OptVal Function Library: Documentation

Version 10.3

NO WARRANTY

The OptVal Function Library is a suite of Microsoft Office Excel VBA add-ins that can be used to value and measure the risk of exchange-traded and over-the-counter (OTC) derivatives contracts. By downloading and installing the OptVal Function Library, you are agreeing to be bound by the following agreement:

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DESCRIPTION

The OptVal Function Library is a set of Microsoft Excel Add-Ins designed to value and measure the risk of hundreds of different exchange-traded and over-the-counter (OTC) derivatives contracts.

This documentation describes how to use the different valuation and risk measurement functions contained in the Library.

PROGRAM USE

The easiest way to understand how to apply the OptVal functions is to double click on the the OV Library desktop icon. Once in Excel, open the Excel file, OPTVAL Standard option valuation.xlsx, which is contained in the subdirectory where you installed OptVal. The Excel file has two worksheets that demonstrate the application of the OptVal Function Library routines—one Protected and the other Unprotected. The Protected sheet does not permit editing other than for the input parameters on the left hand-side of the page. The Unprotected sheet permits editing of all fields so as to allow the user to experiment with the different valuation functions.

Below is the Protected sheet with the default input parameters. Note that the highlighted box has a reported European-style call option value of 4.2005. The syntax for this function call is

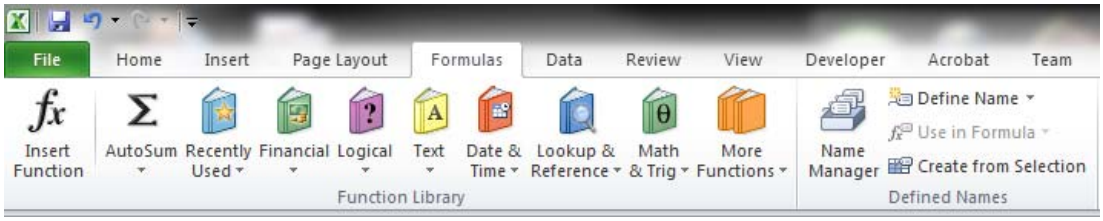
OV_OPTION_VALUE(s,x,t,r,i,v,cp,ae)

where the option is computed based on the asset price (s), the option's exercise price (x) and time remaining to expiration expressed in years (t), the risk-free interest rate expressed as an annualized rate (r), the income rate (i) and the volatility rate of the underlying asset, a call/put indicator variable (cp), and an American/European-style option indicator variable (ae).

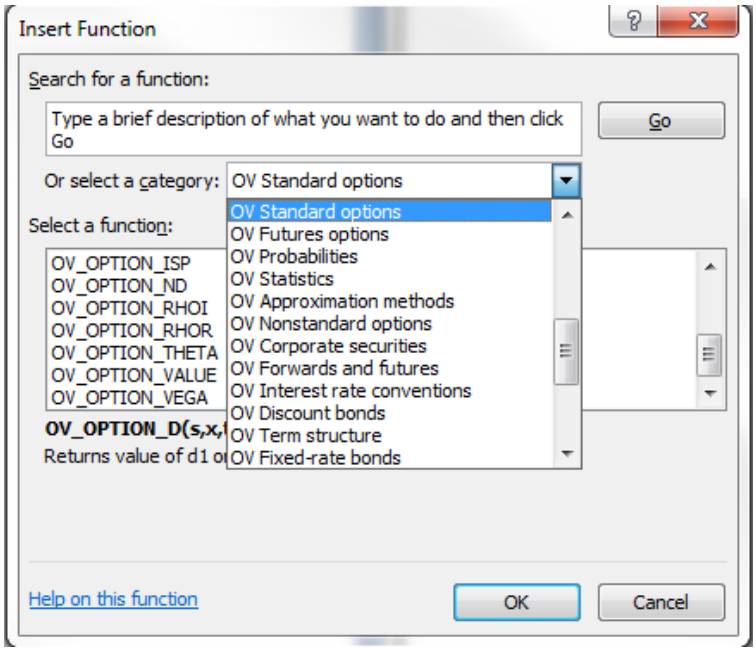
F5 =OV_OPTION_VALUE(C3,C11,C12,C8,C4,C5,F3,F4)

	A	B	C	D	E	F	G	H	I
1	Standard Black-Scholes (1973)/Merton (1973) option valuation								
2		***Asset***				***Option type/Option style***			
3		Price	100		(C)all/(P)ut	C	C	P	P
4		Income rate	3%		(E)ur/(A)m	E	A	E	A
5		Volatility rate	20%		Value	4.2005	4.2006	3.7055	3.7437
6					Delta	0.5358	0.5358	-0.4567	-0.4622
7		***Market***			Eta	12.7554	12.7554	-12.3258	-12.3448
8		Interest rate	5%		Gamma	0.0394	0.0394	0.0394	0.0402
9					Rhor - r	12.3447	12.3376	-12.3447	-10.2674
10		***Option parameters***			Rhor - i	-13.3949	-13.3825	11.4183	9.6899
11		Exercise price	100		Vega	19.6993	19.7006	19.6993	19.7006
12		Years to expiration	0.25		Theta	8.7413	8.7418	6.7810	6.9906
13					Implied volatility	0.2000	0.2000	0.2000	0.2000
14					Implied asset price	100.0000	100.0000	100.0000	100.0000

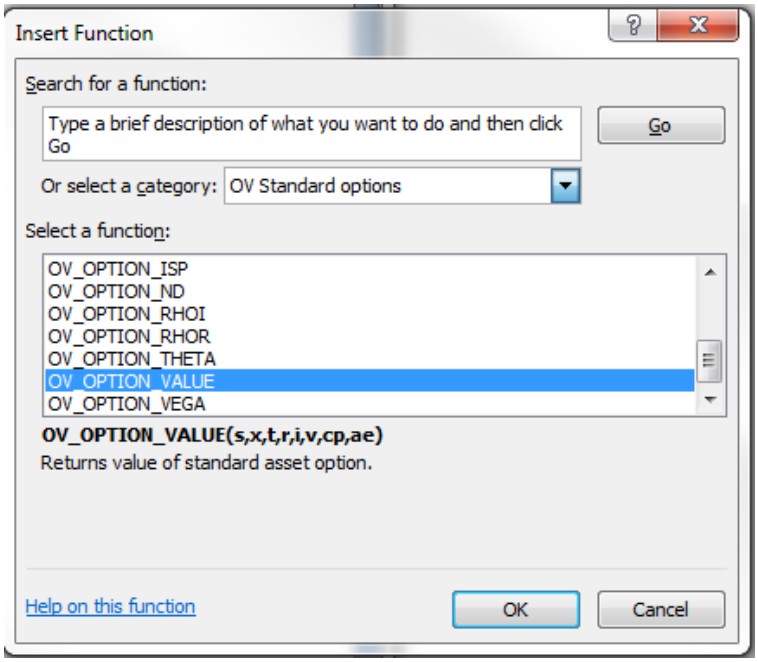
To understand how to call such functions from the OptVal Function Library, place the cursor Formulas in the menu bar.



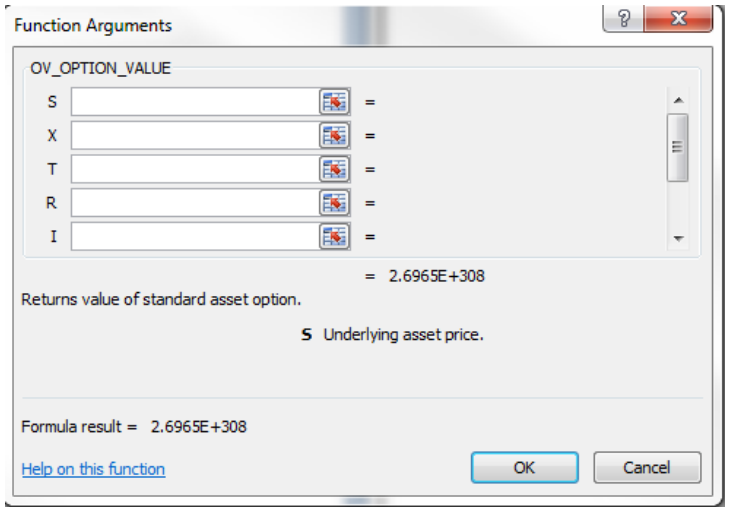
Click the Insert Function button at the top left hand-side of the page. The menu below will appear. In the window to the right of the label Or select a category:, select either RPI futures or RPI options, which include the valuation/risk functions for RPI futures and RPI options, respectively. Click OK.



If you click OV Standard options category, the different functions appear in the list to the left. Choose from the list (e.g., OV_OPTION_VALUE).



After a particular function is called, the User is prompted for the necessary input parameters (or Function Arguments, as Excel refers to them).



The function categories together with the list of functions contained within each category are contained in the following pages.

FUNCTION CATEGORIES

OV Approximation methods

OV_APPROX_ACCRUAL_OPT_MC(s,lower,upper,payt,t,r,i,v,n,ntrial)

Returns Monte Carlo simulation-generated value of accrual option on asset given asset price (s), lower (lower) and upper (upper) bounds on asset price range, payment amount if within range (payt), time remaining to expiration (t), risk-free interest rate (r), asset income rate (i), asset volatility rate (v), number of time steps (n), and number of simulation runs (ntrial). All rates are annualized and in decimal form, and time to expiration is measured in years. Asset price is assumed to be log-normally distributed.

