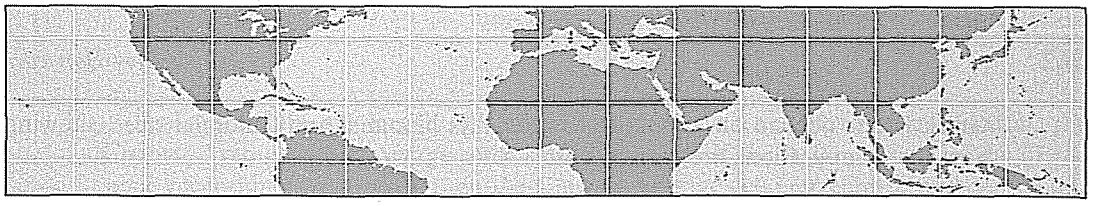

DerivaGem Software

The software accompanying this book is DerivaGem for Excel, Version 1.51. It requires Excel Version 7.0 or later. The software consists of three files: dg151.dll, DG151.xls, and DG151functions.xls To install the software, you should create a directory with the name DerivaGem (or some other name of your own choosing) and load DG151.xls and DG151functions.xls into the directory. You should load dg151.dll into the Windows\System directory (Windows 95 and 98 users) or the WINNT\System32 directory (Windows 2000 and Windows NT users).[1]

Excel 2000 users should ensure that Security for Macros is set at *Medium* or *Low*. Check *Tools* followed by *Macros* in Excel to change this. While using the software, you may be asked whether you want to enable macros. You should click *Enable Macros*.

Updates to the software can be downloaded from the author's website:

http://www.rotman.utoronto.ca/~hull

There are two parts to the software: the Options Calculator (DG151.xls) and the Applications Builder (DG151functions.xls). Both parts require dg151.dll to be loaded into the Windows\System or WINNT\System32 directory.

New users are advised to start with The Options Calculator.

THE OPTIONS CALCULATOR

DG151.xls is a user-friendly options calculator. It consists of three worksheets. The first worksheet is used to carry out computations for stock options, currency options, index options, and futures options; the second is used for European and American bond options; the third is used for caps, floors, and European swap options.

The software produces prices, Greek letters, and implied volatilities for a wide range of different instruments. It displays charts showing the way that option prices and the

[1] Note that it is not uncommon for Windows Explorer to be set up so that *.dll files are not displayed. To change the setting so that the *.dll file can be seen, proceed as follows. In Windows 95, click *View*, followed by *Options*, followed by *Show All Files*. In Windows 98 click *View*, followed by *Folder Options*, followed by *View*, followed by *Show All Files*. In Windows 2000, click *Tools*, followed by *Folder Options*, followed by *View*, followed by *Show Hidden Files and Folders*.

Greek letters depend on inputs. It also displays binomial and trinomial trees, showing how the computations are carried out.

General Operation

To use the options calculator, you should choose a worksheet and click on the appropriate buttons to select Option Type, Underlying Type, and so on. You should then enter the parameters for the option you are considering, hit *Enter* on your keyboard, and click on *Calculate*. DerivaGem will then display the price or implied volatility for the option you are considering, together with Greek letters. If the price has been calculated from a tree, and you are using the first or second worksheet, you can then click on *Display Tree* to see the tree. Sample displays of the tree are shown in Chapters 11 and 17. Many different charts can be displayed in all three worksheets. To display a chart, you must first choose the variable you require on the vertical axis, the variable you require on the horizontal axis, and the range of values to be considered on the horizontal axis. Following that you should hit *Enter* on your keyboard and click on *Draw Graph*. Note that, whenever the values in one or more cells are changed, it is necessary to hit *Enter* on your keyboard before clicking on one of the buttons.

If your version of Excel is later than 7.0, you will be asked whether you want to update to the new version when you first save the software. You should choose the *Yes* button.

Options on Stocks, Currencies, Indices, and Futures

The first worksheet (Equity_FX_Index_Futures) is used for options on stocks, currencies, indices, and futures. To use it you should first select the Underlying Type (Equity, Currency, Index, or Futures). You should then select the Option Type (Analytic European, Binomial European, Binomial American, Asian, Barrier Up and In, Barrier Up and Out, Barrier Down and In, Barrier Down and Out, Binary Cash or Nothing, Binary Asset or Nothing, Chooser, Compound Option on Call, Compound Option on Put, or Lookback). You should then enter the data on the underlying asset and data on the option. Note that all interest rates are expressed with continuous compounding.

