Profit Forecast Model Using Monte Carlo Simulation in Excel

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Abstract

Profit forecast is very important for any company. The purpose of this study is to provide a method to estimate the profit and the probability of obtaining the expected profit. Monte Carlo methods are stochastic techniques--meaning they are based on the use of random numbers and probability statistics to investigate problems. Monte Carlo simulation furnishes the decision-maker with a range of possible outcomes and the probabilities they will occur for any choice of action. Our example of Monte Carlo simulation in Excel will be a simplified profit forecast model. Each step of the analysis will be described in detail. The input data for the case presented: the number of leads per month, the percentage of leads that result in sales, , the cost of a single lead, the profit per sale and fixed cost, allow obtaining profit and associated probabilities of achieving.

Keywords: Profit forecast; Monte Carlo simulation; Probabilities.

1. Introduction

Monte Carlo simulation is a method for *iteratively* evaluating a deterministic model using sets of random numbers as inputs. This method is often used when the model is complex, nonlinear, or involves more than just a couple uncertain parameters. A simulation can typically involve *over 10,000 evaluations* of the model, a task which in the past was only practical using super computers.

Monte Carlo simulation furnishes the decision-maker with a range of possible outcomes and the probabilities they will occur for any choice of action. It shows the extreme possibilities—the outcomes of going for broke and for the most conservative decision—along with all possible consequences for middle-of-the-road decisions.

The technique was first used by scientists working on the atom bomb; it was named for Monte Carlo, the Monaco resort town renowned for its casinos. Since its introduction in World War II, Monte Carlo simulation has been used to model a variety of physical and conceptual systems.

The Monte Carlo method is just one of many methods for analyzing uncertainty propagation, where the goal is to determine how *random variation*, *lack of knowledge*, or *error* affects the *sensitivity*, *performance*, or *reliability* of the system that is being modeled.

Monte Carlo simulation is categorized as a sampling method because the inputs are randomly generated from *probability distributions* to simulate the process of sampling from an actual *population*. So, we try to choose a distribution for the inputs that most closely *matches data we already have*, or best represents our *current state of knowledge*. The data generated from the simulation can be represented as probability distributions (or histograms) or converted to *error bars*, *reliability predictions*, *tolerance zones*, and *confidence intervals*. (Figure 1).

Schematic showing the principal of stochastic uncertainty propagation
Figure 1
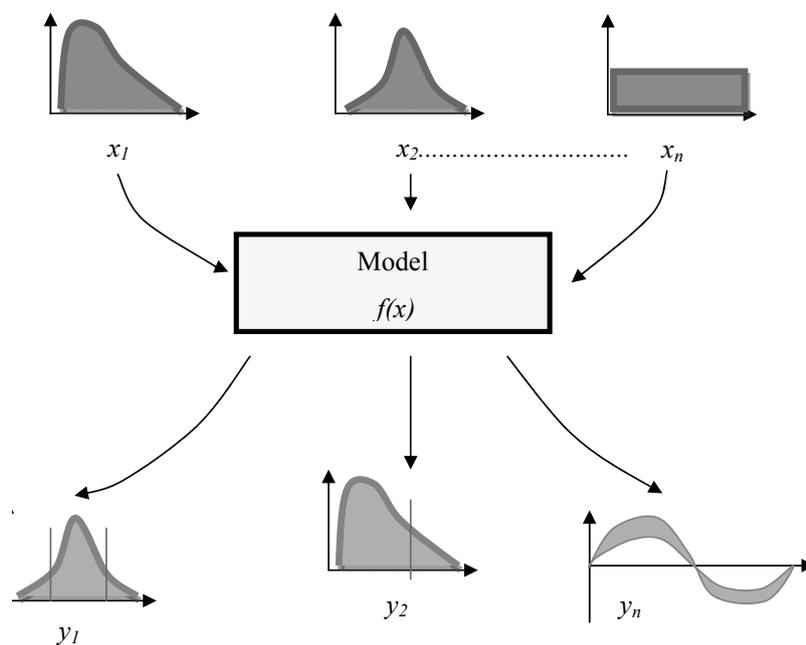
The steps in Monte Carlo simulation corresponding to the uncertainty propagation shown in Figure 1 are fairly simple, and can be easily implemented in Excel for simple models. All we need to do is follow the five simple steps listed below:

Step 1: Create a parametric model, $y = f(x_1, x_2, ..., x_n)$.