OV_APPROX_ASIAN_OPT_MC (s,x,t,r,i,v,n,ntrial,cp,sx,ag)

Returns Monte Carlo simulation-generated value of Asian option on asset given asset price (s), exercise price (x), time to expiration (t), risk-free interest rate (r), asset income rate (i), asset volatility rate (v), number of time steps (n), number of simulation runs (ntrial), call/put indicator variable (cp), asset price/exercise price indicator variable (sx), and arithmetic/geometric average indicator (ag). Call/put indicator is set to "C" or "c" for call and "P" or "p" for put. Asset price/exercise average price indicator variable is set to "s" or "S" for asset price and "x" or "X" for exercise price. Arithmetic/geometric average price indicator is set to "a" or "A" for arithmetic average and "g" or "G" for geometric average. All rates are

annualized and in decimal form, and time to expiration is measured in years. Asset price is assumed to be log-normally distributed. Values European-style options only.

OV_APPROX_MAXMIN_OPT_MC (s1,s2,x,t,r,i1,i2,v1,v2,rho,n,ntrial,cp,ae,mm)

Returns Monte Carlo simulation-generated value of option on minimum or maximum of two asset prices given current asset prices (s1 and s2), exercise price (x), time to expiration (t), risk-free interest rate (r), asset income rates (i1 and i2), asset volatility rates (v1 and v2), correlation between asset returns (rho), number of time steps per simulation run (n), number of simulation runs (ntrial), call/put indicator variable (cp), European-/American-style option indicator variable (ae), and arithmetic/geometric average indicator (ag), and maximum/minimum indicator variable (mm). Call/put indicator is set to "C" or "c" for call and "P" or "p" for put. European-/American-style option indicator is set to "e" or "E" for European-style and "a" or "A" for American-style. Maximum/minimum indicator is set to "x" or "X" for maximum and "n" or "N" for minimum. All rates are annualized and in decimal form, and time to expiration is measured in years. Asset prices are assumed to be log-normally distributed.

OV_APPROX_SPRD_OPT_BIN(s1,s2,x,t,r,i1,i2,v1,v2,rho,n,cp,ae)

Returns binomial method-generated value of option on spread between two asset prices given current asset prices (s1 and s2), exercise price (x), time to expiration (t), risk-free interest rate (r), asset income rates (i1 and i2), asset volatility rates (v1 and v2), correlation between asset returns (rho), number of time steps (n), call/put indicator variable (cp), and European-/American-style option indicator variable (ae). Call/put indicator is set to "C" or "c" for call and "P" or "p" for put. European-/American-style option indicator is set to "e" or "E" for European-style and "a" or "A" for American-style. All rates are annualized and in decimal form, and time to expiration is measured in years. Asset prices are assumed to be log-normally distributed. Uses Boyle, Evnine and Gibbs (1989) binomial method.

OV_APPROX_SPRD_OPT_MC(s1,s2,x,t,r,i1,i2,v1,v2,rho,n,ntrial,cp)

Returns Monte Carlo-simulation-generated value of option on spread between two asset prices given current asset prices (s1 and s2), exercise price (x), time to expiration (t), risk-free interest rate (r), asset income rates (i1 and i2), asset volatility rates (v1 and v2), correlation between asset returns (rho), number of time steps (n), number of simulation runs (ntrial), and call/put indicator variable (cp). Call/put indicator
is set to "C" or "c" for call and "P" or "p" for put. All rates are annualized and in decimal form, and time to expiration is measured in years. Asset prices are assumed to be log-normally distributed. Values European-style spread option only.

OV_ APPROX_STD_OPT_BIN(s,x,t,r,i,v,n,cp,ae,mthd)

Returns binomial method-generated value of standard asset option given current asset price (s), exercise price (x), time to expiration (t), risk-free interest rate (r), asset income rate (i), asset volatility rate (v), number of time steps (n), call/put indicator variable (cp), European-/American-style option indicator variable (ae), and binomial method type indicator (mthd). Call/put indicator is set to "C" or "c" for call and "P" or "p" for put. European-/American-style option indicator is set to "e" or "E" for European-style and "a" or "A" for American-style. Method indicator is set to 1 for Cox, Ross and Rubinstein (1979) corrected coefficients, 2 for Jarrow and Rudd (1983) coefficients, and 3 for Cox, Ross and Rubinstein (1979) approximate coefficients. All rates are annualized and in decimal form, and time to expiration is measured in years. Asset price is assumed to be log-normally distributed.

OV_APPROX_STD_OPT_BIN_BND(s,bnd,x,t,r,i,v,n,cp,ae,mthd)

Returns binomial method-generated value of standard asset option with maximum/minimum asset price bound given current asset price (s), maximum/minimum price bound at which the option is exercised immediately (bnd), exercise price (x), time to expiration (t), risk-free interest rate (r), asset income rate (i), asset volatility rate (v), number of time steps (n), call/put indicator variable (cp), European-/American-style option indicator variable (ae), and binomial method type indicator (mthd). Call/put indicator is set to "C" or "c" for call and "P" or "p" for put. European-/American-style option indicator is set to "e" or "E" for European-style and "a" or "A" for American-style. Method indicator is set to 1 for Cox, Ross and Rubinstein (1979) corrected coefficients, 2 for Jarrow and Rudd (1983) coefficients, and 3 for Cox, Ross and Rubinstein (1979) approximate coefficients. All rates are annualized and in decimal form, and time to expiration is measured in years. Asset price is assumed to be log-normally distributed. Bound is maximum for call and minimum for put.

OV_ APPROX_STD_OPT_BIN_FUGIT(s,x,t,r,i,v,n,cp,ae,mthd)

Returns binomial method-generated expected time to early exercise for standard asset option given current asset price (s), exercise price (x), time to expiration (t), risk-free interest rate (r), asset income rate (i), asset volatility rate (v), number of time steps (n), call/put indicator variable (cp), European-/American-style option indicator variable (ae), and binomial method type indicator (mthd). Call/put indicator is set to "C" or "c" for call and "P" or "p" for put. European-/American-style option indicator is set to "e" or "E" for European-style and "a" or "A" for American-style. Method indicator is set to 1 for Cox, Ross and Rubinstein (1979) corrected coefficients, 2 for Jarrow and Rudd (1983) coefficients, and 3 for Cox, Ross and Rubinstein (1979) approximate coefficients. All rates are annualized and in decimal form, and time to expiration is measured in years. Asset price is assumed to be log-normally distributed.

OV_ APPROX_STD_OPT_MC(s,x,t,r,i,v,n,ntrial,cp)

Returns Monte Carlo simulation-generated value of standard asset option given current asset price (s), exercise price (x), time to expiration (t), risk-free interest rate (r), asset income rate (i), asset volatility rate (v), number of time steps (n), number of simulation runs (ntrial), and call/put indicator variable (cp). Call/put indicator is set to "C" or "c" for call and "P" or "p" for put. All rates are annualized and in decimal form, and time to expiration is measured in years. Asset price is assumed to be log-normally distributed. Values European-style options only.

OV_ APPROX_STD_OPT_TRI (s,x,t,r,i,v,n,lambda,cp,ae)

Returns trinomial method-generated value of standard asset option given current asset price (s), exercise price (x), time to expiration (t), risk-free interest rate (r), asset income rate (i), asset volatility rate (v), number of time steps (n), lambda (lambda), call/put indicator variable (cp), and European-/American-style option indicator variable (ae). Call/put indicator is set to "C" or "c" for call and "P" or "p" for put. European-/American-style option indicator is set to "e" or "E" for European-style and "a" or "A" for American-style. All rates are annualized and in decimal form, and time to expiration is measured in years. Asset price is assumed to be log-normally distributed. Uses Kamrad and Ritchken (1991) trinomial method. Lambda is number greater than or equal to 1. At 1, probability of mid-step is 0, trinomial method is equivalent to binomial method. At lambda = sqrt(2), probability of mid-step is ½. At lambda = 1.22474, probability of mid-step is 1/3, and at lambda = sqrt(3), probability is 2/3.

OV Asset

OV_ASSET_EV(s,x,t,alpha,v,ab)

Returns expected asset price conditional upon asset price being above or below threshold level (x) at end of investment horizon (t) given current asset price (s), expected rate of price appreciation (alpha), volatility rate (v), and above/below indicator (ab). Indicator variable is set to "A" or "a" for above threshold and "B" or "b" for below threshold. All rates are annualized and in decimal form, and investment horizon is measured in years. Asset price is assumed to be log-normally distributed at end of investment horizon.

OV_ASSET_PROB(s,x,t,alpha,v,ab)

Returns probability that asset price will be above or below threshold level (x) at end of investment horizon (t) given current asset price (s), expected rate of price appreciation (alpha), volatility rate (v), and above/below indicator (ab). Indicator variable is set to "A" or "a" for above threshold and "B" or "b" for below threshold. All rates are annualized and in decimal form, and investment

horizon is measured in years. Asset price is assumed to be log-normally distributed at end of investment horizon.

OV_ASSET_PROB_INV(s, t,alpha,v,ab,prob)

Returns critical threshold level at end of investment horizon (t) given current asset price (s), expected rate of price appreciation (alpha), volatility rate (v), above/below indicator (ab), and probability of being above or below. Indicator variable is set to "A" or "a" for above threshold and "B" or "b" for below threshold. All rates are annualized and in decimal form, and investment horizon is measured in years. Asset price is assumed to be log-normally distributed at end of investment horizon.

OV Bonds - Conventions

OV_IR_CONV_ED_YIELD(rate,days)

Returns continuously compounded yield on Eurodollar time deposit given its nominal yield rate (rate) and days to maturity (days). All rates are annualized and in decimal form.

OV_IR_CONV_REPO_YIELD (rate,days)

Returns continuously compounded yield on standard repurchase agreement (repo) given its nominal interest rate (rate) and days to maturity. All rates are annualized and in decimal form.

OV_IR_CONV_TBILL_PRICE(disc,days)

Returns price of T-bill given its discount (disc) and days to maturity (days). Discount is dollar discount from 100, and all rates are annualized and in decimal form.

