Options Analysis Toolkit

Before You Begin

The User's Manual describes how to use Intermark Financial Tool-kits Version 8 for Microsoft Excel, on a Windows platform. Before continuing you should be familiar with basic Excel skills in particular formula concepts and techniques. Chapter 2 describes some features of Excel array formulas for those not familiar with the subject.

System Requirements

To run the Intermark Financial Tool-kits, you must have the following hardware and software installed on your computer:

- Microsoft Windows 2000 SP4, XP SP1
- Up to 15 megabytes (MB) of available disk space on a stand alone computer.
- Microsoft Excel 2000 or above

Chapter 1. Using The Tool-kits

The add-in functions are developed as Dynamic Link Libraries (DLLs). DLLs are a key feature of Microsoft's operating environment. It enables applications to use libraries at run time rather than at compile time. This provides flexibility and enables the functions to be called from Excel Macro, Visual Basic for Application, Visual Basic, Microsoft Access, C, C++ or Visual C++ compilers.

Attaching the Add-In Macro Spreadsheet

To make the functions of Intermark Financial Toolkits available, you need to activate the "Optoolkit" add-in. The file "optoolkit.xla" is placed into the IVolatility SDK installation folder. Please use the Tools -> Add-Ins ... menu item in Microsoft Excel and press the Browse button. Navigate then to IVolatility SDK installation folder and find this file, press OK. Now, all the different option calculation models implemented in Intermark Toolkits are available for using in your MS Excel application!

Calling The Add-In Functions From Excel

Excel Syntax Example

=IMUOA_Price (parameters)

Excel usage hints

Functions Passing Arrays

Some of the tool-kit functions require that an argument be entered as an array.

In Excel, arrays can be passed as either:

I. a range on a spreadsheet e.g. A1:B5, or
II. as absolute values enclosed in '{}' braces. e.g. {1,2;3,4;5,6}. A ';' signifies the end of one row and the beginning of next.

In Excel, a mixture of I and II is not permitted, i.e. {A1;B1:C1} is not a valid function input.

Functions Returning Arrays

Some of the tool-kit functions return an entire array of values. In the Yield add-ins the functions ending with RANGE are such functions, e.g. IMUOA_DARRAY( ).

Excel has an in-built capability for functions to return arrays. A few Excel functions that use this feature are the TREND( ), LINEST( ) and
GROWTH( ) functions.

Functions that return arrays must, however, be entered as array formulas.

To create an array formula:

1. Select the range of cells in which you want to enter the formula.
2. Enter the formula.
3. Press CONTROL+SHIFT+ENTER, or
   press SHIFT+ENTER+click the check box in the formula bar.

For information on arrays, see 'Array' in 'Excel Reference Manual'.

A useful function to use in conjunction with array formulas is the TRANSPOSE( ) function.

Errors

When using the add-ins the following error values may be displayed on a spreadsheet:

#NAME?

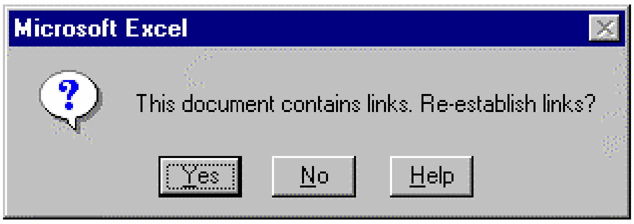
The #NAME? error value occurs when you use a name that Microsoft Excel does not recognise.

A possible cause of this error is misspelling the function. Use the function wizard to help prevent this.

#REF!

The #REF! error value occurs when you refer to a cell that is not valid.

The most likely cause of this error is when the add-in has not been loaded. Please try loading the relevant macro sheet by going to the directory and then selecting the filename from the open file dialogue box.



If a sample spreadsheet contains links and display the message 'This document contains links. Re-establish link?', then you should make sure the relevant macro sheet is opened.

#VALUE!

The #VALUE! error value occurs when you use the wrong type of argument or operand.

This error can be caused when there is a space or a character in an input range or in an input cell.

99999999.9

If an incorrect value (e.g. negative volatility or negative time) is given as a parameter in a function call or if a function could not return a valid value (e.g. the implied volatility function due to an option price being lower than the theoretical minimum price), the function will return the error value of 99999999.9 in Excel. When analysing option portfolios, these error values should be checked for.

######

This occurs if the column is not wide enough to display the values. This could be because the add-in is returning the error value 99999999.9.

Status Code

For the Yield Add-in, if the function call is successful, the result requested by return_type is returned. See Appendix I for return_type definitions. However, if an error occurs, then the value #ERR! or #N/A is returned. There is one exception to this rule, which occurs when return_type specifies that the status for the calculation be returned (type 27).

