Advanced Forecasting Techniques and Models: Stochastic Processes

Short Examples Series using Risk Simulator

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Forecasting – Stochastic Processes

File Name: *Forecasting – Stochastic Processes*
Location: *Modeling Toolkit | Forecasting | Stochastic Processes*
Brief Description: *This sample model illustrates how to simulate Stochastic Processes (Brownian Motion Random Walk, Mean-Reversion, Jump-Diffusion, and Mixed Models)*
Requirements: *Modeling Toolkit, Risk Simulator*

A stochastic process is a sequence of events or paths generated by probabilistic laws. That is, random events can occur over time but are governed by specific statistical and probabilistic rules. The main stochastic processes include Random Walk or Brownian Motion, Mean-Reversion and Jump-Diffusion. These processes can be used to forecast a multitude of variables that seemingly follow random trends but yet are restricted by probabilistic laws. We can use Risk Simulator's *Stochastic Process* module to simulate and create such processes. These processes can be used to forecast a multitude of time-series data including stock prices, interest rates, inflation rates, oil prices, electricity prices, commodity prices, and so forth.

Stochastic Process Forecasting

To run this model, simply:

1. Select **Risk Simulator | Forecasting | Stochastic Processes**.
2. Enter a set of relevant inputs or use the existing inputs as a test case (Figure 1).
3. Select the relevant process to simulate.
4. Click on **Update Chart** to view the updated computation of a single path or click **OK** to create the process.

Please note that you can use Risk Simulator's Data Diagnostic tool to calibrate and compute the required input parameters in the model.

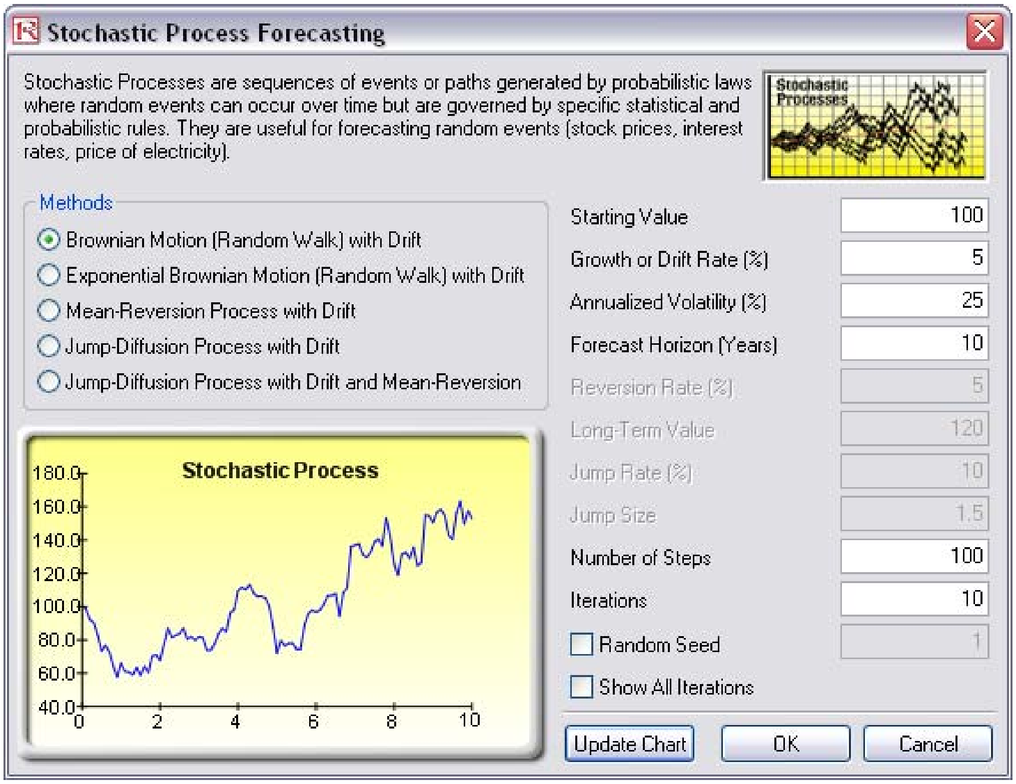


Figure 1: Running a stochastic process forecast

Model Results Analysis

For your convenience, the analysis *Report* worksheet is included in the model. A stochastic time-series chart and forecast values are provided in the report as well as each step's time period, mean, and standard deviation of the forecast (Figure 2). The mean values can be used as the single-point estimate, or assumptions can be manually generated for the desired time period. That is, after finding the appropriate time period, create an assumption with a normal distribution with the appropriate mean and standard deviation computed. A sample chart with 10 iteration paths is included to graphically illustrate the behavior of the forecasted process.

Clearly, the key is to calibrate the inputs to a stochastic process forecast model. The input parameters can be obtained very easily through some econometric modeling of historical data. The Data Diagnostic and Statistical Analysis models show how to use Risk Simulator to compute these input parameters. See Dr. Johnathan Mun's Modeling Risk, 2nd Edition (Hoboken, NJ: John Wiley & Sons, 2006), for the technical details on obtaining these parameters.

