Foreign Exchange Accumulator

General Description

- A FX Accumulator has the following features:
- The holder has to buy fixed amounts of a FX from the issuer at a strike price K per unit of FX on a series of settlement dates.
- The fixed amount bought when the FX spot rate is greater than K is less than the fixed amount bought when the FX spot rate is less than K (in our case, 8 and 20 millions).

- On any day when the spot rate is above a barrier price B, the contract is settled and ended.

- On any settlement date when the cumulative undiscounted payoff is greater than a trigger value TG, the contract is settled and ended.

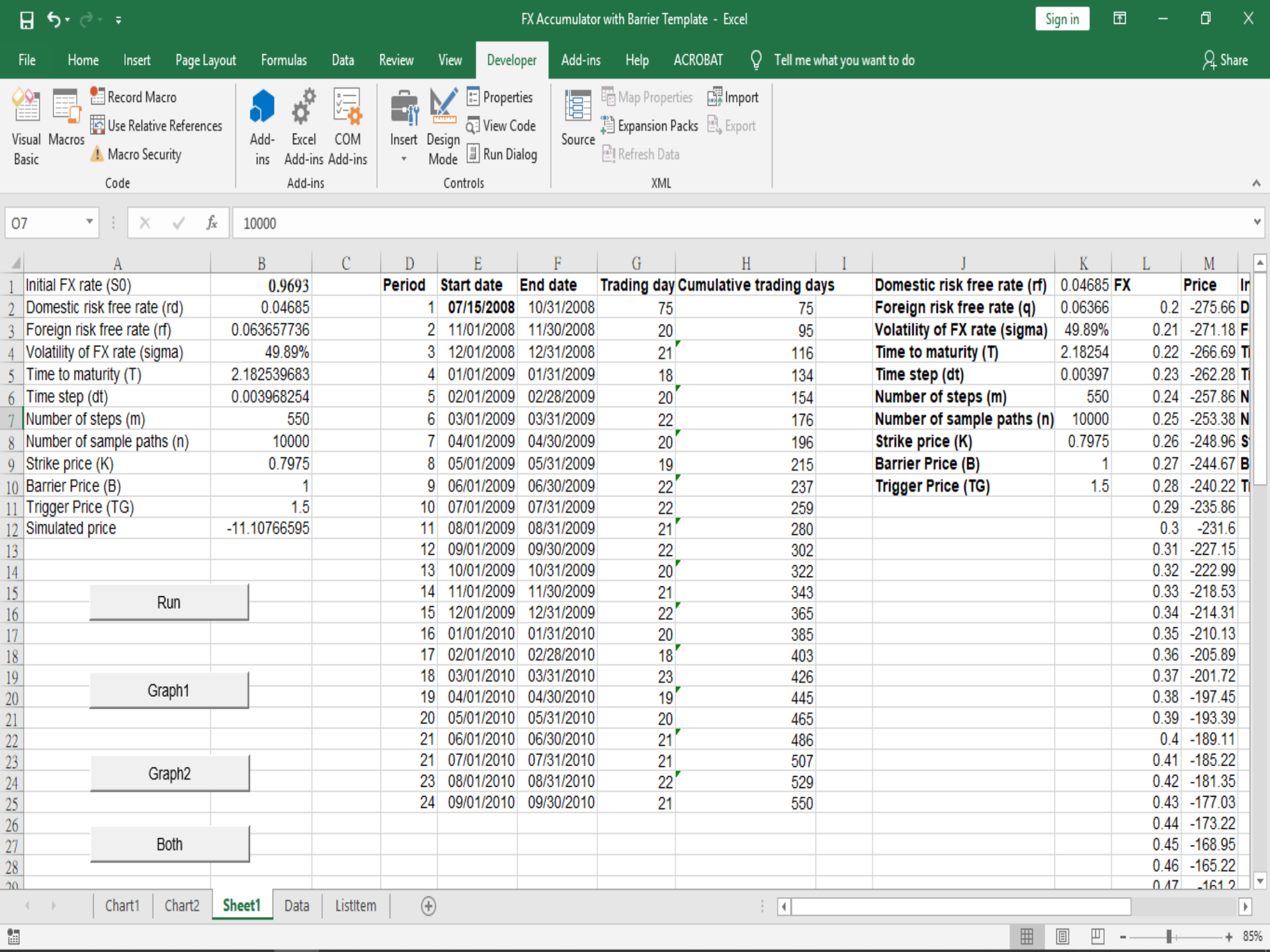
General Description

- Write VBA code that estimates value as well as price sensitivities to initial FX spot rate and volatility for FX Accumulators by
  - Simulating multiple paths for a geometric brownian motion FX spot rate process
  - Estimating the value of the FX Accumulator for each path and averaging those values
  - Estimating price sensitivities to the initial FX rate and its volatility.

Note

- Once you have simulated multiple paths for the geometric brownian motion FX spot rate process, transform these paths through the “Emartingale” public function before using them.

- The function is an implementation of “empirical martingale simulation”, a corrective method that aims to ensure the martingale property of the simulated results holds, i.e. the current price at time 0 equals the expected PV of any future time t price.


