System Architecture for Capital Budgeting in Non-Financial Institution

Galina T. Naydenova[1]

***Abstract* – This article will be provided universal structure of management system of the modeling business transaction and risk analysis for a long- term horizons and possible links between the modules. The system will allow managers of corporations to make better investments and/or financial decisions. It will propose methods for interpolation and extrapolation with the ability to minimize errors.**

***Keywords* – Capital budgeting, Monte Carlo Simulation, Interpolation, Extrapolation, Financial model, System structure**

I. INTRODUCTION

Capital budgeting [8,9] is a process of generation, estimation and risk indexing and choosing of the best investment project of point of view of maximize firm's value.

Capital budgeting is one of the most important areas of decision-making by financial manager. It is from this perspective is increasingly necessary methodology for calculation and forecasting the financial agreements or risk analysis of investment project in conditions of market uncertainty. Market uncertainty arising from market conditions, by participants, on misinformation, competence and experience of the financial manager. From the perspective of financial managers, the most important aspect in risk analysis of investment project is the impact of project over interrelation risk-profit of the firm.

This document is occupied with the task to describe the architecture of the system that will help the corporate manager for project evaluator.

The purpose of financial manager is to select those projects that have greater importance to maximize the wealth of corporation. This will be described in the next point of this paper.

II. SYSTEM STRUCTURE

The aim is to create a flexible system with which to predict of estimation values of the financial model or agreement.

The system consists of several modules interconnected with each other.

The first of them is the ***Market variables***, which consists of a set of values of market variables. These market variables may be interest rate, exchange rate (all possible), cost of product manufactured and obtained from reliable world-famous sources. All in one degree or another is correlated. This in turn leads to a correlation matrix with a huge amount and this leads to the cover of many system resources and time for calculation.

In making prediction and taking the right decision for future period financial managers should conform with the phases of the cycle. The economical cycle [15] is divided into three stages of economic expansion - early, middle and late, and conditional of two stages of economic contraction (recession) - early and late. There are sectors that are covered completely with this cycle (Fig.1). For example, automobile meets the phase of "early economic recovery", electrical engineering of the "average expansion", production of ferrous metals' – "latest economic expansion", the food industry – "early economic contraction" and with the insurance business – "recession later".

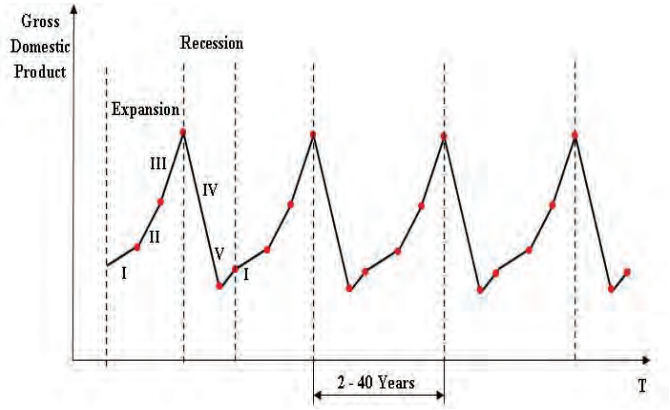

Fig. 1. Phases of economic cycle

Financial manager makes projection for future projects in two ways: intuitive or based on the economic cycle. Through the second manner is made selection (according to the perspective of the manager) of the best horizon from previous years, which meets in such conduct of future expectation.

The proposed system (Figs.2, 5 and 6) for planning and forecasting projects, those spans of time is used to minimize the correlation matrix calculations and increase performance. This information retrieval is proposed in the second module of the system – ***Define Market***. Not only, here are included necessary part of the history of market variables but their volatility and correlation between them and the estimated value of the financial model (Fig. 2). Volatility and correlation matrix are input values for Monte Carlo simulation. Forecast values can be depicted graphically. Unlike the spreadsheet software, in which by changing the values in the table change

[1]Galina T. Naydenova is with the Faculty of Computer Since and Technology of TU-Varna, Studentska 1 str., 9000 Varna, Bulgaria, E-mail: galina_m@abv.bg

chart type, in this system will be possible here also not only this but and return option to change the values in the table by manipulating the ***2D graphics***. This gives greater freedom of financial managers to determine the width of the volatility of the forecast values according to his expectations.

