**İSTANBUL TECHNICAL UNIVERSITY ★ INSTITUTE OF SCIENCE AND TECHNOLOGY**



# QUANTITATIVE APPROACHES IN FINANCIAL RISK MANAGEMENT OF CONSTRUCTION ENTERPRISES

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# İNŞAAT İŞLETMELERİNDE FİNANSAL RİSK YÖNETİMİ İÇİN SAYISAL YAKLAŞIMLAR

**YÜKSEK LİSANS TEZİ**

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**FOREWORD**

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August, 2001 Metin Kılıç

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## ABBREVIATIONS

| | |
|---|---|
| **NPV** | : Net present value |
| **VaR** | : Value at risk |
| **VaRC** | : Value at risk contributory |
| **Econ. Cap.** | : Economical capital |
| **Vol** | : Volatility |
| **Conf. Coef.** | : Confidence coefficient |
| **Stan. Dev.** | : Standard deviation |
| **RAROC** | : Risk adjusted return on capital |
| **BIS** | : Bank for International Settlements |
| **CPM** | : Critical path method |
| **GARCH** | : Generalised Autoregressive Conditional Heteroskedasticity |
| **App** | : Appendix |

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## LIST OF SYMBOLS

| | |
|---|---|
| $\mu$ | : Mean |
| $\sigma$ | : Standard deviation |
| $\rho$ | : Correlation coefficient |
| $\varepsilon$ | : Standard Normal Variant |
| $\mathbf{w_i}$ | : Monetary weight of a particular project in the whole project portfolio |
| $\Delta \mathbf{t}$ | : Discrete time period |

## SUMMARY


### QUANTITATIVE APPROACHES IN FINANCIAL RISK MANAGEMENT OF CONSTRUCTION ENTERPRISES

**Metin KILIÇ**

An enterprise's failure to establish a management structure that adequately identifies, measures, monitors, and controls the financial risks involved in its various projects and/or lines of business has long been considered an unsafe and an unsound conduct. But well-defined and well-organised ways of quantitative risk measurement and management have emerged during the last decade, especially along with the academic advancements in the field of financial engineering.

In Turkey, for financial institutions, market risk gained a high profile when the "Banking Supervisory Board" published "The Supervisory Treatment of Market Risks" in February 2001. Banks, as it was proposed in the treatment, have to set aside capital to cover the market risks inherent in their business activities. There is little doubt that financial institutions, as the lender bodies of the economy, would require the same risk-averse business practices from their corporate customers (their borrowers) to ensure that their loan repayments would be fulfilled, or require higher interest rate charges from those they assess as "riskier than others". This interaction between the lenders and borrowers would eventually change the way business has traditionally been conducted in every industry, and help spread around the modern risk-averse business conducts.

The aim of this thesis will not be to answer every question regarding the risks in construction projects, but rather to demonstrate a framework within which decisions involving financial risks inherent can be depended on quantitative approaches; namely "value at risk" and "stress tests".

**ÖZET**

**İNŞAAT İŞLETMELERİNDE
FİNANSAL RİSK YÖNETİMİ İÇİN
SAYISAL YAKLAŞIMLAR**

**Metin KILIÇ**

Bir firmanın, üstlenilen çeşitli projelerdeki ve/veya iş kollarındaki finansal riskleri yeterince tanımaması, bu riskleri ölçümlememesi, izleyip, kontrol etmemesi epeydir güvensiz ve başarısız iş yönetimi olarak düşünülmüştür. Ancak sayısal risk ölçümlemesi ve yönetiminin iyi tanımlanmış ve iyi organize olmuş metotları, özellikle finans mühendisliği ve stokastik modelleme alanlarında kat edilen gelişmelerle, son 10 yılda ortaya çıkmıştır.

Türkiye'de finansal risk yönetimi önemi özellikle "Bankacılık Düzenleme ve Denetleme Kurumu"nun, Şubat 2001 tarihinde yayınladığı "Piyasa Risklerinin Yönetimi" başlıklı düzenlemesi ile artmıştır. Bankalar, düzenlemedeki getirilen şartlar gereğince, iş aktivitelerinden kaynaklanan piyasa risklerine karşılık olarak yeterli sermayeyi bulundurmalılardı. Şüphesiz ki bankalar, ekonomide kaynak dağıtımını yapan organlar olarak, aynı riske hassas yönetim şeklini kendi kurumsal müşterilerinden (kaynak kullanıcılardan) de bekleyecekler, kredi kullandırırken mevcut alternatifler arasından tercihlerini daha risksiz gördükleri kurumlardan yana kullandıracaklar veya diğerlerinden daha riskli yönetim tarzı izlediklerini gözlemledikleri müşterilerine daha maliyetli kredi kullandıracaklardır. Ekonomideki kaynak dağıtıcılar (bankalar) ve kaynak kullanıcılar arasındaki bu etkileşim zamanla geleneksel yönetim anlayışlarını değiştirecek; modern, riski yönetebilen iş yönetimi uygulamalarının yaygınlaşmasını sağlayacaktır.

Bu tez, inşaat projelerinin haiz olduğu tüm risklere değinmektense, projelerin karşı karşıya kaldıkları ve risk yelpazesinin büyük bir çoğunluğunu oluşturan, piyasa risklerinin sayısal olarak, "riske maruz değer" ve "stres testleri" gibi yöntemlerle, ölçümlemesini ve piyasa risklerinin yönetimi için bir çerçeve çizilmesini amaçlamaktadır.

# 1. INTRODUCTION

## 1.1. NEED FOR GENERAL RISK MANAGEMENT

On the other hand, during recent years, supervisory boards in almost every industry have increasingly emphasized the importance of sound risk management processes and strong internal controls when evaluating the activities of the institutions they supervise. This greater emphasis reflects the view that properly managing risks has always been critical to the conduct of safe and sound business activities and has become even more important as new technologies, product innovation, and the size and speed of business transactions have changed the nature of business activities. Accordingly, while a firm's financial performance is an important indicator of the adequacy of management, it is essential that examiners give significant weight to the quality of risk management practices and internal controls when evaluating the management and overall financial condition.

Businesses have always faced the risk of losses in on and off-balance-sheet positions arising from undesirable market movements, and there have always been regulations to cope with risks at the developed countries. However, the sharp variations in the revenues generated by business activities in the developing countries, where the markets tend to be more instable, has heightened the need among regulators and project financing bodies of these countries to ensure that management of businesses have the systems to control and the capital to absorb the risks posed by market-related exposures.

In Turkey, risk management gained a high profile in the leadership of financial institutions. Banks, as it was proposed by the "Banking Supervisory Board", have to set aside capital to cover the market risks inherent in their business activities. (Banking Supervisory Board of Turkey. The Supervisory Treatment of Market Risks). There is little doubt that financial institutions, as the lender bodies of the economy, would require the same risk-averse business practices from their corporate customers (their borrowers) to ensure that their loan repayments would be fulfilled, or require higher interest rate charges from those they assess as "riskier than others". This interaction between the lenders and borrowers would eventually change the way business has traditionally been conducted in every industry, and help spread around the modern risk-averse business conducts. For sure, projects of the construction sector would get their share from the new wave, and try to keep up with the new trend in order to vie with the global competition in the project-financing arena.

Consistent with the greater emphasis given to risk management, many firms, especially the ones open to public, in the developed countries are instructed to effectively measure and announce their "Value at Risk" figure, the number obtained from the identically named methodology, on their balance sheets. The idea is that the shareholders or stakeholders (not only majority shareholders but employees, customers, input suppliers and small investors of the firm as well) have the right to know not only the profits obtained after some business conducts but also the risks taken to reach that final profit figure. From that point on, taking and managing risks are fundamental to the business of not only financial institutions, as it has always been, but also other firms operating in different sectors. In accordance with the practices in the developed countries and as a consequence of globalization, many supervisory bodies of different sectors in the developing countries also started to place significant supervisory emphasis on the adequacy of a firm's management of risk including its system of internal controls.

## 1.2. THE GENERAL RISK SPECTRUM

An institution's failure to establish a management structure that adequately identifies, measures, monitors, and controls the risks involved in its various projects and lines of business has long been considered an unsafe and an unsound conduct. But well-defined and well-organised ways of quantitative risk measurement and management have emerged during the last decade. The conclusion was that the principles of sound management should apply to the entire spectrum of risks facing an institution including, but not limited to; credit, market, liquidity, operational, legal, and reputation risk:

- Credit risk arises from the potential that a borrower or counterparty will fail to perform on an obligation.

- Market risk is the risk to a firm's condition resulting from adverse movements in financial markets, such as unpredictable changes in interest rates, foreign exchange rates, inflation or equity prices.
- Liquidity risk is the potential that a firm will be unable to meet its obligations as they come due. This may be because of an inability to liquidate assets or to obtain adequate funding for a project (referred to as "funding liquidity risk") or to easily offset specific exposures without significantly lowering market prices because of inadequate market depth or market disruptions ("market liquidity risk").
- Operational risk arises from the potential that inadequate information systems, operational problems, rule violations, fraud, or unforeseen catastrophes will result in unexpected losses.
- Legal risk arises from the potential that unenforceable contracts, lawsuits, or adverse judgements can disrupt or otherwise negatively affect the operations or condition of a firm.
- Reputation risk is the potential that negative publicity regarding a firm's business practices, whether true or not, will cause a decline in the customer base, costly litigation, or revenue reductions.

In practice, a firm's business activities present various combinations and concentrations of these risks depending on the nature and scope of its particular area of activities.

## 1.3. COSTS AND RISKS OF CONSTRUCTION PROJECTS

The crucial goal of project management is to complete a project according to construction management plan and within budget. To accomplish the budgetary goal:

- a realistic initial project budget that oversees the risks inherent in the cash flows,
- a reasonable project time frame to properly discount the expected future cash flows to present time,
- a budgetary plan linked to project activities that incorporates any change simultaneously to upcoming activities,
- a methodology to track the variance between activity cost and budget,

- an understanding of the relationship between completion time and project activities and their respective costs,

are needed. Each of these topics is an essential ingredient in bringing a project in within budget.

But these are no-easy tasks. It is recognized that even two analysts performing a cost or feasibility analysis on the same project may derive different results due to the degree of subjectivity inherent in the estimation process. However, it is desirable to standardize feasibility and budgeting methodologies, where possible, in order to provide consistency to the process and, thereby, increase the credibility of the resulting estimates. The credibility of these analyses, in terms of realistically predicting future, is crucial since they might threat the overall financial condition of the construction project if the prejudgments on risks broadly differ from those realized.

A main source of this subjectivity is professionals' understanding and treatment risks involved in these analyses in their own way. Lack of uniformity to measure risks in a consistent fashion causes biased assessments. This problem highlighted the need for quantitative approaches that diminish subjectivity in the assessments via measuring risks in a predetermined manner, and flourished a new field of profession; risk management.

