World Academy of Science, Engineering and Technology
International Journal of Economics and Management Engineering
Vol:4, No:2, 2010

Financial Analysis Analogies for Software Risk

Masood Uzzafer

***Abstract*—**A dynamic software risk assessment model is presented. Analogies between dynamic financial analysis and software risk assessment models are established and based on these analogies it suggested that dynamic risk model for software projects is the way to move forward for the risk assessment of software project. It is shown how software risk assessment change during different phases of a software project and hence requires a dynamic risk assessment model to capture these variations. Further evolution of dynamic financial analysis models is discussed and mapped to the evolution of software risk assessment models.

***Keywords*—**Software Risk Assessment, Software Project Management, Software Cost, Dynamic Modeling.

I. Introduction

OFTEN risk management is considered an element of finance, recently risk management adaptation in different fields of engineering and science is recognized. Researchers in different areas of research are developing risk assessment models suitable for their field of interest and the area of software development is no exception. Risk management in the field of finance is the activity which mainly deals with quantitative risk assessment that requires quantitative assessment of monetary loss with associated probabilities. Contrary to that software risk management involves an entire framework to manage risk where risk assessment is a component within the risk management framework. Financial risk assessment is a critical activity and all the management decisions related to a financial investment are based upon the quantitative assessment of risk.

As the complexity of software grows so as the need of processes and models to understand and manage the risk inherited in software projects. Researchers in the field of finance and insurance developed various models for risk management and researchers in other fields of science could benefit from the research done in the financial sector if some analogies could be established between the fields of finance and the field of interest to adopt the financial risk assessment models. This paper is a step in that direction with the aim to establish analogies between dynamic financial analysis and software risk assessment and hence adopts the dynamic risk modeling for software projects.

Through various evolutionary steps financial risk model have become mature and are now being used in a dynamic setting, where the time variations of a financial investment are simulated and observed. Dynamic financial model are simulation models and simulate how risk events cause an impact on a financial investment that change overtime and varying degree of probabilities. Hence dynamic risk modeling allows an insight into the future. Financial management deploys different set of management decisions and observes how those decisions impact the profit and loss under different set of management decisions; it helps financial management to select the most optimum set of decision to manage the given financial investment.

Static risk management and assessment models operates without any feedback capability and lacks the dynamics of decision adjustments based on a futuristic risk assessment of risk events. Static risk management and assessment models assume that the decisions are made one time only and are irreversible, treating decisions as one time only and irreversible limits the capability of risk assessment model and hence recognizes the value of a risk assessment model which is dynamic in nature and capable of capturing the variations due to the changing environment [1].

Dynamic Risk Modeling (DRM) and Dynamic Financial Analysis (DFA) models are used for risk modeling in finance. The difference between the two models is that DRM is a simple form while DFA is applied to an entire financial operation hence it models more complex risk situations. Dynamic financial risk management models are simulation models [1]. In these models different financial strategies are simulated for a specific financial scenario. Strategy is a set of action defined to combat risk events. Scenario is a set of parameters which may be affected by risk, in case of financial investment scenario is set of parameters related the financial investment. A financial scenario defines a setup, environment or parameters which may be affected by a strategy. Based on these definitions, a software project scenario could include software development environment, design and testing processes, engineering expertise, management policies, human resources and contracts. Enterprises need to understand the impact of various management strategies under variety of future scenarios, where each proposed strategy is associated with a set of outcomes, a strategy may work well in one scenario may not work in another scenario.

This paper is organized the following way, section II describes Dynamic Financial Analysis (DFA) and its evolutionary paths, section III gives an overview of software risk assessment models and analogies are drawn between DFA and software risk assessment models, section IV describes the dynamic risk modeling for software projects risk assessment and discuss a software development project scenario in a dynamic environment and finally some conclusions are drawn in section V.

Author is with University of Nottingham, Malaysia Campus, Kuala Lumpur, Malaysia (e-mail: keyx8muz@nottingham.edu.my).

International Science Index, Economics and Management Engineering Vol:4, No:2, 2010 waset.org/Publication/10719

International Science Index, Economics and Management Engineering Vol:4, No:2, 2010 waset.org/Publication/10719

II. Dynamic Financial Analysis

DFA has evolved through four models namely Financial Budgeting, Sensitivity or Stress Testing, Stochastic Modeling and Dynamic Modeling. Financial Budgeting is a static model which uses only one set of assumptions and based on that produce future financial projections of a financial firm. For example it could aggregate cash flow and expenses from various departments and generate a future projection of the capital required for the firm to continue its operations. This enables a company to define its future business plan and take management decisions about its future financial position. As illustrated in Fig. 1, a financial budget provides only one projected path into the future.