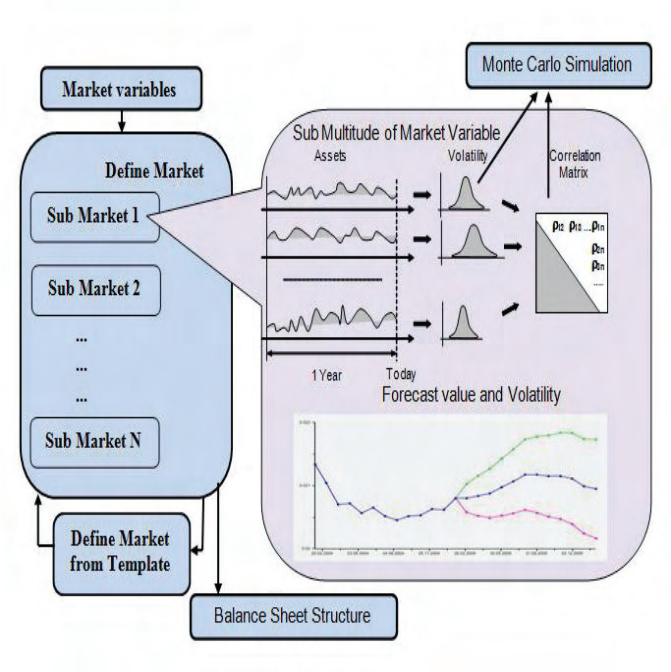

Fig. 2. Creation and Define Markets

It should be mentioned that taken up by the time span of time of historical data is possible for one reason or another to missing data.

This will lead to problems in the calculations that must be performed by the proposed system for risk management. Solving the problem is by using a linear interpolation method [3].

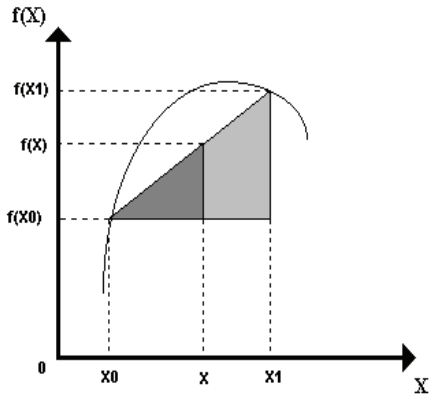

Fig. 3. Linear interpolation method

The simple method of interpolation, shown in the Fig.3, is to connect two points in a straight line. And this can be described with Eg.1:

$$f(x) = f(x_0) + \frac{f(x_1) - f(x_0)}{x_1 - x_0}(x - x_0) \quad (1)$$

Interpolation is the analytical method of estimating output values inside the range of tabulated, known or measured data points. This method gives relatively accurate results only in case where the distance between two points is very small or close to each other. It will be use in building the system.

Extrapolation is another method by which performs detection of missing or estimated future points. Extrapolation is the process of taking data values at points x_1, ..., x_n, and approximating a value outside the range of the given points. This is most commonly experienced when has periodic repetition in the case of economic cycles and that data is used to approximate the next data point. For example, forecast values predictions take historic data and extrapolate a future forecast scenarios. Extrapolation can be used as a tool for predicting economic phenomena.

It will consider four variants of extrapolation:

First variant

By extrapolation method finding a point which lies outside the scope of the sample can be done only with approximate accuracy in the vicinity of the last point of the range. The formula for calculating the extrapolation Eq.1 is the same as interpolation. Depending on the values that have starting and ending point of the sample is assumed and the direction (up or down in Fig.4 – blue line), which is expected to find a future point for a long time. The disadvantage of this method is that a large interval of time finding the point or value will be a big mistake.

Second variant

To avoid the disadvantage of the first variant can be assumed that all points before and after the interval adopts a value of two end points thereof (Fig.4- orange lines). This will minimize the error in the setting of a large space. It uses interpolation formula for finding points in the near surroundings and the proposed way to remove error in larger intervals.

