

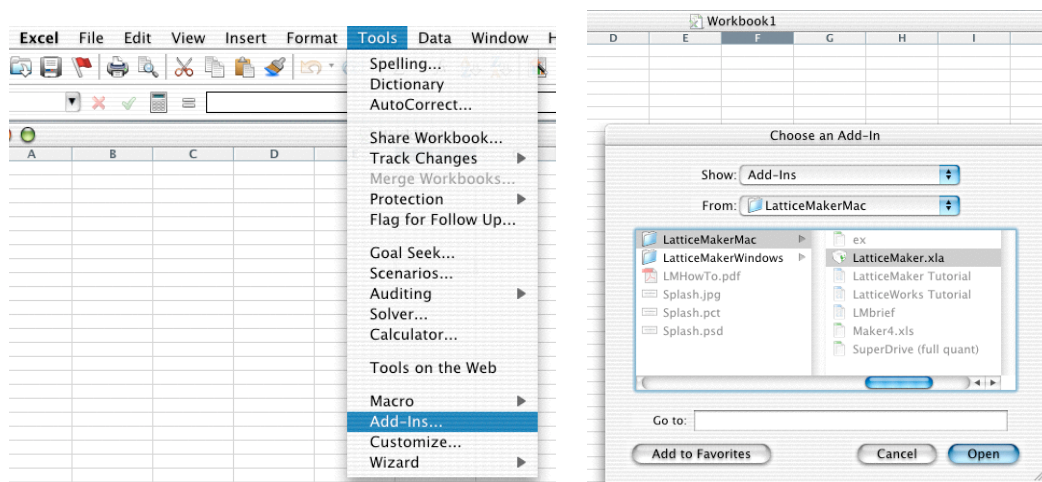
LatticeMaker

INTRODUCTION

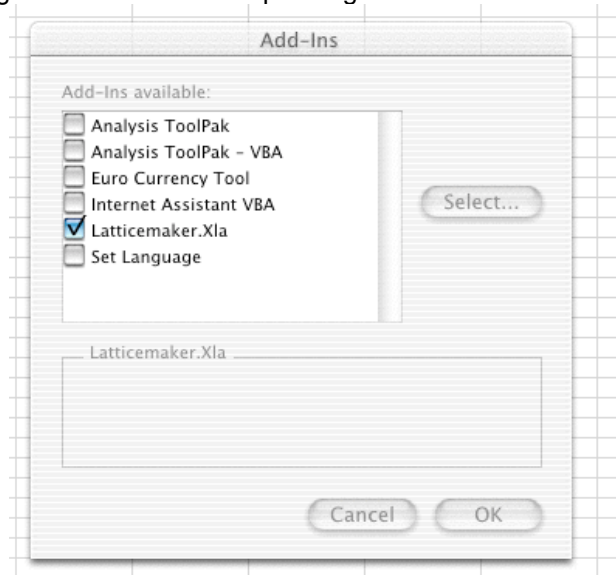
LatticeMaker is a Microsoft Excel add-in that allows you to quickly and easily represent asset prices as binomial lattices on a spreadsheet as well as perform the valuation of derivative securities or investment projects with real options. While suitable for a number of relatively simple real-world problems, it is designed primarily as a teaching tool. Information about sophisticated software solutions with the ability to handle applications with complicated cash-flow structures is available at www.investmentscience.com. The example referred to in this document, along with many others, is available for free download at that site.

INSTALLATION AND START-UP

You may add LatticeMaker to your list of Excel add-ins. Simply go to the Tools menu item select Add-ins... and then browse for the file LatticeMaker.xla.



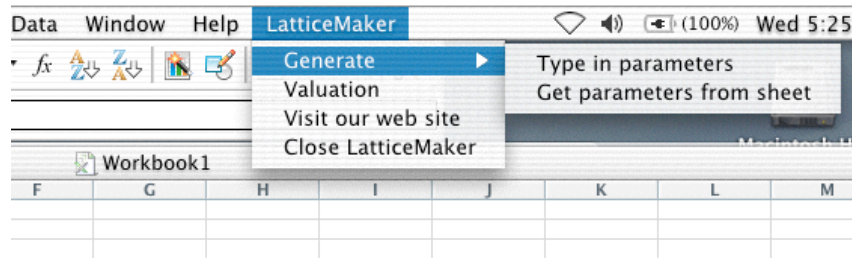
Once LatticeMaker has been included in Excel's add-ins list, you may choose to automatically load it at start-up by placing a check in the corresponding checkbox.



Alternatively, you can start LatticeMaker by simply double-clicking in the LatticeMaker.xla application icon. Note: if you use this start-up method Excel will not automatically provide a fresh workbook. Simply create a new workbook to start working.

CREATING LATTICES

In order to build a lattice for a price process, there are two different parameter input methods. The first one opens a dialog box in which the user directly types in parameter values. The second method opens a dialog box in which the user specifies the cell references on an existing worksheet where the corresponding parameters are stored.