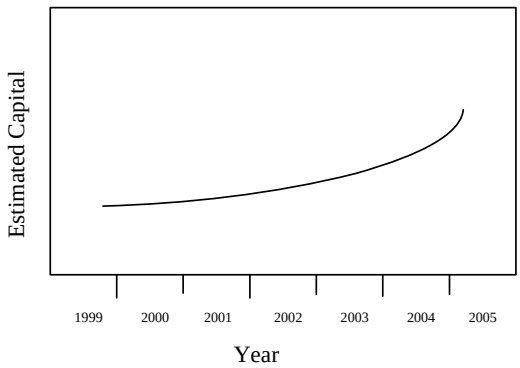

Fig. 1 Financial Budgeting

The next evolutionary step allowed models to incorporate different set of assumptions defined with ion a specific range and provide a future financial projection of a financial firm by changing the assumptions within the defined range. These models are called sensitivity and stress testing models, such models can be best describe as models that incorporates best and worst case scenarios and generate the expected future outcome. These models add additional financial paths into the future as illustrated in Fig. 2.

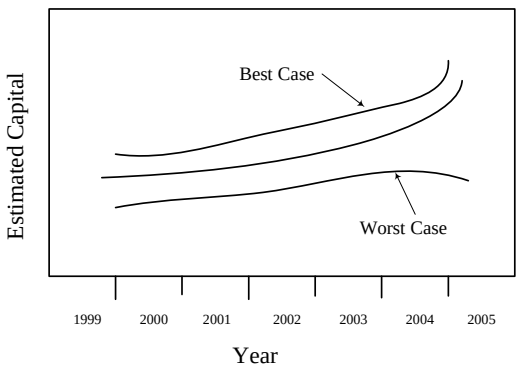

Fig. 2 Sensitivity and Stress Testing

When there are series of assumptions, it becomes difficult to decide which one is the most optimum without understanding the difference in the possible outcomes and the probability of each outcome. Next stage of models allowed users to describe series of assumptions and generate possible outcome in terms of probability rather than in terms of fixed values. Computer simulations generates results for a scenario which would reflect the inter relationship of different parameters and their impact on the probability of the expected outcome as shown in Fig. 3.

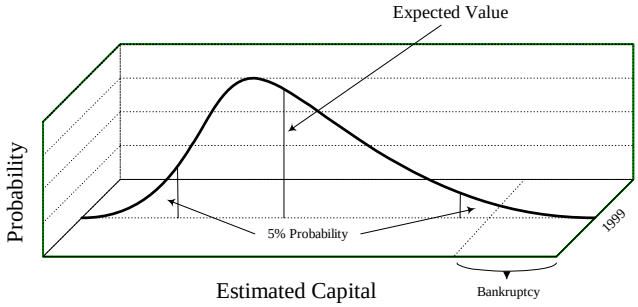

Fig. 3 Stochastic Modeling

This model allows decision makers to think in terms of probability and make decisions based on the probability of events and their impact. Distributions are chosen such that which closely model the behavior of financial investments, where extreme losses are represented with low probability should these extreme losses occur they bring high magnitude of losses similarly high profit margins are low probability events should they occur brings high profits margins.

The most recent evolutionary step in financial modeling is dynamic modeling which incorporates feedback loops into the model. Dynamic modeling allows management to intervene into the process with different set of decisions hence some kind of intelligence is added into the model. For example if a given assumption show that the loss is unacceptably high for a financial firm then the model will assume that management will inject more cash into the firm or scale down its operations. Fig. 4 illustrates how a financial investment change under a management strategy deployed to combat risk events over different period of time segments.

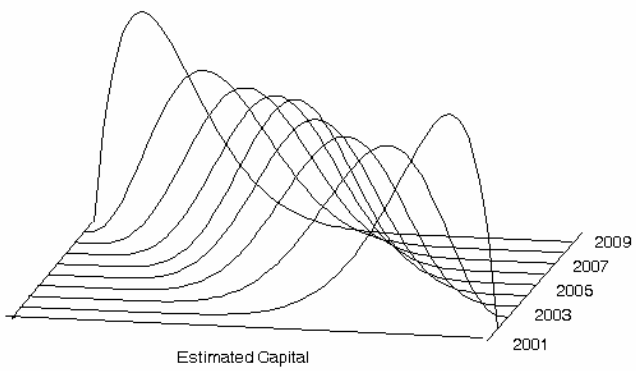

Fig. 4 Dynamic Modeling

Dynamic model simulate alternate strategic decisions to generate different financial results, thus allows a comparison of different financial results generated by different strategic decisions. For example a strategic management decision through feedback loop could change the shape of the

International Science Index, Economics and Management Engineering Vol:4, No:2, 2010 waset.org/Publication/10719

probability of the expected financial output over the period of next five years.

