

Application of Monte Carlo Simulation in Retirement Investment Planning



MGT 239

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Agenda

Part I: Introduction

Part II: Portfolio Proposition

Part III: Simulation Proposition & Processes

Part IV: Simulation Results & Conclusion

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4 Types of Retirement Planning

- Government-sponsored Plans:
Social Security plan
- Individual plans:
IRAs and Roth IRAs
- Company-sponsored plans: 401k
- Annuities

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How to choose the best portfolio?

Consider:

The expected return on the portfolio

The STDEV of portfolio's return, which indicates the risk of the portfolio.

Three Portfolio Propositions

Portfolio I:
Risk Neutral

CD 50% + GE 30% + IBM 20%

Portfolio II:
Risky

CD 20% + GE 20% + IBM 60%

Portfolio III:
Risk Free

CD 100%

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Assumptions and Constraints

Assumptions

- **Historical database were used to predict the future.**
- **Choose put option as hedging method for GE and call option for IBM.**
- **Taxes aren't taken into account**

Assumptions and Constraints

Constraints

- **Global economy suffers from financial meltdown.**
- **Simulated in one year span, static model, crossing the time horizon.**
- **Limited function of @ Risk package**

Data Collection

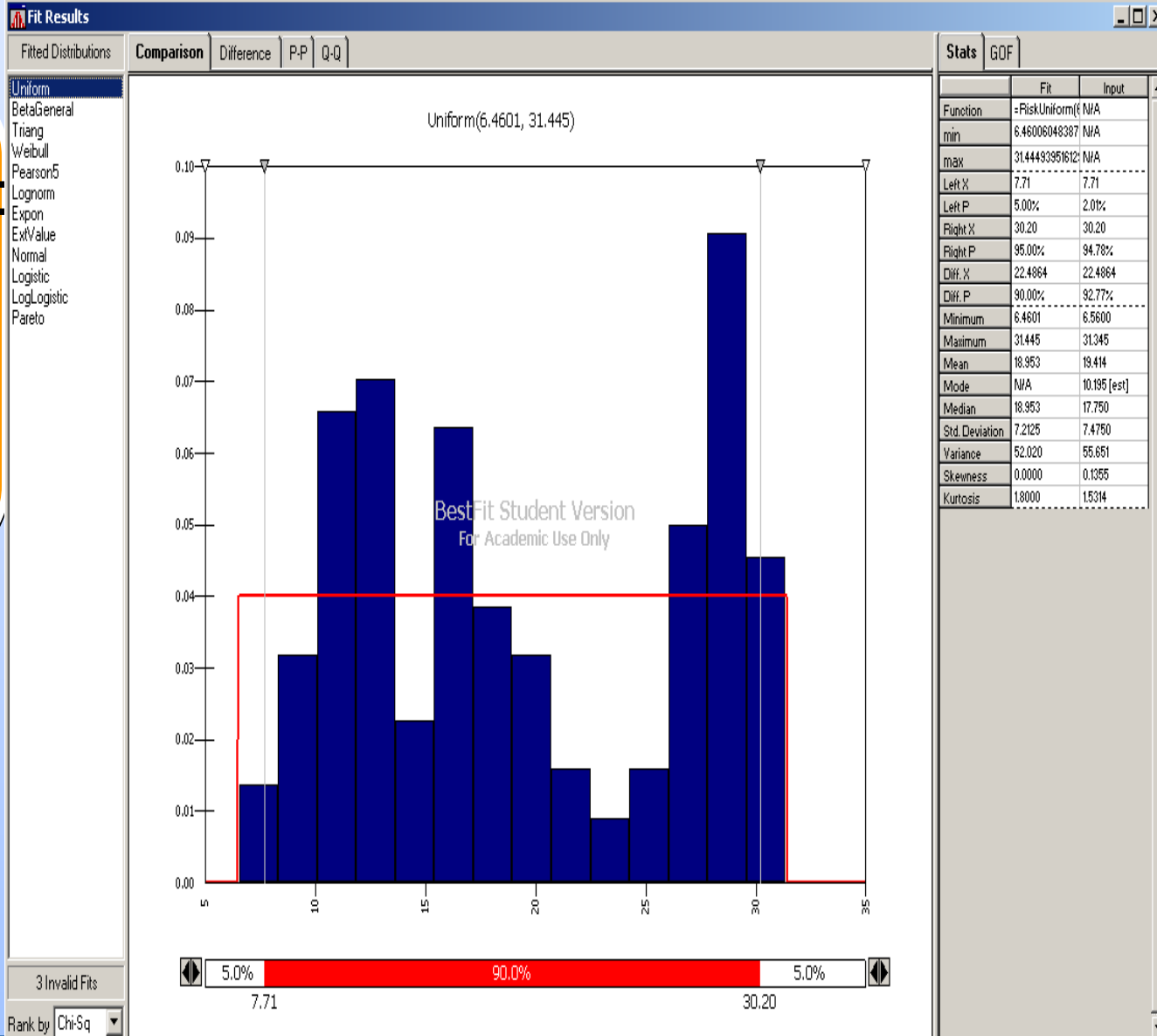
- Historical daily average stock prices (2008-2009) from Yahoo Finance
- Volatility and variation from the correlation matrix