Step 2: Generate a set of random inputs, $x_{i1}, x_{i2}, ..., x_{in}$.

Step 3: Evaluate the model and store the results as y_i.

Step 4: Repeat steps 2 and 3 for $i = 1$ to n.

Step 5: Analyze the results using histograms, summary statistics, confidence intervals, etc.

2. Profit Forecast Model Using Monte Carlo Simulation in Excel

The Scenario: Company ABC wants to know how profitable it will be to market their new gadget, realizing there are many uncertainties associated with market size, expenses, and revenue.

The Method: Use a Monte Carlo Simulation to estimate profit and evaluate risk.

Step 1: Creating the Model

We are going to use a top-down approach to create the sales forecast model, starting with:

$$Profit = Income\text{-}Expenses$$

Both income and expenses are uncertain parameters, but we aren't going to stop here, because one of the purposes of developing a model is to try to break the problem down into more fundamental quantities. Ideally, we want all the inputs to be *independent*.

We'll say that *Income* comes solely from the number of sales (S) multiplied by the profit per sale (P) resulting from an *individual purchase* of a gadget, so *Income* = S*P. The *profit per sale* takes into account the sale price, the initial cost to manufacturer or purchase the product wholesale, and other transaction fees (credit cards, shipping, etc.). For our purposes, we'll say the P may fluctuate between 50 ron and 80 ron.

We could just leave the number of sales as one of the primary variables, but for this example, Company ABC generates sales through *purchasing leads*. The number of sales per month is the number of leads per month (L) multiplied by the conversion rate (R) (the percentage of leads that result in sales). So our final equation for *Income* is:

$$Income = L \cdot R \cdot P$$

We'll consider the *Expenses* to be a combination of fixed overhead (H) plus the total cost of the leads. For this model, the cost of a single lead (C) varies between 0,20 ron and 0,80 ron. Based upon some market research, Company ABC expects the number of leads per month (L) to vary between 1000 and 2000. Our final model for Company ABC's profit forecast is:

$$Profit = L \cdot R \cdot P - (H + L \cdot C)$$

where:

Y = Profits
$X_1 = L \in [1000 \div 2000]$
$X_2 = C \in [0,2 \div 0,8]$
$X_3 = R \in [0,01 \div 0,05]$
$X_4 = P \in [50 \div 80]$

Notice that H is also part of the equation, but we are going to treat it as a constant in this example. The inputs to the Monte Carlo simulation are just the uncertain parameters (X_i).

This is not a comprehensive treatment of modeling methods, but I used this example to demonstrate an important concept in uncertainty propagation, namely *correlation*. After breaking *Income* and *Expenses* down into more fundamental and measurable quantities, we found that the number of leads (L) affected both income *and* expenses. Therefore, income and expenses are not independent. We could probably break the problem down even further, but we won't in this example. We'll assume that L, R, P, H, and C are all independent.

It is easier to decompose a model into independent variables (when possible) than to try to mess with correlation between random inputs.
The input values are presented in table 1.

Input values

Table 1

Input Values (input)				
	Nominal		**Min**	**Max**
Leads per Month **(L)**	1500		1000	2000
Cost Per Lead **(C)**	0,50	–	0,20	0,80
Conversion Rate **(R)**	3,0%		1,0%	5,0%
Profit per Sale **(P)**	65,00		50,00	80,00

Step2: Generate a set of random inputs using Excel sheet, (Data-Data Analysis- Random number generation), figure 2.

Monte Carlo model using Excel seet

Figure 2

	A	B	C	D	E	F	G
1		L (rand)	C (rand)	R (rand)	P (rand)		Profit
2	1	1829	0,0107	53,7053	0,7935		-1397,19
3	2	1695	0,0318	52,6112	0,7729		523,73
4	3	1813	0,0183	56,6616	0,7944		-558,02
5	4	1977	0,0394	53,9186	0,7931		1628,72
6	5	1920	0,0249	53,5524	0,7103		198,23
7	6	1503	0,0499	51,6572	0,7583		1737,09
8	7	1282	0,0268	51,6352	0,7819		-226,61
9	8	1837	0,0498	50,5319	0,6646		2401,43
10	9	1256	0,0115	51,4841	0,7321		-1173,01
11	10	1329	0,0193	56,0372	0,7856		-609,47
12	11	1748	0,0225	52,5095	0,7842		-306,31
13	12	1789	0,0378	60,6507	0,7827		1697,19
14	13	1179	0,0247	50,0385	0,7903		-473,48
15	14	1867	0,0226	59,3597	0,7584		92,42
16	15	1721	0,0413	63,8029	0,7869		2179,12