In this case a value of #ERR! or #N/A will not be returned, but a status code, which can be useful in determining the source of error in a calculation is returned. See Appendix I for Status Codes.

Note:
Please refer to Microsoft Excel’s manuals or on-line help for further information.

Exiting Excel

When exiting Excel, the system will automatically close the hidden file *.XLMs by calling the ‘AUTO_CLOSE’ macro defined in the macro sheets. This can be invoked by using the ‘Macro Run Command’.

Chapter 2: Options Valuation Module reference

The Options add-in calculates option price and implied volatility for European and American style options. It also calculates sensitivities, such as delta, gamma, fugit, kappa (vega), rho, theta and theta2. It uses Black Scholes and Cox-Rubenstein (binomial) models for the calculations thus supporting options on Stocks and Stock Indices. Users have ability to change the number of steps to over 600 for Cox-Rubenstein (binomial) model. It also contains a cumulative normal distribution function to provide extra flexibility. This enables the users to produce pricing matrices, risk return profiles and implied volatility analysis for either individual or portfolio of options. The models take account of constant and/ or discrete dividend payments when calculating the values.

The Option add-in comprises a 3-D graphical simulation for option analysis. Users can use this to visualize effect of changes in any of the key option variables.

Functions Reference

IMUOA_PRICE( )

Description

returns the theoretical price of an option based on the option_class_type and option_model_type.

Excel Syntax

=IMUOA_PRICE(short_term_interest_rate, underlying_price, strike_price, volatility, years_to_expiry, external_discount, option_class_type, option_model_type)

short_term_interest_rate	is the short term interest rate.
underlying_price	is the price of the underlying instrument.
strike_price	is the strike price.
volatility	is the volatility of the underlying
years_to_expiry	is years to maturity.
external_discount	is the external force of discount, and is required for options on currencies and cash. For options on cash, it is the continuous compounded constant dividend yield. Where an underlying cash instrument pays a discrete dividend, please see section on Discrete Dividend Functions.
option_class_type	is set to 0 for puts, and 1 for calls.
option_model_type	is set to 0 for Black-Scholes, 1 for Cox-Rubinstein.

Example

Consider a European put option with a strike of 100 on a stock. The present value of the stock is 85.5 with a volatility of 37.12%. The short term interest rate is 14.0%, the option expires on 31-Oct-89 and today's date is 29-Sep-89. The price of the option under a Cox-Rubinstein model is calculated by:

=IMUOA_PRICE(14%, 85.5, 100, 37.12%, (DATE(89,10,31)-DATE(89,9,29))/365, 0, 0, 1)

Related Function

IMUOA_DPRICE( )
IMUOA_DARRAY( )

IMUOA_DELTA( )

Description

returns the delta of an option based on the option_class_type and option_model_type.

Excel Syntax

=IMUOA_DELTA(short_term_interest_rate, underlying_price, strike_price, volatility, years_to_expiry, external_discount, option_class_type, option_model_type)

short_term_interest_rate	is the short term interest rate.
underlying_price	is the price of the underlying instrument.
strike_price	is the strike price.
volatility	is the volatility of the underlying
years_to_expiry	is years to maturity.
external_discount	is the external force of discount, and is required for options on currencies and cash. For options on cash, it is the continuous compounded constant dividend yield. Where an underlying cash instrument pays a discrete dividend, please see section on Discrete Dividend Functions.
option_class_type	is set to 0 for puts, and 1 for calls.
option_model_type	is set to 0 for Black-Scholes, 1 for Cox-Rubinstein.

Related Function

IMUOA_DDELTA( )

IMUOA_GAMMA( )

Description

returns the gamma of an option based on the option_class_type and option_model_type.

Excel Syntax

=IMUOA_GAMMA(short_term_interest_rate, underlying_price, strike_price, volatility, years_to_expiry, external_discount, option_class_type, option_model_type)

short_term_interest_rate	is the short term interest rate.
underlying_price	is the price of the underlying instrument.
strike_price	is the strike price.
volatility	is the volatility of the underlying
years_to_expiry	is years to maturity.
external_discount	is the external force of discount, and is required for options on currencies and cash. For options on cash, it is the continuous compounded constant dividend yield. Where an underlying cash instrument pays a discrete dividend, please see section on Discrete Dividend Functions.
option_class_type	is set to 0 for puts, and 1 for calls.
option_model_type	is set to 0 for Black-Scholes, 1 for Cox-Rubinstein.