One of the former attempts of involving risk dimension into feasibility and budgeting analyses was that of Burkhardt.

$$C = C_1 + C_2 + C_3 + C_4 = \sum_{1}^{4} C_i \tag{1.1}$$

C : Project cost

$C_1$ : Legal and land-acquirement expenses

$C_2$ : Project financing expenses

$C_3$ : Consulting expenses

$C_4$ : Construction cost

The first two of these cost items create cash outflows in the recent period. Hence, they involve relatively less subjectivity in predicting the figures. Although the consulting expenses will be incurred throughout the project, they may be settled at the initial agreement to avoid any uncertainty and confliction that may arise in the future. On the other hand the project's production cost is where the most of the uncertainty and subjectivity lies. There are two main reasons of this uncertainty:

- With the generic way of discounting future cash flows to find the present values, a single discount factor, generally represented by the prevailing term interest rate figure, is used. This discount factor is assumed constant during the discount period. This assumption ignores the term structure of interest rates, ie. possible changes in the interest rates, and increases the vulnerability to changes (volatility) in the interest rates, ie basis risk.
- The activity unit costs, which add up to form a project's production cost, may change overtime beyond what they are expected to be in the beginning. Some of the major reasons for this variation can be unexpected inflation or as in the case of an international project, unexpected changes in the foreign exchange rates that may alter project in-out flows vitally.

When presenting the construction cost, $C_4$, Sorguç considers a mark up coefficient, $\beta$, that is multiplied by the expected construction cost in order to incorporate the unpredictabilities that may undermine the safe conduct of the project. His effort was for a predetermined methodology for measuring and quantifying market risks that could cope with, if not all but, financial risks presented in this mark up coefficient. On the other hand, he also listed the factors that may affect construction cost and quality. Although the thesis would focus on only market (financial) risks in the projects, the author strongly recommends the readers to review Sorguç's list in order to familiarize themselves with the factors that jeopardize the budget (ie prejudged cost) and quality of the projects. The list can be found at the appendix.

### 1.4. THE SCOPE OF THE THESIS

The scope of this thesis will be to:

- Identify major financial risks, namely "Market Risks" in projects,
- Explore quantitative approaches to measure them, namely "Value at Risk" and "Stress Tests",
- Illustrate the applications of underlined methodologies in construction.

The purpose of this thesis is not to answer every question regarding the risks in projects, but rather to demonstrate a framework that can be benefited as a hand guide within which decisions involving financial risks (market risks) inherent can be depended on quantitative approaches.

At this point, it would be useful to clarify the party whose market risks would be explored; the party whose capital is at risk ie the party who might not saw what he expected to reap before initiating the project. If the critical question refers to the money invested, then the answer to the topic question may be of concern of two parties depending on the agreements of the deal:

- For lump sum contracts, the awarded bidder conveys the market risk because the price has been set at the beginning, and the unexpected increases in the cost of production beyond prediction would be met from the bidder's capital.
- For unit price contracts, the owner conveys the market risk because the awarded bidder would reflect the changes in the market prices to the earned values.
- Build-operate-transfer (BOT) systems, the awarded bidder, who will bear the production costs, incur the operation costs, and faces the risk of not being able to raise the expected revenues, will bear the market risks.

In many developing countries, as in Turkey, the major projects are infrastructure projects conveyed by the public bodies, and a great majority of these projects is unit price contracts. As mentioned above the owner conveys the market risk because the awarded bidder would reflect the changes in the market prices to the earned values. But it should be noted that even if the contract is a unit price contract, because of the time lag between the earned values being reported and they are actually paid, the awarded bidder still would bear some market risk.

On the other hand, a different kind of contracting, borrow the land – build the facility – and get a share in the ownership, is still widely employed in private sector ie. an agreement between a landowner and a construction company where the landowner supplies only the land and gets a certain predetermined share on the ownership of the completed facility. For example: the landowner has the land that a project can be built on, the contractor builds an apartment or a shopping mall or some other facility, and on the final product both parties share the 50 to 50 % of the ownership. In this case, the construction firm would bear the market risk.

Either the owner or the awarded bidder bears market risk, the main point is that market risk threats the capital. Since capital at risk may belong to different parties depending on the agreement, to avoid any confusion, the author will use the term "construction enterprise" to represent the capital supplier. The author will also extend the quantitative risk measurement methodologies to a level where the economical capital (optimum equity) can be derived for a profit-oriented enterprise or individual (ie. capital supplier) given the market risk profile of the project or the portfolio of projects carried on.

The author would deliberately try to explain the theoretical parts briefly, without going through too much theory that might diffuse the engineer readers' minds. Because the author's eventual goal is:

- To expand project managers' understanding of financial risks inherent in their construction projects,
- To inform the project managers on the availability of quantitative risk measurement methodologies that may help them assess, manage and control their projects' financial risk exposures, and
- To help project managers better communicate with risk management professionals and local or international project financiers; ie commercial and investment banks, The World Bank, IFC, OPIC, and etc.

The term "market risk" used throughout the thesis must be considered as defining financial (or economical) risks that the project and eventually the construction enterprise would be exposed to as a result of adverse movements in the financial markets.

It should be made clear that the aim of this thesis is not to discover new quantitative decision-making tools, but rather to apply many existing tools from other disciplines, mainly finance and economics, to projects' financial risk management.

The main motivation of the author while choosing the scope of his thesis was his background in construction management and financial engineering, and the scarceness of the academic research on the subject. The author has been working on the return & risk measurement and management of investments for six years as of year-2001, and he had experiences on the practical applications of developed and developing countries. On the other hand, when compared to other areas of project management, the field of measuring and managing financial risks is the least advanced in terms of academic research although it is one of the most forward looking one.

## 2. MARKET RISK

Market risk is the risk to a firm's financial condition resulting from adverse movements in the level or volatility of market prices of money borrowing/lending instruments, foreign currencies, commodities and equities. On the other hand, market risk in projects can be defined as the potential loss in a project that is associated with adverse inflow and/or outflow changes

- of a given probability
- over a specified time horizon
- that are resultants of unpredictable financial market movements.

The widely used methodology for numerical measurement of market risk is called "value-at-risk" (VaR).

In developed countries' practice, businesses calculate one-day VaR numbers, which are then compared with actual daily profits or losses, and hence they backtest their models. Then, they scale up this one-day VaR number by square root of 10 (It is accepted that standard deviation, ie risk, increases with the square root of time.) to meet the 10-day survival period laid down by supervisory bodies. The obtained number is the "economical capital", the capital that must be invested in the firm by its shareholders in order to ensure safe business conduct. (JP Morgan, 1996) (Bank for International Settlements, 1988)

In construction business, driving VaR and then economical capital figure starts from calculating VaR for each project, and followed by calculation of VaR for overall project portfolio (business-wide) if the project investor carries on more than one project at a time. Individual project risks add up to form the overall balance sheet risk of a typical construction enterprise. The procedure may seem cumbersome but indeed this is what is employed for measuring VaR of a business firm operating in another sector as well; first VaR for business units (departments), and there after VaR for the whole firm are calculated. But the first step of any level of VaR calculation for any type of business is identifying risk factors that cause the unpredictability.

The risk factors in a typical construction project that form the majority of the market risk include economical properties that describe the project's descriptive characteristics, such as:

- Cash flows in foreign currencies,
- Borrowing rates for external project financing,
- Price of inputs / outputs.

Unpredictability in foreign exchange rates forms one of the risk factors in projects. In finance literature, unpredictability in an instrument is named as "volatility". (Butler, 1999) Volatility in foreign exchange rates may affect the value of the expected inflows and outflows denominated in the local currency, hence expected net present value of project. It may be useful to clarify the issue with some examples. Some of the inputs of project activities are import items, and therefore costs of the project activities, ie outflows, increase as the foreign exchange rate increase, ie as the Turkish Lira depreciates. The project in consideration may be taking place in a foreign country, and the payments of earned values, ie project inflows, might be paid in a foreign currency, which again exposes the construction enterprise to foreign exchange risk because inflows decrease as the foreign exchange rate decrease, ie as the Turkish Lira appreciates.

Since enterprises often accept market interest rates as a benchmark for the discount factor(s) of future cash flows in a project, the volatility in interest rates causes alterations in the expected net present value of projects. This again causes inaccuracy in calculation of the net present value of a project during the feasibility analysis and forms market risk since the expected NPV may differ from realized profits. For example: the project may have a projected outflow of 1 million liras one-year from now on. The appropriate discount factor, ie 1-year term interest rate may be let's say 50% at the moment, implying a present value of 666,666 liras of outflow (1,000,000/(1+0.5)). But if the discount factor is decreased to 40%, the same outflow is now worth 714,286 liras, which is higher than initially predicted. Since this is an outflow, the decline in the discount factor faded away some portion of the expected net present value, ie profit. As the example demonstrates, each project's net present value is sensible to interest rate levels in the economy.

On the other hand, inflation (general price level in the economy) is another major risk factor especially in high inflationary economical environments where price levels often vary beyond prediction. There must be no doubt about the importance of this unpredictability in a project. This alteration may wipe off all the expected profit of a construction firm if there is a "lump-sum" contract signed with the owner. For unit price contracts, the owner bears the inflation risk but, on the other hand, it must be noted that this inflation unpredictability would create a tension on the construction firm's capital even if the contract is a "unit price" contract, especially in a time when there is a considerable time lag between the earned values' being reported to the owner and the owner's paying the outstanding debt to construction enterprise. Because the longer the time lags, the more exposed the construction enterprise would be to the unpredictability in inflation. By the time the payment done, the construction enterprise might not be fully paid for the work it performed since inflation would be wiping off some of the profits expected from the earned values. Therefore, unpredicted changes in input/output prices can completely undermine the realised net present value of a project.

A critical point to be borne in mind in specifying the risk factors in a market risk measurement system is that the system should be comprehensive to capture all the risks inherent in the project. Although the market risks would typically include the ones outlined above, project specific addings must not be disregarded.

Although VaR methodology has been accepted as a standard in measuring market risk, there are some limitations that must be kept in mind. Some weaknesses exist because:

- Market price movements are not always normally distributed, the assumption that drives the VaR methodology, because they display 'fat tails', ie they tend to have a wider dispersion of extreme events.
- Value at Risk cannot adequately capture event risk arising from exceptional market circumstances.
- External funding risk for a project is not fully assessed in a value-at-risk measure without a proper liquidity adjustment.
- The past is not always a good approximation of the future, for example, correlation assumptions among the risk factors may break down.