OV_IR_CONV_TBILL_YIELD (disc,days)

Returns continuously compounded yield on T-bill given its stated discount (disc) and number of days between settlement date and maturity date (days). All rates are annualized and in decimal form.

OV_IR_CONV_TBOND_CDTSF(prce)

Converts decimal price (prce) to price quoted in 64ths.

OV_IR_CONV_TBOND_CDTTS(prce)

Converts decimal price (prce) to price quoted in 32nds.

OV_IR_CONV_TBOND_CONVFAC(ncoup,ny,coup)

Returns conversion factor for U.S. Treasury bond deliverable on CBT's T-bond futures contract given stated annual coupon interest rate of nominal bond underlying futures contract expressed in decimal form (ncoup) (e.g., for CBT's T-bond futures contract, ncoup = .06), number of years from first delivery date on futures until bond's maturity date in decimal (ny), and deliverable bond's annualized coupon rate (coup).

OV_IR_CONV_TBOND_CSFTD(prce)

Converts price quoted in 64ths to decimal price.

OV_IR_CONV_TBOND_CTSTD(prce)

Converts price quoted in 32nds to decimal price.

OV Bonds - Floating rate

OV_IR_FLOAT_FIXED(fixed, npaytr, freq, nxtim, face, term, rate, vd)

Returns value/duration of fixed-rate bond given zero-coupon yield curve. Function arguments are annualized fixed rate (fixed), number of interest payments remaining (npaytr), frequency of interest payments per year (freq), time until next interest payment in years (nxtim), notional amount of bond (face), vector of terms to maturity of zero-coupon rates (term), vector of zero-coupon rates (rate), and value/duration indicator variable (vd). Indicator variable is set to "v" or "V" for bond value and "d" or "D" for bond duration. All rates are annualized and in decimal form. Accrued interest assume par value of 100. Dates expressed in Microsoft Excel format. If date fields are references to other formatted date cells, there is no need to convert to Microsoft serial number format.

OV_IR_FLOAT_FLOATING(reset, freq, nxtim, face, term, rate, vd)

Returns value/duration of floating-rate bond given zero-coupon yield curve. Function arguments are annualized interest rate at last reset date (reset), frequency of interest payments per year (freq), time until next interest payment in years (nxtim), notional amount of bond (face), vector of terms to maturity of zero-coupon rates (term), vector of zero-coupon rates (rate), and value/duration indicator variable (vd). Indicator variable is set to "v" or "V" for bond value and "d" or "D" for bond duration. All rates are annualized and in decimal form. Accrued interest assume par value of 100. Dates expressed in Microsoft Excel format. If date fields are references to other formatted date cells, there is no need to convert to Microsoft serial number format.

OV_IR_FLOAT_INVERSE(reset, fixed, npaytr, freq, nxtim, face, term, rate, vd)

Returns value/duration of an inverse floater given zero-coupon yield curve. Function arguments are annualized interest rate of inverse floater at last reset date (reset), annualized fixed rate (fixed), number of interest payments remaining (npaytr), frequency of interest payments per year (freq), time until next interest payment in years (nxtim), notional amount of bond (face), vector of terms to maturity of zero-coupon rates (term), vector of zero-coupon rates (rate), and value/duration indicator variable (vd). Indicator variable is set to "v" or "V" for bond value and "d" or "D" for bond duration. All rates are annualized and in decimal form. Accrued interest assume par value of 100. Dates expressed in Microsoft Excel format. If date fields are references to other formatted date cells, there is no need to convert to Microsoft serial number format.

OV_IR_FLOAT_SWAP_RATE (nyear, freq, term, rate)

Returns implied fixed rate on fixed-for-floating interest rate swap given zero-coupon yield curve. Function arguments are term of swap ion years (nyear), frequency of interest payments per year (freq), vector of terms to maturity of zero-coupon rates (term), and vector of zero-coupon rates (rate). All rates are annualized and in decimal form.

OV_IR_FLOAT_SWAP_VALUE(fixed,reset,npaytr,freq,nxtim,face,term,rate,vd)

Returns value/duration of fixed-for-floating interest rate swap given zero-coupon yield curve. Function arguments are annualized fixed rate (fixed), annualized interest rate of floating-rate leg at last reset date (reset), number of interest payments remaining (npaytr), frequency of interest payments per year (freq), time until next interest payment in years (nxtim), notional amount of swap (face), vector of terms to maturity of zero-coupon rates (term), vector of zero-coupon rates (rate), and value/duration indicator variable (vd). Indicator variable is set to "v" or "V" for bond value and "d" or "D" for bond duration. All rates are annualized and in decimal form.

OV Bonds - Fixed rate

OV_IR_FIXED_AI(ndt,lcpn,ncpn,coup)

Returns accrued interest to date on coupon-bearing bond given current (settlement) date, last coupon date (lcpn), next coupon date (ncpn), and coupon interest rate (coupon). All rates are are annualized and in decimal form. Accrued interest is based on par value of 100. Dates expressed in Microsoft format. If date fields are references to other formatted date cells, there is no need to convert to Microsoft serial number format.

OV_IR_FIXED_NCOUPSR(ncpn,mdat)

Returns number of coupons remaining on coupon-bearing bond given next coupon payment date (ncpn), and maturity date (mdt). Dates expressed in Microsoft format. If date fields are references to other formatted date cells, there is no need to convert to Microsoft serial number format.

OV_IR_FIXED_NDAYSNC(ndt, ncpn)

Returns number of days until next coupon payment given current (settlement) date (ndt), and next coupon payment date (ncpn). Dates expressed in Microsoft format. If date fields are references to other formatted date cells, there is no need to convert to Microsoft serial number format.

OV_IR_FIXED_YLD(coup, freq, face, tb, ncoupr, yld, vdc)

Returns value, duration and/or convexity of fixed-rate bond given coupon interest rate in decimal (coup), number of coupon payments per year (freq), face value of bond (face), time until next coupon payment (tb), number of coupons remaining during bond's life (ncoupr), yield to maturity (yld), and value/duration/convexity indicator variable (vdc). Indicator is set to “v” or “V” for bond value, “d” or “D” for duration, and/or “c” or “C” returns convexity. All rates are annualized and in decimal form. Yield to maturity is continuous rate. Dates expressed in Microsoft Excel format. If date fields are references to other formatted date cells, there is no need to convert to Microsoft serial number format.

OV_IR_FIXED_YLD_DATE (ndt, nxtcpn, coup, freq, face, mdt, yld, vdc)

Returns value (including accrued interest), duration, and/or convexity of fixed-rate bond given current (settlement) date, next coupon date, next coupon date (nxtcpn), coupon interest rate in decimal (coup), number of coupon payments per year (freq), face value of bond (face), maturity date (mdt), yield to maturity (yld), and value/duration/convexity indicator variable (vdc). Indicator is set to “v” or “V” for bond value, “d” or “D” for duration, and/or “c” or “C” returns convexity. All rates are annualized and in decimal form. Yield to maturity is continuous rate. Dates expressed in Microsoft Excel format. If date fields are references to other formatted date cells, there is no need to convert to Microsoft serial number format.

OV_IR_FIXED_YLD_DATE_YIELD(ndt, nxtcpn, coup, freq, face, mdt, bprce)

Returns yield to maturity of fixed-rate bond given current (settlement) date, next coupon date, next coupon date (nxtcpn), coupon interest rate in decimal (coup), number of coupon payments per year (freq), face value of bond (face), maturity date (mdt), yield to maturity (yld), and current (settlement) bond price (bprce). All rates are annualized and in decimal form. Yield to maturity is continuous rate. Dates expressed in Microsoft Excel format. If date fields are references to other formatted date cells, there is no need to convert to Microsoft serial number format.

OV_IR_FIXED_YLD_YIELD(coup, freq, face, tb, ncoupr, bprce)

Returns yield to maturity of fixed-rate bond given coupon interest rate in decimal (coup), number of coupon payments per year (freq), face value of bond (face), time until next coupon payment (tb), number of coupons remaining during bond's life (ncoupr), yield to maturity (yld), and current (settlement) bond price (bprce). All rates are annualized and in decimal form. Yield to maturity is continuous rate. Dates expressed in Microsoft Excel format. If date fields are references to other formatted date cells, there is no need to convert to Microsoft serial number format.

OV_IR_FIXED_ZC(coup, freq, face, tb, ncoupr, term, rate, vdc)

Returns value, duration and/or convexity of fixed-rate bond given coupon interest rate in decimal (coup), number of coupon payments per year (freq), face value of bond (face), time until next coupon payment (tb), number of coupons remaining during bond's life (ncoupr), vector of terms to maturity of zero-coupon bonds (term), vector of of zero-coupon rates (rate), and value/duration/convexity indicator variable (vdc), Indictor variable is set to “v” or “V” for bond value, “d” or “D” for duration, and/or “c” or “C” for convexity. Rates are annualized and in decimal form. Zero-coupon rates are continuously compounded. Dates expressed in Microsoft Excel format. If date fields are references to other formatted date cells, there is no need to convert to Microsoft serial number format.

OV_IR_FIXED_ZC_DATE (ndt, nxtcpn, coup, freq, face, mdt, term, rate,vdc)

Returns value (including accrued interest), duration, and/or convexity of fixed-rate bond given current (settlement) date (ndt), next coupon date (nxtcpn), coupon interest rate (coup), number of coupon payments per year (freq), face value of bond (face), maturity date (mdt), vector of terms to maturity of zero-coupon bonds (term), vector of zero-coupon rates (rate), and value/duration/convexity indicator variable. Indicator variable is set to “v” or “V” for bond value, “d” or “D” for duration, and “c” or “C” for convexity. All rates are annualized and in decimal form. Zero-coupon rates are continuously compounded. Dates expressed in Microsoft Excel format. If date fields are references to other formatted date cells, there is no need to convert to Microsoft serial number format.