	C	CA	COMR	DE	DOW	EK	GE	GT	HB	IBM	NC	SO
Component	1	2	3	4	5	6	7	8	9	10	11	12
μ	-0.00146	-0.00066	0.00013	-0.00001	-0.00084	0.00033	-0.00137	0.00103	0.00303	0.00082	0.00285	0.00025
σ	0.02537	0.03315	0.03568	0.02448	0.02040	0.01761	0.01801	0.02064	0.02414	0.02546	0.02787	0.01473
Exponent	-0.52623	-0.43924	-0.28601	-0.1528	-0.31425	0.005269	-0.42446	0.152147	0.612942	0.043628	0.51782	0.007397
Current Price	48.1875	52.125	23.125	36.75	116.5	68.625	125.625	43.6875	28.875	93.9375	50.375	25.8125
Simulated Price	28.47066	33.59586	17.37274	31.54258	85.08455	68.98755	82.1746	50.86674	53.29904	98.12656	84.54764	26.00415
Holdings (shares)	120	300	725	200	100	200	200	250	325	150	100	500

Simulation of Distribution of Stock Price

GE Stock Price:

Uniform
Distribution



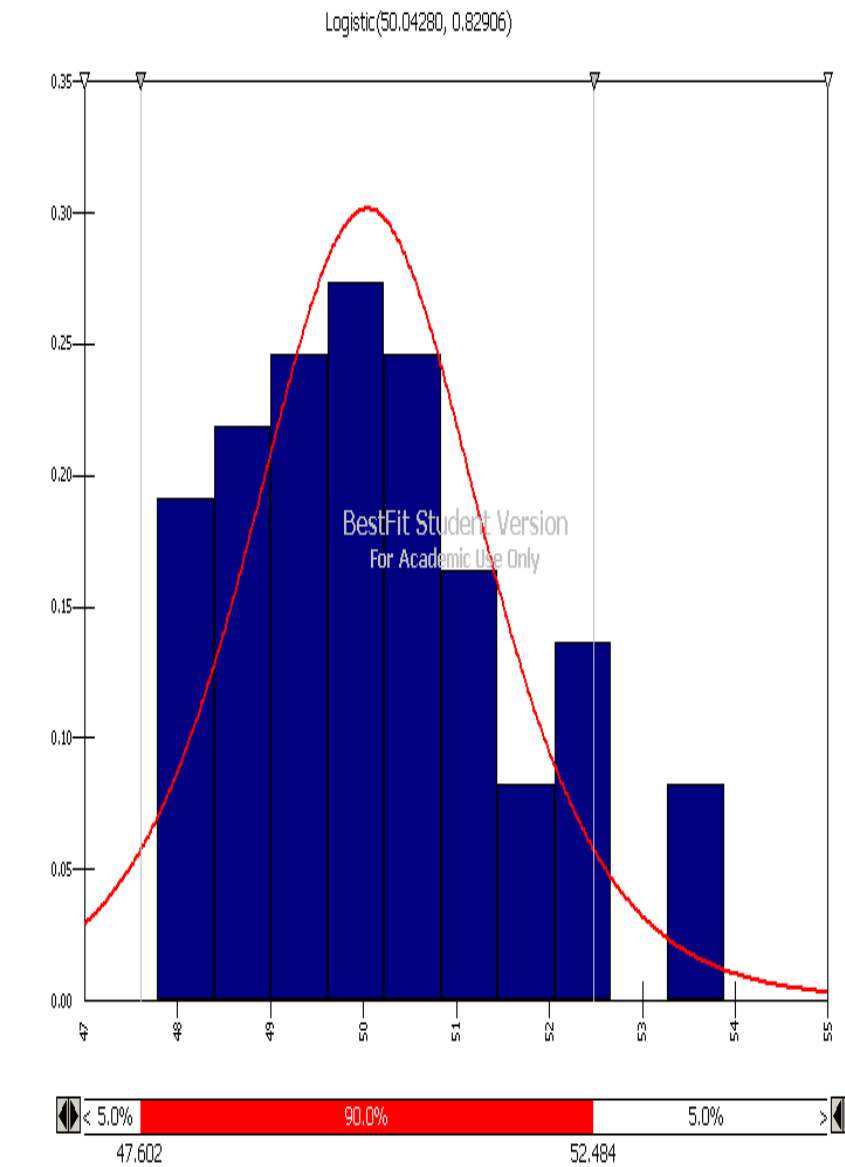
Simulation of Distribution of Stock Price