Therefore, value-at-risk numbers had to be multiplied by a safety constant known as "safety factor". This safety factor can be calculated by comparing the predicted value-at-risk numbers with the realised profit and loss figures. If there were a significant discrepancy between actual and model-generated numbers, then a plus factor would be added/subtracted to/from the safety factor. The aim of this backtesting is to figure out the accurate safety factor value in order to reach a model with good prediction ability. (Garman, 1996)

## 2.1 . MEASURING MARKET RISK

"There are significant differences in the internal and external point of views about a satisfactory market risk measure. Internally, managers need a measure that allows active, efficient management of the firm's risk position. Externally, project financiers (project finance institutions like; The World Bank, IFC, OPIC, and etc.) and regulators (like The Banking Supervisory Board in financial sector) want to be sure that a firm's potential for catastrophic losses is accurately evaluated and that the capital is sufficient to survive such losses." (www.trema.com)

### 2.1.1. Timeliness and Scope:

The need for a total risk measure implies that risk measurement cannot be decentralized. The reason for centralization depends on the theory of portfolio selection and the well-known fact that the total risk of a firm is not, in general, the sum of the business units' risks or the sum of all running projects' risks. (Markowitz, 1952) More generally, imperfect correlations among different projects' returns imply that the total enterprise risk exposure must be driven by the overall project portfolios' return distribution, which embeds the correlations and the changes in portfolio composition. In addition, given the already costly project-financing situation in developing countries, choices among alternative projects require managers to consider risk/return trade-offs. (Markowitz, 1952) Here, trade-off means substitution.

### 2.1.2. Efficiency:

Risk measurement is costly and time consuming. Consequently, managers compromise between measurement precision on the one hand and the cost of reporting on the other. This trade-off will have a great effect on the risk measurement system a construction enterprise will adopt.

### 2.1.3. Information Content:

Supervisors have a single risk measurement goal. They want to know, to a high degree of precision, the maximum loss a business is likely to experience over a given time horizon. They then can set the business' required capital (ie. its economic net value) to be greater than the estimated maximum loss and be almost sure that the business will not fail over that time horizon. In other words, supervisors would focus on the extreme left tail of the business' return distribution and on the size of that tail in adverse circumstances.

Managers have a more complex set of risk information needs. In addition to shared concerns over sustainable losses, they must consider risk/return trade-offs. That calls for a different risk measure than the "left-tail" statistics, a different horizon, and a focus on more usual market conditions. Furthermore, even when concerned with the level of sustainable losses, the manager may want to monitor risk on the basis of a probability of loss that can be observed with some frequency (eg. over a month rather than over a year). This allows managers to use the risk measurement model to answer questions such as:

- Is the model currently valid? For example, if the loss probability is set at 5%, do we observe a violation once every 20 days (1 to 20 ie 5 to 100) on average?
- Are employees correctly motivated to manage and not just avoid risk?

### 2.1.4. Selection of Confidence Levels:

There are several conventions in use for the VaR probability. The 95% interval (ie. 2.5% left tail) and the 98% interval (ie. 1% left tail) are commonly used. Unlike capital, the selection of a VaR confidence level is more a matter of convenience and management reporting. So, as long as management understands the meaning of the level, VaR confidence level must not be thought of as a "worst case loss limit". However, it must be noted that the further you go into the left tail, the more divergence there will be between a normal distribution and the actual distribution.

# 3. VALUE AT RISK

Value at risk (VaR) is a statistical measure of risk, which is used extensively for measuring the market risk of assets and/or liabilities on the balance sheet. Value at risk can be defined as:

"The amount of money such that a business is expected to lose less than that amount of money for a certain days out of 100 business days." (Neftci, 2000)

The above definition can be for 1-day value at risk measured at the 99% confidence level. Other horizons or confidence levels may be used in practice as well to suit the specific needs of the end users. For example, if a business' 1-week, 95% value at risk is $2 millions, then the business would be expected to lose less than $2 millions over 95 weeks out of 100. Such an estimate would be based upon the balance sheet's current composition and recent market conditions.

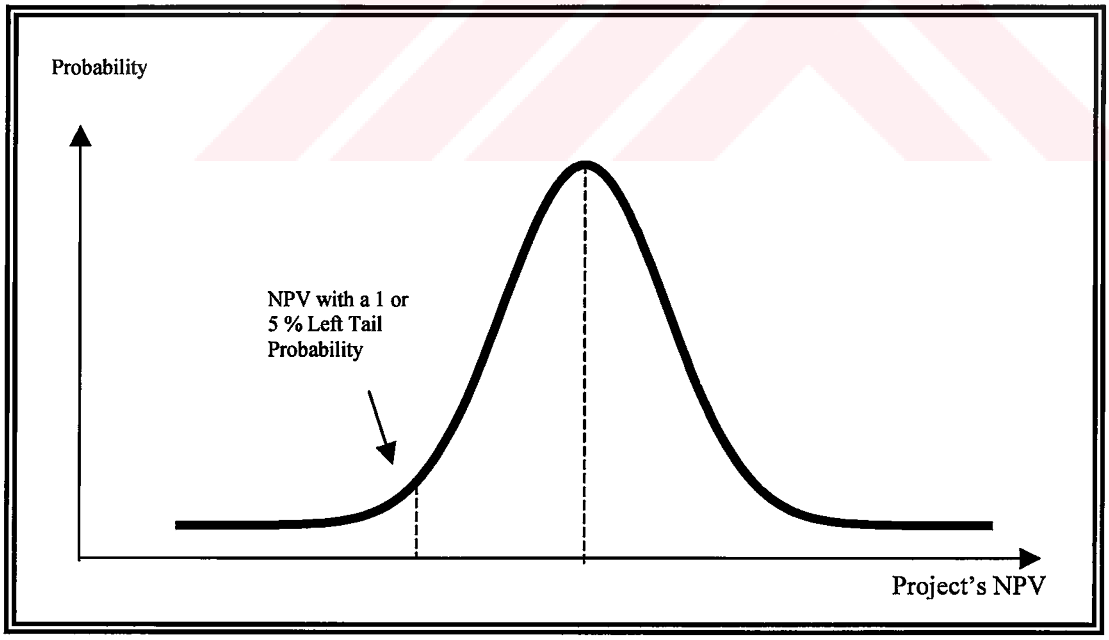


Figure (3.1) Probability Distribution of a Project's NPV

Because of its technical nature, it might be useful to define Value at Risk (VaR) with simpler definitions. Below are two different definitions to VaR:

- "A forecast of a given percentile, usually in the lower tail, of the distribution of returns on a portfolio of assets and/or liabilities over some period. It is similar in principle to an estimate of the expected return on a portfolio of assets and/or liabilities, which is a forecast of the 50th percentile. The only difference is that the aim is to figure out the 1st or 2.5th percentile of return distribution in VaR calculations.
- An estimate of the level of a possible loss on a portfolio of assets and/or liabilities that is expected to be equalled or exceeded." (www.glorimondi.org/var)

In the graph, the portfolio's one-month 99% (or 95%) VaR was found by simply locating that point on the x-axis such that 99% (or 95%) of the probability falls to the right of the point. This represents the upper bound on a 99% (or 95%) confidence interval for the amount that the portfolio might lose.

Under the light of the generic definitions of VaR in business, a project's VaR can be defined as the estimate of the level of a possible loss on a project for a certain period of time. It would be useful to clarify the vague phrase "certain period of time".

- When evaluating a possible loss that may be realized from the whole project, the time parameter must be equal to the time length of the project. Because the construction enterprise might like to see how much deviation from initially anticipated might be observable during the whole project.
- When evaluating a possible loss that may be realized during the time lag between earned values being reported and the owner's actually making the payment, the time parameter must be equal to the estimated time lag.

As understood from the definitions, VaR figure can be calculated to serve the specific need of the construction enterprise. As it will be explored in formula (3.1) what will change will be the discrete time intervals where the standard deviations (volatilities) are calculated. For example:

- If the construction firm has a lump-sum contract with the owner and is concerned of the deviations that may be realized throughout the project production, then the discrete time intervals that the standard deviation of changes is calculated will be project duration. This means that if the project duration is, say, 2 years, the standard deviation of changes in risk factors in formula (3.1) would be calculated by taking the standard deviation of historically observed 2-yearly changes for, say, the last 20 years.

- If the construction firm has a unit-price contract with the owner and is concerned of the deviations that may be realized throughout the time lag between the earned values' being reported and they are paid, then the discrete time intervals that the standard deviation of changes is calculated will be anticipated time lag. This means that if the time lag is, say, 1 month, the standard deviation of changes in risk factors in formula (3.1) would be calculated by taking the standard deviation of historically observed 1-monthly changes for, say, the last 1 year.

While deriving VaR figure, in formula (3.1):

- The present value of outflows (costs) must have a positive sign that means that any unexpected change would increase the VaR, and
- The present value of inflows (revenues that would be generated when the project has been accomplished) must have a negative sign that means that any unexpected change would decrease the VaR.

This sign differentiation means that the unpredictability in outflows would be naturally hedged by the unpredictability in inflows, and the final VaR figure would be incorporating this interaction.

As the author has stated at the introduction, he would like to extend VaR analysis to a level where the economical capital could be calculated. The economical capital, which is driven from the VaR figure and must be set aside for the project, may be thought of as the capital serving as a cushion for unpredictable losses. Calculating a fair economical capital figure is important because being too cautious (conservative) in the calculations would yield a higher figure than needed, which causes inefficient allocation of shareholders' wealth, on the hand, where having too much appetite for gearing return on capital would yield a lower figure than needed, which threats the safe conduct of the business.

There are two critical questions that need to be answered while calculating the economical capital: What should the time interval, where the standard deviation of the changes in risk factors is calculated, be? What should the plausible time length of an extraordinary condition in the financial markets be that the construction enterprise would be vulnerable to? The first question refers to discrete time intervals, where the standard deviation figure in formula (3.1) is calculated, and as an industry standard in economical capital calculations, the time interval is usually taken as 1-day standard deviations (ie volatilities) observed in the past. After 1-day VaR figure is obtained, the second question refers to the expected time length of extraordinary conditions in financial markets where the VaR figure is extended throughout this time length to figure out the economical capital figure, and as an industry standard it is usually taken as 10-days (10-day survival period ie 2 business weeks).

Once 1-day VaR figure is calculated, multiplying 1-day VaR figure by square root of 10 and by a safety factor gives the economical capital figure. The reason of multiplying by the square root survival time period is that standard deviation increases by the square root of time. On the other hand, the safety factor can be calculated by comparing the predicted 1-day VaR numbers with the realized 1-day profit and loss figures. If there were a significant discrepancy between actual and model-generated numbers, then a plus factor would be added/subtracted to/from the safety factor. The aim of this backtesting is to figure out the accurate safety factor value in order to reach a model with good prediction ability of economical capital.

It is a tough question to answer how much of the hereby-calculated project's financial risk figure should be reflected to the bidding price. Reflecting whole VaR figure to bidding price would reduce the bidder's competitiveness, while avoiding including them might shrink the profits from the project should the mentioned markets risks realize. It would be the best if some of these risks were tried to be eliminated by entering into financial risk management (derivative) contracts with financial institutions. Forward, swaps and option contracts could be used to reduce foreign exchange risk. Caps, floors, and collars could be used to hedge borrowing interest rate risks. Commodity futures and options could be used to hedge some of the input price risks. Once all the diversifiable risks were eliminated by available financial contracts, then, undiversifiable risks would be of concern to construction enterprises, and how much of these risks might be reflected to bidding price will a choice depending on the risk and return preferences of the construction enterprise.