OV Commodity swaps

OV_SWAP_COMMODITY(t, f, r, vdr)

Returns value/discount factor sum/fixed-rate of fixed-for-floating commodity swap with uniform delivery quantities given time to payment vector (t), forward price vector (f), zero-coupon yield curve (r), and return

value indicator variable (vdr). Indicator variable is set to "V" or "v" for commodity swap value, "D" or "d" for sum of discount factors, and "R" or "r" for fixed rate. All rates are annualized and in decimal form and time to expiration is measured in years.

OV_SWAP_COMMODITY_QUANTITY(t, f, r, quan, vdr)

Returns value/discount factor sum/fixed-rate of fixed-for-floating commodity swap with time-varying delivery quantities given time to payment vector (t), forward price vector (f), zero-coupon yield curve (r), quantity vector (quan), and return value indicator variable (vdr). Indicator variable is set to "V" or "v" for commodity swap value, "D" or "d" for sum of discount factors, and "R" or "r" for fixed rate. All rates are annualized and in decimal form and time to expiration is measured in years.

OV Currency swaps

OV_SWAP_CURRENCY (t, f, r, vdr)

Returns value/discount factor sum/fixed-rate of fixed-for-floating currency swap with uniform delivery quantities given time to payment vector (t), forward currency rate vector (f), zero-coupon yield curve (r), and return value indicator variable (vdr). Indicator variable is set to "V" or "v" for commodity swap value, "D" or "d" for sum of discount factors, and "R" or "r" for fixed rate. All rates are annualized and in decimal form and time to expiration is measured in years.

OV_SWAP_CURRENCY_QUANTITY(t, f, r, quan, vdr)

Returns value/discount factor sum/fixed-rate of fixed-for-floating currency swap with time-varying delivery quantities given time to payment vector (t), forward currency rate vector (f), zero-coupon yield curve (r), quantity vector (quan), and return value indicator variable (vdr). Indicator variable is set to "V" or "v" for commodity swap value, "D" or "d" for sum of discount factors, and "R" or "r" for fixed rate. All rates are annualized and in decimal form and time to expiration is measured in years.

OV Corporate securities

OV_CORP_BOND_FIRM(firm,face,t,r,vf,vind)

Returns value/volatility rate of zero-coupon corporate bond given firm value (firm), face value of bond (face), term to maturity of bond (t), risk-free interest rate (r), firm volatility rate (vf), and value/volatility indicator variable (vind). Indicator variable is set to "1" to return bond value and "2" to return

bond volatility rate. All rates are annualized and in decimal form, and term to maturity is measured in years. Firm value is assumed to be log-normally distributed at end of bond's life.

OV_CORP_BONDDELTA_FIRM(firm,face,t,r,vf,gind)

Returns delta/eta of zero-coupon corporate bond given firm value (firm), face value of bond (face), term to maturity of bond (t), risk-free interest rate (r), firm volatility rate (vf), and delta/eta indicator variable (gind). Delta/eta indicator variable is set to "d" or "D" to return delta and "e" or "E" to return eta. All rates are annualized and in decimal form, and term to maturity is measured in years. Firm value is assumed to be log-normally distributed at end of bond's life.

OV_CORP_BOND_STOCK(stock,face,t,r,vs,vind)

Returns value/volatility rate of zero-coupon corporate bond given stock value (stock), face value of bond (face), term to maturity of bond (t), risk-free interest rate (r), stock volatility rate (vs), and value/volatility indicator variable (vind). Value/volatility indicator variable is set to "1" to return bond value and "2" to return bond volatility rate. All rates are annualized and in decimal form, and term to maturity is measured in years. Firm value is assumed to be log-normally distributed at end of bond's life.

OV_CORP_CREDIT_SPREAD(face,bv,t,r,cy)

Returns credit spread or yield to maturity of zero-coupon corporate bond given face value of bond (face), market price of bond (bv), term to maturity of bond (t), risk-free interest rate (r), and spread/yield indicator variable (cy). Spread/yield indicator variable is set to "c" or "C" to return credit spread and "y" or "Y" to return yield to maturity. All rates are annualized and in decimal form, and term to maturity is measured in years. Firm value is assumed to be log-normally distributed at end of bond's life.

OV_CORP_CVBOND_FIRM(firm,ns,ncb,face,t,r,vf,vind)

Returns value/volatility rate of zero-coupon convertible bond given firm value (firm), number of shares of stock outstanding (ns), number of shares underlying convertible bond (ncb), face value of convertible bond (face), term to maturity of convertible bond (t), risk-free interest rate (r), firm volatility rate (vf), and convertible bond value/volatility indicator variable (vind). Indicator variable is set to "1" to return convertible bond value and "2" to return convertible bond volatility rate. All rates are annualized and in decimal form, and term to maturity is measured in years. Firm value is assumed to be log-normally distributed at end of bond's life.

OV_CORP_CVBOND_STOCK (stock,ns,ncb,face,t,r,vs,vind)

Returns value/volatility rate of zero-coupon convertible bond given aggregate value of stock (stock), number of shares of stock outstanding (ns), number of

shares underlying convertible bond (ncb), face value of convertible bond (face), term to maturity of convertible bond (t), risk-free interest rate (r), stock volatility rate (vs), and convertible bond value/volatility indicator variable (vind). Indicator variable is set to "1" to return convertible bond value and "2" to return convertible bond volatility rate. All rates are annualized and in decimal form, and term to maturity is measured in years. Firm value is assumed to be log-normally distributed at end of bond's life.

OV_CORP_CVBONDDELTA_FIRM(firm,ns,ncb,face,t,r,vf,gind)

Returns delta/eta of zero-coupon convertible bond given firm value (firm), number of shares of stock outstanding (ns), number of shares underlying convertible bond (ncb), face value of convertible bond (face), term to maturity of convertible bond (t), risk-free interest rate (r), firm volatility rate (vf), and convertible bond delta/eta indicator variable (gind). Delta/eta indicator variable is set to "d" or "D" to return delta and "e" or "E" to return eta. All rates are annualized and in decimal form, and term to maturity is measured in years. Firm value is assumed to be log-normally distributed at end of bond's life.

OV_CORP_DEFAULT_PREMIUM(firm,face,t,r,vf)

Returns default premium of zero-coupon corporate bond given firm value (firm), face value of bond (face), term to maturity of convertible bond (t), risk-free interest rate (r), and firm volatility rate (vf). All rates are annualized and in decimal form, and term to maturity is measured in years. Firm value is assumed to be log-normally distributed at end of bond's life.

OV_CORP_EXPECTED_LOSS(firm,face,t,alpha,vf)

Returns expected loss on zero-coupon corporate bond given firm value (firm), face value of bond (face), term to maturity of bond (t), expected rate of value appreciation of firm (alpha), and firm volatility rate (vf). All rates are annualized and in decimal form, and term to maturity is measured in years. Firm value is assumed to be log-normally distributed at end of bond's life.

OV_CORP_EXPECTED_RETURN(r,efr,eta)

Returns expected security return given risk-free interest rate (r), expected firm return (efr), and security eta (eta). All rates are annualized and in decimal form. Expected returns are computed based on their risk relative to expected return on firm.

OV_CORP_FIRM_STOCK(stock,face,t,r,vs,vind)

Returns firm value/volatility rate given stock value (stock), face value of zero-coupon bond (face), term to maturity of bond (t), risk-free interest rate (r), stock volatility rate (vs), and value/volatility indicator variable (vind). Value/volatility indicator variable is set to "1" to return firm value and "2" to return firm volatility rate. All rates are annualized and in decimal form, and

term to maturity is measured in years. Firm value is assumed to be log-normally distributed at end of bond's life.

OV_CORP_FIRM_STOCK_CVBOND(stock,ns,ncb,face,t,r,vs,vind)

Returns firm value/volatility rate given stock value (stock), number of shares of stock outstanding (ns), number of shares underlying convertible bond (ncb), face value of zero-coupon bond (face), term to maturity of bond (t), risk-free interest rate (r), stock volatility rate (vs), and value/volatility indicator variable (vind). Value/volatility indicator variable is set to "1" to return firm value and "2" to return firm volatility rate. All rates are annualized and in decimal form, and term to maturity is measured in years. Firm value is assumed to be log-normally distributed at end of bond's life.

OV_CORP_OPTION_FIRM (firm,face,t,r,vf,cp,x,topt)

Returns stock option value given firm value (firm), face value of zero-coupon corporate bond (face), term to maturity of bond (t), risk-free interest rate (r), firm volatility rate (vf), call/put indicator variable (cp), exercise price (x), and time to expiration of option (topt). Indicator variable is set to "c" or "C" for call and "p" or "P" for put. All rates are annualized and in decimal form, and term to maturity is measured in years. Firm value is assumed to be log-normally distributed at end of bond's life.

OV_CORP_PROB_DEFAULT (firm, face,t,alpha,vf)

Returns probability of default of zero-coupon corporate bond given firm value (firm), face value of zero-coupon bond (face), term to maturity of bond (t), expected rate of value appreciation of firm (alpha), and firm volatility rate (vf). All rates are annualized and in decimal form, and term to maturity is measured in years. Firm value is assumed to be log-normally distributed at end of bond's life.

OV_CORP_RECOVERY_VALUE(firm, face,t,alpha,vf)

Returns expected recovery value of zero-coupon corporate bond given firm value (firm), face value of zero-coupon bond (face), term to maturity of bond (t), expected rate of value appreciation of firm (alpha),
and firm volatility rate (vf). All rates are annualized and in decimal form, and term to maturity is measured in years. Firm value is assumed to be log-normally distributed at end of bond's life.