IBM Stock Price:
Geometric
Random Walk
Distribution

- Logistic
- ExValue
- Lognom
- Normal
- Pearson5
- BetaGeneral
- Weibull
- Triang
- Pareto
- Uniform
- Expon

3 Invalid Fits

Rank by Chi-Sq



Function	=RiskLogistic(N/A)	
α	50.0428022150(N/A)	
β	0.82906063656(N/A)	
Left X	47.602	47.602
Left P	5.00%	0.00%
Right X	52.484	52.484
Right P	95.00%	90.00%
Diff. X	4.8822	4.8822
Diff. P	90.00%	90.00%
Minimum	-Infinity	47.7850
Maximum	+Infinity	53.8850
Mean	50.04280	50.1487
Mode	50.04280	48.7250 [est]
Median	50.04280	49.9725
Std. Deviation	1.50375	1.4679
Variance	2.26126	2.1188
Skewness	0.0000	0.6307
Kurtosis	4.2000	2.8594



Simulation GE Return with/without Option

**Higher Return:
Using
Put Option**

	A	B	C	D
1	Demonstration of Hedging using Put Options (GE)			
2		With Hedging	No Hedging	
3	Current Price $P(0)$	31.44		
4				
5	Expiration Time T	0.75		
6	Risk-free Rate r	3.21		
7	Exercise Price S	29		
8				
9	Price of put option	0.3		
10	Price at Expiration	18.930		
11	Cash Flow at Exp	-2.440	-12.510	
12	Discounted C.F.	-0.220	-1.126	
13	Return on Portfolio	-0.520	-1.126	
14	Percentage Return	-1.65%	-3.58%	
15				

Simulation IBM Return with/without Option

Higher Return:

Not using
call options

	A	B	C
1	Demonstration of IBM Hedging using Call Options		
2		With Hedging	No Hedging
3	Current Price $P(0)$	101	
4	Drift μ (annual)	0.08230	
5	Volatility σ (annual)	0.02546	
6	Expiration Time T	0.75	
7	Risk-free Rate r	3.21	
8	Exercise Price S	103	
9			
10	Price of call option	1.5	
11	Price at Expiration	107.404	
12	Cash Flow at Exp	4.404	6.404
13	Discounted C.F.	0.397	0.577
14	Return on Portfolio	-1.103	0.577
15	Percentage Return	-1.09%	0.57%