Example

Consider a European put option with a strike of 2200 on an index. The present value of the index is 2190 with a volatility of 37.12%. The short term interest rate is 14.0%, the option expires on 31-Oct-89 and today's date is 29-Sep-89. The gamma of the option under a Black-Scholes model is calculated by:

=IMUOA_GAMMA(14%, 2190, 2200, 37.12%, (DATE(89,10,31)-DATE(89,9,29))/365, 0, 0, 0)

which equals

0.0016

Related Function

IMUOA_DGAMMA( )

IMUOA_RHO( )

Description

returns the rho of an option based on the option_class_type and option_model_type.

Excel Syntax

=IMUOA_RHO(short_term_interest_rate, underlying_price, strike_price, volatility, years_to_expiry, external_discount, option_class_type, option_model_type)

short_term_interest_rate	is the short term interest rate.
underlying_price	is the price of the underlying instrument.
strike_price	is the strike price.
volatility	is the volatility of the underlying
years_to_expiry	is years to maturity.
external_discount	is the external force of discount, and is required for options on currencies and cash. For options on cash, it is the continuous compounded constant dividend yield. Where an underlying cash instrument pays a discrete dividend, please see section on Discrete Dividend Functions.
option_class_type	is set to 0 for puts, and 1 for calls.
option_model_type	is set to 0 for Black-Scholes, 1 for Cox-Rubinstein.

Related Function

IMUOA_DRHO( )

IMUOA_KAPPA( )(Vega)

Description

returns the kappa of an option based on the option_class_type and option_model_type. This is the price change of the option if the implied volatility moves by 1%.

Excel Syntax

=IMUOA_KAPPA(short_term_interest_rate, underlying_price, strike_price, volatility, years_to_expiry, external_discount, option_class_type, option_model_type)

short_term_interest_rate	is the short term interest rate.
underlying_price	is the price of the underlying instrument.
strike_price	is the strike price.
volatility	is the volatility of the underlying
years_to_expiry	is years to maturity.
external_discount	is the external force of discount, and is required for options on currencies and cash. For options on cash, it is the continuous compounded constant dividend yield. Where an underlying cash instrument pays a discrete dividend, please see section on Discrete Dividend Functions.
option_class_type	is set to 0 for puts, and 1 for calls.
option_model_type	is set to 0 for Black-Scholes, 1 for Cox-Rubinstein.

Related Function

IMUOA_DKAPPA( )

IMUOA_THETA( )

Description

returns the theta of an option based on the option_class_type and option_model_type.

This is the price drop of the option per business day (252 days per year), assuming the instrument price moves exactly as assumed by the underlying model, compare with THETA2( ). In the rare event of a negative value being returned, this would indicate a price increase in the option. To calculate the theta per actual day (365 days per year), multiply the returned value by 252/365.

Excel Syntax

=IMUOA_THETA(short_term_interest_rate, underlying_price, strike_price, volatility, years_to_expiry, external_discount, option_class_type, option_model_type)

short_term_interest_rate	is the short term interest rate.
underlying_price	is the price of the underlying instrument.
strike_price	is the strike price.
volatility	is the volatility of the underlying
years_to_expiry	is years to maturity.
external_discount	is the external force of discount, and is required for options on currencies and cash. For options on cash, it is the continuous compounded constant dividend yield. Where an underlying cash instrument pays a discrete dividend, please see section on Discrete Dividend Functions.
option_class_type	is set to 0 for puts, and 1 for calls.
option_model_type	is set to 0 for Black-Scholes, 1 for Cox-Rubinstein.

Example

Consider a European put option with a strike of 2200 on an index. The present value of the index is 2190 with a volatility of 37.12%. The short term interest rate is 14.0%, the option expires on 31-Oct-89 and today's date is 29-Sep-89. The theta of the option under a Black-Scholes model is calculated by:

=IMUOA_THETA(14%, 2190, 2200, 37.12%, (DATE(89,10,31)-DATE(89,9,29))/365, 0, 0, 0)

which equals

2.09

Per actual day with would be

=2.09*252/365

which equals

1.44

Related Function

IMUOA_DTHETA( )
IMUOA_DTHETA2( )
IMUOA_THETA2( )

IMUOA_THETA2( )

Description

returns the theta2 of an option based on the option_class_type and option_model_type.

This is the price drop of the option per business day (252 days per year), assuming the instrument price does not change, compare with IMUOA_THETA( ). This would be the same as Theta for a future. In the rare event of a negative value being returned, this would indicate a price increase in the option. To calculate the theta per actual day (365 days per year), multiply the returned value by 252/365.