VaR is a powerful measure of risk. Its use is not limited to measurement of risks inherent in a certain asset class; it can measure the market risk of either a project the construction enterprise undertakes or a financial instrument the enterprise holds.

Moreover, all sources of market risk for a construction enterprise, attributed by either projects or any other financial instruments are captured via their contribution to the probability distribution for an enterprise's profitability.

Although it is a useful tool, estimating VaR can be challenging. Various methodologies are used, including:

- Parametric VaR
- Monte Carlo VaR
- Historical VaR

Each of these methods has its strengths and weaknesses. Conceptually, they all work by dividing the task of estimating a probability distribution into two components:

- Estimating probability distributions for various risk factors that affect the value of a project or projects and thereby an enterprise. Such risk factors might include various input/output prices (ie activity costs as in the project management), interest rates, and exchange rates. For example, it might be assumed that the risk factors are normally distributed with volatilities and correlations based upon recent market behaviour for each risk factor.
- Determining a probability distribution for the net present value of a project based upon the historic values of various input/output prices (ie activity costs), borrowing interest rates, and exchange rates. Here, correlations are embedded in the historic net present values of the project. Therefore, the distribution encompasses correlations as well as volatilities, and the VaR estimate captures all hedging and diversification effects within the project. But it should be noted that the sensitivity of the net present value of a project to a particular risk factor would not be easy to measure via this method.

VaR analysis can be systematised. To do so, a database of volatility and correlation estimates for all the risk factors that might affect a project is maintained. A computer then tracks the values of the project, and provides up-to-date VaR estimates as the project is on the run.

A limitation of VaR is that it only measures risk in one of the two senses:

- "Because the joint distribution for risk factors is based upon recent market behaviour of these factors, the analysis would reflect present changes in the risk factors. However, the analysis reflects the shifts slowly. An example can be given on a multi currency cash flow project where there are imported inputs (ie. outflows) and local currency denominated expected revenues (ie. inflows): if the daily average appreciation of US Dollar against Turkish Lira shifts from 0.25% to 0.40%, a VaR analysis would not immediately recognise this. It would take perhaps 50 or 100 days before sufficient daily price data was collected to reveal that the appreciation path had shifted. Therefore, VaR analysis must often be supplemented with stress testing.

- On the other hand, because the analysis is based upon current balance sheet items of the enterprise, it does potentially measure risks based upon a balance sheet's current composition. For example, if the construction enterprise purchased a forward or options contact that fixes the project's import costs in the future then the diminishment in the foreign exchange rate risk would be instantaneously reflected in the VaR figures." (www.contingencyanalysis.com)

As a summary, there are three commonly used VaR measurement methodologies:

- Parametric Model
- Monte Carlo Simulation
- Historical Model.

All VaR approaches share some common attributes:

- Each approach uses market risk factors (e.g. foreign exchange rates, interest rates, input/output prices).
- Each approach requires a choice of historical time horizon for the market data, which brings the issue of trade off between the number of data points versus the current relevancy of the data.
- Each approach assumes that past relationships will be repeated, eg, correlations will be maintained.

The VaR approach has some important limitations; it:

- does not give a good description of the next extreme event
- does not cover every aspect of market risk, eg. project specific risks. Therefore, VaR should be supplemented by other measures such as stress tests.

## 3.1. PARAMETRIC VaR MODEL

### 3.1.1. Parametric VaR Approach

"The parametric (delta-normal) method assumes that all asset returns, therefore those of affecting a project's net present value, are normally distributed. This method consists of going back in time, for example for a year, and computing variances and correlations for all risk factors. A project's market risk is then generated by a combination of linear exposures to many risk factors that are assumed to be normally distributed, and by the forecast of the covariance matrix." (www.glorimundi.org)

To calculate VaR of a project via parametric model:

- Risk factors that affect the NPV of a project must be identified. Typical risk factors, as stated throughout the thesis, can be input/output prices, foreign exchange rates, project-financing rates, and etc. Then, forecasts of volatility of risk factors and correlations among them are needed.
- Net present value figures obtained under different risk factor scenarios are required. Hence, one can drive the risk and return characteristics of the project.

In addition, assumptions on the model should also be noted. These are:

- the existence of a linear value sensitivity to factor changes,
- a normal probability distribution of changes in risk factors.

The advantages of Parametric VaR are as follows:

- It is fast calculated compared to Monte Carlo and Historical Simulation.
- It allows the calculation of a diversified VaR Contribution (VaRC) by an activity and/or a risk factor.

On the other hand, the disadvantages are given below:

- It assumes stable correlations.
- It gives little insight on the description of non-linear risks.

The formula for calculating VaR for a project that is exposed to a single risk factor is:

$$\text{VaR} = \text{NPV} \times \sigma \times \text{Conf. Coef.} \qquad (3.1)$$

Here,

NPV : net present value of the project

$\sigma$ : standard deviation of the changes in risk factor

Conf. Coef. : confidence coefficient derived from standard normal distribution table. For example; 2.33 for 99% confidence level, 1.96 for 97.5% confidence level. (Butler, 1999)

This formula gives the VaR figure of a project under a single risk factor ie the possible loss that may be realized with an anticipated probability and for a certain period of time. Then the question must be "for what period?": This formula calculates the possible loss during the time period that matches with the time periods that the standard deviation calculation is calculated on. For example:

- If one wants to see the possible loss that may be realized in one day, then the standard deviation of 1-day changes (ie, daily changes) in the risk factor is of concern in VaR calculation.
- If one wants to see the possible loss that may be realized in one year, then the standard deviation of 1-year changes (ie, annual changes) in the risk factor is of concern in VaR calculation.

To calculate the value at risk of a portfolio of projects under a single risk factor, proper correlation (correlation, among the risk factors) adjustment must be done in standard deviation calculation. It must be noted that same formula applies to the calculation of a project's standard deviation under two risk factors. For instance, for a firm carrying out two projects, X and Y, the standard deviation of the portfolio can be calculated as below (Markowitz, 1952):

$$\sigma_{x+y} = \sqrt{w_1^{\,2}\sigma_1^{\,2} + w_2^{\,2}\sigma_2^{\,2} + 2w_1\sigma_1 w_2\sigma_2\rho_{12}} \qquad (3.2)$$

Here,

$\sigma_{X+Y}$ : standard deviation of the project portfolio,

$w_1$ : weight of project-1's NPV in the project portfolio,

$w_2$ : weight of project-2's NPV in the project portfolio,

$\sigma_X$ : stand-alone value at risk of project-X,

$\sigma_Y$ : stand-alone value at risk of project-Y,

$\rho_{X,Y}$ : correlation between historic NPV's of project-X and project-Y. Historic NPV means; the net present value of a project if it were to be undertaken in the past.

Another important aspect of the parametric model is what is known as "contributory VaR" (VaRC), which enables to identify the sources of the project's risk. Therefore, VaRC is a way to see where the risk is coming from in projects, and hence it helps taking proper actions.

### 3.1.2. Parametric VaR Approach in Project Budgeting

Risk analysis adds an additional dimension to traditional budgeting efforts. That dimension is a quantitative measure of uncertainty associated with the estimate for a given risk factor (or for given risk factors) in a project. The budget analyst hence grabs a more complete picture of possible outcomes for the period budgeting done, and may embed a probabilistic risk variable on the budget estimate.

Parametric cost estimation is a process of using risk factors to develop a budget estimate. These risk factors include economical properties that show the project's economical descriptive characteristics, such as:

- Cash flows in foreign currencies
- Borrowing rates in external project financing
- Change in the price of inputs / outputs

After defining the risk factors and obtaining the historic data sets for them, historic averages and standard deviations for each of them and the correlations among them are calculated to figure out the overall standard deviation for the project via formula (3.2). Here "w" figures will be the weight of exposures in the project's NPV in each risk factor. Then, the expected standard deviation in the NPV of the project, which assesses quantitative risks and hence helps to yield more accurate budgeting estimates, is calculated via formula (3.1) with a certain degree of confidence.

The benefit of this methodology in project budgeting is that the analyst will obtain not only simple NPV or inflow/outflow figures for each project as in the traditional way, but also a probabilistic distribution of each. This means knowing the risks inherent in a project or a portfolio of projects in a numerical fashion, which then enables further calculations like VaR.

The VaR figure would be the standard deviation multiplied by the value of standard normal distribution function for the predefined degree of confidence. (2,33 for 99%, 1,96 for 95%; these figure are obtained from standard normal distribution tables.) One important point to note is that the VaR figure obtained will be reflecting a VaR figure for the whole project duration. Therefore, if one wants to extend the VaR to figure out the economical capital, the VaR figure must be divided by square root of duration to get the economical capital figure that must be set aside for the next year.

The advantages of using Parametric Cost Estimating methodology are:

- The accuracy of the cost estimate using the model will exceed the accuracy of the traditional comparative budget cost estimates. The analyser will be looking at a probabilistic distribution of NPV rather than looking at a vague point estimate.
- The methodology will enable the evaluation of a project not only in terms of its NPV but also risks inherent. This means a new way of looking at the projects: Risk adjusted NPV.
- The probabilistic distribution generated by the model that is based on current construction cost data will build a database for future use in a similar project at a given point in time and at a particular geographic location. Hence, reasonable cost estimates in the future can be produced without the need for detailed plans and specifications.
- Because of its incorporating risks associated with uncertainty and hence by yielding more accurate results than those of conventional methodologies, the parametric budgeting may be used to determine the maximum amount of contingency (unanticipated) payments.
- Cost comparison estimates can be done instantaneously based on criteria changes.

### 3.1.3. Risk & Return Optimisation in Project Selection under Budget Constraint

A cash flow analysis would indicate only return dimension of a project in project evaluation. It ignores the uncertainty associated with the estimate for risk factors. For example a typical cash flow analysis would be indifferent for choosing the better alternative between project-A and project-B, in the figure (3.2) below, because both have the same mean (ie average, mostly expected value of NPV). But faced with the additional information supplied by the risk dimension, the decision-maker would no longer be indifferent. If project-A were selected, the spread in possible outcomes would be far less than that of project-B. In other words, the greater variation in the possible outcomes of project-B would make it less attractive to a risk-averse project investor.