Simulation Proposition for two Portfolios

Return of Portfolio I

$$Y1=0.5*R1 +0.3*R2+0.2*R3$$

Return of Portfolio II

$$Y2=0.2*R1 +0.2*R2+0.6*R3$$

Simulation Graphic Results

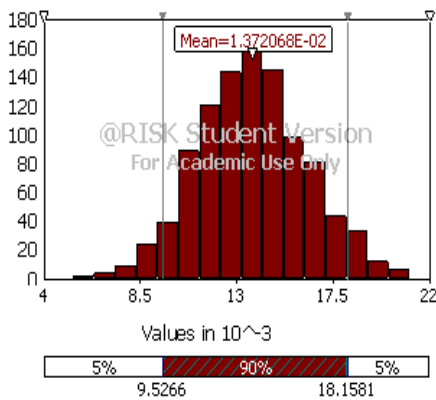
Return of Portfolio I

Return of Portfolio II

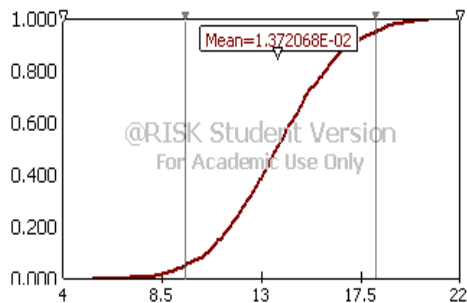
Simulation Results for
Sinario 1 weighted rate / C5

Simulation Results for
Sinario 2 weighted rate / D5

Distribution for Sinario 1 weighted rate/C5



Distribution for Sinario 1 weighted rate/C5



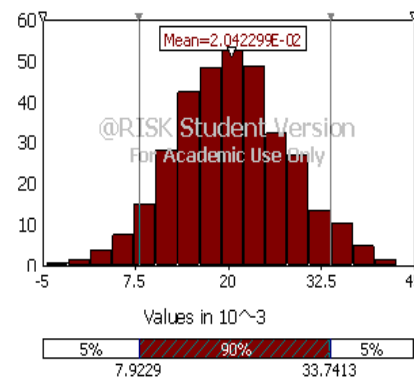
Summary Information

Workbook Name	.xls, GE stock Put Option.
Number of Simulations	1
Number of Iterations	1000
Number of Inputs	7
Number of Outputs	8
Sampling Type	Monte Carlo
Simulation Start Time	5/23/2009 15:20
Simulation Stop Time	5/23/2009 15:20
Simulation Duration	00:00:04
Random Seed	12345

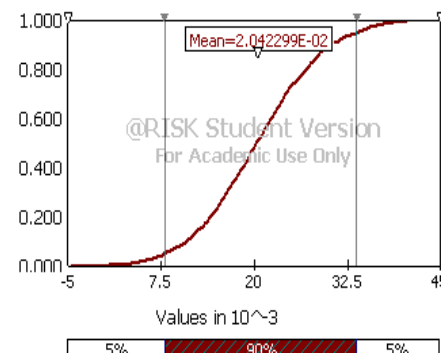
Summary Statistics

Statistic	Value	%tile	Value
Minimum	0.00536647	5%	0.009526596
Maximum	0.02107257	10%	0.010545739
Mean	0.013720684	15%	0.01104148
Std Dev	0.002548554	20%	0.011570051
Variance	6.49513E-06	25%	0.011970033
Skewness	0.045169824	30%	0.012353388
Kurtosis	2.912265261	35%	0.012745024
Median	0.013640449	40%	0.013063722
Mode	0.014891791	45%	0.013367184
Left X	0.009526596	50%	0.013640449
Left P	5%	55%	0.013990184
Right X	0.018158047	60%	0.014311997
Right P	95%	65%	0.014701922
Diff X	0.00863145	70%	0.014968989
Diff P	90%	75%	0.015430794
#Errors	0	80%	0.015899751

Distribution for Sinario 2 weighted rate/D5



Distribution for Sinario 2 weighted rate/D5



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Simulation Duration	00:00:04
Random Seed	12345