III. Software Risk Assessment Models

Software risk assessment deals with the quantitative analysis of risk factor which is referred as risk exposure or risk impact. There are different techniques used in software projects for quantitative risk factor analysis, but no matter how it is evaluated the risk factor definition remains the same. There are three main procedures used in the software projects for risk exposure analysis, briefly discussed here.

The foundation work is carried out by Barry Boehm [2], he outlined a procedure to calculate the risk factor value using the following expression:

$$RE = P*L$$

Where RE = Risk Exposure
P = Probability of an unsatisfactory outcome
L = Loss due to the unsatisfactory outcome

The probability of unsatisfactory event is obtained through export opinion and a decision tree is constructed based on the different scenarios yielding different values of risk exposure. Decision tree helps to select the most optimum value for the risk exposure after taking all the possible outcomes into consideration. This procedure evaluates single values of probability and loss and generates a single value of risk exposure, while it helps to understand the risks inherit in software projects it does not take into account the uncertainty involved in the estimation process. This procedure is analogous to Financial Budgeting model and provides a single view of the event.

Barbara et al [3] analyzed the uncertainty and risk involved in the software cost estimation. They presented that the uncertainty in the software cost estimation is due to different errors namely measurement, model, assumption and scope error. Due to those errors the uncertainty cannot be a fixed value rather it can be defined within a range of values, such that:

$$(E2 – E1) * P2$$

Where E1 = Loss if original assumption is true
E2 = Loss if alternate assumption is true
P2 = probability that the alternate assumption is true

This model is analogous to the Sensitivity or Street testing model, it provides an assessment based on the optimum and expected event values.

Richard [4] discussed a procedure for quantitative risk assessment for software cost estimation, based on regression loaded with the risk factors. Each risk factor has its probability distribution derived through expert opinion further joint probability distribution of all the risk factors is derived by multiplication since risk factors are considered independent. These values are processed through Monte Carlo simulation which generates a probability distribution of the estimated software cost. This model is equivalent to the stochastic modeling of the financial analysis.

There is no software risk assessment model available yet which is equivalent to the dynamic modeling of the financial analysis. Dynamic modeling provides futuristic assessment of the risk events based on specific scenarios and strategies and hence is suitable for modeling software risk events.

IV. Dynamic Software Risk Modeling

The software risk assessment models discussed are static risk assessment models not capable of capturing the time variations of a risk factor hence they provide a view based on the current available information. It describes how an enterprise should manage and reduce risk by deploying strategies based on the assessment taken at current time. While existing models provide a rich insight as to how enterprises should manage risk they lack prediction capabilities of the nature and behavior of a risk event in the future to help decision makers define strategies to combat different risk scenarios and how those strategies should evolve over time.

Probability distributions used in the static risk assessment models look at a risk factor based on the available facts and strategic decisions are based on that information. The probability of impact of a risk factor could change over time causing all the perceived probabilities, assumptions and estimations to change over time.

A dynamic risk assessment provides a time varying understanding of risk factors. In the dynamic model based on the future assessment of the risk events the enterprise attempts to abate the risk by taking preventative actions at different times. These assessments are repeated over time to check that the preventative actions are really effective. This results in a dynamic risk management in the form of feedback loops of assessments and preventative actions followed by new assessment and preventive actions.

A hypothetical software risk scenario is discussed to elaborate the discussion further. The scenario shows how a strategy applied to deal with a risk event could change the perceived probability assessment related to that risk event.

A software project manager expects a risk of software personal shortage during a software development project and flags this as a risk factor for further analysis. The number of software personal shortage could range 0 to 10 with the most likely value of 5 with high certainty; other values around 5 are equally likely to happen. This forms a Gaussian distribution with the number of personal shortage event as random.

Through expert opinion it is established that the shortage of personal translates into the project delays which affect the estimated cost. A shortage of 0 represents no delay while shortage of 1 corresponds to 5 percent delay in the project and each subsequent shortage adds further 5 percent delay into the schedule.