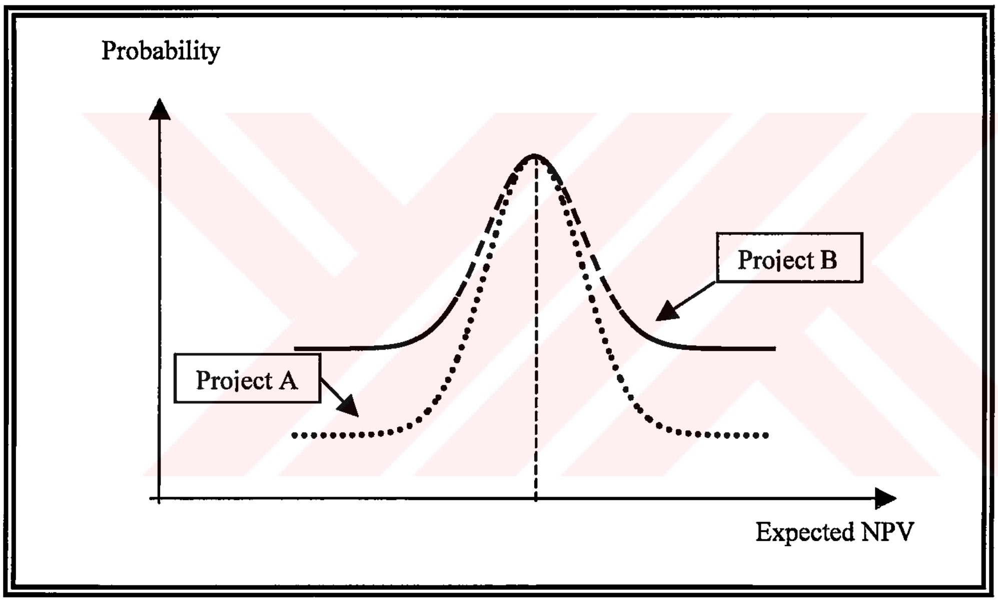


Figure (3.2) Probability Distribution of NPV of Two Compared Projects

An important aspect of parametric method is that it may enable the decision-makers to utilize a model during the feasibility phase that displays the projects that must be undertaken via maximizing the return over risk ratio of the overall project portfolio under a budget constraint. This approach is commonly referred as "Risk Adjusted Return on Capital Optimization, RAROC" in finance literature. (JP Morgan, 1996)

This methodology helps the senior management invest among the projects that yields the highest return-over-risk ratio for a given budget constraint. For this purpose, calculation of a return (NPV) and risk structure for each project, and a correlation matrix composed of the correlations driven from expected project returns (NPV's) are needed.

Here, it may be useful to define the market risk in a project again. Market risk in a project is the alteration in the expected net present value of the project arising from the changes in the financial risk factors. As described before, typical financial risk factors for projects are foreign exchange rate risk, borrowing interest rate risk, inflation risk.

The procedure for "risk & return optimisation in project selection under budget constraint" model is described below:

Firstly, net present values must be calculated under each possible risk factor scenario in order to drive the market risk profile of each project. This helps the analyst build a distribution profile of probable NPV figures, and enables to obtain a numerical measurement of risk of each project by simply calculating the standard deviation of outcomes.

Secondly, the correlation matrix must be built-in. The elements of the correlation matrix are composed of the correlations between the probable return series of the projects driven by changing risk factor scenarios. For example: If the enterprise has 8 alternative projects in consideration, then 8x8=64 correlation figures must be filled in the matrix. One point to keep in mind is that the matrix is symmetric, ie. Xij=Xji, and the diagonal numbers are all equal to 1, ie. Xii=Xjj=1. These properties reduce the number of calculations more than half. The value of a Xij element is the correlation between possible expected net present values for project-i and project-j.

Thirdly, the expected net present value of each project must be calculated. This is easy once the outcomes of probable scenarios are in hand. It can be calculated by employing a simple arithmetic average method.

After deriving the return and risk figures of each project, and correlation figures between projects, the rest is a problem of optimisation via "linear programming". In this optimisation problem, the aim is to maximise the return over risk ratio subject to a budget constraint. (A sample program for the optimum project portfolio selection model can be downloaded at www.metink.homestead.com/models.html)

One more point to note is that after figuring out the "risk-over-return ratio maximised" project portfolio combination, a value at risk figure can be calculated given the risk, return and duration characteristics of the selected combination. The computed VaR number will be showing the capital at risk during the duration of the project portfolio. Then, the economical capital that is required for safely management of the construction enterprise in one year can be derived by dividing the VaR figure by the square root of the duration of the project portfolio. The reason for dividing the calculated project portfolio VaR by the square root of portfolio duration is for scaling purposes because standard deviation ie risk is proportional to the square root of time. This means that if the duration of the project portfolio is 4 years and the VaR figure is found as 100 billion Turkish Liras, then the VaR for 1 year will be 100 divided by square root of 4. This yields an annual VaR figure of 50 billion Turkish Liras. It must be noted that the final figure, ie 50 billion Turkish Liras, is generally multiplied with a safety coefficient.

## 3.2. MONTE CARLO SIMULATION

Monte Carlo VaR is a measurement of market risk based on statistical techniques. The simulation attempts to generate a distribution of potential value changes for an asset. Thus, the VaR figure is derived from the simulation outputs. It allows the modelling of individual risk factors, and is flexible in simulation of different processes.

The idea of the Monte Carlo simulation is simple. First, a large number of scenarios that follow the same underlying distribution are generated. Second, for each scenario the value of the project is calculated and recorded. Here, the calculated values form the probability distribution of the project's market value, from which the Value-at-Risk figure can be derived.

It is clear that by using the Monte Carlo simulation, the problems of the parametric model coming from linearity and normality assumptions can be overcome. For parametric model, it was the linearity and normality assumptions that have made the calculation of the standard deviation of the project's probable NPV distribution possible. Now that the closed form solution is not applied, there is no longer the need to settle for linear approximation, but instead the full market value of instruments can be used. There is also no longer any obligation to draw the simulated scenarios from a jointly normal distribution. (Joy and others, 1999)

Beside overcoming linearity problem, the shortcomings of the normal assumption still apply to Monte Carlo VaR. For example, the distribution of major risk factors in construction may be far from normal in reality. This can be easily verified by plotting a risk factor's (interest rates, foreign exchange rates, or input/output prices) historic data against the normal distribution. The figure generally encountered is that the true/realised distribution displays skewness and fatter tails than one would expect with the normality assumption. This means that the risk involved can be underestimated using the normal model.

While the normal assumption has gained a position of an industry standard as being easy to implement, there is an emerging need for better models closer to the reality of market moves. The underlying distribution is always derived from two sources: the historical data, and the stochastic model that is used for interpreting the data. The same historical data can lead to very different values-at-risk, under different statistical models. This leads to the question of; what is a good model?

### 3.2.1. Stochastic Modelling:

Models can be compared and ranked by measuring how well they predict the future behaviour. However, a good prediction does not mean that the model would suggest point-estimation for the value of a variable, such as the rainfall in a dam's hinterland would be 25.75 centimetres for the next year. Instead, a good predictive model has stochastic properties, which are close to the true behaviour. For example, the rainfall in the hinterland will be between 18 and 33 centimetres with a confidence interval of 95%, or if the critical value of the rainfall that may cause a float is 40 cm, the probability to exceed this critical value is 99.5%.

Establishing a good statistical risk model in terms of good projecting capability involves determining the model structure as well as the corresponding procedures to estimate model parameters. In order to build powerful models, one cannot simply choose some single parametric joint distributions. Instead the model must be tailor-made. Standard distributions are important as well as the concept of conditional probability.

As a simple example of conditional probability, we can consider the budgeting of an international project with cash flows denominated in three currencies, United States Dollar, Euro, and Japanese Yen. In this example EUR/USD distribution depends on the changes of USD/YEN. To simulate scenarios it is firstly necessary to draw a value for USD/YEN, followed by a value for EUR/USD using the already drawn USD/YEN as a model parameter. This simple example illustrates how variables can be modelled with a hierarchical dependency structure. The use of conditional models also incorporates the intuitively clear causality between the variables, for example, changes in strong currencies affect weaker currencies and not the other way round as suggested by a symmetric correlation. But for practical reasons, especially in financial modelling, ordinary correlation relationship has a wide industry wide use.

The descriptive power of such a hierarchical model is superior to a simple parametric model. One must remember that in addition to the confidence level controlled by the risk manager, there is an additional element of uncertainty hidden in the adopted statistical model, and the only method of reducing this unseen risk is to increase the accuracy of the model. Of course the construction of such a model and its adaptation to the historical data, is a major task that requires expertise in both the statistical modelling techniques and the inner workings of real life. The benefits of such a model include increased confidence in the resulting value at risk figures, as well as the possibility to extend the use of value at risk beyond the role of passive monitoring and into a tool of active business-wide risk management. It is important to note that even when an advanced model based on conditional distributions is used, the principal difficulty lies in the construction and adaptation of the model. Once the model data is in place, the Monte Carlo simulation itself will not be significantly more time-consuming than the simulation based on a far simpler model.

### 3.2.2. The Mechanisms of Simulation:

It is clear why the Monte Carlo simulation sets problems in technical implementation. The number of scenarios needed to form a reliable estimate of the variable's probability distribution can be vast, and therefore for each scenario the whole variable has to be revalued. A step by step approach can be as following:

(1) Generate R random, independent variables (R = # of risk factors),

(2) Transform the R uniform random variables into independent "normal" variables,

(3) Multiply the vector of independent normal variables by the "square root" of the covariance matrix of risk factor returns to generate correlated normal variables; the correlated normal variables are risk factor returns,

(4) Apply the risk factor returns to the current level of risk factors to obtain "trial" risk factor values,

(5) Fully reprice the variable using the "trial" values; determine the change in value, and record the results,

(6) Repeat steps 1-5 enough times to generate a distribution of potential values,

(7) Read the Monte Carlo VaR at the desired level of confidence using the distribution of changes.

A generic function, F, to generate "Standard Normal Random Numbers" in visual basic code can be as the following:

$$F = \text{rnd}() + \text{rnd}() + \text{rnd}() + \text{rnd}() + \text{rnd}() + \text{rnd}() + \text{rnd}() + \text{rnd}() + \text{rnd}() + \text{rnd}() + \text{rnd}() + \text{rnd}() - 6 \qquad (3.3)$$

This function helps skip the first step as well. (Wilmott, 1998)

### 3.2.3. VBA Code for Monte Carlo Simulation in Excel™

To automate the Monte Carlo Simulation process, one can use the macro language that accompanies Microsoft Office, Visual Basic for Applications (VBA). The algorithm is very simple. The program only needs to:

1. Recalculate the worksheet (to generate new random numbers),
2. Retrieve the results,
3. Store it either in a new worksheet or in an array,
4. Repeat the process.

On modern computers, 1000 iterations can be completed in less than 30 seconds, with the results reasonably accurate.

The program consists of a simple "For-Next Loop", which iterates steps 1-3 above. The results can be stored temporarily in the first column of worksheet "Sheet 2". To run the program in Excel, one only has to perform the following steps.

1. Open the Visual Basic Editor. This is accomplished through the menu sequence: [Tools] – [Macro] – [Visual Basic Editor], or by pressing <Alt-F11>.
2. An Excel workbook by default contains a number of objects (typically three Worksheet objects), but no "Modules". Since VBA programs must reside in Modules to be executed, the user must first create a Module object with the menu

sequence: [Insert] – [Module] inside the VBA editor. This opens a blank screen into which VBA code can be typed.