OV_CORP_RFBOND_STOCK_WEIGHTS(firm,face,t,alpha,vf,wind)

Returns dynamic replication weights for risk-free bond and stock that replicates zero-coupon corporate bond given firm value (firm), face value of bond (face), term to maturity of convertible bond (t), expected rate of value appreciation of firm (alpha), firm volatility rate (vf), and weight indicator variable. Weight indicator variable is set to "1" to return weight on risk-free bonds and "2" to return weight on stock. All rates are annualized and in

decimal form, and term to maturity is measured in years. Firm value is assumed to be log-normally distributed at end of bond's life.

OV_CORP_RFBOND_VALUE(face,t,r)

Returns value of risk-free, zero-coupon bond given face value of bond (face), term to maturity of convertible bond (t), and risk-free interest rate (r). All rates are annualized and in decimal form, and term to maturity is measured in years.

OV_CORP_STOCK_FIRM(firm,face,t,r,vf,vind)

Returns stock value/volatility rate given firm value (firm), face value of zero-coupon corporate bond (face), term to maturity of bond (t), risk-free interest rate (r), firm volatility rate (vf), and value/volatility indicator variable (vind). Value/volatility indicator variable is set to "1" if stock value is returned and "2" if stock volatility rate is returned. All rates are annualized and in decimal form, and term to maturity is measured in years. Firm value is assumed to be log-normally distributed at end of bond's life.

OV_CORP_STOCKDELTA_FIRM(firm,face,t,r,vf,gind)

Returns stock delta/eta given firm value (firm), face value of zero-coupon corporate bond (face), term to maturity of bond (t), risk-free interest rate (r), firm volatility rate (vf), and delta/eta indicator variable (gind). Delta/eta indicator variable is set to "d" or "D" for stock delta and "e" or "E" for stock eta. All rates are annualized and in decimal form, and term to maturity is measured in years. Firm value is assumed to be log-normally distributed at end of bond's life.

OV_CORP_WARRANT_STOCK(s,ns,nw,x,t,r,v,vfs,vind)

Returns warrant value/volatility rate given stock price (s), number of shares outstanding (ns), number of warrants outstanding (nw), exercise price of warrant (x), time to expiration of warrant (t), risk-free interest rate (r), volatility rate of stock or firm (v), indicator variable identifying whether volatility rate is for stock or firm (vfs), and value/volatility indicator variable (vind). Volatility rate indicator variable is set to "s" or "S" for stock volatility rate and "f" or "F" for firm volatility rate. Value/volatility indicator variable is set to "1" to return warrant value and "2" to return warrant volatility rate. All rates are annualized and in decimal form, and time to expiration is measured in years. Firm value is assumed to be log-normally distributed at end of warrant's life.

OV_CORP_WARRANTDELTA_STOCK(s,ns,nw,x,t,r,v,vfs,gind)

Returns warrant delta/eta given stock price (s), number of shares outstanding (ns), number of warrants outstanding (nw), exercise price of warrant (x), time to expiration of warrant (t), risk-free interest rate (r), volatility rate of stock or firm (v), indicator variable identifying whether

volatility rate is for stock or firm (vfs), and delta/eta indicator variable (gind). Volatility rate indicator variable is set to "s" or "S" for stock volatility rate and "f" or "F" for firm volatility rate. Delta/eta indicator variable is set to "d" or "D" for warrant delta and "e" or "E" for warrant eta. All rates are annualized and in decimal form, and time to expiration is measured in years. Firm value is assumed to be log-normally distributed at end of warrant's life.

OV Futures

OV_FORWARD_DELTA(r,i,t)

Returns delta of forward/futures contract given risk-free interest rate (r), income rate (i), and time to expiration (t). All rates are annualized and in decimal form and time to expiration is measured in years.

OV_FORWARD_IB(s,f,t)

Returns implied cost of carry rate given underlying asset price (s), forward/futures price (f), and time to expiration (t). All rates are annualized and in decimal form and time to expiration is measured in years.

OV_FORWARD_II(s,f,r,t)

Returns implied income rate given underlying asset price (s), forward/futures price (f), risk-free interest rate (r), and forward/futures time to expiration (t). All rates are annualized and in decimal form and time to expiration is measured in years.

OV_FORWARD_IR(s,f,i,t)

Returns implied risk-free interest rate given underlying asset price (s), forward/futures price (f), income rate (i), and forward/futures time to expiration. All rates are annualized and in decimal form and time to expiration is measured in years.

OV_FORWARD_IS(f,r,i,t)

Returns implied asset price given forward/futures price (f), risk-free interest rate (r), income rate (i), and forward/futures time to expiration (t). All rates are annualized and in decimal form and time to expiration is measured in years.

OV_FORWARD_RHOI(s,r,i,t)

Returns income rate rho of forward/futures given asset price (s), risk-free interest rate (r), income rate (i), and forward/futures time to expiration (t). All rates are annualized and in decimal form and time to expiration is measured in years.

OV_FORWARD_RHOR (s,r,i,t)

Returns interest rate rho of forward/futures contract given underlying asset price (s), risk-free interest rate (r), income rate (i), and forward/futures time to expiration (t). All rates are annualized and in decimal form and time to expiration is measured in years.

OV_FORWARD_THETA(s,r,i,t)

Returns theta of forward/futures given asset price (s), risk-free interest rate (r), income rate (i), and forward/futures time to expiration (t). All rates are annualized and in decimal form and time to expiration is measured in years.

OV_FORWARD_VALUE(s,r,i,t)

Returns implied forward/futures price given underlying asset price (s), risk-free interest rate (r), income rate (i), and forward/futures time to expiration (t). All rates are annualized and in decimal form and time to expiration is measured in years.

OV_FORWARD_VALUE_DISCRETE(s, r, t, income, term, fp$)

Returns forward/futures price given underlying asset price (s), risk-free interest rate (r), forward/futures, time to expiration (t), vector of income receipts (income), vector of time to receipts (term), and forward or prepaid forward indicator variable (fp). Indicator variable is set to "F" or "f" for forward/futures price and "P" or "p" for prepaid forward/futures price. All rates are annualized and in decimal form and time to expiration is measured in years.

OV Futures options

OV_FOPTION_D(s,x,t,r,v,n)

Returns value of d1 or d2 in Black (1976) futures option valuation equation given underlying futures price (f), exercise price (x), time to expiration (t), risk-free interest rate (r), futures volatility rate (v), and indicator variable defining integral limit (n). All rates are annualized and in decimal form, and time to expiration is measured in years. The indicator variable is set to 1 for d1, -1 for -d1, 2 for d2, and -2 for -d2. All rates are annualized and in decimal form, and time to expiration is measured in years.

OV_FOPTION_DELTA(s,x,t,r,v,cp,ae)

Returns delta (i.e., change in option price resulting from change in futures price) of standard futures option given underlying futures price (f), exercise

price (x), time to expiration (t), risk-free interest rate (r), futures volatility rate (v), call put indicator variable, and European-/American-style option indicator variable (ae). Call/put indicator is set to "C" or "c" for call and "P" or "p" for put. Option style indicator is set to "E" or "e" for European-style and "A" or "a" for American-style. If European-style, result is computed using Black-Scholes (1973)/Merton (1973), and, if American-style, result is computed numerically using Barone-Adesi and Whaley (1987).

OV_FOPTION_ETA(s,x,t,r,v,cp,ae)

Returns eta (i.e., percentage change in option price resulting from percentage change in futures price or price elasticity) of standard futures option given underlying futures price (f), exercise price (x), time to expiration (t), risk-free interest rate (r), futures volatility rate (v), call put indicator variable, and European-/American-style option indicator variable (ae). Call/put indicator is set to "C" or "c" for call and "P" or "p" for put. Option style indicator is set to "E" or "e" for European-style and "A" or "a" for American-style. If European-style, result is computed using Black-Scholes (1973)/Merton (1973), and, if American-style, result is computed numerically using Barone-Adesi and Whaley (1987).

OV_FOPTION_GAMMA (s,x,t,r,v,cp,ae)

Returns gamma (i.e., change in delta resulting from change in futures price) of standard futures option given underlying futures price (f), exercise price (x), time to expiration (t), risk-free interest rate (r), futures volatility rate (v), call put indicator variable, and European-/American-style option indicator variable (ae). Call/put indicator is set to "C" or "c" for call and "P" or "p" for put. Option style indicator is set to "E" or "e" for European-style and "A" or "a" for American-style. If European-style, result is computed using Black (1976), and, if American-style, result is computed numerically using Barone-Adesi and Whaley (1987).

OV_FOPTION_ISD(s,x,t,r,op,cp,ae)

Returns option price-implied standard deviation rate (or volatility rate) of standard futures option given underlying futures price (f), exercise price (x), time to expiration (t), risk-free interest rate (r), option price (op), call put indicator variable, and European-/American-style option indicator variable (ae). Call/put indicator is set to "C" or "c" for call and "P" or "p" for put. Option style indicator is set to "E" or "e" for European-style and "A" or "a" for American-style. If European-style, result is computed
using Black (1976), and, if American-style, result is computed numerically using Barone-Adesi and Whaley (1987). Function returns value -99 if solution is infeasible.

OV_FOPTION_ISP(x,t,r,v,op,cp,ae)

Returns futures option price-implied futures price of standard futures option given exercise price (x), time to expiration (t), risk-free interest rate (r),

futures volatility rate (v), option price (op), call put indicator variable, and European-/American-style option indicator variable (ae). Call/put indicator is set to "C" or "c" for call and "P" or "p" for put. Option style indicator is set to "E" or "e" for European-style and "A" or "a" for American-style. If European-style, result is computed using Black (1976), and, if American-style, result is computed numerically using Barone-Adesi and Whaley (1987). Function returns value -99 if solution is infeasible.