In the case of European and American equity options, a table pops up allowing you to enter dividends. Enter the time of each ex-dividend date (measured in years from today) in the first column and the amount of the dividend in the second column. Dividends must be entered in chronological order.

You must click on buttons to choose whether the option is a call or a put and whether you wish to calculate an implied volatility. If you do wish to calculate an implied volatility, the option price should be entered in the cell labeled Price.

Once all the data has been entered you should hit *Enter* on your keyboard and click on *Calculate*. If Implied Volatility was selected, DerivaGem displays the implied volatility in the Volatility (% per year) cell. If Implied Volatility was not selected, it uses the volatility you entered in this cell and displays the option price in the Price cell.

Once the calculations have been completed, the tree (if used) can be inspected and charts can be displayed.

When Analytic European is selected, DerivaGem uses the Black–Scholes equations in Chapters 13 and 14 to calculate prices, and the equations in Chapter 15 to calculate Greek letters. When Binomial European or Binomial American is selected, a binomial tree is constructed as described in Chapter 17. Up to 500 time steps can be used.

The input data are largely self-explanatory. In the case of an Asian option, the Current Average is the average price since inception. If the Asian option is new (Time since Inception equals zero), then the Current Average cell is irrelevant and can be left blank. In the case of a Lookback Option, the Minimum to Date is used when a Call is valued and the Maximum to Date is used when a Put is valued. For a new deal, these should be set equal to the current price of the underlying asset.

Bond Options

The second worksheet (Bond_Options) is used for European and American options on bonds. You should first select a pricing model (Black-European, Normal-Analytic European, Normal-Tree European, Normal-American, Lognormal-European, or Lognormal-American). You should then enter the Bond Data and the Option Data. The coupon is the rate paid per year and the frequency of payments can be selected as Quarterly, Semi-Annual, or Annual. The zero-coupon yield curve is entered in the table labeled Term Structure. Enter maturities (measured in years) in the first column and the corresponding continuously compounded rates in the second column. The maturities should be entered in chronological order. DerivaGem assumes a piecewise linear zero curve similar to that in Figure 4.1. Note that, when valuing interest rate derivatives, DerivaGem rounds all times to the nearest whole number of days.

When all data have been entered, hit *Enter* on your keyboard. The quoted bond price per $100 of Principal, calculated from the zero curve, is displayed when the calculations are complete. You should indicate whether the option is a call or a put and whether the strike price is a quoted (clean) strike price or a cash (dirty) strike price. (See the discussion and example in Section 26.2 to understand the difference between the two.) Note that the strike price is entered as the price per $100 of principal. You should indicate whether you are considering a call or a put option and whether you wish to calculate an implied volatility. If you select implied volatility and the normal model or lognormal model is used, DerivaGem implies the short-rate volatility, keeping the reversion rate fixed.

Once all the inputs are complete, you should hit *Enter* on your keyboard and click *Calculate*. After that the tree (if used) can be inspected and charts can be displayed. Note that the tree displayed lasts until the end of the life of the option. DerivaGem uses a much larger tree in its computations to value the underlying bond.

Note that, when Black's model is selected, DerivaGem uses the equations in Section 26.2. Also, the procedure in Section 26.2 is used for converting the input yield volatility into a price volatility.

Caps and Swap Options

The third worksheet (Caps_and_Swap_Options) is used for caps and swap options. You should first select the Option Type (Swap Option or Cap/Floor) and Pricing Model (Black-European, Normal-European, or Lognormal-European). You should then enter data on the option you are considering. The Settlement Frequency indicates the frequency of payments and can be Annual, Semi-Annual, Quarterly, or Monthly. The software calculates payment dates by working backward from the end of the life of the cap or swap option. The initial accrual period may be a nonstandard length between 0.5 and 1.5 times a normal accrual period. The software can be used to imply either a

volatility or a cap rate/swap rate from the price. When a normal model or a lognormal model is used, DerivaGem implies the short rate volatility keeping the reversion rate fixed. The zero-coupon yield curve is entered in the table labeled Term Structure. Enter maturities (measured in years) in the first column and the corresponding continuously compounded rates in the second column. The maturities should be entered in chronological order. DerivaGem assumes a piecewise linear zero curve similar to that in Figure 4.1.