FX Accumulator with Barrier Template - Excel
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O7
10000
Initial FX rate (S0) 0.9693
Domestic risk free rate (rd) 0.04685
Foreign risk free rate (rf) 0.063657736
Volatility of FX rate (sigma) 49.89%
Time to maturity (T) 2.182539683
Time step (dt) 0.003968254
Number of steps (m) 550
Number of sample paths (n) 10000
Strike price (K) 0.7975
Barrier Price (B) 1
Trigger Price (TG) 1.5
Simulated price -11.10766595
Run
Graph1
Graph2
Both
Period Start date End date Trading day Cumulative trading days
1 07/15/2008 10/31/2008 75 75
2 11/01/2008 11/30/2008 20 95
3 12/01/2008 12/31/2008 21 116
4 01/01/2009 01/31/2009 18 134
5 02/01/2009 02/28/2009 20 154
6 03/01/2009 03/31/2009 22 176
7 04/01/2009 04/30/2009 20 196
8 05/01/2009 05/31/2009 19 215
9 06/01/2009 06/30/2009 22 237
10 07/01/2009 07/31/2009 22 259
11 08/01/2009 08/31/2009 21 280
12 09/01/2009 09/30/2009 22 302
13 10/01/2009 10/31/2009 20 322
14 11/01/2009 11/30/2009 21 343
15 12/01/2009 12/31/2009 22 365
16 01/01/2010 01/31/2010 20 385
17 02/01/2010 02/28/2010 18 403
18 03/01/2010 03/31/2010 23 426
19 04/01/2010 04/30/2010 19 445
20 05/01/2010 05/31/2010 20 465
21 06/01/2010 06/30/2010 21 486
21 07/01/2010 07/31/2010 21 507
23 08/01/2010 08/31/2010 22 529
24 09/01/2010 09/30/2010 21 550
Domestic risk free rate (rf) 0.04685
Foreign risk free rate (q) 0.06366
Volatility of FX rate (sigma) 49.89%
Time to maturity (T) 2.18254
Time step (dt) 0.00397
Number of steps (m) 550
Number of sample paths (n) 10000
Strike price (K) 0.7975
Barrier Price (B) 1
Trigger Price (TG) 1.5
FX Price
0.2 -275.66
0.21 -271.18
0.22 -266.69
0.23 -262.28
0.24 -257.86
0.25 -253.38
0.26 -248.96
0.27 -244.67
0.28 -240.22
0.29 -235.86
0.3 -231.6
0.31 -227.15
0.32 -222.99
0.33 -218.53
0.34 -214.31
0.35 -210.13
0.36 -205.89
0.37 -201.72
0.38 -197.45
0.39 -193.39
0.4 -189.11
0.41 -185.22
0.42 -181.35
0.43 -177.03
0.44 -173.22
0.45 -168.95
0.46 -165.22
Chart1 Chart2 Sheet1 Data ListItem
85%

J	K	L	M	N	O	P	Q	R
Domestic risk free rate (rf)	0.04685	**FX**	**Price**	**Initial FX rate (S0)**	**0.9693**	**Sigma**	**Price**	
Foreign risk free rate (q)	0.06366	0.2	-275.66	**Domestic risk free rate (rf)**	0.04685	0.1	-53.698	
Volatility of FX rate (sigma)	49.89%	0.21	-271.18	**Foreign risk free rate (q)**	0.06366	0.11	-53.96	
Time to maturity (T)	2.18254	0.22	-266.69	**Time to maturity (T)**	2.18254	0.12	-54.303	
Time step (dt)	0.00397	0.23	-262.28	**Time step (dt)**	0.00397	0.13	-54.814	
Number of steps (m)	550	0.24	-257.86	**Number of steps (m)**	550	0.14	-55.208	
Number of sample paths (n)	10000	0.25	-253.38	**Number of sample paths (n)**	10000	0.15	-55.877	
Strike price (K)	0.7975	0.26	-248.96	**Strike price (K)**	0.7975	0.16	-56.399	
Barrier Price (B)	1	0.27	-244.67	**Barrier Price (B)**	1	0.17	-57.17	
Trigger Price (TG)	1.5	0.28	-240.22	**Trigger Price (TG)**	1.5	0.18	-57.868	
		0.29	-235.86			0.19	-58.43	
		0.3	-231.6			0.2	-59.577	
		0.31	-227.15			0.21	-59.901	
		0.32	-222.99			0.22	-61.093	
		0.33	-218.53			0.23	-61.76	
		0.34	-214.31			0.24	-62.731	
		0.35	-210.13			0.25	-63.505	
		0.36	-205.89			0.26	-64.095	
		0.37	-201.72			0.27	-65.417	
		0.38	-197.45			0.28	-65.908	
		0.39	-193.39			0.29	-67.259	
		0.4	-189.11			0.3	-67.631	
		0.41	-185.22			0.31	-68.63	
		0.42	-181.35			0.32	-69.625	
		0.43	-177.03			0.33	-69.822	
		0.44	-173.22			0.34	-71.239	
		0.45	-168.95			0.35	-71.307	
		0.46	-165.22			0.36	-72.673	
		0.47	-161.2			0.37	-73.405	

FX Rate Dynamics

- At step j + 1 of a path, rate S changes as follows:

$$S_{j+1} = S_j + (r_f - r_q)S_j\Delta t + \sigma S_j\sqrt{\Delta t}Z_j$$

  - r_f is the domestic risk-free rate
  - r_q is the foreign risk-free rate
  - Δt is the time between 2 steps
  - σ is the annual FX rate volatility
  - Z_j is a random value from a standard normal distribution (NormInv on Excel)