Excel Syntax

=IMUOA_THETA2(short_term_interest_rate, underlying_price, strike_price, volatility, years_to_expiry, external_discount, option_class_type, option_model_type)

short_term_interest_rate	is the short term interest rate.
underlying_price	is the price of the underlying instrument.
strike_price	is the strike price.
volatility	is the volatility of the underlying
years_to_expiry	is years to maturity.
external_discount	is the external force of discount, and is required for options on currencies and cash. For options on cash, it is the continuous compounded constant dividend yield. Where an underlying cash instrument pays a discrete dividend, please see section on Discrete Dividend Functions.
option_class_type	is set to 0 for puts, and 1 for calls.
option_model_type	is set to 0 for Black-Scholes, 1 for Cox-Rubinstein.

Related Function

IMUOA_DTHETA2( )
IMUOA_DTHETA( )
IMUOA_THETA( )

IMUOA_FUGIT( )

Description

returns the fugit of an option based on the option_class_type and option_model_type.

This is the expected time to exercise. For a European option, this will always be the number of years to expiry. For an American option, the fugit can be significantly shorter.

Excel Syntax

=IMUOA_FUGIT(short_term_interest_rate, underlying_price, strike_price, volatility, years_to_expiry, external_discount, option_class_type, option_model_type)

short_term_interest_rate	is the short term interest rate.
underlying_price	is the price of the underlying instrument.
strike_price	is the strike price.
volatility	is the volatility of the underlying
years_to_expiry	is years to maturity.
external_discount	is the external force of discount, and is required for options on currencies and cash. For options on cash, it is the continuous compounded constant dividend yield. Where an underlying cash instrument pays a discrete dividend, please see section on Discrete Dividend Functions.
option_class_type	is set to 0 for puts, and 1 for calls.
option_model_type	is set to 0 for Black-Scholes, 1 for Cox-Rubinstein.

Related Function

IMUOA_DFUGIT( )

IMUOA_IMPLIEDVOL( )

Description

returns the implied volatility of an option based on the option_class_type and option_model_type.

Excel Syntax

=IMUOA_IMPLIEDVOL(short_term_interest_rate, underlying_price, strike_price, option_price, years_to_expiry, external_discount, option_class_type, option_model_type)

short_term_interest_rate	is the short term interest rate.
underlying_price	is the price of the underlying instrument.
strike_price	is the strike price.
option_price	is the price of the option.
years_to_expiry	is years to maturity.
external_discount	is the external force of discount, and is required for options on currencies and cash. For options on cash, it is the continuous compounded constant dividend yield. Where an underlying cash instrument pays a discrete dividend, please see section on Discrete Dividend Functions.
option_class_type	is set to 0 for puts, and 1 for calls.
option_model_type	is set to 0 for Black-Scholes, 1 for Cox-Rubinstein.

Remarks

By default a returned implied volatility if entered in the PRICE() function will return an option price ±0.5% of the option price passed to IMPLIED_VOL() (i.e. tolerance on 0.5).

Related Function

IMUOA_DIMPLIEDVOL( )
IMUOA_VOL_TOL( )

IMUOA_VOL_TOL( )

Description

Sets the tolerance in the implied volatility function.

By default a returned implied volatility if entered in the PRICE( ) function will return an option price ±0.5% of the option price passed to IMUOA_IMPLIED_VOL() (i.e. tolerance on 0.5). In Excel, if a different level of accuracy is required, the IMUOA_VOL_TOL() function can used to alter the tolerance in the implied volatility function (i.e. how close a price is considered a 'hit').

This may considerably alter the speed of calculation.

Excel Syntax

=IMUOA_VOL_TOL(tolerance)

tolerance   is the tolerance for IMPLIEDVOL( ).

Example

To set a ±0.1 tolerance for the IMPLIEDVOL( ) use

=IMUOA_VOL_TOL(0.1)

Related Function

IMUOA_DIMPLIEDVOL( )
IMUOA_IMPLIEDVOL( )

IMUOA_NORMAL( )

Description

returns the cumulative normal distribution of a normal distribution.

Excel Syntax

=IMUOA_VOL_TOL(standard_deviations)

standard_deviations   is the standard deviation.

Example

The cumulative normal below the +1 standard deviation mark is given by

=IMUOA_NORMAL(1.0)

which equals

```
0.841
```

IMUOA_SETOPTSTEP( )

Description

Sets the numbers of steps used in the binomial tree for American options.

Excel Syntax

=IMUOA_SETOPTSTEP(steps)

steps	is the number of steps. The minimum recommended steps is 16, the maximum is 606. The steps should be an even number.