Once all the inputs are complete, you should click *Calculate*. After that, charts can be displayed. Note that, when Black's model is used, DerivaGem uses the equations in Sections 26.3 and 26.4.

Greek Letters

In the Equity_FX_Index_Futures worksheet, the Greek letters are calculated as follows.

Delta: Change in option price per dollar increase in underlying asset.

Gamma: Change in delta per dollar increase in underlying asset.

Vega: Change in option price per 1% increase in volatility (e.g., volatility increases from 20% to 21%).

Rho: Change in option price per 1% increase in interest rate (e.g., interest increases from 5% to 6%).

Theta: Change in option price per calendar day passing.

In the Bond_Options and Caps_and_Swap_Options worksheets, the Greek letters are calculated as follows:

DV01: Change in option price per one basis point upward parallel shift in he zero curve.

Gamma01: Change in DV01 per one basis point upward parallel shift in the zero curve, multiplied by 100.

Vega: Change in option price when volatility parameter increases by 1% (e.g., volatility increases from 20% to 21%)

THE APPLICATIONS BUILDER

The Applications Builder is DG151functions.xls. It is a set of 21 functions and seven sample applications from which users can build their own applications.

The Functions

The following is a list of the 21 functions included in the Applications Builder. Full details are on the first worksheet (FunctionSpecs).

1. Black_Scholes. This carries out Black–Scholes calculations for a European option on a stock, stock index, currency, or futures contract.
2. TreeEquityOpt. This carries out binomial tree calculations for a European or American option on a stock, stock index, currency, or futures contract.

3. BinaryOption. This carries out calculations for a binary option on a stock, stock index, currency, or futures contract.
4. BarrierOption. This carries out calculations for a barrier option on a non-dividend-paying stock, stock index, currency, or futures contract.
5. AverageOption. This carries out calculations for an Asian option on a non-dividend-paying stock, stock index, currency, or futures contract.
6. ChooserOption. This carries out calculations for a chooser option on a non-dividend-paying stock, stock index, currency, or futures contract.
7. CompoundOption. This carries out calculations for compound options on non-dividend-paying stocks, stock indices, currencies, and futures.
8. LookbackOption. This carries out calculations for a lookback option on a non-dividend-paying stock, stock index, currency, or futures contract.
9. EPortfolio. This carries out calculations for a portfolio of options on a stock, stock index, currency, or futures contract.
10. BlackCap. This carries out calculations for a cap or floor using Black's model.
11. HullWhiteCap. This carries out calculations for a cap or floor using the Hull–White model.
12. TreeCap. This carries out calculations for a cap or floor using a trinomial tree.
13. BlackSwapOption. This carries out calculations for a swap option using Black's model.
14. HullWhiteSwap. This carries out calculations for a swap option using the Hull–White model.
15. TreeSwapOption. This carries out calculations for a swap option using a trinomial tree.
16. BlackBondOption. This carries out calculations for a bond option using Black's model.
17. HullWhiteBondOption. This carries out calculations for a bond option using the Hull–White model.
18. TreeBondOption. This carries out calculations for a bond option using a trinomial tree.
19. BondPrice. This values a bond.
20. SwapPrice. This values a plain vanilla interest rate swap. Note that it ignores cash flows arising from reset dates prior to start time.
21. IPortfolio. This carries out calculations for a portfolio of interest rate derivatives.

Sample Applications

DG151functions.xls includes seven worksheets with sample applications:

A. Binomial Convergence. This investigates the convergence of the binomial model in Chapters 11 and 17.

B. GreekLetters. This provides charts showing the Greek letters in Chapter 15.

C. Delta Hedge. This investigates the performance of delta hedging as in Tables 15.2 and 15.3.

D. Delta and Gamma Hedge. This investigates the performance of delta plus gamma hedging for a position in a binary option.

E. Value and Risk. This calculates Value at Risk for a portfolio consisting of three options on a single stock using three different approaches.

F. Barrier Replication. This carries out calculations for the static options replication example in Section 22.13.

G. Trinomial Convergence. This investigates the convergence of the trinomial tree model in Chapter 28.