A COMPUTER SIMULATION MODEL REGARDING THE COMPARISON OF THE EFFECTIVENESS OF CAPITAL INVESTMENT RANKING CRITERIA

by

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B.S. in Boğazici University, 1986.

Submitted to the Institute for Graduate Studies in Social Sciences in partial fulfillment of the requirements for the degree of Master Of Arts

in

Business Administration

Boğaziçi University

1989

A C K N O W L E D G E M E N T S

This study was conducted under the supervision of Prof. Dr.İ.Özer Ertuna to whom to I wish to express my deep gratitude for his invaluable guidance, support and patience.

I would also like to express my deep gratitude to Prof.Dr.Muzaffer Bodur and Dr.Mine Uğurlu for their invaluable contributions to my thesis. I wish also extend my acknowledgements to Mrs. Sehavet Armağan for her continuous support during the study.

In particular, I would like to thank to my mother, my father and brother for their continuous encouragement and help at all phases of this study and also I wish to thank to Miss Zeynep Gücelioğlu for her invaluable help.

ABSTRACT

In the research reported here, the effectiveness of five capital investment ranking criteria are investigated by a simulation model under uncertain inflationary environment where the end results are evaluated in a comparative way.

The investment alternatives studied by the simulation model based on realistic data obtained from Türkiye Sınai Kalkınma Bankası A.Ş. were evaluated according to five capital investment ranking criteria. The results of the net present worth of the firm and the profitability per year were compared for each ranking criteria.

Findings of the research show that the investment ranking criteria which takes into consideration the time value of money are significantly better than the criteria which does not take into consideration the time value of money. It is also observed that as the initial investment level increases the decrease of capital rationing causes an increase in net present worth and the number of investments but a decrease in the profitability per year. Another important implication of the study is that the ranking criteria performs better under lower uncertainty than the higher uncertainty.

Ö Z E T

Bu tez çerçevesinde, yatırımların değerlendirilmesinde kullanılan yöntemler belirsiz enflasyon ortamında incelenmiş sonuçlar bu amaçla hazırlanan benzetim modelinde değerlendirilmiştir.

Çalışmada kullanılan yatırım alternatifleri Türkiye Sınai Kalkınma Bankası'ndan temin edilen örnek alternatifleri temel alan benzetim programı tarafından üretilmiş ve bu alternatifler üzerinden 5 yatırım değerlendirme yöntemi değerlendirilmiştir. Firmanın net bugünkü değeri ve senelik karlılığı tüm yatırım değerlendirme yöntemleri için karşılaştırılarak belirsiz enflasyon ortamında daha iyi sonuç verecek yöntemlere ulaşılmaya çalışılmıştır.

Çalışma bulguları, paranın zaman değerini göz önüne alan yöntemlerin diğer yöntemlerden üstün olduğunu göstermiştir. Çalışmanın diğer önemli bir sonucu da ön yatırım miktarındaki artışın, net bugünkü değerde ve yatırım yapılan proje sayısında artış, senelik karlılıkta düşüş yarattığı yönündedir. En son olarak belirsizlikteki artışın yatırım değerlendirme yöntemlerinin etkinliğini azalttığı yolunda eğilim gözlenmiştir.

TABLE OF CONTENTS

PAGE

PAGE

PAGE

LIST OF TABLES

PAGE

PAGE

LIST OF FIGURES

I. INTRODUCTION

Capital investments and the decision of choosing the right alternative to invest is a very crucial problem of the managers, owners and workers of the firm. Investments define the future existence and profitability of the firms.

In literature there are many methods developed to evaluate different investment proposals which operate with a certainty or an uncertainty assumption. Later, the researchers like Van Horn [1971] and Kim [1979] demonstrated that the expected future cash flows and discount rates must be modified according to inflation. Son Nan-Chen [1984], examined the impact of uncertain inflation on capital budgeting in a multi-period context.

Although, the mathematical modeling of capital budgeting under uncertain inflation is not rare and many researches brought new ideas, the modeling of capital budgeting under uncertain inflation by computer simulation is rare.

This study was designed and based on a computer simulation model which was used to determine the impact of uncertain inflation on capital budgeting in a multi-period context and to test the effectiveness of capital investment ranking criteria under uncertain inflation. The simulation model designed and used in this study based on the the simulation model developed by White and Smith [1986] for their study in comparing the effectiveness of then investment ranking criteria.

Instead of isolating capital budgeting problem from its weakness, capital rationing was taken into the context of this study.

In order to realize the aim of this study 5 different investment ranking criteria were compared by the results obtained for the firm at the end of the simulation runs. The ranking criteria which were compared are namely, random selection, payback period, profitability index, future worth and present worth.