Further, shortage of personal is directly related to the cost estimation. Delays in schedule increases the cost by the same amount hence 5 percent delay adds 5 percent to the estimated software cost. Following Table describes this scenario:

The project is split into different phases according to percentage of the software project completed; this will help to

International Science Index, Economics and Management Engineering Vol:4, No:2, 2010 waset.org/Publication/10719

monitor the changes due to risk events at different levels of a software project. The software manager estimates that at every project phase there is a risk shortage of one software development personal. Further the software manager assessed that a shortage of 7 or more software development personal would be disastrous for the software project at any phase of the project, and he decided that as a strategy, to combat this risk, one software development person will be added at each software project. That is why even though the number of software personal improves as software project moves through different phases of completion, it does not change the mean of the risk impact probability distribution.

TABLE I
PERSONAL SHORTAGE, DELAY AND COST INCREMENT FACTOR

Number of Personal Shortage	Percentage of Delay	Cost Increment Factor
0	0	0
1	5	1.05
2	10	1.1
3	15	1.15
4	20	1.2
5	25	1.25
6	30	1.3
7	35	1.35
8	40	1.4
9	45	1.45
10	50	1.5

As shown in the figure the area under the event 7 or in other words the probability of event 7 is high during the early phases of the software project. As the project moves through different phases of completion the probability of event 7 or more gradually goes down and finally become negligible. Due to the fact that as project moves through different phases and continues to get the software personal added to the project, the risk probability starts to shrink. This situation is depicted in Fig. 5 where probability of risk event change shapes moving through different phases of project.

Over the period of time as software personals join the project the probability of losing personals more then the mean value starts to shrink. It is clear that the probability of event 7 gradually decreases and eventually become zero. The strategy to gradually add software personal change the shape of the probability distribution as project moves through different completion phases.

Even though that the personal shortage is a discrete event but it is illustrated through the continuous probability distribution on the grounds that the change in personal number may not be happening exactly at the project phases. A person may be partially available or not available for a specific project phase hence forming a continuous distribution.

This scenario illustrates that the dynamic risk modelling and management intervention through feedback loop. Dynamic risk modelling can help software practitioners to understand the futuristic impact of a risk event and how management decisions can alter the shapes and impact of a risk factor.

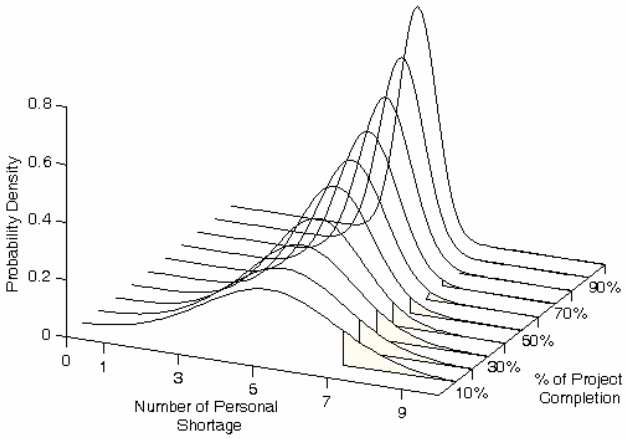

Fig. 5 Dynamic Risk Analysis of the risk factor impact

V. CONCLUSION

Dynamic Financial Analysis models and software risk assessment models are discussed and analogies are drawn. It is proposed that dynamic models are well suited for the software risk assessment modelling. Dynamic model provides a time varying understanding of risk factors and hence a futuristic look of the risk factor impact could be drive.

Currently available software risk assessment models are not capable to capture the time variations in different software project parameters. As the software development environment becomes dynamic where many environment parameters change over time hence it requires all the assumptions and decisions to be updated and adjusted according to the changes in the project environment parameters.

Future work on dynamic software risk model requires that it should be integrated with the software risk management framework and hence need software risk management frameworks to be adjusted such that to accommodate the dynamic nature of the assessment, which requires management of the software project to setup different set of decisions to be tested to select decisions which best suite the given software project.

REFERENCES

[1] Casualty Actuarial Society, Dynamic Risk Modeling Handbook, www.casact.org/research/drm
[2] Software Risk Management: Principles and Practices, Barry W. Boehm, IEEE Software, January 1991, Pages 33-40.
[3] Barbara Kitchenham, Stephen Linkman, Estimates, Uncertainty and Risk. IEEE Software vol. 4, issue 3, May/June 1997, Pages 69 – 74.
[4] Richard Fairley, Risk Management for Software Projects, IEEE Software, vol. 11, issue 3 Pages 57 – 67, May 1994.