3. Type in the program:

```
Sub Monte ()
For I = 1 To 1000
        Range("A1").Cells(I, 1) = Rnd() + Rnd() + Rnd() + Rnd() + Rnd() +
        Rnd() + Rnd() + Rnd() + Rnd() + Rnd() + Rnd() + Rnd() – 6
Randomize
Next I
End Sub
```

While typing the program, one must be aware that spelling is critical, and extra spaces can be disastrous; although VBA provides context-sensitive help with syntax.

4. Run the program. This can be done either with the "Play" button on the VBA editor toolbar, or within Excel through the [Tools] – [Macro] – [Macros] menu sequence. If everything is working properly, the numbers must be seen on the worksheet rapidly. (www.erisks.com)

This program enables the user to obtain 1,000 normal random numbers. After these numbers are obtained, they can be used to fit specific need of the end user. For example; in continuous time finance given the assumption that the asset returns (foreign exchange rates or interest rates, two major risk factor of a typical project) are normally distributed, the expected return from an asset in a discrete period of time, $\Delta t$, can be modelled as following (generic geometric Brownian motion):

$$\Delta Price / Price = \mu.\Delta t + \sigma.\varepsilon.(\Delta t)^{1/2} \tag{3.4}$$

Here:

$\mu$ : annualized historic mean of changes in the risk factor

$\sigma$ : annualized historic standard deviation (volatility) of the changes

$\varepsilon$ : random number drawn from standard normal distribution

$\Delta t$ : discrete time interval where the forecast will be done (in terms of years).

This generic formula can be used to model the behaviour of any stochastic (time depended) variable, and can serve as a benchmark approach. Here, in our case, the limitation for the usage is that the variable's change (or its return as in finance) must historically demonstrate normal distribution behaviour. On the other hand, the formula can be extended to model the behaviour of any variable by choosing the appropriate distribution where the randomly drawn numbers, $\varepsilon$, would be generated. For example, if the variable shows behaviour complying with the triangular distribution, as in project scheduling, then the standardised random numbers, $\varepsilon$, must be drawn from a standard triangular distribution. (Hull, 1997)

### 3.2.4. Monte Carlo Simulation on Critical Path Method

Network methods for scheduling, such as stand-alone CPM, do not provide a measure of uncertainty associated with the estimate of a particular target in a project. It is a deterministic tool. The duration of each activity is assumed having one value. Yet the time required for completing an activity in a project depends on many factors. Some of the factors are resources, methods, technology, site condition, weather, and regulations. This means that the time that is required to complete an activity is not deterministic. But the critical path method (CPM) is calculated based on only the mean duration of activities, it ignores the uncertainty that can be calculated in terms of standard deviation historically observed. Simulations can incorporate this uncertainty of the duration estimate in the overall CPM network analysis.

Monte Carlo Simulation is a very versatile method of risk analysis that can be used in many diverse applications. Further than the measurement of risk associated with a project's NPV, Monte Carlo Simulation can be applied to risk analysis of CPM schedules and range estimating.

Monte Carlo Simulation can be executed in a variety of ways. Complex Monte Carlo Simulations can also be set up in a spreadsheet application such as Microsoft Excel. The basic steps involved in the process are outlined below.

In terms of CPM schedules, each activity or groups of activities that are close to the critical path and thought to have a variable duration are described using a statistical distribution. This could be as simple as a uniform distribution between a minimum and maximum duration, a normal distribution described by a mean and standard deviation, or as complicated as a Beta or Exponential Distribution. The most common, and usually the easiest to generate, is a triangular distribution made up of the pessimistic, most likely, and optimistic durations. (PERT)

A random number (step 1 below) is then mapped onto the distribution (step 2) to give the activity a possible duration for that run (step 3). After all the activities have been given a duration, the critical path is determined and a maximum duration of the project is calculated (step 4).

This is repeated many times and the maximum duration is stored each time. This results in a distribution of the maximum duration of the project on which a risk analysis can be based. Depending on the distributions used for the activities this distribution may or may not be normal, but with the proper tests it is usually reasonable to assume normality.

The following algorithm can summarise Monte Carlo Simulation for CPM:

1. Generate a random number on the interval [0-1]
2. Transform the random number into an appropriate statistical distribution (e.g., normal, beta, uniform), the resulting number is referred to as a random variate.
3. Substitute the random variates into the appropriate variables in the model.
4. Calculate the desired output parameters within the model.
5. Store the resulting output for further statistical analysis.
6. Repeat steps 1-5 a number of times (note that the generated uniform random numbers must be different in each iteration), when done exit to step 7.
7. Analyse the collected sample of output and perform risk analysis. (www.msproject.com)

### 3.3. HISTORICAL VaR

The construction of a good risk model is by no means a simple task, but one that requires careful thinking and theoretical knowledge. It may be due to this difficulty, that one is tempted to use shortcuts such as "Historical Value-at-Risk" where the current risk is calculated using a short series, for example, 50 historical movements as the sample. It is easy to see why "Historical VaR" is appealing because neither a model structure, as in Monte Carlo VaR, nor a parametric estimation, as in

Parametric VaR, is needed. This can, however, result in a serious bias due to the fact that the dynamic nature of modelling may not be thoroughly captured with history.

Historical value at risk is indeed a simplification of Monte Carlo value at risk where, instead of randomly generating scenarios, scenarios are drawn directly from historical data. For example, the 1-year VaR of a project might be estimated with 20 historical scenarios as follows:

(1) Collect data for how applicable key factors affecting the worth of the project have performed over the last 20 years. For each year, determine the percent change in each of the key factors. This will produce 20 one-year scenarios for the performance of the set of key factors.

(2) Re-value the project under each of the 20 scenarios, determining for each one what would be the project's profit or loss if that scenario were to occur over the next year.

(3) Form a histogram of the results from which VaR can be estimated.

Historical VaR is easy to implement. It has been argued that, because scenarios are drawn directly from the past, they accurately reflect the extreme movements that may not be captured by Monte Carlo's random numbers. On the other hand, since the number of scenarios used is limited by the availability of historical data, the methodology may have greater convergence error than Monte Carlo VaR. (Fallon, 1996)

## 3.4. COMPARISON OF DIFFERENT VaR METHODS

Table (3.1): Comparison of different VaR methodologies (Pritsker, 1996)

| | Parametric Model | Monte Carlo Simulation | Historical Simulation |
|---|---|---|---|
| Speed of Computation | Good | Slow | Reasonable |
| Ability to identify hot spots | Good | Mediocre | Mediocre |
| Ability to capture non-linear price movement | Not Good | Good | Good |
| Ability to model non-normality | Not Good | Mediocre | Good |

## 3.5. ADJUSTMENTS TO VaR CALCULATIONS

"A number of adjustments are applied to VaR methods before they yield to decisions:

- Covariance matrix adjustment
- Kurtosis adjustment
- Liquidity adjustment" (Neftci, 2000)

### 3.5.1. Covariance Matrix Adjustment:

The purpose of covariance matrix adjustment is to find the estimate of correlations that may prevail in the future. The methods used are:

- Simple moving average (equally weighted)
- Exponentially weighted moving average
- Generalised Autoregressive Conditional Heteroskedasticity (GARCH)

### 3.5.2. Kurtosis Adjustment:

Standard VaR approaches are short of a thorough treatment to non-normality. Many of the variables driving the analysis may not perfectly fit a certain type of distribution. For example: as in project budgeting financial returns may not perfectly fit normal distribution, or as in scheduling the probability distribution of an activity's duration may not be perfectly represented by a triangular distribution. Although there is no specific approach to cope with the abnormalities in every distribution, kurtosis adjustment is a sound way to eliminate the abnormalities in normal distributions.

Risk factor distributions used in project evaluation possess "fat tails", ie. extremities are observed much more often than predicted by normality assumption. Therefore, VaR measures based on normality assumption will underestimate risk and exhibit too many backtesting violations. Fatness of the left tail can be interpreted as a measure of how often "crises" happen. Crises (large negative returns) happen much more frequently in the real world than in the normal distribution world. The probability that returns will be worse than 2.33 times the standard deviation is 1% for a normal distribution but it is significantly greater than 1% for a leptokurtic (fat-tailed) distribution.

Kurtosis provides the simplest metric for the fatness of tails. It is the fourth moment of a sample distribution. Kurtosis is significant when measuring VaR because,

- It alters the probability of VaR being exceeded therefore it is important for accurate risk quantification.
- It is important for backtesting performance.
- It is important for comparing risks of alternative instruments.

### 3.5.3. Liquidity Adjustment:

Liquidity is the ability to easily raise the needed cash. Liquidity risk is the financial risk from a possible loss of liquidity. Liquidity risk is especially a critical issue in developing countries where projects are generally financed by borrowed funds, ie via usage of financial leverage. This causes a liquidity problem in case of a financial crisis in two aspects:

- Specific liquidity risk is the risk that a construction enterprise will lose liquidity. This might happen if the company's credit rating fell or something else happens which might cause counterparties to avoid trading with or lending to the institution.
- Systematic liquidity risk affects all participants in the project. It is the risk that all of the project participants, lenders, borrowers, project owner, will lose liquidity. This generally occurs during periods of macro economical crisis.

Liquidity risk tends to compound other risks. It can be most damaging for enterprises undertaking financially leveraged projects, a situation, which may create a need for immediate cash. A simple example of such a situation may be that of a construction enterprise, which experiences loan recalls or additional collateral as a result of bankruptcy rumour. Therefore, it is important to recognise the liquidity risk. It can add significantly to losses. Therefore, it must be measured, monitored, and controlled. In addition to that, if it is not included in the VaR calculations via liquidity adjustment, it can give negative incentives to managers because they will want to undertake more financially leveraged projects (a case of making profit with other people's -borrowed- money) because of their will to increase return on shareholders' equity.

The simplest way to account for liquidity risk is to extend the duration of projects to reflect an appropriate "liquidation or close out period". For example, for a project with duration of h years, this amounts to a liquidity adjustment multiplier of:

| | | |
|---|---|---|
| $h = 1$ | : | $1$ |
| $h = 3$ | : | $1/3\,(1 + \sqrt{2} + \sqrt{3}) = 1.4$ |
| $h = 5$ | : | $1/5\,(1 + \sqrt{2} + \sqrt{3} + \sqrt{4} + \sqrt{5}) = 1.7$ |
| $h = 10$ | : | $1/10\,(1 + \sqrt{2} + \sqrt{3} + \ldots + \sqrt{9} + \sqrt{10}) = 2.25$ |

This adjustment is entered in the VaR calculations, as an end of calculations multiplier such as a safety constant. (Neftci, 2000)

## 3.6. STRESS TESTS

Advances in the Value-at-Risk calculation algorithms, and the estimation of the underlying statistical distribution will lead to more accurate value-at-risk figures. However, no matter how reliable the value-at-risk figure is, one question remains unanswered. In the 5% (or 2.5% or 1%) of cases where the losses are greater than the value-at-risk figure indicates, how much does the project stand to lose? For an answer, one must complete the Value-at-Risk figure with a worst-case analysis.