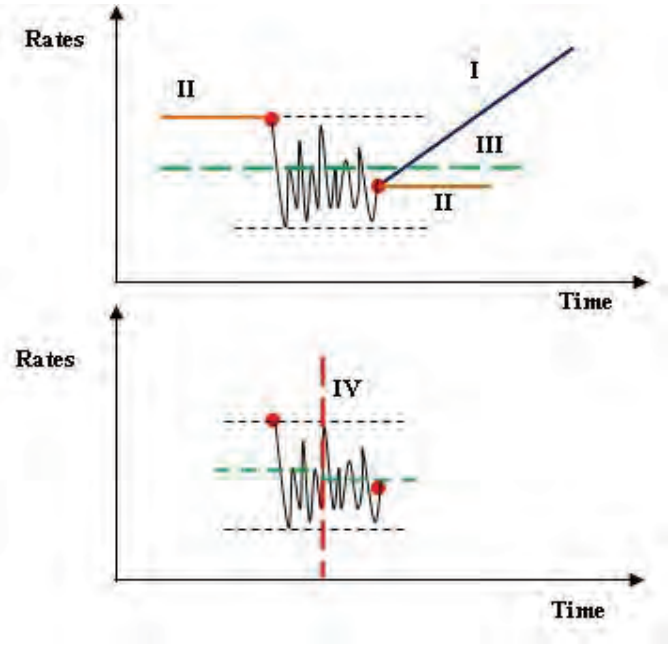

Fig. 4. Extrapolation methods

Third variant

Since the second variant also has a shortcoming here is offered the opportunity to find the average of the sample (Fig.4 – green line). Thus the error becomes even smaller. However, this also is insufficient to reach as close as possible to the finding value of market variable.

Fourth variant

The above three variants not offered sufficient reduction of error. For this is fourth version offers.

In the third variant the two endpoints of the range are equal value after averaging it. This will lead to a problem in cases when extreme situation occur different from that of the normal behavior of market variables.

For example, in cases where have unusual trend of the price distribution for two consecutive months. For instance, lowering the price of a product together with a large user activity before a specific event and then increase the price and lowering the interest of the consumer to that product. In such situation, it will get an extreme point, different from the average of the range produced by a third variant. This will lead again to an error.

Therefore it is proposed to be made conditional split the sample of market values. Each half is to find the average value (Fig.4).

Thus, finding the expected value for a long time interval is suppose to be much more accurately than the proposed three variant above.

Thus, by methods of interpolation and extrapolation is proposed to solve one problem that will arise in the system.

One advantage of this system in comparisons with spreadsheet software is that is possible to quickly and easily create a new market from existing. The goal here is to change some values to the perspective of the manager without much effort and waste of time [6]. This is the third module of the system called ***Create Market from Template*** (Fig. 2)**.**

Simulation is a statistical – based behavior approach that applies predetermined probability distribution and random number to estimate risky outcomes. By typing the various cash flow components together in a mathematical model and repeating the process numerous times, the financial managers can develop a probability distribution of project returns.

Monte-Carlo simulation is another module (Fig.5) of the system. Monte-Carlo simulations are popular in financial applications, as they are able to value multi-dimensional financial instruments or models. The simulations are easy to specify mathematically, with an obvious translation to sequential code, and so can be easily implemented in software.

As mentioned above, the input values for Monte Carlo simulation is the correlation matrix and the volatility of market variable. After receipt and multiplication in the simulation is obtained covariance matrix is undergoing transformation as a result is obtained Cholesky matrix.

Through a random generator to generate random numbers normally distributed. These normally distributed numbers are presented with a normal distribution bell-shaped with range from 0 to 1. After generating their numbers are presented in Deviation vector, which is obtained by multiplying Cholesky matrix. The result of this multiplication is co variation vector. He in turn is summed with a series of forecast values, provided by a variety of established markets. Steps listed here to be repeated multiple times from 1000 – 5000 runs. As a result of this entire scenario is derived vector, which applied to financial instruments or portfolio calculations and from here the presentation of cost allocation and generate the results of Monte Carlo simulation. These results may be: Value at Risk, Expected Value, Expected Loss, Confidence Value, CFaR/EaR, etc., which are presented in normal distribution form.

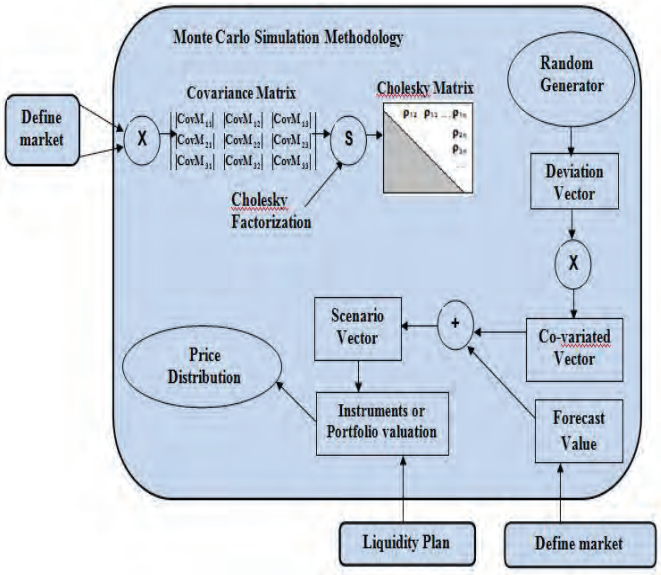

Fig. 5. Monte Carlo Simulation

Generated results from Monte Carlo simulation are recorded in the ***Liquidity Plan module***. Then here can be compared with planned values and this forecast results generated by Monte Carlo simulation.