Step 5: Analyze the results

Analyzing the results obtained by random generation of each data value input limits and calculating profit from using relation (1) implies:
- Calculating the main statistical indicators, Table 2;
- Grouping profit equal ranges, Figure 3;
- Determine the cumulative probability, Figure 4;
- Determination of specific indicators descriptive statistics Table 3;
- Determine the probability of obtaining a profit, Table 4.

Summary Statistics	
Sample Size (*n*):	5000
MEAN:	678,51
STDEV:	1009,34

Histogram of Monte Carlo Simulation Results
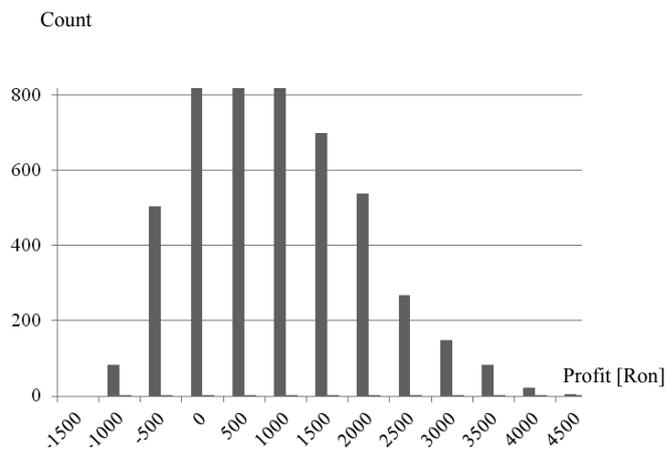
Cumulativ probability depending on profit

Figure 4

Cumulative probability
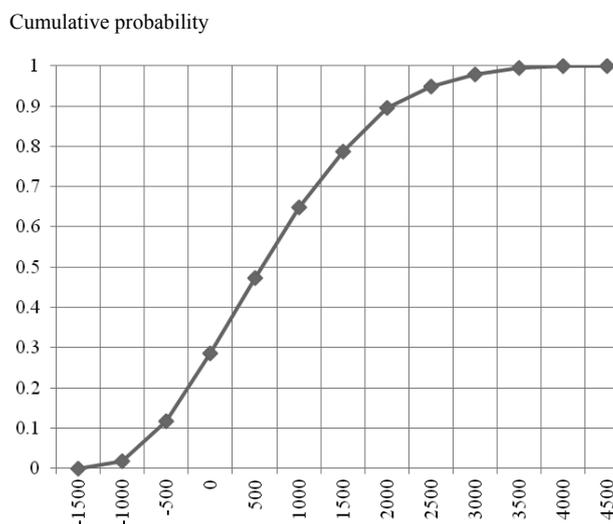
Table 3

Descriptive statistics	
Mean	384,6153846
Standard Error	100,1606107
Median	268
Mode	83
Standard Deviation	361,1342175
Sample Variance	130417,9231
Kurtosis	-1,619555088
Skewness	0,393009744
Minimum	0
Maximum	939
Sum	5000

Probabilities			
Pr(y > 0):		71,46%	
Pr(y <	0	**) =**	28,54%
Pr(y >	500	**) =**	52,70%
Pr(y >	1000	**) =**	35,26%
		Pr(500<y <4000)=	52,60%

3. Conclusions

Monte Carlo simulation is easy to apply and are often used to calculate the value of companies, to evaluate investments in projects at a business unit or corporate level, or to evaluate financial derivatives, in our case the profit. Unlike traditional methods of profit determination, Monte Carlo simulation comes with additional informations regarding the probability of achieving a profit. If company ABC submitted will realize a profit of more than 500 ron with a probability of over 50% and the probability for not making profit is 28%.

References
- Wayne L. W, (2004), Microsoft Excel Data Analysis and Business Modeling, Publisher: Microsoft Press