The underlying principle for stress tests is compelling. It is impossible to create a stochastic model that reflects the future completely. First, history does not repeat itself, and second, there are always some surprises. It is like considering the textbook example of calculating the probability of picking one black ball from a pot containing 20 white balls and 80 black balls, when, in the real world, it is possible to believe that somebody may have replaced the entire pot with only red balls.

"Stress testing" has been adopted as a generic term describing various techniques used in project evaluation to measure their potential vulnerability to exceptional but plausible events. The most common of these techniques involve the determination of the impact on the project's return caused by a move in a particular market risk factor (a simple sensitivity test), or by a simultaneous move in a number of risk factors, reflecting an event (scenario analysis). The scenarios are developed either by drawing on a significant event experienced in the past (historical scenarios) or by thinking through the consequences of a plausible event which has not yet happened (hypothetical scenarios). Other techniques used by some contractors to capture their exposure to extreme events include a maximum loss approach, in which risk managers estimate the combination of market moves that would be most damaging to a project, and extreme value theory, which is the statistical theory concerned with the behaviour of the "left-tails" of a distribution. (Longin, 2000)

In most of practices, stress tests supplement value-at-risk (VaR). VaR is thought to be a critical tool for tracking the riskiness of a project on a day-to-day level, and for assessing the risk-adjusted returns of projects. However, VaR has been found to be of limited use in measuring exposures to extreme events. This is because, by definition, such events occur too rarely to be captured by empirically driven statistical models. Furthermore, observed correlation patterns between various risk factors (and thus the correlations that would be estimated using data from ordinary times) tend to change when the market movements themselves are large. Stress tests offer a way of measuring and monitoring the project consequences of extreme scenarios of this type.

Stress tests enable project managers to track a project's exposure to input price changes during events that are considered plausible, without obliging them to develop a statistical model for such events. This, in turn, allows senior management to determine whether the project's exposures match the risk taking preferences. Because of their insightful approach, stress tests are thought to ease the dialogue between risk managers, senior managers and project managers about the risks taken, and smooth the progress of methods for monitoring and managing those risks.

In developed countries' practice, contractors tend to use both historical and hypothetical scenarios. Historical scenarios are easier to formulate and to understand intuitively. Hypothetical scenarios allow risk managers to challenge the common tendency to pay more attention to past events than future dangers. In both cases, scenarios must be chosen with an eye on markets in which the institution is highly involved. The usefulness of the scenarios is enhanced when they are run at periodic intervals, allowing the project's exposure to be tracked over time. Corporate-level stress tests are facilitated by the presence of firm-wide information-technology systems, which offer risk managers an up-to-date, practical, accurate source of information as a total exposure driven by different projects on the run.

A stress test estimates the exposure to a specified event, but not the probability of such an event occurring. In addition, numerous decisions in the specification of a stress test must be made that rely on the judgement and experience of the risk manager. There is thus no guarantee that the risk manager will choose the "right" scenarios or interpret the results effectively.

Stress tests also impose a high computational cost, particularly from the need to revalue complex projects, and from collecting the data of different position-carried markets ie, foreign exchange markets for foreign exchange exposures or money markets for borrowing exposures. This is especially the case of multinational construction enterprises carrying out many projects worldwide since there will be various foreign currency in and outflows in consideration.

## 4. CONCLUSION

Risk Analysis, in a broad sense, is any method – qualitative and/or quantitative – for assessing the impacts of risk on plans and schedules. There are numerous risk analysis methods that blend both qualitative and quantitative techniques. The goal of any of these methods is to help the decision-maker choose a course of action, given a better understanding of the possible outcomes that could occur. If one uses data to solve problems, make forecasts, develop strategies, or make decisions, then VaR should be considered as an appropriate way of measuring risks in a quantitative fashion.

In Turkey, market risk gained popularity after "Banking Supervisory Board" announced "The Supervisory Treatment of Market Risks". Banks, as it was proposed in the treatment, have to set aside capital to cover the market risks inherent in their business activities. There is little doubt that financial institutions, as the lender bodies of the economy, would require the same risk-averse business practices from their corporate customers (their borrowers) to ensure that their loan payments would be fulfilled, or require higher interest rate charges from those they assess as "riskier than others". This interaction between the lenders and borrowers would eventually change the way business has traditionally been conducted, and help spread around the modern risk-averse business conducts. For sure, construction sector, as the compelling locomotive of the economy, would take its part.

It is apparent that risk understanding, risk taking and hence risk management has always been present when construction enterprises plan to convey new projects. However, too often in practice all this is carried out in a very intuitive manner. The author hopes to contribute to academia in employing an approach to Burkhardt's mark up coefficient that is added up to the final estimated production cost figure by contractors before bidding at the auction.

VaR is an important new concept in risk management. It gives the maximum loss that an institution can expect to lose with a certain frequency over a specific time horizon. To implement VaR calculations, it is important to use the right method, especially under unusual circumstances such as economical crises.

Beside the problem of identifying the right method, VaR measures may mislead unless they properly account for rare or unique events (fat left-tails) and liquidity risk. Therefore, in some situations, it may not be the right risk-management concept, and a construction enterprise may want to investigate alternatives, such as stress tests.

Stress test is very important because it is impossible to create a quantitative model that reflects the future completely. First, history does not repeat itself, and second, there are always some surprises. The task of risk modeling becomes even more challenging in developing countries where the financial markets tend to be more instable. Therefore, with almost no doubt, it may be argued that stress tests would gain a further meaning and value for the risk managers in Turkey.

Despite the contribution that quantitative risk management tools can make to an enterprise's understanding of financial risks, these risks can be misunderstood if they are not communicated effectively to a management that understands the value and limitations of these sophisticated financial tools. Thus, an enterprise should employ VaR analysis and stress tests in the context of a broader risk-management culture, fostered by not only its risk managers but also its senior management.

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## APPENDIX

### APP.A. INTEREST RATE EXPOSURE IN A PROJECT

In the first part of the appendix, the author would give a comprehensive example on the interest rate exposure of a project. Below is a hypothetical cash flow of a project, and thereon, net present value of the project calculated under different discount factors. As discussed in the thesis before, the discount factor for a project's cash flows is represented by the market interest rate that matches with the duration of the cash flow. It is often accepted that the interest rate levels in the economy can be a benchmark for the project investor since they are considered as an exhibit of alternative cost of the investment in consideration.

Table (A.1): Cash flow of a two month hypothetical project and NPV's under different discount factors.

| Month | Cash Flows |
|---|---|
| 1 | -1250 |
| 2 | 1400 |

| Discount Factors | NPV |
|---|---|
| 60% | 79 TL |
| 65% | 74 TL |
| 70% | 69 TL |
| 75% | 64 TL |
| 80% | 59 TL |
| 85% | 54 TL |
| 90% | 49 TL |
| 95% | 44 TL |
| 100% | 39 TL |
| 105% | 34 TL |
| 110% | 30 TL |
| 115% | 25 TL |
| 120% | 21 TL |

The market interest rate for a 2-month period was 76.89% when the example was structured. But there was a high volatility in the interest rate market implying that the real alternative cost of the money invested in the project might be far from initially considered. The situation was increasing the vulnerability of the project's NPV to 1&2-month term interest rate since the project had an outflow with a duration of 1 month and an inflow with a duration of 2 months. The extent of the variation in NPV can be observed in the table above. The hypothetical project's NPV changes from 76 TL if the interest rates were to be realized at a level of 60% during the project, to 21 TL if the interest rates were to be realized at a level of 120% during the project.

Now, the value at risk figure of a construction enterprise will be calculated step by step should the enterprise decide to undertake the project. Since the intend of the author is only to demonstrate the framework of the methodology, the historic data that the calculation of the deviations (volatility) in NPVs would be built on will be limited to past 20 day's data, but it must be noted that in the real life application the historic data where the NPV volatility calculations would be built on should not be less than the duration of the project.

Table (A.2): VaR calculation regarding historical model.

| | 1-Month Int. Rate | 2-Month Int. Rate | NPV of 1-M Outflow | NPV of 2-M Inflow | NPV of the Project | Daily Change in 1-M |
|---|---|---|---|---|---|---|
| 14.May.01 | 80.37% | 85.41% | -693 TL | 755 TL | 62 TL | (t-(t-1))/t |
| 15.May.01 | 78.71% | 83.72% | -699 TL | 762 TL | 63 TL | 0.82% |
| 16.May.01 | 77.54% | 82.51% | -704 TL | 767 TL | 63 TL | 0.71% |
| 17.May.01 | 76.54% | 81.48% | -708 TL | 771 TL | 63 TL | 0.60% |
| 18.May.01 | 76.00% | 80.90% | -710 TL | 774 TL | 64 TL | 0.44% |
| 21.May.01 | 75.80% | 80.67% | -711 TL | 775 TL | 64 TL | 0.29% |
| 22.May.01 | 75.45% | 80.15% | -712 TL | 777 TL | 65 TL | 1.28% |
| 23.May.01 | 75.00% | 79.00% | -714 TL | 782 TL | 68 TL | 4.89% |
| 24.May.01 | 74.54% | 78.74% | -716 TL | 783 TL | 67 TL | -1.10% |
| 25.May.01 | 74.43% | 79.16% | -717 TL | 781 TL | 65 TL | -3.39% |
| 28.May.01 | 74.02% | 78.71% | -718 TL | 783 TL | 65 TL | 0.40% |
| 29.May.01 | 74.45% | 79.45% | -717 TL | 780 TL | 64 TL | -2.23% |
| 30.May.01 | 74.88% | 79.98% | -715 TL | 778 TL | 63 TL | -0.84% |
| 31.May.01 | 75.15% | 80.45% | -714 TL | 776 TL | 62 TL | -1.46% |
| 01.Jun.01 | 75.00% | 80.20% | -714 TL | 777 TL | 63 TL | 0.75% |

| | | | | | | |
|---|---|---|---|---|---|---|
| 04.Jun.01 | 74.30% | 79.40% | -717 TL | 780 TL | 63 TL | 0.95% |
| 05.Jun.01 | 75.88% | 80.88% | -711 TL | 774 TL | 63 TL | 0.09% |
| 06.Jun.01 | 75.60% | 80.50% | -712 TL | 776 TL | 64 TL | 0.78% |
| 07.Jun.01 | 74.39% | 79.19% | -717 TL | 781 TL | 65 TL | 1.15% |
| 08.Jun.01 | 72.19% | 76.89% | -726 TL | 791 TL | 66 TL | 1.55% |

**Volatility (stand. Dev. of daily changes) = 1.70%**

**Expected NPV as of 08.Jun.01 = 66 TL**

**99% VaR of NPV = 2.60 TL**

Without a proper analysis of market risk sourcing from interest rate volatility, a construction enterprise could bid at 66 TL for the project, which was reflecting the worth of the project in June 8th, let's say, at the auction date. But the construction enterprise would be ignoring the volatility in the interest rates by bidding at a single day's worth that could vitally undermine its profit expectations from the project.

