5500%	0,5500%	0,5500%	0,5500%
2,95%	0,8000%	0,8000%	0,8000%	0,8000%	0,8000%	0,8000%	0,8000%
3,20%	**1,0500%**	**1,0500%**	**1,0500%**	**1,0500%**	**1,0500%**	**1,0500%**	**1,0500%**
3,45%	1,3000%	1,3000%	1,3000%	1,3000%	1,3000%	1,3000%	1,3000%
3,70%	1,5500%	1,5500%	1,5500%	1,5500%	1,5500%	1,5500%	1,5500%
3,95%	1,8000%	1,8000%	1,8000%	1,8000%	1,8000%	1,8000%	1,8000%

Sensitivity Table BB: Fixed Across Variable Rate Down

0,35%	5,55%	5,80%	6,05%	**6,30%**	6,55%	6,80%	7,05%
2,45%	0,3500%	0,6000%	0,8500%	1,1000%	1,3500%	1,6000%	1,8500%
2,70%	0,1000%	0,3500%	0,6000%	0,8500%	1,1000%	1,3500%	1,6000%
2,95%	(0,1500%)	0,1000%	**0,3500%**	0,6000%	0,8500%	1,1000%	1,3500%
3,20%	(0,4000%)	(0,1500%)	0,1000%	**0,3500%**	0,6000%	0,8500%	1,1000%
3,45%	(0,6500%)	(0,4000%)	(0,1500%)	0,1000%	**0,3500%**	0,6000%	0,8500%
3,70%	(0,9000%)	(0,6500%)	(0,4000%)	(0,1500%)	0,1000%	**0,3500%**	0,6000%
3,95%	(1,1500%)	(0,9000%)	(0,6500%)	(0,4000%)	(0,1500%)	0,1000%	**0,3500%**



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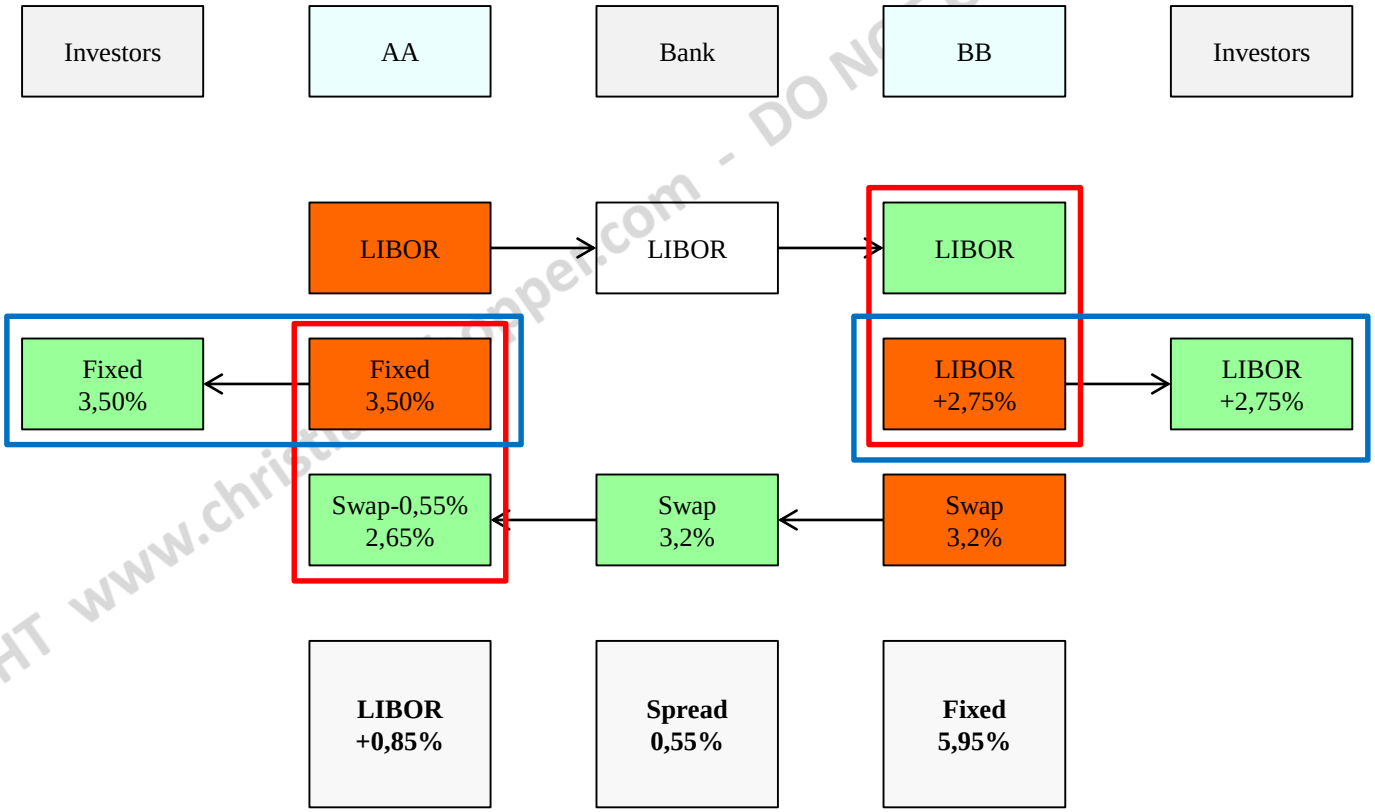

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Foreign Exchange

Intro

- Forward outrights are the purchase or sale of currency for settlement on a fixed date in the future
- The future outright rate is a reflection of the spot rate and the interest rates in the two currencies
- It holds that there should be interest rate parity since you could:
  - buy foreign currency now and place funds on deposit for several months;
  - put domestic currency on deposit for several months and then buy foreign currency;
  - buy foreign currency forward at the quoted rate
- The theory states that if interest rate parity does not hold, there would be an arbitrage opportunity to move funds into one currency or the other

Start Date	1-Jun-01
Finish Date	2-Jul-01
Spot Rate	1,2100
Base Currency Rate	3,00%
Variable Currency Rate	5,00%
Contract Amount	1.000.000
Days in Year	360

Scenario

- Base currency rate (USD) 3%
- Variable currency rate (EUR) 5%
- Spot rate (EUR/USD) 1.21
- Days 31
- Notional days in year 360

Result

- The base currency interest rate is lower than the foreign rate and therefore one would expect the forward outright to fall

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Foreign Exchange (cont´d)

Inputs	
Start Date	1-Jun-01
Finish Date	2-Jul-01
Spot Rate	1,2100
Base Currency Rate	3,00%
Variable Currency Rate	5,00%
Contract Amount	1.000.000
Days in Year	360

Management Summary	
Days	31,00
Forward Outright	1,2121
Forward Margin	0,0021
Amount	1.212.079
Percentage Gain/(Loss)	0,17%
Difference in rates	2,00%

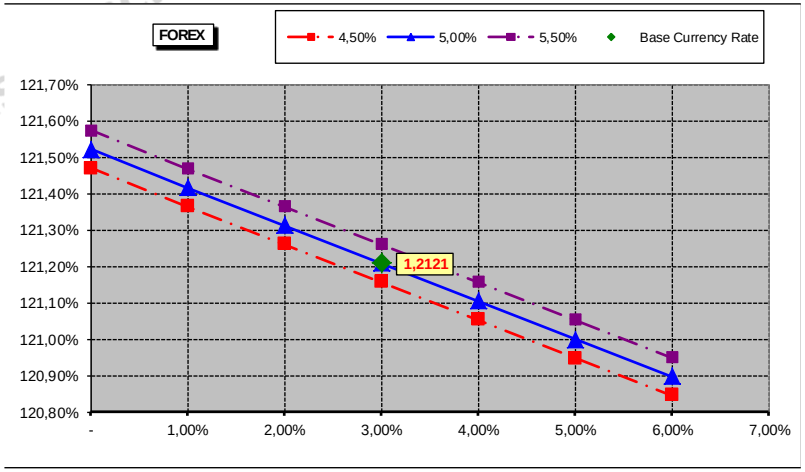
Sensitivity Table : 003% Across and 005% Down