Example

To set the steps to 50 use

=IMUOA_SETOPTSTEP(50)

which equals

50

Discrete Dividend Functions

If European options on cash pays one or more discrete dividends before the option expires, the present value of the dividend should be deducted from the underlying instrument price and the standard functions above should be used. However, American options, due to the possibility of early exercise, need a different approach. There are 9 additional functions listed below which mirror the IMUOA_PRICE( ), IMUOA_DELTA( ), IMUOA_GAMMA( ), IMUOA_RHO( ), IMUOA_KAPPA( ), IMUOA_THETA( ), IMUOA_THETA2( ), IMUOA_FUGIT( ) and IMUOA_IMPLIEDVOL( ) functions discussed previously, but take two extra parameters at the end of the list of arguments.

IMUOA_DPRICE( ), IMUOA_DDELTA( ), IMUOA_DGAMMA( )

IMUOA_DRHO( ), IMUOA_DKAPPA( ), IMUOA_DTHETA( )

IMUOA_DTHETA2( ), IMUOA_DFUGIT( ), IMUOA_DIMPLIEDVOL( )

Description

Discrete dividend functions for the IMUOA_PRICE( ), IMUOA_DELTA( ), IMUOA_GAMMA( ), IMUOA_RHO( ), IMUOA_KAPPA( ), IMUOA_THETA( ), IMUOA_THETA2( ), IMUOA_FUGIT( ) and IMUOA_IMPLIEDVOL( ).

Excel Syntax

```
=IMUOA_DPRICE(…,pv_dividend_array, dividend_time_array)
=IMUOA_DELTA(…,pv_dividend_array, dividend_time_array)
=IMUOA_DGAMMA(…,pv_dividend_array, dividend_time_array)
=IMUOA_DRHO(…,pv_dividend_array, dividend_time_array)
=IMUOA_DKAPPA(…,pv_dividend_array, dividend_time_array)
=IMUOA_DTHETA(…,pv_dividend_array, dividend_time_array)
=IMUOA_DTHETA2(…,pv_dividend_array, dividend_time_array)
=IMUOA_DFUGIT(…,pv_dividend_array, dividend_time_array)
=IMUOA_DIMPLIEDVOL(…,pv_dividend_array, dividend_time_array)
```

…	represent the parameters of the non discrete dividend associated function.
pv_dividend_array	is an array containing the present value of the discrete dividends.
dividend_time_array	is an array containing the time (in years) of the discrete dividends ordered with the most recent dividend first.

Example

See IMOPT3.XLS for an illustration of these functions.

Related Function

IMUOA_DARRAY( )
IMUOA_PRICE( )

IMUOA_DELTA( )
IMUOA_GAMMA( )
IMUOA_RHO( )
IMUOA_KAPPA( )
IMUOA_THETA( )
IMUOA_THETA2( )
IMUOA_FUGIT( )
IMUOA_IMPLIEDVOL( )

IMUOA_DARRAY( )

Description

Returns an array of analysis, for the discrete dividends IMUOA_DPRICE( ) function.

The elements of the array are

- option price
- delta
- gamma
- rho
- theta
- theta2
- kappa
- fugit

Excel Syntax

=IMUOA_DARRAY(…, pv_dividend_array, dividend_time_array)

…	represent the parameters of the non discrete dividend associated function.
pv_dividend_array	is an array containing the present value of the discrete dividends.
dividend_time_array	is an array containing the time (in years) of the discrete dividends ordered with the most recent dividend first.

Remarks

This function must be entered as an array formula in Excel.
The horizontal array that is return with this function can be transposed using the Excel TRANSPOSE( ) function.

Example

See IMOPT4.XLS for an illustration of this function.