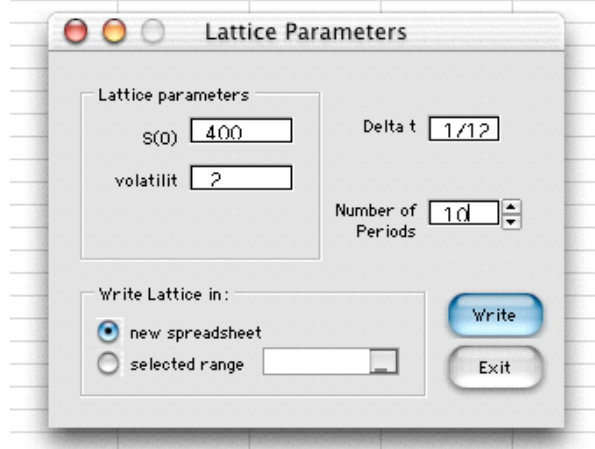


Once an input method has been selected, there are three different lattice models available to represent an uncertain price process:

- *Discrete Geometric Brownian Motion (GBM)*: Standard Cox , Ross, Rubinstein multiplicative model. Requires initial value $S(0)$, volatility σ , length of time period Δt , and number of time periods.
- *Additive*: Simple additive model with jump size u . Requires initial value $S(0)$, jump size u , and number of time periods. Caution: Process is not guaranteed to be non-negative.
- *Custom (multiplicative)*: Multiplicative model with user defined “up” and “down” multiplicative factors. Requires initial value $S(0)$, size of up move u , size of down move d , and number of time periods. Formulas to convert from volatility to u and d can be found on page 298 of [Investment Science](#).

Once a model has been appropriately specified (and output range if applicable), simply click the **Write** button to generate the lattice. The way the lattice is generated actually depends on the input method selected (Type in parameters/Get parameters from sheet). We now explain the difference between the two methods.

Type in parameters: The dialog includes a box for output range specification or alternatively the option to generate the lattice in a new worksheet on the active workbook.



Your lattice model will be written to the desired location, time and parameter labels will be added.
Note: If you specify a range, you must allow room for the time banner and the model parameters. A model with n time steps will need a to be at least $n+6$ rows tall and $n+1$ columns wide.

Get parameters from sheet: Your lattice will be created will be generated to the right of the initial value $S(0)$ cell. Attention: any previously stored data in those cells will be overwritten, so please make sure the $(n+1)$ by $(n+1)$ range to the right of $S(0)$ is free. This method does not generate any time or parameter labels.

VALUATION

Valuing an asset or commodity is generally done by creating a second lattice, identical in size to the first, whose entries are dependent on those of the original lattice. It is often convenient to place the new lattice directly below the first.

You should compute the value of the $n+1$ terminal nodes directly on the spreadsheet. You should also write one instance (at any node) of the formula that computes the value at time $n-1$. LatticeMaker will simply copy this formula backward throughout the lattice.

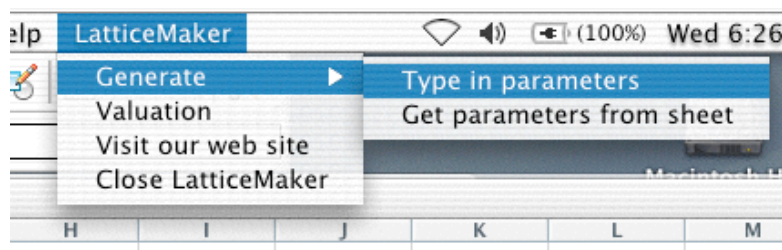
To complete the lattice, select Valuation from the LatticeMaker menu. A dialog will prompt you to select or provide the RANGE OF WORKSHEET CELLS containing the terminal nodes as well as the WORKSHEET CELL containing the valuation formula to be copied. The size and shape of the lattice is automatically determined based on the number of terminal nodes. The lattice will be generated when you click the Write button.

EXAMPLE: THE SIMPLICIO GOLD MINE LEASE

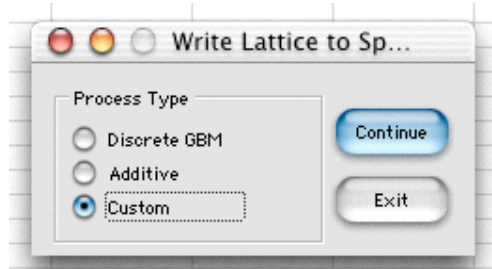
Here we will use LatticeMaker to help solve example 12.7 of Investment Science. At the Simplicio mine, up to 10,000 ounces of gold can be extracted per year, at a cost of \$200 per ounce. The price of gold is currently \$400, but fluctuates randomly. The term structure of interest rates is flat at 10%. We assume that the price obtained for mined gold is the price that held at the beginning of the year, but that cash flows occur at the end of the year. We wish to determine the value of a ten year lease on this mine.

Step 1: generate the gold price lattice.