Base Currency Rate - Across	1,000%
Variable Currency Rate - Down	0,250%

Units $0

Slope per 1% change	(0,0010)

1,2121	-	1,00%	2,00%	3,00%	4,00%	5,00%	6,00%
4,25%	1,2144	1,2134	1,2123	1,2113	1,2103	1,2092	1,2082
4,50%	1,2147	1,2136	1,2126	1,2116	1,2105	1,2095	1,2084
4,75%	1,2149	1,2139	1,2129	1,2118	1,2108	1,2097	1,2087
5,00%	1,2152	1,2142	1,2131	1,2121	1,2110	1,2100	1,2090
5,25%	1,2155	1,2144	1,2134	1,2123	1,2113	1,2103	1,2092
5,50%	1,2157	1,2147	1,2136	1,2126	1,2116	1,2105	1,2095
5,75%	1,2160	1,2149	1,2139	1,2129	1,2118	1,2108	1,2097



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Foreign Exchange (cont´d) - Examples

Inputs	
Start Date	1-Jul-14
Finish Date	1-Okt-14
Spot Rate	1,3500
Base Currency Rate	2,50%
Variable Currency Rate	1,75%
Contract Amount	1.000.000
Days in Year	360

Inputs	
Start Date	1-Jul-14
Finish Date	1-Okt-14
Spot Rate	1,3500
Base Currency Rate	2,50%
Variable Currency Rate	3,25%
Contract Amount	1.000.000
Days in Year	360

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Foreign Exchange (cont´d) - Examples

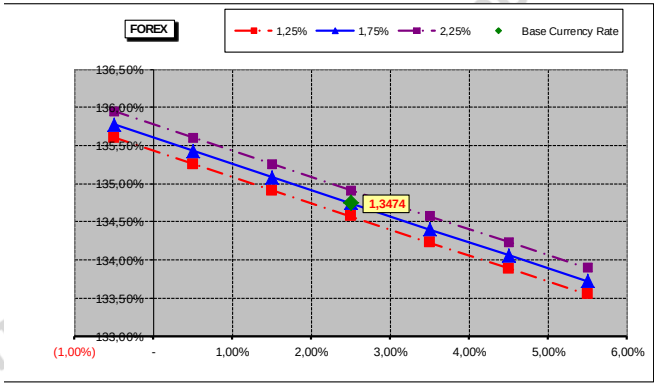
Sensitivity Table : 003% Across and 002% Down

Units $0

Base Currency Rate - Across	1,000%
Variable Currency Rate - Down	0,250%

Slope per 1% change	(0,0034)

1,3474	(0,50%)	0,50%	1,50%	2,50%	3,50%	4,50%	5,50%
1,00%	1,3552	1,3517	1,3483	1,3449	1,3415	1,3381	1,3347
1,25%	1,3560	1,3526	1,3491	1,3457	1,3423	1,3389	1,3355
1,50%	1,3569	1,3534	1,3500	1,3466	1,3432	1,3398	1,3364
1,75%	1,3578	1,3543	1,3509	1,3474	1,3440	1,3406	1,3372
2,00%	1,3586	1,3552	1,3517	1,3483	1,3449	1,3415	1,3381
2,25%	1,3595	1,3560	1,3526	1,3491	1,3457	1,3423	1,3389
2,50%	1,3604	1,3569	1,3534	1,3500	1,3466	1,3432	1,3398



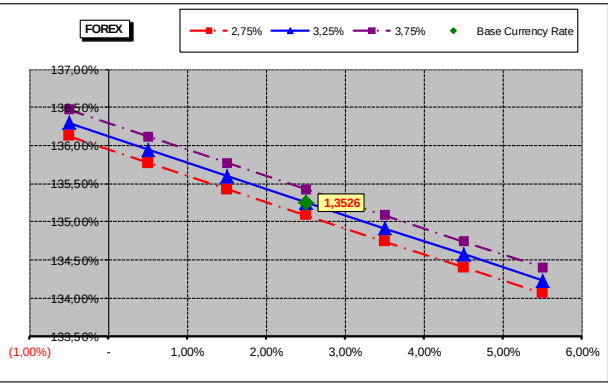
Sensitivity Table : 003% Across and 003% Down

Units $0

Base Currency Rate - Across	1,000%
Variable Currency Rate - Down	0,250%

Slope per 1% change	(0,0034)

1,3526	(0,50%)	0,50%	1,50%	2,50%	3,50%	4,50%	5,50%
2,50%	1,3604	1,3569	1,3534	1,3500	1,3466	1,3432	1,3398
2,75%	1,3612	1,3578	1,3543	1,3509	1,3474	1,3440	1,3406
3,00%	1,3621	1,3586	1,3552	1,3517	1,3483	1,3449	1,3415
3,25%	1,3630	1,3595	1,3560	1,3526	1,3491	1,3457	1,3423
3,50%	1,3638	1,3603	1,3569	1,3534	1,3500	1,3466	1,3432
3,75%	1,3647	1,3612	1,3577	1,3543	1,3509	1,3474	1,3440
4,00%	1,3655	1,3621	1,3586	1,3551	1,3517	1,3483	1,3449



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Futures

Scenario

- Buying the future at 750 yields a loss since the spot rate in June is 724
- Since you have to buy five units, the total loss is 130
- Commodities A and F will yield a profit since the spot rate at maturity is greater than the futures rate

Futures Menu

v1.0 1-Jan-2001

Buy = Obligation to buy on expiry
Sell = Obligation to sell commodity at a fixed price on expiry
Prices are quoted per tonne

Units $0

Commodity	Contract Size	Jan Spot	June Future	Spot June	Spot-Future
A	10	620,00	680,00	790,00	110,00
B	5	785,00	750,00	724,00	(26,00)
C	50	115,00	125,00	110,00	(15,00)
D	100	69,00	75,00	75,00	-
E	100	70,00	80,00	70,00	(10,00)
F	20	40,00	90,00	102,00	12,00

Select Commodity:	B
Quantity:	5,00
Buy or Sell:	Buy
June Future	750,00
Spot June	724,00

Profit/(Loss)	(26,00)
Total Profit/(Loss)	(130,00)

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Options

Commodity	Contract Size	Exercise or Strike Price	Total	June Call	June Put	Current Price
Shares	1.000	5,00	5.000,00	0,78	0,38	5,25
Interest Rate for Period	3,00%					

Scenario

- Call the right to buy shares at 5.00 over a (12mth) period ending in June
- The underlying price at the time of writing is 5.25
- The price of the call option is 0.78
- The price of the put option is 0.38

- **Note**: The model assumes standard a 1 yr time horizon (as input for calculating the present value of the strike price)

Result

- Maximum loss on the call options is limited to 0.78
  - Since this is a right and not an obligation to buy.
- Likewise, the maximum loss on the put options is limited to 0.38

- In its most simple form the pricing of the call and put options should equate to call/put parity through the formula:

Spot + Put = Call + Present Value of Exercise Price

- The PV of the exercise price is based on the underlying interest rate

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Excursion: Call-Put Parity

In financial mathematics, **put–call parity** defines:

- A relationship between the price of a European call option and European put option, …
- … both with the **identical strike price and expiry**, …
- … namely that a portfolio of **long a call** option **and short a put** option is **equivalent** to (and hence has the same value as) …
- … a **single forward contract at this strike price and expiry**

- This is **because**:
  - if the price at expiry is above the strike price, the call will be exercised, …
  - … while if it is below, the put will be exercised, …
  - … and thus in either case one unit of the asset will be purchased for the strike price, …
  - … **exactly as in a forward contract**

- The validity of this relationship requires that certain assumptions be satisfied: In practice transaction costs and financing costs (leverage) mean this relationship will not exactly hold, but **in liquid markets the relationship is close to exact**

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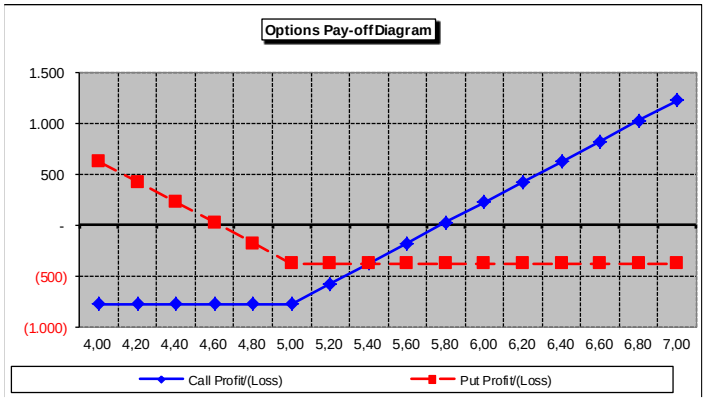
Options (cont´d) - Call

Commodity	Contract Size	Exercise or Strike Price	Total	June Call	June Put	Current Price
Shares	1.000	5,00	5.000,00	0,78	0,38	5,25
Interest Rate for Period	3,00%					

Call (Buy) or Put (Sell):	Call
Cost with Option	5.780,00
Maximum Loss	(780,00)

Put-call Parity Formula	S + P = C + Present Value of Exercise Price	S = Share Price
S + P	5,63	P = Put
C	0,78	C = Call
PV	4,85	
C + PV	5,63	
Error	(0,00)	
Error on Parity	None: S + P = C + Present Value of Exercise Price	

Interval for Graph and Table	0,20	Cost with option	Adopt	Cost without Option	Profit / (Loss)
Expiry Security Price	4,00	4.780,00	4.780,00	4.000,00	(780,00)
	4,20	4.980,00	4.980,00	4.200,00	(780,00)
	4,40	5.180,00	5.180,00	4.400,00	(780,00)
	4,60	5.380,00	5.380,00	4.600,00	(780,00)
	4,80	5.580,00	5.580,00	4.800,00	(780,00)
	5,00	5.780,00	5.780,00	5.000,00	(780,00)
	5,20	5.980,00	5.780,00	5.200,00	(580,00)
	5,40	6.180,00	5.780,00	5.400,00	(380,00)
	5,60	6.380,00	5.780,00	5.600,00	(180,00)
	5,80	6.580,00	5.780,00	5.800,00	20,00
	6,00	6.780,00	5.780,00	6.000,00	220,00
	6,20	6.980,00	5.780,00	6.200,00	420,00
	6,40	7.180,00	5.780,00	6.400,00	620,00
	6,60	7.380,00	5.780,00	6.600,00	820,00
	6,80	7.580,00	5.780,00	6.800,00	1.020,00
	7,00	7.780,00	5.780,00	7.000,00	1.220,00



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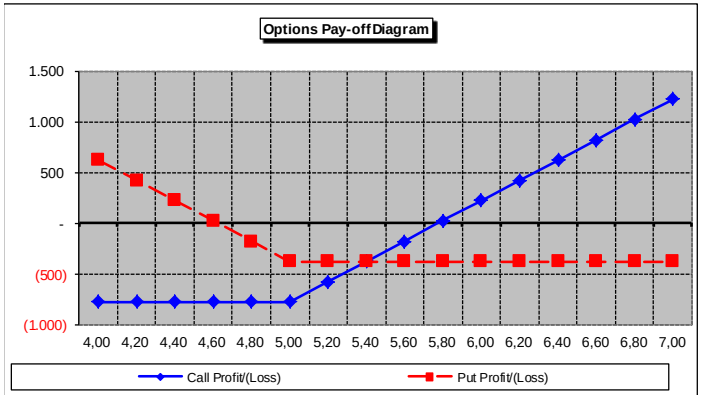
Options (cont´d) - Put

Commodity	Contract Size	Exercise or Strike Price	Total	June Call	June Put	Current Price
Shares	1.000	5,00	5.000,00	0,78	0,38	5,25
Interest Rate for Period	3,00%					

Call (Buy) or Put (Sell):	Put
Cost with Option	4.620,00
Maximum Loss	(380,00)

Put-call Parity Formula	S + P = C + Present Value of Exercise Price	S = Share Price
S + P	5,63	P = Put
C	0,78	C = Call
PV	4,85	
C + PV	5,63	
Error	(0,00)	
Error on Parity	None: S + P = C + Present Value of Exercise Price	

Interval for Graph and Table	0,20	Cost with option	Adopt	Cost without Option	Profit / (Loss)
Expiry Security Price	4,00	4.620,00	4.620,00	4.000,00	620,00
	4,20	4.620,00	4.620,00	4.200,00	420,00
	4,40	4.620,00	4.620,00	4.400,00	220,00
	4,60	4.620,00	4.620,00	4.600,00	20,00
	4,80	4.620,00	4.620,00	4.800,00	(180,00)
	5,00	4.620,00	4.620,00	5.000,00	(380,00)
	5,20	4.620,00	4.620,00	5.200,00	(380,00)
	5,40	4.620,00	4.620,00	5.400,00	(380,00)
	5,60	4.620,00	4.620,00	5.600,00	(380,00)
	5,80	4.620,00	4.620,00	5.800,00	(380,00)
	6,00	4.620,00	4.620,00	6.000,00	(380,00)
	6,20	4.620,00	4.620,00	6.200,00	(380,00)
	6,40	4.620,00	4.620,00	6.400,00	(380,00)
	6,60	4.620,00	4.620,00	6.600,00	(380,00)
	6,80	4.620,00	4.620,00	6.800,00	(380,00)
	7,00	4.620,00	4.620,00	7.000,00	(380,00)



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Options (cont´d) - Examples

Commodity	Contract Size	Exercise or Strike Price	Total	June Call	June Put	Current Price
Shares	1.000	40,00	40.000,00	3,20	1,90	42,00
Interest Rate for Period	3,00%					

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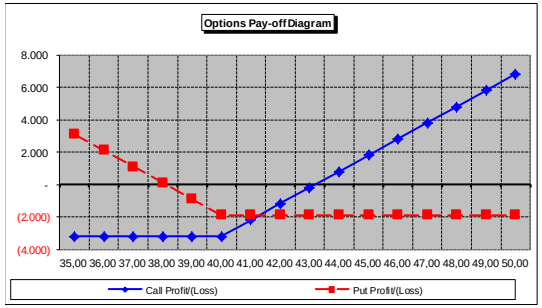
Options (cont´d) – Examples / Call