Related Function

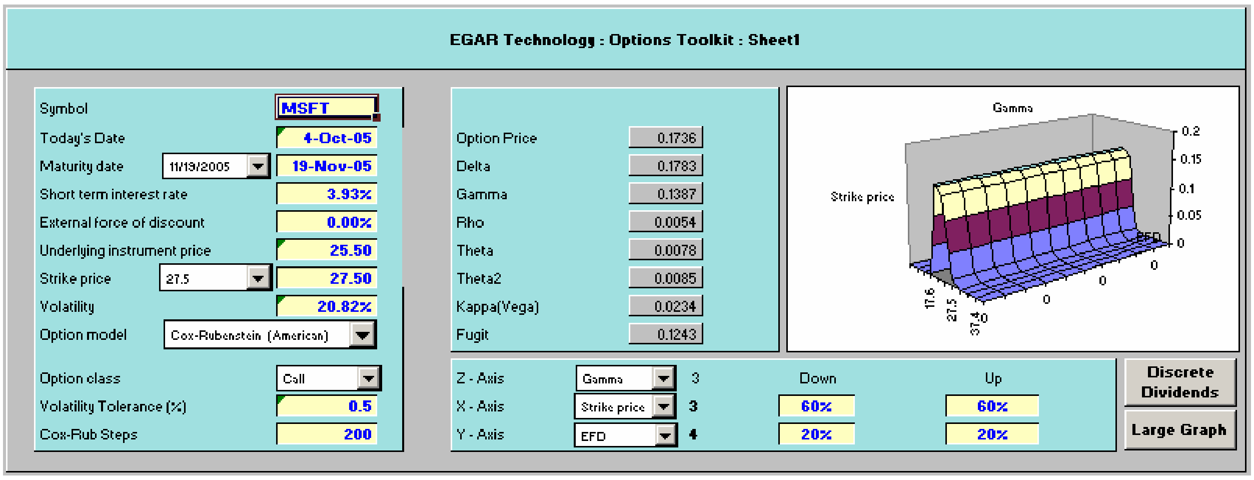
IMUOA_DPRICE( )
IMUOA_DDELTA( )
IMUOA_DGAMMA( )
IMUOA_DRHO( )
IMUOA_DKAPPA( )
IMUOA_DTHETA( )
IMUOA_DTHETA2( )
IMUOA_DFUGIT( )

Sample Applications

3-D Simulation Analysis

File Name

IMSOPT1.XLS



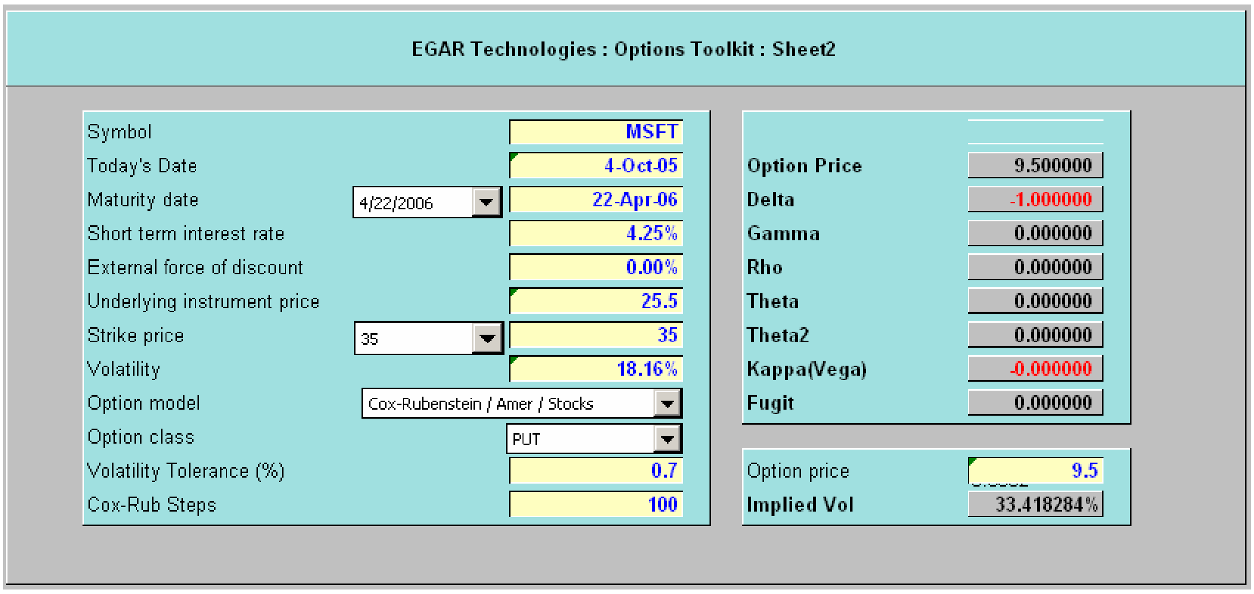
Description

Users can use this to visualise effect of changes in any of the key options variables. The user can select any of the input variables for X- or Y- axis and any of the calculated variables for Z-axis. The up and down percentage is specified by the users. This provides a flexible scenario analysis tool for all the options.