Stochastic Process Forecasting

Statistical Summary

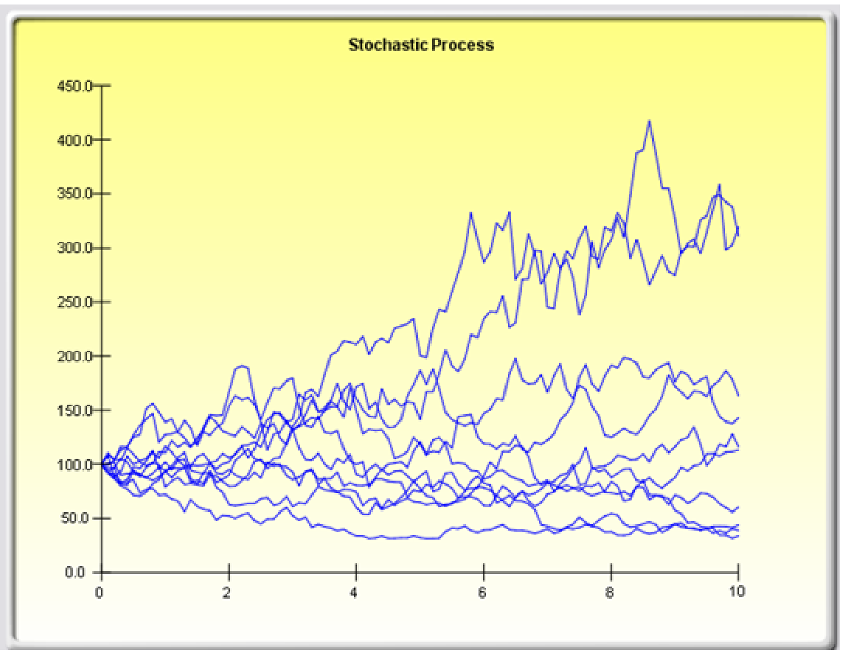
A stochastic process is a sequence of events or paths generated by probabilistic laws. That is, random events can occur over time but are governed by specific statistical and probabilistic rules. The main stochastic processes include Random Walk or Brownian Motion, Mean-Reversion, and Jump-Diffusion. These processes can be used to forecast a multitude of variables that seemingly follow random trends but yet are restricted by probabilistic laws.

The Random Walk Brownian Motion process can be used to forecast stock prices, prices of commodities, and other stochastic time-series data given a drift or growth rate and a volatility around the drift path. The Mean-Reversion process can be used to reduce the fluctuations of the Random Walk process by allowing the path to target a long-term value, making it useful for forecasting time-series variables that have a long-term rate such as interest rates and inflation rates (these are long-term target rates by regulatory authorities or the market). The Jump-Diffusion process is useful for forecasting time-series data when the variable can occasionally exhibit random jumps, such as oil prices or price of electricity (discrete exogenous event shocks can make prices jump up or down). Finally, these three stochastic processes can be mixed and matched as required.

The results on the right indicate the mean and standard deviation of all the iterations generated at each time step. If the Show All Iterations option is selected, each iteration pathway will be shown in a separate worksheet. The graph generated below shows a sample set of the iteration pathways.

Stochastic Process: Brownian Motion (Random Walk) with Drift

Start Value	100	Steps	100.00	Jump Rate	N/A
Drift Rate	5.00%	Iterations	10.00	Jump Size	N/A
Volatility	25.00%	Reversion Rate	N/A	Random Seed	1431155157
Horizon	10	Long-Term Value	N/A		



Time	Mean	Stdev
0.0000	100.00	0.00
0.1000	99.10	7.47
0.2000	96.03	7.22
0.3000	94.97	13.59
0.4000	97.39	15.57
0.5000	99.50	17.01
0.6000	97.79	20.92
0.7000	102.23	25.54
0.8000	106.54	26.54
0.9000	102.34	21.16
1.0000	102.77	20.86
1.1000	103.30	22.41
1.2000	103.27	19.23
1.3000	103.02	23.61
1.4000	97.78	19.65
1.5000	96.84	20.53
1.6000	100.92	25.22
1.7000	105.18	26.90
1.8000	100.75	30.33
1.9000	101.20	29.71
2.0000	103.67	36.95
2.1000	108.09	42.76
2.2000	111.58	42.61
2.3000	111.25	41.54
2.4000	108.47	35.22
2.5000	107.13	32.56
2.6000	108.95	32.95
2.7000	114.64	38.78
2.8000	114.13	36.61
2.9000	114.97	35.91
3.0000	114.33	39.90
3.1000	112.69	39.94
3.2000	115.11	39.89
3.3000	117.64	42.82
3.4000	114.70	39.91
3.5000	115.52	43.45
3.6000	117.60	49.89
3.7000	120.21	51.94
3.8000	116.64	53.52
3.9000	118.70	56.12
4.0000	113.19	56.71
4.1000	109.09	58.33
4.2000	103.70	52.23
4.3000	108.41	53.12
4.4000	108.67	56.30
4.5000	105.96	52.42
4.6000	106.12	55.80
4.7000	107.70	55.11
4.8000	109.43	58.43
4.9000	114.50	59.64
5.0000	110.44	53.91

Figure 2: Stochastic process forecast results