Commodity	Contract Size	Exercise or Strike Price	Total	June Call	June Put	Current Price
Shares	1.000	40,00	40.000,00	3,20	1,90	42,00
Interest Rate for Period	3,00%					

Call (Buy) or Put (Sell):	Call
Cost with Option	43.200,00
Maximum Loss	(3.200,00)

Put-call Parity Formula	S + P = C + Present Value of Exercise Price	S = Share Price
S + P	43,90	P = Put
C	3,20	C = Call
PV	38,83	
C + PV	42,03	
Error	1,87	
Error on Parity	1,87	

Interval for Graph and Table	1,00	Cost with option	Adopt	Cost without Option	Profit / (Loss)
Expiry Security Price	35,00	38.200,00	38.200,00	35.000,00	(3.200,00)
	36,00	39.200,00	39.200,00	36.000,00	(3.200,00)
	37,00	40.200,00	40.200,00	37.000,00	(3.200,00)
	38,00	41.200,00	41.200,00	38.000,00	(3.200,00)
	39,00	42.200,00	42.200,00	39.000,00	(3.200,00)
	40,00	43.200,00	43.200,00	40.000,00	(3.200,00)
	41,00	44.200,00	43.200,00	41.000,00	(2.200,00)
	42,00	45.200,00	43.200,00	42.000,00	(1.200,00)
	43,00	46.200,00	43.200,00	43.000,00	(200,00)
	44,00	47.200,00	43.200,00	44.000,00	800,00
	45,00	48.200,00	43.200,00	45.000,00	1.800,00
	46,00	49.200,00	43.200,00	46.000,00	2.800,00
	47,00	50.200,00	43.200,00	47.000,00	3.800,00
	48,00	51.200,00	43.200,00	48.000,00	4.800,00
	49,00	52.200,00	43.200,00	49.000,00	5.800,00
	50,00	53.200,00	43.200,00	50.000,00	6.800,00



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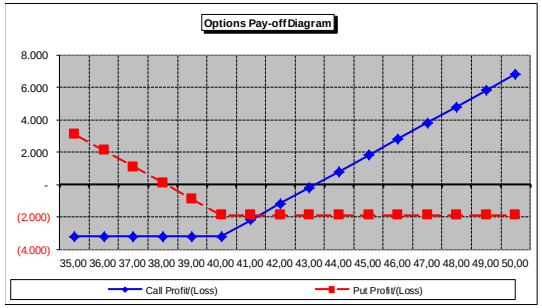
Options (cont´d) – Examples / Put

Commodity	Contract Size	Exercise or Strike Price	Total	June Call	June Put	Current Price
Shares	1.000	40,00	40.000,00	3,20	1,90	42,00
Interest Rate for Period	3,00%					

Call (Buy) or Put (Sell):	Put
Cost with Option	38.100,00
Maximum Loss	(1.900,00)

Put-call Parity Formula	S + P = C + Present Value of Exercise Price	S = Share Price
S + P	43,90	P = Put
C	3,20	C = Call
PV	38,83	
C + PV	42,03	
Error	1,87	
Error on Parity	1,87	

Interval for Graph and Table	1,00	Cost with option	Adopt	Cost without Option	Profit / (Loss)
Expiry Security Price	35,00	38.100,00	38.100,00	35.000,00	3.100,00
	36,00	38.100,00	38.100,00	36.000,00	2.100,00
	37,00	38.100,00	38.100,00	37.000,00	1.100,00
	38,00	38.100,00	38.100,00	38.000,00	100,00
	39,00	38.100,00	38.100,00	39.000,00	(900,00)
	40,00	38.100,00	38.100,00	40.000,00	(1.900,00)
	41,00	38.100,00	38.100,00	41.000,00	(1.900,00)
	42,00	38.100,00	38.100,00	42.000,00	(1.900,00)
	43,00	38.100,00	38.100,00	43.000,00	(1.900,00)
	44,00	38.100,00	38.100,00	44.000,00	(1.900,00)
	45,00	38.100,00	38.100,00	45.000,00	(1.900,00)
	46,00	38.100,00	38.100,00	46.000,00	(1.900,00)
	47,00	38.100,00	38.100,00	47.000,00	(1.900,00)
	48,00	38.100,00	38.100,00	48.000,00	(1.900,00)
	49,00	38.100,00	38.100,00	49.000,00	(1.900,00)
	50,00	38.100,00	38.100,00	50.000,00	(1.900,00)



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Commodity Options

Commodity	Contract Size	Exercise or Strike Price	June Call	June Put	Spot June	Spot-Strike
Commodity A	10	625,00	78,00	24,00	790,00	165,00
		650,00	62,00	33,00		140,00
		675,00	49,00	45,00		115,00
Commodity B	5	780,00	28,00	53,00	724,00	(56,00)
		810,00	19,00	75,00		(86,00)
		840,00	13,00	100,00		(116,00)

Select Commodity:	Commodity B
Quantity:	5,00
Call (Buy) or Put (Sell):	Put
Strike Price:	810,00
June Put	75,00
Strike + Option	885,00
Spot June	724,00
Difference to Strike	86,00

Profit/(Loss)	11,00
Total Profit/(Loss)	55,00

Units $0

Call = Right but not the obligation to buy
Put = Right but not the obligation to sell
Prices are quoted per tonne

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Interest Options

Scenario

- Price schedule with call and put premiums
- Determine the effect of a 1% change in interest rates on the overall gain or loss

Result

- As the interest rate changes, the futures price moves in the opposite direction
  - This is due to the interest loss calculated at the interest rate
- The position on the option is different since there are a number of prices and costs
  - Using the mid-price of 9,200, the call is 172
  - The gain is: 8,600
  - This is offset by the interest lost of 5,000 calculated as 0.5% over the six-month period.

Exercise or Strike Price	Call	Put
9.100,00	360,00	-
9.150,00	245,00	150,00
9.200,00	172,00	204,00
9.250,00	120,00	301,00
9.300,00	76,00	342,00

Current Price	9.215,00		Units $0
Contract Amount	1.000		
Total Amount	1.000.000	No of Contracts	1000
Frequency	Bi-annual - 6 months	Value of a tick	0,05
Interest Rates Change	1,00%	100 Ticks	
Futures Price Change	(1,00%)	-100 Ticks	

(A) Futures Hedge		
New Expiry Price	9.115,00	Current Price +/(-) Futures Movement
Profit/(Loss) (A)	(5.000,00)	Futures Movement * No of Contracts * Tick Value
Interest Gain/ (Loss) (B)	5.000,00	Total Amount * Interest Rate * Period
Overall Profit/(Loss)	**-**	**A + B**

(B) Options Hedge		
Implied Interest Rate	7,85%	Formula: 100 - 9215/1000
Call (Buy) or Put (Sell):	Call	Call = Right but not the obligation to buy Put = Right but not the obligation to sell commodity
Strike Price:	9.200,00	
Call	172,00	Look up from above
Premium (A)	(8.600,00)	No of Contracts * Price * Tick Value
Interest Gain/ (Loss) (B)	5.000,00	Total Amount * Interest Rate * Period
Profit on Options (C)	-	
Net Effect	**(3.600,00)**	**A + B + C**