Simple Options Calculator

File Name

IMSOPT2.XLS



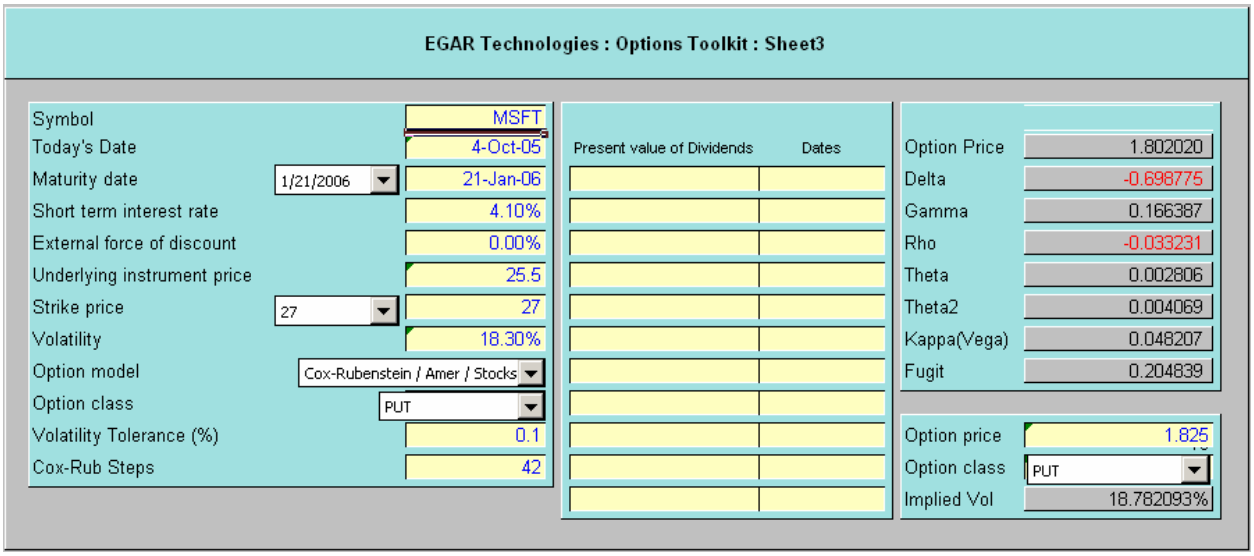
Description

This is an option calculator describing how the non-discrete dividend add-in functions can be used in their simplest form. The sheet calculates option price and Greeks and also calculates implied volatilities from the market price of the option based on the selected model.

Discrete Dividend

File Name

IMSOPT3.XLS



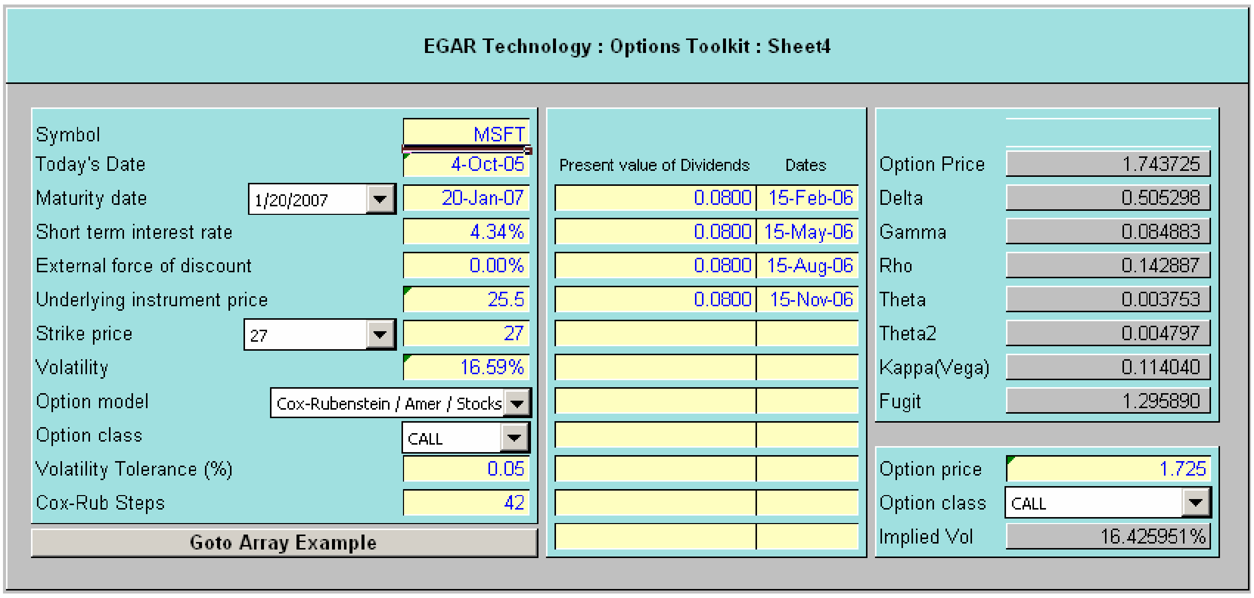
Description

This sheet describes how the discrete dividend payments can be incorporated in the models. The user is required to enter present value of dividend and dividend dates. All of the function which take account of the discrete dividend payments start with D e.g. IMUOA_DPRICE( ), IMUOA_DDELTA( ) etc.