OV_FOPTION_ND(s,x,t,r,v,n)

Returns value of N(d1) or N(d2) in Black (1976) futures option valuation equation given underlying futures price (f), exercise price (x), time to expiration (t), risk-free interest rate (r), futures volatility rate (v), and indicator variable defining integral limit (n). All rates are annualized and in decimal form, and time to expiration is measured in years. The indicator variable is set to 1 for N(d1), -1 for N(1d1), 2 for N(d2), and -2 for N(-d2). All rates are annualized and in decimal form, and time to expiration is measured in years.

OV_FOPTION_RHOR (s,x,t,r,v,cp,ae)

Returns interest rate rho (i.e., change in option price from change in risk-free interest rate) of standard futures option given underlying futures price (f), exercise price (x), time to expiration (t), risk-free interest rate (r), futures volatility rate (v), call put indicator variable, and European-/American-style option indicator variable (ae). Call/put indicator is set to "C" or "c" for call and "P" or "p" for put. Option style indicator is set to "E" or "e" for European-style and "A" or "a" for American-style. If European-style, result is computed using Black (1976), and, if American-style, result is computed numerically using Barone-Adesi and Whaley (1987).

OV_FOPTION_THETA(s,x,t,r,v,cp,ae)

Returns theta (i.e., change in option price resulting from change in time to expiration) of standard futures option given underlying futures price (f), exercise price (x), time to expiration (t), risk-free interest rate (r), futures volatility rate (v), call put indicator variable, and European-/American-style option indicator variable (ae). Call/put indicator is set to "C" or "c" for call and "P" or "p" for put. Option style indicator is set to "E" or "e" for European-style and "A" or "a" for American-style. If European-style, result is computed using Black (1976), and, if American-style, result is computed numerically using Barone-Adesi and Whaley (1987). Value of theta is positive, which implies option value falls as time to expiration is shortened.

OV_FOPTION_VALUE(s,x,t,r,v,cp,ae)

Returns value of standard futures option given underlying futures price (f), exercise price (x), time to expiration (t), risk-free interest rate (r), futures volatility rate (v), call put indicator variable, and European-/American-style option indicator variable (ae). Call/put indicator is set to "C" or "c" for call and

"P" or "p" for put. Option style indicator is set to "E" or "e" for European-style and "A" or "a" for American-style. If European-style, result is computed using Black (1976), and, if American-style, result is computed numerically using Barone-Adesi and Whaley (1987). Value of theta is positive, which implies option value falls as time to expiration is shortened.

OV_FOPTION_VEGA (s,x,t,r,v,cp,ae)

Returns vega (i.e., change in option price resulting from change in futures volatility rate) of standard futures option given underlying futures price (f), exercise price (x), time to expiration (t), risk-free interest rate (r), futures volatility rate (v), call put indicator variable, and European-/American-style option indicator variable (ae). Call/put indicator is set to "C" or "c" for call and "P" or "p" for put. Option style indicator is set to "E" or "e" for European-style and "A" or "a" for American-style. If European-style, result is computed using Black (1976), and, if American-style, result is computed numerically using Barone-Adesi and Whaley (1987).

OV Nonstandard options

OV_NS_ACCRUAL_OPTION(s,xlower,xupper,amount,td,tb,n,r,i,v)

Returns value of accrual option that pays fixed amount of cash at expiration each time asset finishes within price range on a particular date. Function arguments are asset price (s), lower asset price bound (xlower), upper asset price bound (xupper), time to first check (td), time between checks (tb), total number of checks (n), risk-free interest rate (r), asset income rate (i), and asset volatility rate (v). Rates are annualized and in decimal form. Time is measured in years.

OV_NS_ALL_OR_NOTHING_OPTION(s,x,t,r,i,v,cp,ac)

Returns value of all-or-nothing option. For asset-or-nothing option, value is per unit of asset price. For cash-or-nothing, value is per dollar. Function arguments are asset price (s), threshold price (x), time to expiration (t), risk-free interest rate (r),), asset income rate (i), asset volatility rate (v), call/put indicator (cp), and asset-or-nothing/cash-or-nothing option indicator. Call/put indicator is set to "C" or "c" for call and "P" or "p" for put. Asset-or-nothing/cash-or-nothing indicator is to "A" or "a" for asset-or-nothing option and "C" or "c" for cash-or-nothing option. Rates are annualized and in decimal form. Time to expiration is measured in years.

OV_NS_BARRIER_OPTION(s, x, h, t, rebate, r, i, v, TypeFlag$)

Returns value of European-style barrier options. Barrier option is option that comes into existence or terminates automatically when underlying asset

price touches pre-specified level. Down-and-out call, for example, is call that expires if asset price falls below pre-specified "out" barrier. At that time, option buyer may receive cash rebate. Function arguments are asset price (s), exercise price (x), barrier price level (h), time to expiration (t), risk-free interest rate (r), asset income rate (i), asset volatility rate (v), and barrier option type indicator variable (TypeFlag). TypeFlag variable is three-character string set as follows: 1) "cdi" for down-and-in call, 2) "cui" for up-and-in call, 3) "pdi" for down-and-in put, 4) "pui" for up-and-in put, 5) "cdo" for down-and-out call, 6) "cuo" for up-and-out call, 7) "pdo" for down-and-out put, and 8) "puo" for up-and-out put. Rates are annualized and in decimal form. Time to expiration is measured in years.

OV_NS_CHOOSER_OPTION(s, x, td, t, r, i, v)

Returns value of European-style chooser option. Chooser option is option that conveys right to choose whether option is to be standard call or put after time t, where call and put have same exercise price X and time to maturity T. Function arguments are asset price (s), exercise price (x), time to decision date (start date), time to expiration (includes td) (t), risk-free interest rate (r), asset income rate, and asset volatility rate (v). Rates are annualized and in decimal form. Time to expiration is measured in years.

OV_NS_COMPOUND_OPTION(s,cp1,x1,tim1,cp2,x2,tim2,r,i,v)

Returns value of European-style compound options. Compound option is option on option. Most common forms are calls on calls, puts on calls, calls on puts, and puts on puts. Function arguments are asset price (s), call/put indicator for nearby option (cp1), exercise price of nearby option (x1), time to expiration of nearby option (t1), call/put indicator for option to be delivered (cp2), exercise price of delivered option (x2), time to expiration of delivered option (t2), risk-free interest rate (r), asset income rate (i), and asset volatility rate (v). Call/put indicators are set to "C" or "c" for call and "P" or "p" for put. Rates are annualized and in decimal form. Time to expiration is measured in years.

OV_NS_CONTINGENT_PAY_OPTION(s, x, t, r, i, v, cp)

Returns value of European-style contingent-pay option. Contingent-pay option is option whose premium is set today but is paid at expiration contingent upon option being in the money. Function arguments are asset price (s), exercise price (x), time to expiration (t), risk-free interest rate (r), asset income rate (i), asset volatility rate (v), and call/put indicator (cp). Rates are annualized and in decimal form. Time to expiration is measured in years.

OV_NS_EXCHANGE_OPTION(s1,s2,t,i1,i2,v1,v2,rho)

Returns value of option to exchange asset 2 for asset 1. Function arguments are asset 1 price (s1), asset 2 price (s2), time to expiration of option (t), asset 1 income rate (i1), asset 2 income rate (i2), asset 1 volatility rate

(v1), asset 2 volatility rate (v2), and correlation of returns of asset 1 and asset 2. Rates are annualized and in decimal form. Time to expiration is measured in years.

OV_NS_FORWARD_START_OPTION(s,alpha,td,t,r,i,v,cp)

Returns value of European-style forward-start option. Forward-start option is like standard option except option's life begins only after pre-specified period. Function arguments are asset price (s), degree to which call is in-the-money (put is out-of-the-money) on start date of option (alpha), time to start date (td), time to expiration (includes td) (t), risk-free interest rate (r), asset income rate (i), asset volatility rate (v), and call/put indicator (cp). Call/put indicator is set to "C" or "c" for call and "P" or "p" for put. Rates are annualized and in decimal form. Time to expiration is measured in years.

OV_NS_GAP_OPTION(s, x1, x2, t, r, i, v, cp)

Returns value of European-style gap option. Gap option is option whose payoff is determined by exercise priceX1, but another constantX2 determines whether or not payoff is made. Function arguments are asset price (s), exercise price determining payoff (x1), trigger price determining exercise (x2), time to expiration, risk-free interest rate (r), asset income rate (i), asset volatility rate (v), and call/put indicator (cp). Call/put indicator is set to "C" or "c" for call and "P" or "p" for put. Rates are annualized and in decimal form. Time to expiration is measured in years.

OV_NS_LOOKBACK_OPTION(s, sm, t, r, i, v, cp)

Returns value of European-style lookback option. Lookback call option provides its holder with settlement proceeds equal to difference between terminal asset price and lowest asset price observed during life of option. Lookback put option provides its holder with settlement proceeds equal to difference between highest asset price during life of option and terminal asset price. Function arguments are asset price (s), current minimum asset price for call (or current maximum price for put) (sm), time to expiration (t), risk-free r interest rate (r), asset income rate(i), asset volatility rate (v), and call/put indicator variable (cp). Call/put indicator is set to "C" or "c" for call and "P" or "p" for put. Rates are annualized and in decimal form. Time to expiration is measured in years.

OV_NS_MAXMIN_OPTION(s1,s2,x,t,i1,i2,v1,v2,rho,cp,mm)

Returns value of European-style option on minimum or maximum of two risky assets. Function arguments are prices of asset 1 and 2 (s1 and s2), exercise price (x), time to expiration (t), asset income rates (i1 and i2), asset volatility rates (v1 and v2), correlation between asset returns (rho), call/put indicator variable, and maximum/minimum indicator variable (mm). Call/put indicator is set to "C" or "c" for call and "P" or "p" for put. Maximum/minimum indicator is set to "X" or "x" for maximum and "M" or "m" for minimum. Rates are annualized and in decimal form. Time to expiration is measured in years.