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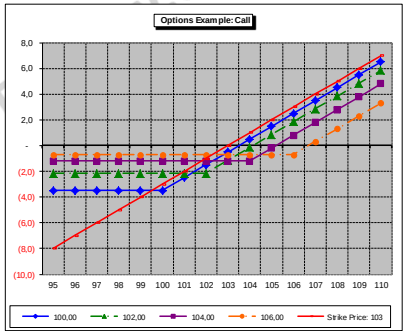
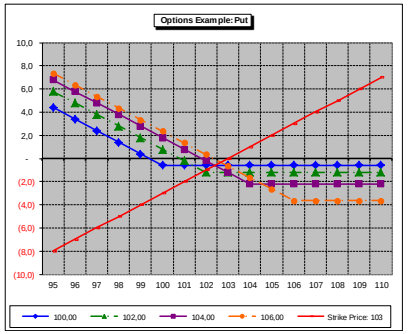
Options Example

	(A) Call Options		(B) Put Options		Units $0
	Strike Price	Premium (points)	Strike Price	Premium (points)	
Price less 3	100,00	3,50	100,00	0,60	
Price less 2	101,00	2,80	101,00	0,85	
Price less 1	102,00	2,15	102,00	1,20	
At-the-money	103,00	1,50	103,00	1,50	
Price plus 1	104,00	1,20	104,00	2,20	
Price plus 2	105,00	0,85	105,00	2,80	
Price plus 3	106,00	0,70	106,00	3,65	

Select: Call

Interval	1,00						
Market Price	100,00	101,00	102,00	103,00	104,00	105,00	106,00
Call	3,50	2,80	2,15	1,50	1,20	0,85	0,70
95,00	(3,50)	(2,80)	(2,15)	(1,50)	(1,20)	(0,85)	(0,70)
96,00	(3,50)	(2,80)	(2,15)	(1,50)	(1,20)	(0,85)	(0,70)
97,00	(3,50)	(2,80)	(2,15)	(1,50)	(1,20)	(0,85)	(0,70)
98,00	(3,50)	(2,80)	(2,15)	(1,50)	(1,20)	(0,85)	(0,70)
99,00	(3,50)	(2,80)	(2,15)	(1,50)	(1,20)	(0,85)	(0,70)
100,00	(3,50)	(2,80)	(2,15)	(1,50)	(1,20)	(0,85)	(0,70)
101,00	(2,50)	(2,80)	(2,15)	(1,50)	(1,20)	(0,85)	(0,70)
102,00	(1,50)	(1,80)	(2,15)	(1,50)	(1,20)	(0,85)	(0,70)
103,00	(0,50)	(0,80)	(1,15)	(1,50)	(1,20)	(0,85)	(0,70)
104,00	0,50	0,20	(0,15)	(0,50)	(1,20)	(0,85)	(0,70)
105,00	1,50	1,20	0,85	0,50	(0,20)	(0,85)	(0,70)
106,00	2,50	2,20	1,85	1,50	0,80	0,15	(0,70)
107,00	3,50	3,20	2,85	2,50	1,80	1,15	0,30
108,00	4,50	4,20	3,85	3,50	2,80	2,15	1,30
109,00	5,50	5,20	4,85	4,50	3,80	3,15	2,30
110,00	6,50	6,20	5,85	5,50	4,80	4,15	3,30





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Butterfly

Constellation

- Write two calls at 104.00 and buy a call at 103.00 and one at 105.00

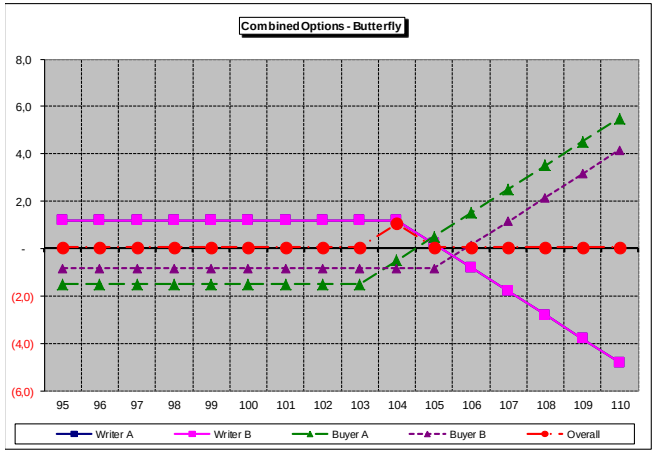
Units $0

	(A) Call Options		(B) Put Options	
	Strike Price	Premium (points)	Strike Price	Premium (points)
Price less 3	100,00	3,50	100,00	0,60
Price less 2	101,00	2,80	101,00	0,85
Price less 1	102,00	2,15	102,00	1,20
At-the-money	103,00	1,50	103,00	1,50
Price plus 1	104,00	1,20	104,00	2,20
Price plus 2	105,00	0,85	105,00	2,80
Price plus 3	106,00	0,70	106,00	3,65

Units $0

	Number	Price	Premium
Write Call A	1	104,00	1,20
Write Call B	1	104,00	1,20
Buy Call A	1	103,00	1,50
Buy Call B	1	105,00	0,85
Interval		1,00	

Market Price	In/Out	Writer	Premium	Net Call	In/Out	Buyer	Premium	Net Put	Overall
95,00	Y	-	2,40	2,40	N	-	(2,35)	(2,35)	0,05
96,00	Y	-	2,40	2,40	N	-	(2,35)	(2,35)	0,05
97,00	Y	-	2,40	2,40	N	-	(2,35)	(2,35)	0,05
98,00	Y	-	2,40	2,40	N	-	(2,35)	(2,35)	0,05
99,00	Y	-	2,40	2,40	N	-	(2,35)	(2,35)	0,05
100,00	Y	-	2,40	2,40	N	-	(2,35)	(2,35)	0,05
101,00	Y	-	2,40	2,40	N	-	(2,35)	(2,35)	0,05
102,00	Y	-	2,40	2,40	N	-	(2,35)	(2,35)	0,05
103,00	Y	-	2,40	2,40	N	-	(2,35)	(2,35)	0,05
104,00	N	-	2,40	2,40	N	1,00	(2,35)	(1,35)	1,05
105,00	N	(2,00)	2,40	0,40	Y	2,00	(2,35)	(0,35)	0,05
106,00	N	(4,00)	2,40	(1,60)	Y	4,00	(2,35)	1,65	0,05
107,00	N	(6,00)	2,40	(3,60)	Y	6,00	(2,35)	3,65	0,05
108,00	N	(8,00)	2,40	(5,60)	Y	8,00	(2,35)	5,65	0,05
109,00	N	(10,00)	2,40	(7,60)	Y	10,00	(2,35)	7,65	0,05
110,00	N	(12,00)	2,40	(9,60)	Y	12,00	(2,35)	9,65	0,05
Average				(0,23)				0,34	0,11
Standard Deviation				3,98				3,95	0,24



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Straddle

Constellation

- Buy two calls and buy two puts

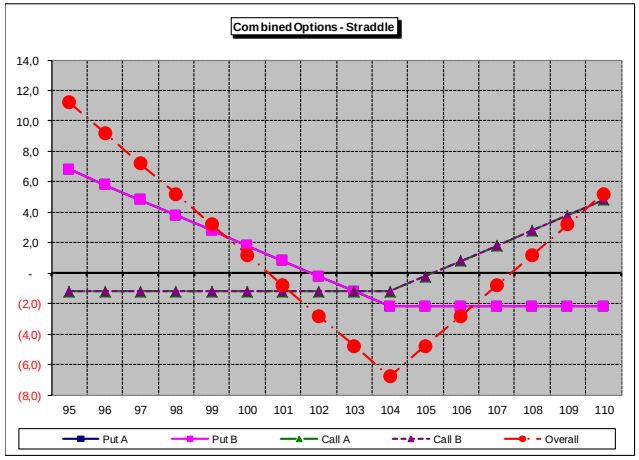
Units $0

	(A) Call Options		(B) Put Options	
	Strike Price	Premium (points)	Strike Price	Premium (points)
Price less 3	100,00	3,50	100,00	0,60
Price less 2	101,00	2,80	101,00	0,85
Price less 1	102,00	2,15	102,00	1,20
At-the-money	103,00	1,50	103,00	1,50
Price plus 1	104,00	1,20	104,00	2,20
Price plus 2	105,00	0,85	105,00	2,80
Price plus 3	106,00	0,70	106,00	3,65