Discrete Dividend, Array Return

File Name

IMSOPT4.XLS



Description

This sheet is same as the previous one, but describes how the function IMUOA_DARRAY( ) can be used for the calculation of price and sensitivities. The function returns a horizontal array and it is faster than the individual function calls.

Multiple Option Series

File Name

IMSOPT5.XLS

EGAR Technology : Options Toolkit : Sheet5

TODAY'S DATE	4-Oct-05	SHORT TERM RATES	3.67%
MODEL	Cox-Rubenstein / Amer / Stocks	EXTERNAL FORCE OF DISCOUNT	0.00%

SYMBOL	IBM	IMPLIED	Inst px	80.45		IMPLIED	
STRIKE	Call Px	VOL	DELTA	4/22/2006	Put Px	VOL	DELTA
65	17	20.06%	0.95		0.5	23.24%	-0.07
70	12.6	19.72%	0.88		0.95	21.07%	-0.14
75	8.6	18.73%	0.76		1.925	19.89%	-0.26
80	5.4	18.31%	0.60		3.6	18.77%	-0.42

SYMBOL	MSFT	IMPLIED	Inst px	25.50		IMPLIED	
STRIKE	Call Px	VOL	DELTA	1/21/2006	Put Px	VOL	DELTA
22.5	3.35	18.78%	0.92		0.175	21.56%	-0.11
24.5	1.75	18.22%	0.71		0.575	19.90%	-0.31
25	1.45	18.55%	0.64		0.725	19.15%	-0.38
27	0.575	18.81%	0.34		1.825	18.48%	-0.69

Description

This spreadsheet shows how the functions can be used for multiple option analysis. The market prices are entered for both call and put options with a different exercise date and price. The spreadsheet calculates implied volatilities and deltas.

Analytic Notes

Options on Bonds (Cash) Models Black Scholes (0) and Cox-Rubenstein (1)

There are two main approaches to analyzing an option on a bond.

The first approach is the ‘Clean Price’ approach. This uses the simple, non-discrete dividend, functions while setting the ‘Underlying Instrument Price’ to the current clean price of the bond, setting the ‘Strike Price’ to the clean strike price of the option, and setting the ‘External Force of Discount’ to the current yield of the bond (coupon divided by price). This approach is applicable to both European and American style options.

The second approach is ‘Dirty Price (including accrued)’ approach. This approach is applicable only to European style options. This uses the simple, non-discrete dividend, functions while setting the ‘Underlying Instrument Price’ to the current dirty price of the bond, setting the ‘Strike Price’ to the dirty strike price of the option, and setting the ‘External Force of Discount’ to zero. If the bond pays one or more coupons before expiry of the option, the present value of the coupon should be deducted from the ‘Underlying Instrument Price’. The Yield Add-in could be used to calculate the dirty prices.

This ‘Dirty Price’ approach is more accurate than the ‘Clean Price’ approach since it takes into account the reinvestment income from the accrued of the bond. The ‘Clean Price’ approach can however be modified to take this into account by first calculating the forward price of the bond, then calculating the ‘External Force of Discount’ which would create that forward price.

Historical Volatility

To calculate the historical volatility of a series, the series would first be transformed into a natural log series, by dividing each data item in the series by the previous data item, and taking the natural log of this number (i.e. using =LN( ) function). With this new series, the volatility can be calculated using the standard deviation function, i.e. =STDEV( ) / =STDEVP( ), in Excel.

The volatility needs to be annualized. Thus, if the series is a daily series, the volatility would be multiplying by the square root of the number of business days per year, e.g. =SQRT(252) if you assume there are 252 business days per year.

It is thus possible to creating a historical volatility graph, using a variable time window.

Short Term Interest Rate

This is the continuously compounded risk free interest rate to the maturity of the option. It is thus necessary to convert any simple money market interest rate to the continually compounded rate. The following formula can be used :

$$\text{countinously compounded rate} = \frac{LN\left(1 + \text{money market rate} \times T^{*}\right)}{\text{time to maturity}}$$

where T^* = days to maturity / money market days per annum.

If days to maturity is greater than 365, use 365 in formula, and set time to maturity to 1.

Example

If,
T* = 182/360 (if money market rate is quoted 360 basis),
time to maturity = 182/365 (or division by 365.25 for leap years) and
money market rate = 8%

then the

continuously compounded rate = 7.95%