The daily standard deviation in the NPV for the past 20 days was 1.70%. The expected NPV in Jun 8th of 2001 is 66 TL. Given standard deviation and expected NPV figures, the VaR with a 99% confidence level can be calculated by the formula (3.1):

VaR = NPV x $\sigma$ x Confidence Coefficient

99% confidence level implies for a confidence coefficient of 2.33, and the formula (3.1) yields a result of 2.60 TL at a 99% confidence level. This means that given the May-June 2001's volatility in the interest rates, the 1-day VaR figure for the project is 2.60 TL, or put it another way; the maximum 1-day loss that could be expected from the project with a 1% (100% - 99%) probability is 2.60 TL.

As discussed before, economical capital figure is derived from VaR figure. In the thesis, economical capital is defined as the capital that should be set aside in order to survive an extraordinary condition in the economy that is assumed to be prevailing during the project duration. In the example the duration of the project is 2 months, and this implies for approximately 40 business days. Then, the economical capital can be calculated with the following formula:

Econ. Cap. = VaR x Square root of the duration x safety coefficient

$= 2.60 \times \sqrt{40} \times 3$

If the safety coefficient is to be assumed as 3, then the formula yields an economical capital figure of 49.29 TL.

The question at that point is what the construction enterprise should do to cope with this uncertainty. Indeed the enterprise should reflect all of the above measured uncertainty of 49.29 TL, which is associated with undertaking the project, to its bidding price at the auction, and must bid at 66 + 49.29 = 115.29 TL. Although 115.29 TL is the fair value of the project, it may be considered as an uncompetitive bidding price since many of other bidders would neglect the risk adjusted pricing our risk-aware enterprise conveyed. In reality this is what makes doing business in many developing countries. Doing feasibility analysis in a proper, risk-adjusted fashion may reduce the competitiveness in a world where many of the competitors are unaware of the risks they are taking, and hence mispricing the projects. Here, in order to reach a relatively competitive bidding price where the enterprise does not reflect all but a proportion of the risk premium to its bidding price, the author suggest that the construction enterprise must set aside the part of the risk premium that is not reflected to the bidding price as capital, and make sure that should the risks realize, the capital is there to form a cushion for losses.

## APP.B. A CASE STUDY ON FX EXPOSURE

Erdemir stands for Eregli Demir Celik Fabrikalari. It is one of the three integrated heavy industrial iron and steel factories of Turkey serving to many other industries along with the construction industry. ERDEMIR has a semi-autonomous ownership in which Turkish public owns the 51 % of the company. It employed 6,588 people as of December 31st, 2000. Since Erdemir is an integrated plant, it has many separate facilities. The main production units are Coke Factory, High Furnaces, Sinter Factory, Steel Foundry, and the Rolling Mills.

As a leading company in the Turkish economy, Erdemir has access to international borrowing markets. During the period between January 2000 and February 2001 when a crawling peg foreign exchange regime was implemented, Erdemir borrowed from the international markets, sold these borrowed foreign currencies against Turkish Lira, and created cheap Turkish Lira funding. This is what it is called taking a short position against foreign currency. The financial risk, here, is called FX Exposure risk.

In this financial operation, the cost to Erdemir is the borrowing rate of the foreign currencies compounded with (for simplicity, we can say "plus") the devaluation of Turkish Lira. If the devaluation of Turkish Lira exceeded the returns obtained from the investments conveyed by the Turkish Lira created via this operation minus foreign currency borrowing rate, then the company would suffer losses.

Things would have been fine though, should the economical stability program implemented along with IMF's stand-by agreement had been on track. But unfortunately, Turkey abandoned the crawling peg regime on February 22$^{nd}$, 2001. The risk was realised, and Turkish Lira devalued almost 100% between February 22$^{nd}$ and July 18$^{th}$, 2001, which was far beyond than the minor devaluation anticipated by the crawling peg regime.

Value at Risk (VaR) methodology, as discussed throughout the thesis, calculates the amount of capital that must be set aside to survive a loss caused by a specific financial position. As an example to the real-life application of VaR methodology, FX Exposure of Erdemir will be calculated.

Erdemir's foreign assets, liabilities and short position calculated by subtracting foreign assets from foreign liabilities can be seen from the table (B.1) below:

Table (B.1): Foreign currency denominated assets and liabilities of Erdemir.

| ASSETS | | LIABILITIES | | SHORT POSITION |
|---|---|---|---|---|
| USD | 36,086,577 | USD | 191,683,901 | 155,597,324 |
| EURO | 846,900 | EURO | 30,052,716 | 29,205,816 |
| JPY | 968,173 | JPY | 21,711,514,289 | 21,710,546,116 |

The results of the VaR calculation performed by three of the VaR calculation methodologies; Parametric, Monte Carlo and Historic Models can be seen from the tables below. The calculation was done as of July 18$^{th}$, 2001 ie, the VaR numbers obtained reflects the market risk of Erdemir as of July 2001. The first table is composed of unadjusted VaR figures, and the second one is composed of kurtosis adjusted VaR figures.

Table (B.2): VaR calculation regarding parametric model.

99% VALUE-AT-RISK : ERDEMIR As of July 18th 2001

| | Present Value | Param. VaR | Hist. VaR | Monte C. VaR |
|---|---|---|---|---|
| FX Exposure (TRL) | -525.74 | 34.23 | 34.44 | 34.35 |
| FX Exposure with Kurtosis Adjustment (TRL) | -525.74 | 37.86 | 38.09 | 37.99 |

The calculations show that the VaR of 525.74 trillion worth of short position is 37.86 trio, 38.09 trio, and 37.99 trio Turkish Lira, regarding respectively Parametric, Historic, and Monte Carlo Models. This result also implies that in order to carry a short position of 525.74 trillion worth of Turkish Lira safely, Erdemir should set aside a capital of 478.87 trio, 481.84 trio, and 480.55 trio Turkish Lira, regarding respectively Parametric, Historic, and Monte Carlo Models.

Although the FX exposure of Erdemir implies that nearly 480 trio of equity (paid capital) is needed in the current market circumstances in order to guarantee safe business conduct; the firm had only 44,35 trio of paid capital. In this case, there might be two solutions for the firm:

- The firm might either decrease its short positions (borrowing) in US dollar, Euro, and Japanese Yen in a range that could be sustained by its current paid capital of 44,35 trio. In order to do that the firm would need to buy back the short sold foreign currencies, and pay back the borrowing.
- The firm might increase its paid capital to 480 trio by fresh capital infection. It could be accomplished by a new public offering.

## APP.C. SORGUÇ'S CLASSIFICATION OF PROJECT RISKS
### (A useful hand guide on risks that affect the cost and quality in the projects)

Sorguç, in his textbook "Construction Management-I", classified the construction projects' risk factors that jeopardize the quality and expected cost. His classification was by the origination of these risk factors. He primarily separated the risk factors into two main categories: External factors and internal factors, and then formed the sub-categories underneath.

**1. External Risk Factors**

1.1. Risks sourcing from the construction itself

1.1.1. Variety in the available design alternatives

1.1.2. Lack of flexibility in structuring the construction organization

1.1.3. Lack of expertise against any possible changes in construction methodology

1.1.4. Inability of mass production

1.1.5. Structural risks like foundation, seismic factors, and etc.

1.2. Risks sourcing from the production

1.2.1. Size of the construction site

1.2.2. Pre-changes in the activity orders

1.2.3. Scale of the construction

1.2.4. Inability of production automation

1.2.5. The level of expertise in production

1.2.6. Alterations in the duration of activities

1.2.7. Properties of the construction site

1.2.8. Risks in calculations

1.3. Risks sourcing from the owner

1.3.1. Needs and requests about the construction

1.3.2. Capability to afford the construction costs

1.3.3. Scale and duration of the construction

1.3.4. Weather and seasonal effects

1.3.5. Interferences by the owner

1.3.6. Preparation period

1.3.7. Owner's contribution in risk sharing

1.4. Risks sourcing from the construction site

1.4.1. Topographical condition

1.4.2. Transportation to construction site

1.4.3. Distance

1.4.4. Price region and labor market

1.4.5. Altitude

1.4.6. Climate

1.4.7. Availability of local procurement

1.4.8. Risks associated with job site

1.5. Risk sourcing from business environment

1.5.1. Business environment (like the quality of public management)

1.5.2. Difficulties in procurement

1.5.3. Market condition

1.5.4. Environmental risks

**2. Internal Risk Factors**

2.1. Scale of the construction enterprise

2.2. Expertise of the construction enterprise

2.3. Quality of construction staff

2.4. Patents and construction systems of the construction enterprise

2.5. Quality of administration (control mechanisms and their quality)

2.6. Capability of project development

2.7. Construction enterprise's flexibility in decision making

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**Treasury Dealer, Ottoman Bank, Istanbul** — *4/00 –*
- Lead financial engineering and market risk management in Treasury Department.
- Developing the valuation and hedging schemes of currency and interest rate options.
- Designing structured products for high yield corporate and Private Banking clients.
- Monitoring greek hedges, and through "Value-at-Risk Analysis" and "RAROC", providing critical guidance on the optimization of the risk & return profiles of the bank's portfolios.
- Had hands-on experience on a wide range of financial engineering methodologies and their real life applications. Built own Excel™ models on continuous time finance & asset pricing, asset & liability management, risk & return optimization, VaR & market risk management.[2]

**Senior Research Analyst, Alpha International, Inc., Washington, DC** — *1/99 - 1/00*
- Structured the asset (interest rate and FX) swap, fixed income and equity portfolios.
- Supervised to all phases of equity / fixed income research analysis including sales, EPS, P/E, interest rate, inflation forecasting and modelling; stock and exotic bond valuation.
- Was a member of project evaluation committee in charge of FDI's market risk exposures.

**Financial Analyst, Merrill Lynch, Arlington, VA (Co-Op)** — *8/98 - 12/98*
- Exposed to the management of risk and return structure of the private client portfolios regarding modern portfolio theory.
- Acquired experience in the management of institutional relationship policies.

**Treasury Analyst, Demir Investment Bank, Istanbul** — *9/95 - 7/97*
- Managed the cash flow of the institution.
- Conducted the daily settlements of mutual funds.
- Gained experience in the allocation of funds between money and capital market instruments.

**Financial Analyst, Mirtur Construction Co., Ankara** — *6/93 - 7/94*
- Conducted feasibility analysis (NPV, IRR, EVA, MVA, and Cost/Benefit) of international projects by taking into consideration embedded options.
- Developed a new project cash flow management system for the company.

## COMPUTER SKILLS

- OmniBank, ValueCalc, MetaStock, SuperCharts, Math Lab, Jump-In, SAS, Primavera
- Excel (Including Macro Modelling via VBA), Word, PowerPoint, Publisher, Web Design

[1] G.W.U. was ranked 20th in International Finance & Banking. (US News Graduate School Reports, 1999)
[2] My Excel™ built-in models on financial management can be downloaded at www.metinkilic.com