Units $0

	Number	Price	Premium
Buy Put A	1	104,00	2,20
Buy Put B	1	104,00	2,20
Buy Call A	1	104,00	1,20
Buy Call B	1	104,00	1,20
Interval		1,00	

Market Price	In/Out	Put	Premium	Net Put	In/Out	Call	Premium	Net Call	Overall
95,00	Y	18,00	(4,40)	13,60	N	-	(2,40)	(2,40)	11,20
96,00	Y	16,00	(4,40)	11,60	N	-	(2,40)	(2,40)	9,20
97,00	Y	14,00	(4,40)	9,60	N	-	(2,40)	(2,40)	7,20
98,00	Y	12,00	(4,40)	7,60	N	-	(2,40)	(2,40)	5,20
99,00	Y	10,00	(4,40)	5,60	N	-	(2,40)	(2,40)	3,20
100,00	Y	8,00	(4,40)	3,60	N	-	(2,40)	(2,40)	1,20
101,00	Y	6,00	(4,40)	1,60	N	-	(2,40)	(2,40)	(0,80)
102,00	Y	4,00	(4,40)	(0,40)	N	-	(2,40)	(2,40)	(2,80)
103,00	Y	2,00	(4,40)	(2,40)	N	-	(2,40)	(2,40)	(4,80)
104,00	N	-	(4,40)	(4,40)	N	-	(2,40)	(2,40)	(6,80)
105,00	N	-	(4,40)	(4,40)	Y	2,00	(2,40)	(0,40)	(4,80)
106,00	N	-	(4,40)	(4,40)	Y	4,00	(2,40)	1,60	(2,80)
107,00	N	-	(4,40)	(4,40)	Y	6,00	(2,40)	3,60	(0,80)
108,00	N	-	(4,40)	(4,40)	Y	8,00	(2,40)	5,60	1,20
109,00	N	-	(4,40)	(4,40)	Y	10,00	(2,40)	7,60	3,20
110,00	N	-	(4,40)	(4,40)	Y	12,00	(2,40)	9,60	5,20
Average				1,23				0,23	1,45
Standard Deviation				6,50				4,11	5,26



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Black-Scholes

The breakthrough in the Black–Scholes model was to use only observable quantities such as:

- maturity date (T);
- domestic interest rate (Int);
- volatility of the share price as measured by standard deviation (S);
- current stock price (P);
- exercise price (X).

The main assumptions for pricing options using the model are as follows:

- Relative price rises in the future are independent of changes in the current price.
- Interest rates and volatility remain constant during the period. This may not be true since volatility reduces as you near the maturity date.
- The probability distribution of relative price changes is lognormal, which means that there is a smaller probability of significant deviations from the mean.
- There are no transactions costs.

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Black-Scholes Inputs

Start Date		1-Jun-01
Maturity Date		1-Dez-01
Days		182 days
Maturity	T	0,499 yrs
Interest Rate	Int	8,00%
Volatility	S	12,00%
Current Stock Price	P	220,00
Exercise Price	X	225,00

Results

	Price	% P
Call Price	9,4251	4,28%
Put Price	5,6264	2,56%

Sensitivity: Call Price

Current Stock Price Across	0,50
Volatility Down	2,500%

Units $0

						Slope	0,60
9,4251	218,50	219,00	219,50	220,00	220,50	221,00	221,50
4,50%	4,0557	4,3806	4,7186	5,0692	5,4321	5,8065	6,1920
7,00%	5,5327	5,8343	6,1448	6,4639	6,7917	7,1277	7,4720
9,50%	7,0371	7,3284	7,6262	7,9306	8,2415	8,5588	8,8824
12,00%	8,5518	8,8376	9,1287	9,4251	9,7266	10,0333	10,3451
14,50%	10,0710	10,3539	10,6412	10,9328	11,2287	11,5289	11,8334
17,00%	11,5924	11,8737	12,1588	12,4475	12,7400	13,0362	13,3360
19,50%	13,1148	13,3954	13,6792	13,9663	14,2566	14,5502	14,8469

Sensitivity: Put Price

						Slope	(0,40)
5,6264	218,50	219,00	219,50	220,00	220,50	221,00	221,50
4,50%	1,7571	1,5819	1,4199	1,2706	1,1334	1,0078	0,8933
7,00%	3,2340	3,0356	2,8461	2,6653	2,4930	2,3291	2,1733
9,50%	4,7385	4,5297	4,3276	4,1320	3,9428	3,7601	3,5837
12,00%	6,2531	6,0389	5,8301	5,6264	5,4279	5,2346	5,0464
14,50%	7,7723	7,5552	7,3425	7,1341	6,9300	6,7303	6,5347
17,00%	9,2937	9,0750	8,8601	8,6489	8,4413	8,2375	8,0373
19,50%	10,8161	10,5967	10,3805	10,1676	9,9580	9,7515	9,5482

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Black-Scholes Chart & the Greeks

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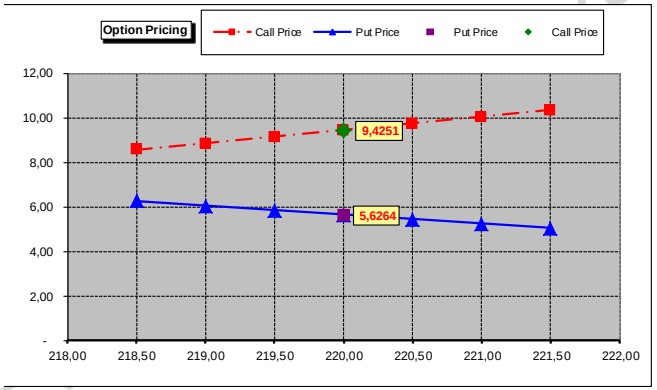
Select Series 12,00% 4

12,00%	8,5518	8,8376	9,1287	9,4251	9,7266	10,0333	10,3451
12,00%	6,2531	6,0389	5,8301	5,6264	5,4279	5,2346	5,0464



(4) Delta		Change in price when underlying price changes
N(d1)	0,5979	
(5) Gamma		Rate at which delta changes
Ln(P/X)	(0,0225)	Gamma highest when option at the money and
Adjusted return	0,0363	reduces away from the price
Time adjusted volatility	0,0847	
d2	0,1632	Writer is always negative gamma
N(d2)	0,5648	
d1	0,2479	
Coefficient	0,3989	
(d1^2/2)	0,0307	
Exp-(d1^2/2)	0,9697	
N'(d1)	0,3869	
=N'(d1)/(P*Time_Adj_Volatility)	0,0208	
(6) Theta		Time decay in an option
d1 at 0% Interest	(0,2228)	Minimum when share price equals exercise price
Coefficient	0,3989	
(d1^2/2)	0,0248	
Exp-(d1^2/2)	0,9755	
N'(d1)	0,3892	
=-P*N'(d1)*S/(2*T^0.5)	(7,2746)	For every 1/100 of a year premium moves by -0.007
(7) Vega		Sensitivity of an option to a change in volatility
=P*T^0.5*N'(d1)	60,4559	Most senstive when at the money