Ones created several submarkets in the *Define Market* module, and be made Monte Carlo simulation of the same financial model is provided a comparative and assessment of different forecast scenario by ***2D or 3D graphics***.

Liquidity Plan module and *Balance Sheet Structure module* have hierarchical structure but Liquidity Plan module is develop in the time. This means a description of the hierarchical structure of all cash flows and market variables distributed in time periods.

The structure of the ***Balance Sheet Structure module*** provides for a description of financial models. They may include derivative instruments, estimation project model of capital budgeting (NPV, IRR, etc.) or other complex models. After describing the module structure, each of the nodes and sub nodes must be connected with market variables provided for this model. To the Balance Structure includes three modules that transmit the flexibility of the system. This are *Mechanism for determine signs of + and - module, Mechanism for assign of arbitrary time screen module* and *Formula Editor module.*

It is provided in the Balance structure a ***Mechanism for determine signs of + and -***. That gives the possibility of unification and subtraction of sub nodes in the main node.

A ***Mechanism for assign of arbitrary time screen*** is necessary for modeling of different balance structures with possibility for given time intervals, different from initially defined, for example if market variables are defined with value through 3 months, and if necessary the calculation to be

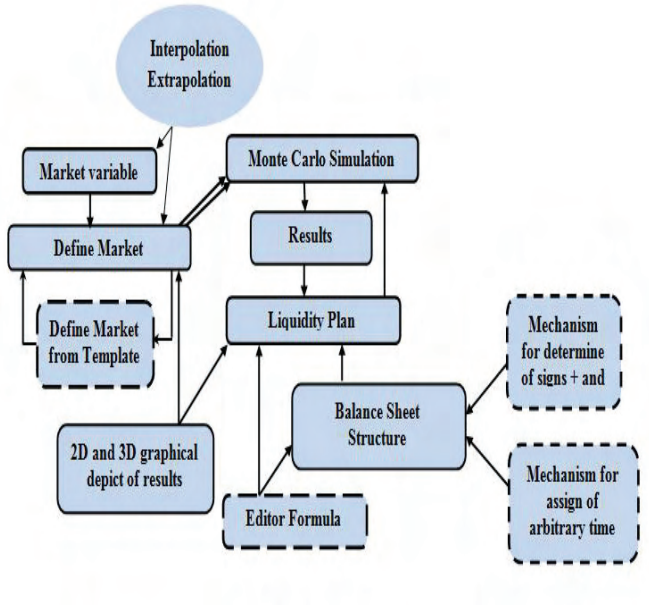

Fig. 6. Management System Architecture

changed through 1 month. That gives a possibility for modeling of different contract and gives fast computation of different at given time intervals and without need of help from firm supporting the software for calculation of price model.

Formula Editor module is projected for calculation of more complex expression consisting of values from nodes and sub nodes. Since in the *Balance Sheet Structure* can only add and subtract nodes or inheritor that module gives the right of supporting operations as addition, subtraction, multiplication, division, logical if, average, natural logarithm, exponent and grade. *Formula Editor* module is in help of Balance Sheet Structure module and Liquidity Plan module.

By calculation of financial model for every next Monte Carlo run each of nodes of hierarchical structure are typed set of values of the temporary memory. All of this sub notes are collected in the main node and result for complete financial model can be view with ***2D or 3D Graphic*** **module**.

III. Conclusion

In document has proposed a management system structure. It will be in help of financial manager who must be able to decide whether an investment is worth undertaking and be able to choose intelligently between two or more alternatives. To do this, a sound procedure to evaluate, compare, and select projects is needed. Each of this principles lied of capital budgeting conception. The system structure depicts each of these principles by flexible way and it is suggested a calculation of more sophisticated financial model. All modules shows in Fig. 6 with a broken line, transmit flexibility and uniqueness of the system compared with spreadsheet software.

Presented are linear interpolation and extrapolation methods to calculate the market values of samples in which there is missing data or to predict futures point based on historical occurrences. Extrapolation approach is proposed to minimize the error. There is no absolutely best method but only the optimal choice under certain circumstances.

Future work will be focusing on building of algorithm of the system. This system architecture is foreseen to work under Windows operation system and Oracle database.

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