OV_NS_RATCHET_OPTION(s, alpha, td, tb, n, r, i, v, cp)

Returns value of European-style ratchet option. Ratchet option (also called cliquet option) is sequence of forward-start options. At end of each option's life new option is written at strike price equal to prevailing asset times preset constant. Function arguments are asset price (s), preset constant (alpha), time to start date (td), time between resets (tb), number of reset dates (n), risk-free interest rate (r), asset income rate (i), asset volatility rate (v), and call/put indicator variable (cp). Call/put indicator is set to "C" or "c" for call and "P" or "p" for put. Rates are annualized and in decimal form. Time to expiration is measured in years.

OV Probabilities

Contains functions for evaluating univariate and bivariate standard normal probabilities.

OV_PROB_PNRM(d)

Returns standard univariate normal density evaluated at d.
Remarks: 1. Distribution is standard normal with mean O and variance 1.

OV_PROB_PRUN(d)

Returns cumulative standard univariate normal probability with upper integral limit d.
Remarks: 1. Distribution is standard normal with mean O and variance 1.

OV_PROB_PRUN_INV(p)
Returns inverse of univariate standard normal integral at probability level p.
Remarks : 1. Distribution is standard normal with mean O and variance 1.

OV_PROB_PRBN(a,b,rho)

Returns cumulative standard bivariate normal probability with upper integral limits a and b and correlation coefficient rho.
Remarks: 1. Distributions are joint standard normal with mean O and variance 1.

OV_PROB_UNIDEV()

Returns univariate standard normal deviate.

OV Products

OV_PRDTS_PROTECTED_EQUITY_NOTE(princ,g,k,t,r,i,v,rp)

Returns value of protected equity note given underlying principal invested (princ), guaranteed minimum return (g), equity participation rate (k), time to expiration (t), risk-free interest rate (r), equity income rate (i), equity volatility rate (v), and total return/price appreciation rate indicator variable (rp). Total return/price appreciation rate indicator is set to “R” or “r” for total return and “P” or “p” for price appreciation. Black-Scholes (1973)/Merton (1973) assumptions are used. All rates are annualized and in decimal form, and time to expiration is measured in years. Equity price is assumed to be log-normally distributed at end of note's life.

OV_PRDTS_PROTECTED_EQUITY_NOTE_WITH_CAP (princ,g1,g2,k,t,r,i,v,rp)

Returns value of protected equity note with cap given underlying principal invested (princ), guaranteed minimum return (g1), guaranteed maximum return (g2), equity participation rate (k), time to expiration (t), risk-free interest rate (r), equity income rate (i), equity volatility rate (v), and total return/price appreciation rate indicator variable (rp). Total return/price appreciation rate indicator is set to “R” or “r” for total return and “P” or “p” for price appreciation. Black-Scholes (1973)/Merton (1973) assumptions are used. All rates are annualized and in decimal form, and time to expiration is measured in years. Equity price is assumed to be log-normally distributed at end of note's life.

OV Profit functions

OV_ PRFT_ASSET(st,s,t,r,i,np)

Returns terminal profit from asset position given terminal asset price (st), initial asset price (s), investment horizon in years (t), risk-free interest rate (r), asset income rate (i), and number of units of asset (np). If asset is purchased (sold), np > 0 (np < 0). Rates are annualized and in decimal form.

OV_PRFT_FUTURES (ft,f,t,r,np)

Returns terminal profit from asset position given terminal futures price (ft), initial futures price (f), investment horizon in years (t), risk-free interest rate (r), and number of futures contracts held of asset (np). If futures is purchased (sold), np > 0 (np < 0). Rates are annualized and in decimal form.

OV_OPTION_PRFT_OPTION(st,op,x,t,r,np,cp)

Returns terminal profit from option position given terminal asset price (st), initial option price (op), investment horizon in years (t), risk-free interest rate (r), and number of units of asset (np). If option is purchased (sold), np > 0 (np < 0). Rates are annualized and in decimal form. Routine can also be used for futures options.

OV Standard options

OV_OPTION_ASSET_EV(s,x,t,alpha,v,ab)

Returns expected asset price conditional upon asset price being above or below threshold level (x) at end of investment horizon (t) given current asset price (s), expected rate of price appreciation (alpha), volatility rate (v), and above/below indicator (ab). Indicator variable is set to "A" or "a" for above threshold and "B" or "b" for below threshold. All rates are annualized and in decimal form, and investment horizon is measured in years. Asset price is assumed to be log-normally distributed at end of investment horizon.

OV_OPTION_ASSET_PROB(s,x,t,alpha,v,ab)

Returns probability that asset price will be above or below threshold level (x) at end of investment horizon (t) given current asset price (s), expected rate of price appreciation (alpha), volatility rate (v), and above/below indicator (ab). Indicator variable is set to "A" or "a" for above threshold and "B" or "b" for below threshold. All rates are annualized and in decimal form, and investment horizon is measured in years. Asset price is assumed to be log-normally distributed at end of investment horizon.

OV_OPTION_ASSET_PROB_INV(s, t,alpha,v,ab,prob)

Returns critical threshold level at end of investment horizon (t) given current asset price (s), expected rate of price appreciation (alpha), volatility rate (v), above/below indicator (ab), and probability of being above or below. Indicator variable is set to "A" or "a" for above threshold and "B" or "b" for below threshold. All rates are annualized and in decimal form, and investment horizon is measured in years. Asset price is assumed to be log-normally distributed at end of investment horizon.

OV_OPTION_D(s,x,t,r,i,v,n)

Returns value of d1 or d2 in Black-Scholes (1973)/Merton (1973) option valuation equation given underlying asset price (s), exercise price (x), time to expiration (t), risk-free interest rate (r), asset income rate (i), asset volatility rate (v), and indicator variable defining integral limit (n). All rates are

annualized and in decimal form, and time to expiration is measured in years. The indicator variable is set to 1 for d1, -1 for -d1, 2 for d2, and -2 for -d2.

OV_OPTION_DELTA(s,x,t,r,i,v,cp,ae)

Returns delta (i.e., change in option price resulting from change in asset price) of standard asset option given underlying asset price (s), exercise price (x), time to expiration (t), risk-free interest rate (r), asset income rate (i), asset volatility rate (v), call put indicator variable, and European-/American-style option indicator variable (ae). Call/put indicator is set to "C" or "c" for call and "P" or "p" for put. Option style indicator is set to "E" or "e" for European-style and "A" or "a" for American-style. If European-style, result is computed using Black-Scholes (1973)/Merton (1973), and, if American-style, result is computed numerically using Barone-Adesi and Whaley (1987). All rates are annualized and in decimal form, and investment horizon is measured in years. Asset price is assumed to be log-normally distributed.

OV_OPTION_ETA(s,x,t,r,i,v,cp,ae)

Returns eta (i.e., percentage change in option price resulting from percentage change in asset price or price elasticity) of standard asset option given underlying asset price (s), exercise price (x), time to expiration (t), risk-free interest rate (r), asset income rate (i), asset volatility rate (v), call put indicator variable, and European-/American-style option indicator variable (ae). Call/put indicator is set to "C" or "c" for call and "P" or "p" for put. Option style indicator is set to "E" or "e" for European-style and "A" or "a" for American-style. If European-style, result is computed using Black-Scholes (1973)/Merton (1973), and, if American-style, result is computed numerically using Barone-Adesi and Whaley (1987). All rates are annualized and in decimal form, and investment horizon is measured in years. Asset price is assumed to be log-normally distributed.

OV_OPTION_GAMMA (s,x,t,r,i,v,cp,ae)

Returns gamma (i.e., change in delta resulting from change in asset price) of standard asset option given underlying asset price (s), exercise price (x), time to expiration (t), risk-free interest rate (r), asset income rate (i), asset volatility rate (v), call put indicator variable, and European-/American-style option indicator variable (ae). Call/put indicator is set to "C" or "c" for call and "P" or "p" for put. Option style indicator is set to "E" or "e" for European-style and "A" or "a" for American-style. If European-style, result is computed using Black-Scholes (1973)/Merton (1973), and, if American-style, result is computed numerically using Barone-Adesi and Whaley (1987). All rates are annualized and in decimal form, and investment horizon is measured in years. Asset price is assumed to be log-normally distributed.

OV_OPTION_ISD(s,x,t,r,i,op,cp,ae)

Returns option price-implied standard deviation rate (or volatility rate) of standard asset option given underlying asset price (s), exercise price (x), time

to expiration (t), risk-free interest rate (r), asset income rate (i), option price (op), call put indicator variable, and European-/American-style option indicator variable (ae). Call/put indicator is set to "C" or "c" for call and "P" or "p" for put. Option style indicator is set to "E" or "e" for European-style and "A" or "a" for American-style. If European-style, result is computed using Black-Scholes (1973)/Merton (1973), and, if American-style, result is computed numerically using Barone-Adesi and Whaley (1987). Function returns value 99 if solution is infeasible. All rates are annualized and in decimal form, and investment horizon is measured in years. Asset price is assumed to be log-normally distributed.

OV_OPTION_ISP(x,t,r,i,v,op,cp,ae)

Returns option price-implied asset price of standard asset option given exercise price (x), time to expiration (t), risk-free interest rate (r), asset income rate (i), asset volatility rate (v), option price (op), call put indicator variable, and European-/American-style option indicator variable (ae). Call/put indicator is set to "C" or "c" for call and "P" or "p" for put. Option style indicator is set to "E" or "e" for European-style and "A" or "a" for American-style. If European-style, result is computed using Black-Scholes (1973)/Merton (1973), and, if American-style, result is computed numerically using Barone-Adesi and Whaley (1987). Function returns value 99 if solution is infeasible. All rates are annualized and in decimal form, and investment horizon is measured in years. Asset price is assumed to be log-normally distributed.