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Black-Scholes – Examples

Start Date		1-Jun-14
Maturity Date		1-Dez-14
Days		182 days
Maturity	T	0,499 yrs
Interest Rate	Int	3,00%
Volatility	S	12,00%
Current Stock Price	P	42,00
Exercise Price	X	40,00

Start Date		1-Jun-14
Maturity Date		1-Dez-15
Days		547 days
Maturity	T	1,499 yrs
Interest Rate	Int	3,00%
Volatility	S	17,00%
Current Stock Price	P	42,00
Exercise Price	X	40,00

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Black-Scholes (cont´d) – Examples

Sensitivity: Call Price

Current Stock Price Across	2,00
Volatility Down	1,000%

Units $0

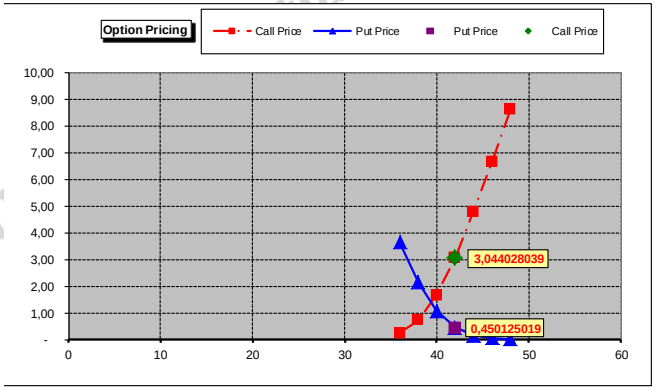
						Slope	0,72
3,0440	36,00	38,00	40,00	42,00	44,00	46,00	48,00
9,00%	0,0835	0,4341	1,3311	2,8080	4,6383	6,6005	8,5946
10,00%	0,1262	0,5281	1,4402	2,8808	4,6686	6,6090	8,5963
11,00%	0,1766	0,6247	1,5497	2,9599	4,7074	6,6226	8,5999
12,00%	0,2336	0,7233	1,6596	3,0440	4,7540	6,6421	8,6063
13,00%	0,2963	0,8233	1,7697	3,1322	4,8077	6,6679	8,6164
14,00%	0,3639	0,9246	1,8800	3,2237	4,8677	6,7000	8,6308
15,00%	0,4356	1,0268	1,9905	3,3180	4,9332	6,7382	8,6499

Sensitivity: Put Price

						Slope	(0,28)
0,4501	36,00	38,00	40,00	42,00	44,00	46,00	48,00
9,00%	3,4896	1,8402	0,7372	0,2141	0,0444	0,0066	0,0007
10,00%	3,5323	1,9342	0,8463	0,2869	0,0747	0,0151	0,0024
11,00%	3,5827	2,0308	0,9558	0,3660	0,1135	0,0287	0,0060
12,00%	3,6397	2,1294	1,0656	0,4501	0,1601	0,0482	0,0124
13,00%	3,7024	2,2294	1,1758	0,5383	0,2138	0,0740	0,0225
14,00%	3,7700	2,3307	1,2861	0,6298	0,2737	0,1061	0,0369
15,00%	3,8417	2,4329	1,3966	0,7241	0,3393	0,1443	0,0560

Select Series: 12,00% | 4

12,00%	0,2336	0,7233	1,6596	3,0440	4,7540	6,6421	8,6063
12,00%	3,6397	2,1294	1,0656	0,4501	0,1601	0,0482	0,0124



Sensitivity: Call Price

Current Stock Price Across	5,00
Volatility Down	2,000%

Units $0

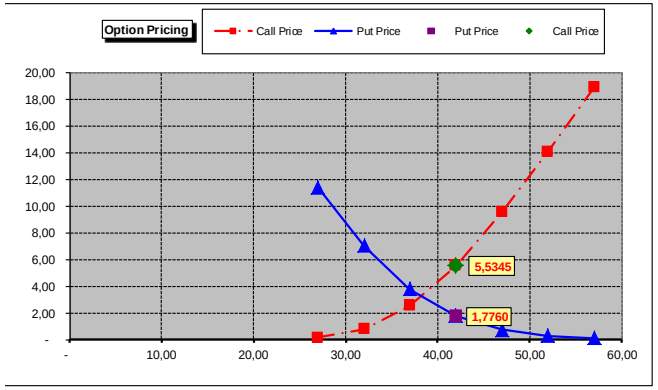
						Slope	0,64
5,5345	27,00	32,00	37,00	42,00	47,00	52,00	57,00
11,00%	0,0066	0,2038	1,4590	4,5336	8,9139	13,7816	18,7613
13,00%	0,0258	0,3666	1,8163	4,8517	9,0677	13,8307	18,7730
15,00%	0,0658	0,5646	2,1756	5,1873	9,2674	13,9177	18,8035
17,00%	0,1302	0,7891	2,5361	5,5345	9,5038	14,0442	18,8606
19,00%	0,2197	1,0339	2,8972	5,8899	9,7692	14,2077	18,9485
21,00%	0,3330	1,2939	3,2585	6,2509	10,0573	14,4041	19,0684
23,00%	0,4678	1,5659	3,6199	6,6159	10,3632	14,6290	19,2190

Sensitivity: Put Price

						Slope	(0,36)
1,7760	27,00	32,00	37,00	42,00	47,00	52,00	57,00
11,00%	11,2481	6,4452	2,7005	0,7751	0,1554	0,0231	0,0027
13,00%	11,2673	6,6081	3,0577	1,0932	0,3092	0,0722	0,0145
15,00%	11,3072	6,8061	3,4170	1,4287	0,5089	0,1591	0,0450
17,00%	11,3716	7,0306	3,7775	1,7760	0,7453	0,2856	0,1021
19,00%	11,4612	7,2753	4,1386	2,1313	1,0107	0,4491	0,1900
21,00%	11,5745	7,5354	4,5000	2,4923	1,2987	0,6456	0,3098
23,00%	11,7093	7,8074	4,8614	2,8574	1,6047	0,8705	0,4604

Select Series: 17,00% | 4

17,00%	0,1302	0,7891	2,5361	5,5345	9,5038	14,0442	18,8606
17,00%	11,3716	7,0306	3,7775	1,7760	0,7453	0,2856	0,1021



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Simulation Options Pricing

Approach

- Alternative to Black–Scholes, which will produce similar results
- Based on suggested volatility value and variance, whereby the volatility is randomized within the variance limits

Simulation | Menu | Run Simulation

v1.0 1-Jan-2001

Start Date	1-Jun-01
Maturity Date	1-Dez-01
Days	182 days
Maturity	0,499 yrs
Interest Rate	8,00%
Volatility	12,00%
Current Stock Price	220,00
Exercise Price	225,00
Volatility	20,00%
Deviation:	4,00%

Simulation
1.000

Prices at a volatility of 20% varying by 04%

	Black-Scholes	Simulation	Variance
Call Price	9,425	14,183	(4,758)
% 220	4,284%	6,447%	(2,163%)
Put Price	5,626	10,385	(4,758)
% 220	2,557%	4,720%	(2,163%)