Summary Statistics

Statistic	Value	%tile	Value
Minimum	-0.004485739	5%	0.007922918
Maximum	0.042632561	10%	0.011031141
Mean	0.020422988	15%	0.012500768
Std Dev	0.007610737	20%	0.014020412
Variance	5.79233E-05	25%	0.015256776
Skewness	0.040183338	30%	0.016322916
Kurtosis	2.90114766	35%	0.017378552
Median	0.020213064	40%	0.018447971
Mode	0.021918814	45%	0.019347742
Left X	0.007922918	50%	0.020213064
Left P	5%	55%	0.021294257
Right X	0.033741258	60%	0.022210313
Right P	95%	65%	0.023278734
Diff X	0.02581834	70%	0.024137437
Diff P	90%	75%	0.025514849
#Errors	0	80%	0.026876841
Filter Min		85%	0.028405013
Filter Max		90%	0.030074187

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Part I: Introduction

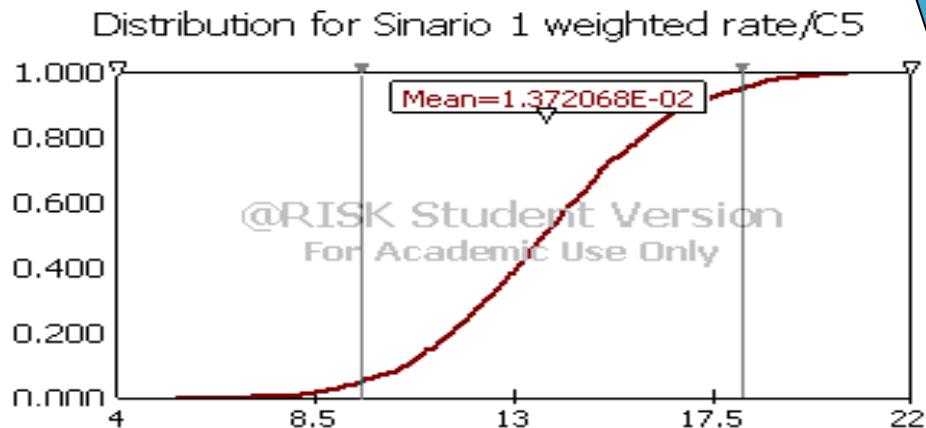
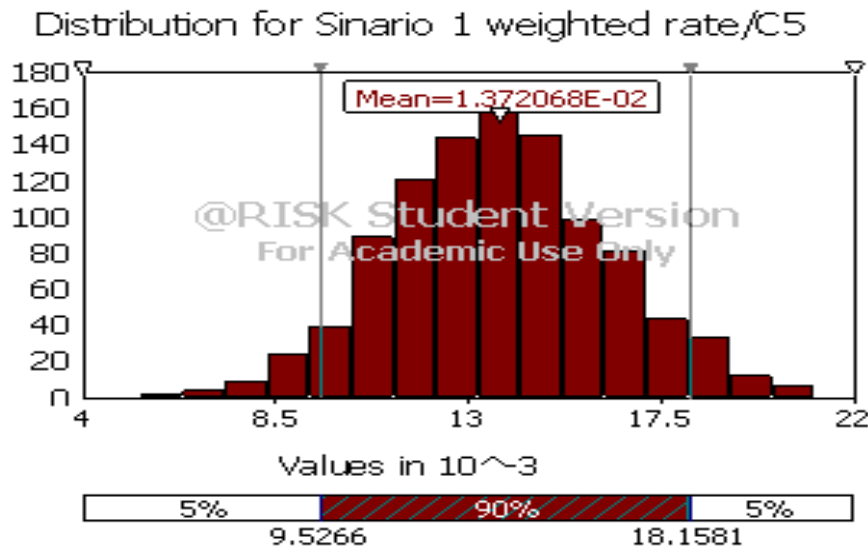
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Portfolio I Results Analysis