Following this brief introduction, the literature survey of the study is presented under six headings. After discussing methodology and the simulation data, the findings of the study are given in detail in four sections. Conclusions derived from the findings and their implications for further research and managers make up the final sections of this thesis.

II. LITERATURE SURVEY

In this study regarding the comparison of the effectiveness of investment ranking criteria under uncertain inflation, in order to have a better understanding of the subject, a thorough review covering capital budgeting in general, ranking criteria, problems of capital budgeting and capital budgeting under uncertainty was carried out. The review given hereafter in this section consists of four parts where the first part summarizes "capital budgeting in general". The second and third parts are related to "evaluation of investments" and "problems of capital budgeting" whose efficiencies were measured and tested. The following part, namely part four, emphasizes the importance of "capital budgeting under uncertainty". The last two parts form the base of the study which is carried after.

2.1. Capital Budgeting In General

The analysis of finance literature reveals that capital budgeting is strictly tied to the term investment or capital investment. When the term "investment" is focused on there is the report of the Engineering Economy Subcommittee (Z94.5) of the ANSI Z94 Standards Committee on Industrial Engineering terminology [1986] which defines the investment as any expenditure which has substantial and enduring value, generally more than one year and which is therefore capitalized.

According to Harold Biermann, Jr., and Seymour Smidt [1988] the term investment refers to the commitments of resources made in the hope of realizing benefits that are expected to occur over a reasonably long period of time in the future. They define capital budgeting as many sided activity that includes searching for new and more profitable investment proposals, investigating, engineering and marketing conditions to predict the consequences of accepting the investment and making economic analysis to determine the profit potential of each investment proposal.

Another definition of investment was given by J.Fred Weston and Allan Meltzer [1970] in their book. They called capital investment as a sacrification of immediate satisfaction for some future expected satisfaction. The objective of capital investment in a firm was predicted as the maximization of the utility or satisfaction of its owners which is directly related to the market price of the owner's equity. Owner's utility and the market price of the owner's equity are directly related with the amount of cash benefits and the timing of these benefits and the risk involved in the attainment. The first determinants can be measured in monetary terms but assessing the degree of risk and measuring its effect is harder that the other two.

The overall review of the literature reveals that, during the capital budgeting process first the assumption of certain and known future benefits namely, cash flows can be used for simplicity and the basic concept of the time value of money can be introduced. According to Biermann and Smidt [1988], when uncertainty is introduced, the procedures for capital budgeting with uncertainty are closely related with the procedures of capital budgeting under certainty and their initial assumptions.

2.2. Evaluation Of Investments

In many business situations there are several investments that can perform the same function for the firm. There may be mutually exclusive or conflicting proposals where the acceptance of one proposal results in the rejection of others in the set or the firm may not have enough funds to acquire all of the proposed investments. To solve the problem of investment, different systems for the evaluation of investment proposals were created. Here it is useful to examine both the merits and deficiencies of some of the systems still used by many business concerns although the investment decisions of top management are influenced by many different factors.

2.2.1. Approaches That Ignore The Time Value Of Money

2.2.1.1. Payback Period

Payback period is defined as the number of years or months required for the related profit or savings in operating cost to equal amount of investment in the report of Engineering Economy Subcommitee (Z94.5) of the ANSI Z94 Standards Committee on Industrial Engineering [1986].

Ordinarily the investments with greater payback period than the pre-set payback period will be rejected.

This method has two weaknesses.

- It fails to give any consideration to cash proceeds earned after the payback date

- It fails to take into account the differences in the timing of proceeds earned prior to the payback date.

2.2.1.2. Accounting Rate Of Return

Rate of return used in accounting is defined as the ratio of annual profit or average annual profit to the initial investment or average book value by the report of Z94.5 5 [1986].

The method has two shortcomings

- It is based on expected accounting profits.

- It fails to take into account the differences in the proceeds which are earned sooner or earned later.

2.2.2. Approaches That Employ Time Value Of Money

The time value of money is an important concept in managerial decision making. Money received today is much more valuable than money received in some future time period provided that there is a positive rate of interest at which funds can be invested.

The time value of money is defined as the expected compound interest rate that capital should of will earn in the report of Z94.5 [1986]. So it is important to understand the investment ranking methods which incorporate the time value of money.

2.2.2.1. Net Present Worth

The net present worth of an investment is simply the excess (or deficiency) of the expected present worth of the stream of net cash benefits promised by the investment over the present value of cash outlays required by its undertaking. This method is based on the assumption that the appropriate discount rate can be defined

$$NPW = \sum_{j=1}^{n} A_j (1 + i)^{-j} - C \qquad (2.2.1)$$

The investment project should be accepted if it has a positive net present value when its anticipated cash flows are discounted at the opportunity cost i.