OV_OPTION_ND(s,x,t,r,i,v,n)

Returns value of N(d1) or N(d2) in Black-Scholes (1973)/Merton (1973) option valuation equation given underlying asset price (s), exercise price (x), time to expiration (t), risk-free interest rate (r), asset income rate (i), asset volatility rate (v), and indicator variable defining integral limit (n). All rates are annualized and in decimal form, and time to expiration is measured in years. The indicator variable is set to 1 for
N(d1), 1 for N(d1), 2 for N(d2), and 2 for N(d2). All rates are annualized and in decimal form, and time to expiration is measured in years.

OV_OPTION_RHOI (s,x,t,r,i,v,cp,ae)

Returns income rate rho (i.e., change in option price from change in income rate) of standard asset option given underlying asset price (s), exercise price (x), time to expiration (t), risk-free interest rate (r), asset income rate (i), asset volatility rate (v), call put indicator variable, and European-/American-style option indicator variable (ae). Call/put indicator is set to "C" or "c" for call and "P" or "p" for put. Option style indicator is set to "E" or "e" for European-style and "A" or "a" for American-style. If European-style, result is computed using Black-Scholes (1973)/Merton (1973), and, if American-style, result is computed numerically using Barone-Adesi and Whaley (1987). All rates are annualized and in decimal form, and investment horizon is measured in years. Asset price is assumed to be log-normally distributed.

OV_OPTION_RHOR (s,x,t,r,i,v,cp,ae)

Returns interest rate rho (i.e., change in option price from change in risk-free interest rate) of standard asset option given underlying asset price (s), exercise price (x), time to expiration (t), risk-free interest rate (r), asset income rate (i), asset volatility rate (v), call put indicator variable, and European-/American-style option indicator variable (ae). Call/put indicator is set to "C" or "c" for call and "P" or "p" for put. Option style indicator is set to "E" or "e" for European-style and "A" or "a" for American-style. If European-style, result is computed using Black-Scholes (1973)/Merton (1973), and, if American-style, result is computed numerically using Barone-Adesi and Whaley (1987). All rates are annualized and in decimal form, and investment horizon is measured in years. Asset price is assumed to be log-normally distributed.

OV_OPTION_THETA(s,x,t,r,i,v,cp,ae)

Returns theta (i.e., change in option price resulting from change in time to expiration) of standard asset option given underlying asset price (s), exercise price (x), time to expiration (t), risk-free interest rate (r), asset income rate (i), asset volatility rate (v), call put indicator variable, and European-/American-style option indicator variable (ae). Call/put indicator is set to "C" or "c" for call and "P" or "p" for put. Option style indicator is set to "E" or "e" for European-style and "A" or "a" for American-style. If European-style, result is computed using Black-Scholes (1973)/Merton (1973), and, if American-style, result is computed numerically using Barone-Adesi and Whaley (1987). Value of theta is positive, which implies option value falls as time to expiration is shortened. All rates are annualized and in decimal form, and investment horizon is measured in years. Asset price is assumed to be log-normally distributed.

OV_OPTION_VALUE(s,x,t,r,i,v,cp,ae)

Returns value of standard asset option given underlying asset price (s), exercise price (x), time to expiration (t), risk-free interest rate (r), asset income rate (i), asset volatility rate (v), call put indicator variable, and European-/American-style option indicator variable (ae). Call/put indicator is set to "C" or "c" for call and "P" or "p" for put. Option style indicator is set to "E" or "e" for European-style and "A" or "a" for American-style. If European-style, result is computed using Black-Scholes (1973)/Merton (1973), and, if American-style, result is computed numerically using Barone-Adesi and Whaley (1987). All rates are annualized and in decimal form, and investment horizon is measured in years. Asset price is assumed to be log-normally distributed.

OV_OPTION_VEGA (s,x,t,r,i,v,cp,ae)

Returns vega (i.e., change in option price resulting from change in asset volatility rate) of standard asset option given underlying asset price (s),

exercise price (x), time to expiration (t), risk-free interest rate (r), asset income rate (i), asset volatility rate (v), call put indicator variable, and European-/American-style option indicator variable (ae). Call/put indicator is set to "C" or "c" for call and "P" or "p" for put. Option style indicator is set to "E" or "e" for European-style and "A" or "a" for American-style. If European-style, result is computed using Black-Scholes (1973)/Merton (1973), and, if American-style, result is computed numerically using Barone-Adesi and Whaley (1987). All rates are annualized and in decimal form, and investment horizon is measured in years. Asset price is assumed to be log-normally distributed.

OV Statistics

OV_STAT_AUTOCORREL(k,x,out)

Returns autocorrelation function of time-series to lag k given number of lags (k), time-series vector (x), and output array indicator (out). Maximum number of lags is 100. To use function, highlight k contiguous cells vertically or horizontally, choose function and enter function information, and simultaneously hit <Shift><Ctrl><Enter>. Standard error of each autocorrelation coefficient is 1/ T , where T is number of observations in time series.

OV_STAT_BOX_PIERCE(k,x,out)

Returns Box-Pierce statistic to test joint significance that all k autocorrelation coefficients are zero. Maximum number of lags is 100. To use function, highlight k contiguous cells vertically or horizontally, choose function and enter function information, and simultaneously hit <Shift><Ctrl><Enter>. Statistic is (approximately) distributed chi-squared with k degrees of freedom. Excel function CHIDIST(x,deg_freedom) returns one-tailed probability of chi-squared distribution. Excel function CHIINV(probability,deg_freedom) returns inverse of one-tailed probability of chi-squared distribution.

OV_STAT_CORREL(x,y)

Returns sample correlation between x and y.

OV_STAT_COV(x,y)

Returns sample covariance between x and y.

OV_STAT_FVARS(xa,xb)

Returns F-test for null hypothesis that variances of two series are equal. To use function, highlight 3 contiguous cells vertically or horizontally, choose

function and enter function information, and simultaneously hit <Shift><Ctrl><Enter>. Three outputs are test statistic, degrees of freedom in numerator, and degrees of freedom in denominator.

OV_STAT_JB(x)

Returns Jarque-Bera test statistic for normality of x. Statistic is (approximately) distributed chi-squared with 2 degrees of freedom. Excel function CHIDIST(x,deg_freedom) returns one-tailed probability of chi-squared distribution. Excel function CHIINV(probability,deg_freedom) returns inverse of one-tailed probability of chi-squared distribution.

OV_STAT_KURT(x)

Returns kurtosis of x.

OV_STAT_MEAN(x)

Returns mean of x.

OV_STAT_OLS_SIMPLE(y,x,intercept,out)

Estimates simple OLS regression of dependent variable vector y on independent variable vector x. Intercept indicator variable is set to "y" or "Y" to use intercept and "n" or "N" to suppress intercept. To use function, highlight five contiguous cells vertically or horizontally to contain function output, choose function and enter function information, and simultaneously hit <Shift><Ctrl><Enter>. Output vector contains five pieces of information: (a) intercept (if any), (b) t-ratio of null hypothesis that intercept is zero (if intercept is used), (c) slope, (d) t-ratio of null hypothesis that slope is zero, and (e) R-squared. Excel function TDIST(x,deg_freedom,tails) returns one- (tails=1) or two-tailed (tails=2) probability of Student t distribution. Excel function TINV(probability,deg_freedom) returns inverse of probability of Student t distribution.

OV_STAT_SEMICOR(b,x,y)

Returns lower semi-correlation between vector x and vector y with upper variable limit b.

OV_STAT_SEMICOV(b,x,y)

Returns lower semi-covariance between vector x and vector y with upper variable limit b.

OV_STAT_SEMIDEV(b,x)

Returns lower semi-standard deviation of vector x with upper variable limit b.

OV_STAT_SEMIVAR(b,x)

Returns lower semi-variance of vector x with upper variable limit b.

OV_STAT_SKEW(x)

Returns skewness of vector x.

OV_STAT_STDEV(x)

Returns standard deviation of vector x.

OV_STAT_TCNST(x,cnst)

Returns t-test for null hypothesis that means of series x is not different from constant (cnst). To use function, highlight 3 contiguous cells vertically or horizontally, choose function and enter function information, and simultaneously hit <Shift><Ctrl><Enter>. Two outputs are test statistic and degrees of freedom.

OV_STAT_TMEANS (x,y,ind)

Returns t-test for null hypothesis that means of two series (x and y) are equal. Note that length of x and length of y may not be equal. To use function, highlight 3 contiguous cells vertically or horizontally, choose function and enter function information, and simultaneously hit <Shift><Ctrl><Enter>. Indicator variable (ind) is set to "y" or "Y" if variances are assumed to be equal and "n" or "N" if variances are not equal. Two outputs are test statistic and degrees of freedom.

OV_STAT_TPMEANS (x,y)

Returns t-test for null hypothesis that means of two paired series (x and y) are equal. To use function, highlight 3 contiguous cells vertically or horizontally, choose function and enter function information, and simultaneously hit <Shift><Ctrl><Enter>. Two outputs are test statistic and degrees of freedom.

OV_STAT_VAR(x)

Returns variance of vector x.

OV_STAT_VOL_EQUAL(x)

Returns standard deviation (volatility) of vector x assuming x has zero mean. Can be used in combination with OV_STAT_VOL_EWMA (x,L), which exponentially weights observations.

OV_STAT_VOL_EWMA(x,L)

Returns standard deviation (volatility) of vector x using exponentially-weighted moving average. The weight coefficient is between 0 and 1, with values of L close to one providing highest weight on most recent observation.