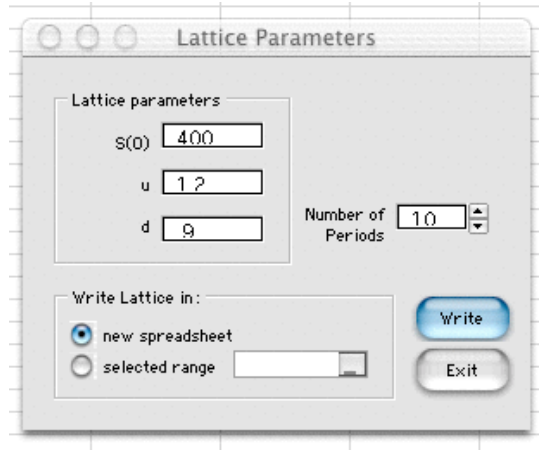
We use the 'type in parameters' method



...and we request a custom type model



...which allows us to specify our u and d multiplicative factors of 1.2 and 0.9. We also specify an initial value of 400 and a timeline of 10 periods.



For simplicity we choose to write the lattice on a new spreadsheet. We simply click on the write button and, almost instantly, we get our desired lattice.

	A	B	C	D	E	F	G	H	I	J	K
1	u	1.2									
2	d	0.9									
3											
4	0	1	2	3	4	5	6	7	8	9	10
5	400	480	576	691	829	995	1194	1433	1720	2064	2477
6		360	432	518	622	746	896	1075	1290	1548	1858
7			324	389	467	560	672	806	967	1161	1393
8				292	350	420	504	605	726	871	1045
9					262	315	378	453	544	653	784
10						236	283	340	408	490	588
11							213	255	306	367	441
12								191	230	275	331
13									172	207	248
14										155	186
15											139
16											

Step 2: Compute valuation primitives and generate valuation lattice

We first need to compute the risk neutral probability $q = (1.1 - 0.9)/(1.2 - 0.9) = 2/3$, and $1 - q = 1/3$. In our example we will use cell E2 to hold this result and cell E1 to hold the risk free return $R=1.1$.

We now create an empty lattice of the same size as the price of gold lattice. We must now provide LatticeMaker with terminal values and one “backwards valuation” example cell.

First of all, as the mine must be returned after 10 years, the value of the lease is clearly zero in year 10, thus we can fill in the last column. Now, let us consider the topmost cell in the column labeled 9. There are two components to the value here: the value from mining in this period and the discounted future value of this lease, as seen from this point.

Clearly, if the price of gold is above \$200 you will extract the maximum possible and otherwise none at all. The price of gold to use can be found in the corresponding cell in the price of gold lattice (\$2063.91) So we could enter the formula $\text{Max}(j5-200, 0) * 10000$ or equivalently $\text{If}[j5 > 200, (j5-200) * 10000, 0]$. The second component of the value is found by using the risk-neutral expected value of the value of the lease in the next period. Therefore, we add q times the topmost cell in the column labeled 10, and q times the cell directly below that one. Each of these two components is discounted back (by dividing by $R=1.1$) to the beginning of the period. Since R is stored in cell E1 and q is stored in cell E2, and assuming the first node of time 9 is on cell J19, the complete formula would be

$$=(\text{MAX}(J5-200, 0) * 10000 / 10^6 + \$E\$2 * K18 + (1 - \$E\$2) * K19) / \$E\$1$$

Note that we divide by 10^6 in order to express value in millions of dollars.

Once the valuation primitives have been set up, we just tell LatticeMaker the location of the end nodes and the sample formula.

	A	B	C	D	E	F	G	H	I	J	K
1	u	1.2		R	1.1						
2	d	0.9		q	0.6667						
3	Gold Lattice										
4	0	1	2	3	4	5	6	7	8	9	10
5	400	480	576	691	829	995	1194	1433	1720	2064	2477
6		360	432	518	622	746	896	1075	1290	1548	1858
7			324	389	467	560	672	806	967	1161	1393
8				292	350	420	504	605	726	871	1045
9					262	315	378	453	544	653	784
10						236	283	340	408	490	588
11							213	255	306	367	441
12								191	230	275	331
13									172	207	248
14										155	186
15											139
16	Lease Price										
17	0	1	2	3	4	5	6	7	8	9	10
18										16.9	0
19											0
20											0
21											0
22											0
23											0
24											0
25											0
26											0
27											0
28											0
29											0

This is done by selecting valuation from the LatticeMaker menu. We simply supply the requested cell ranges in the dialog that pops up, click on the write button and our valuation lattice is done!

15											139
16	<i>Lease Price</i>										
17	0	1	2	3	4	5	6	7	8	9	10
18	24.1	27.8	31.2	34.2	36.5	37.7	37.1	34.1	27.8	16.9	0
19		17.9	20.7	23.3	25.2	26.4	26.2	24.3	20.0	12.3	0
20			12.9	15.0	16.7	17.9	18.1	17.0	14.1	8.7	0
21				8.8	10.4	11.5	12.0	11.5	9.7	6.1	0
22					5.6	6.7	7.4	7.4	6.4	4.1	0
23						3.2	4.0	4.3	3.9	2.6	0
24							1.4	2.0	2.1	1.5	0
25								0.4	0.7	0.7	0
26									0.0	0.1	0
27										0.0	0
28											0
29											

Looking at the leftmost cell, we can see that our valuation model indicates that the current value of the lease is \$24.1 million.

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