Simulation Results for Sinario 1 weighted rate / C5

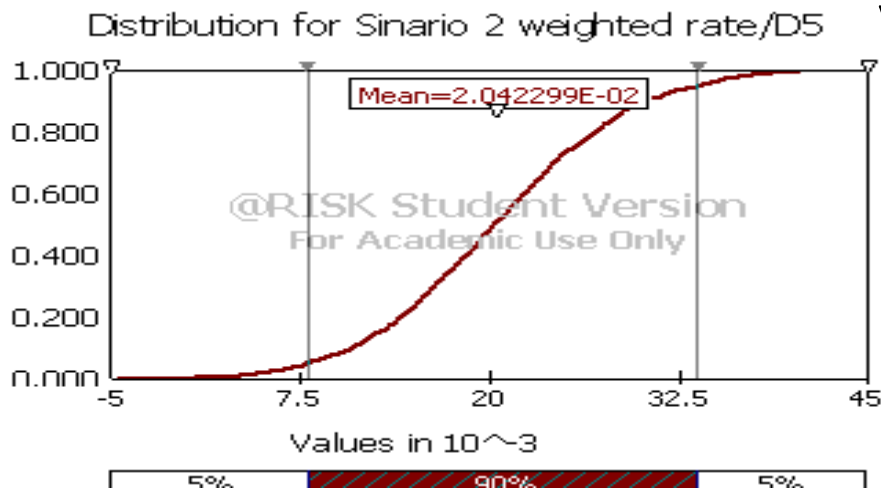
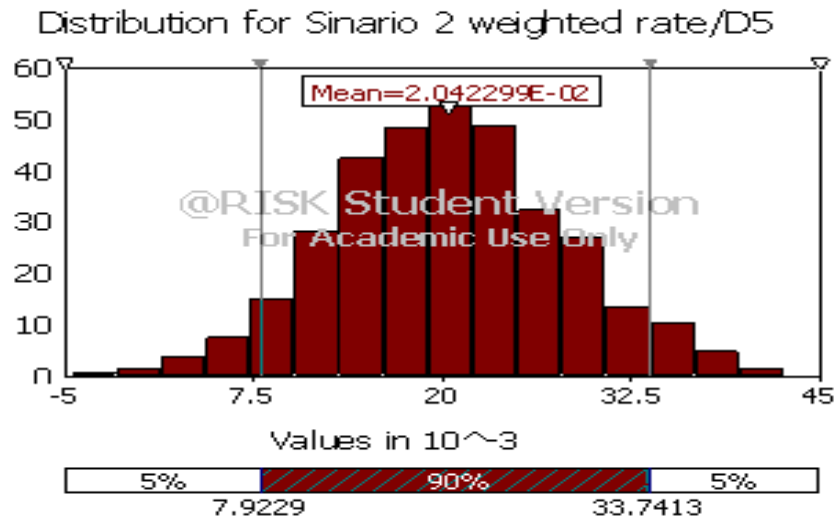


- Mean return = 1.3%
- 90% Confidence Interval return = 0.9% to 1.8%
- Ideal for the less risk tolerant investors who has shorter investment horizon.

Risk Neutral Portfolio:
CD 50%+GE 30%+
IBM 20%

Portfolio II Results Analysis

Simulation Results for Sinario 2 weighted rate / D5



- Mean return = 2%
- 90% Confidence Interval return = 0.75% to 3.25%
- Ideal for the risk takers, who are younger investors with longer investment horizon.

Risky Portfolio:
CD 20%+GE 20%+
IBM 60%

Portfolio III Analysis

100% Risk Free
Certified Deposit

- Point Estimation = 1.73%
- Ideal for the most risk averse investors who are getting old with the shortest investment horizon.

Conclusion: Monte Carlo Simulation in Financial Modeling

Advantages

- Easy to generate unlimited different market scenarios
- A probability test instead of certainty
- Could simulate multiple sources of uncertainty

Conclusion: Monte Carlo Simulation in Financial Modeling

Disadvantages

- Use historical data for volatility & correlations etc.
- Sampling Variations
- Computationally intensive

Conclusion: Monte Carlo Simulation in Financial Modeling

Odds-On Imperfection

“Failing to gauge extreme events at the tail end of the distribution, Monte Carlo financial models often gave big institutions, as well as small investors, a false sense of security.”

----Wall Street Journal May 05. 2009

Simulation Is More of an Art Than a Science

Thank You!