Quartiles	Call Value	Results	Put Value	Results
0	10,478	1	6,679	1,00
1	13,388	249	9,589	249,00
2	14,164	250	10,365	250,00
3	14,954	250	11,155	250,00
4	17,862	250	14,064	250,00
Total Results		1.000		1.000
Range		7,385		7,385
Mean		14,183		10,385
Median		14,164		10,365
Skew		0,026		0,026
Kurtosis		(0,019)		(0,019)
Standard Deviation		1,210		1,210
Coefficient of Variation		0,085		0,117

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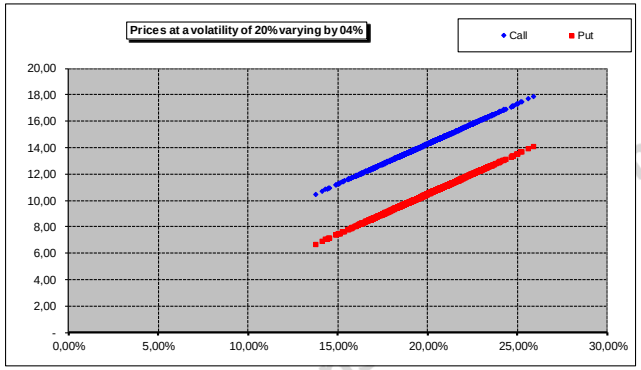
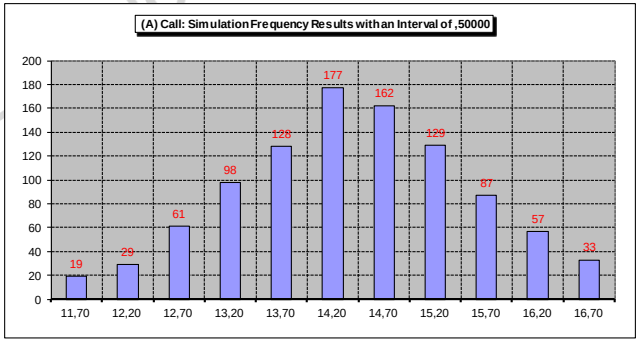
Simulation Options Pricing (cont´d)





(A) Call: Simulation Frequency Results with an Interval of ,50000

Interval	0,50

Amount	No of Results	Percentage
11,700	19	1,9%
12,200	29	3,0%
12,700	61	6,2%
13,200	98	10,0%
13,700	128	13,1%
14,200	177	18,1%
14,700	162	16,5%
15,200	129	13,2%
15,700	87	8,9%
16,200	57	5,8%
16,700	33	3,4%
	980	100,0%

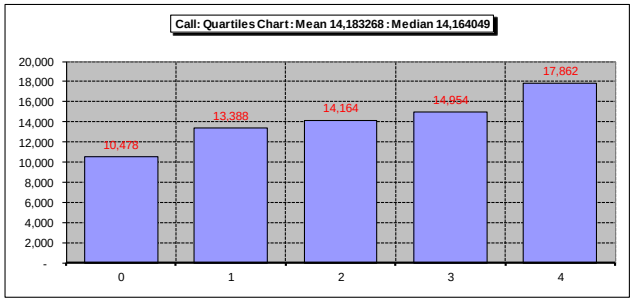
	Factor	% P
Minimum:	0,0009	4,7627%
Maximum:	0,9984	8,1193%
Mean:	0,4786	6,4469%

Minimum Volatility:	0,1375
Maximum Volatility:	0,2590

Less than zero NPV % of trials:	-

Arithmetic Mean	14,183
Median	14,164
Skew	0,026
Kurtosis	(0,019)
R Squared	1,000
Slope	60,801

Call: Quartiles Chart : Mean 14,183268 : Median 14,164049



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Currency Options Pricing

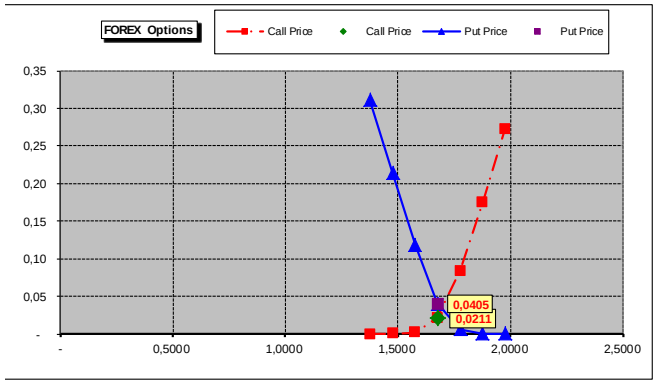
Start Date		1-Jun-01
Maturity Date		16-Aug-01
Days		76 days
Maturity	T	0,208 yrs
Domestic Int. Rate	Rd	8,00%
Foreign Int. Rate	Rf	15,00%
Volatility	S	10,00%
Spot Price	P	1,6770
Exercise Price	X	1,6750

Results

	Price	% P
Call Price	0,0211	1,26%
Put Price	0,0405	2,42%

Select Series 10,00% 4

10,00%	0,0000	0,0000	0,0017	0,0211	0,0840	0,1752	0,2720
10,00%	0,3109	0,2137	0,1182	0,0405	0,0063	0,0004	0,0000



Sensitivity: Call Price

Volatility Across	0,10
Foreign Int. Rate Down	2,500%

Units $0

						Slope	0,45
0,0211	1,3770	1,4770	1,5770	1,6770	1,7770	1,8770	1,9770
2,50%	(0,0000)	(0,0000)	(0,0000)	0,0014	0,0777	0,1748	0,2720
5,00%	(0,0000)	(0,0000)	0,0000	0,0072	0,0780	0,1748	0,2720
7,50%	(0,0000)	0,0000	0,0003	0,0140	0,0801	0,1748	0,2720
10,00%	0,0000	0,0000	0,0017	0,0211	0,0840	0,1752	0,2720
12,50%	0,0000	0,0002	0,0042	0,0283	0,0891	0,1763	0,2721
15,00%	0,0000	0,0008	0,0079	0,0357	0,0949	0,1785	0,2725
17,50%	0,0002	0,0020	0,0123	0,0430	0,1012	0,1816	0,2735

Sensitivity: Put Price

						Slope	(0,53)
0,0405	1,3770	1,4770	1,5770	1,6770	1,7770	1,8770	1,9770
2,50%	0,3109	0,2137	0,1166	0,0209	0,0000	-	-
5,00%	0,3109	0,2137	0,1166	0,0266	0,0003	0,0000	(0,0000)
7,50%	0,3109	0,2137	0,1169	0,0334	0,0024	0,0000	0,0000
10,00%	0,3109	0,2137	0,1182	0,0405	0,0063	0,0004	0,0000
12,50%	0,3109	0,2139	0,1208	0,0478	0,0114	0,0015	0,0001
15,00%	0,3109	0,2145	0,1245	0,0551	0,0172	0,0037	0,0005
17,50%	0,3110	0,2158	0,1289	0,0625	0,0236	0,0068	0,0015

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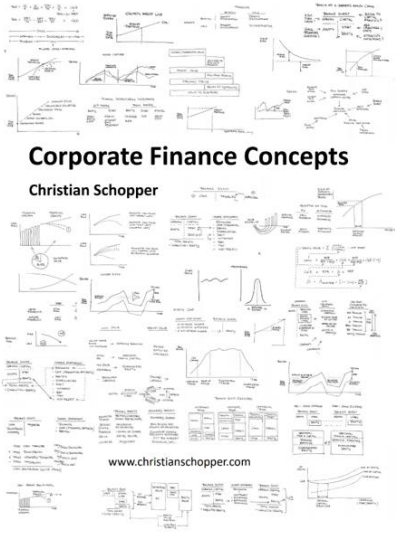

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