The basic strength of net present worth method is derived from the fact that it takes into account the timing of certain cash proceeds that can be withdrawn from the business operations.

The main weakness of the model is coming from the fact that knowledge of certain cash flows are restricted and there way be many possible outcomes. Although the method has the above mentioned weakness, it is still the most reliable and flexible method to compute an overall measure of the investment worth.

Ranking mutually exclusive alternatives by the use of net present worth can be done by calculating and comparing the net present worth of each alternative.

2.2.2.2. Internal Rate Of Return

The internal rate of return method utilizes present value concepts. The procedure is to find a rate of discount that will make the present value of the cash proceeds expected from an investment equal to the present value of cash outlays required by the investment. It represents the highest rate of interest, an investment could afford to pay without losing money if all funds to finance to investment were borrowed and the loan was repaid by the application of the cash proceeds from the investment. This method is based on the assumption that the cost of money is same in all future time period.

$$C = \sum_{j=1}^{n} A_j \, (1 + i)^{-j} \qquad (2.2.2.)$$

should be solved for i.

If the calculated value for i is greater than the hurdle rate or the cost of capital the investment will decrease the market value of owner's equity.

The main strength of the method is that it allows the use of time value of money.

One of the important weaknesses of the method rises when the scale or the size of the investment is considered. The method does not consider the scale of the investment.

The direct ranking and comparison of mutually exclusive alternatives with internal rate of return method may not necessarily lead to the correct choice of investment alternative.

2.2.2.3. Internal Rate Of Return On Incremental Investment

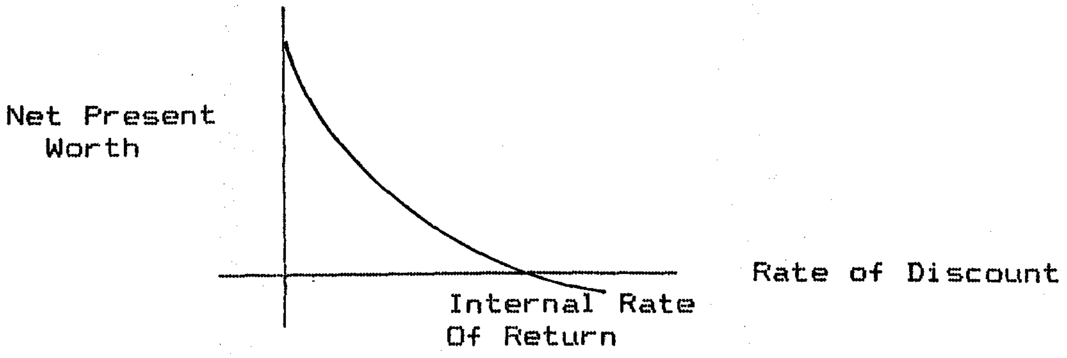
Internal rate of return on incremental investment utilizes the internal rate of return concepts. The computation of internal rate of return on the incremental cash proceeds of a pair of mutually exclusive alternatives is the same with the internal rate of return computations.

The weakness or the difficulty of the method comes into scene when there are more than a pair of mutually exclusive alternatives. Internal rate of return on incremental investment for each pair is computed. This computation is done until only one alternative remains.

In Figure 2.2.2.3. the relation of net present worth and internal rate of return is presented.

FIGURE 2.2.2.3

NPW VERSUS IRR.



2.2.2.4. Profitability Index

The profitability index of an investment is simply the value obtained by dividing the present worth of cash proceeds of an investment by the present worth of the investment type of outlays. This method is based on present worth method and can be used to rank and compare investment proposals.

The weakness of this method is that it does not consider the scale of the investment.

2.2.3. Comparison Of Ranking Criteria

The ranking criteria are discussed and the weaknesses and the strength are given in sections 2.2.1. and 2.2.2.

In this section the study by Bob E. White and Gerald W.Smith in which the effectiveness of ranking criteria was compared will be mentioned.

White and Smith [1986] prepared a computer simulation model to test the effectiveness of ten capital investment ranking criteria. The computer simulation model generated the mutually exclusive investment alternatives according to the random setting of internal rate of return and ranked the alternatives by using the technique that was being tested. The simulation run ends when the horizon time was reached.

At the end of the of the simulation the value obtained by the firm was measured according to net present worth of the firm and the rate of return on initial investment supplied by the firm.

The ranking of capital investment evaluation criteria that was suggested by White and Smith [1986] was as follows.

- Incremental Internal Rate Of Return.
- Incremental Annual Profitability Index.
- Incremental Present Worth.
- Annual Worth.
- Annual Profitability Index.
- Profitability Index.
- Present Worth.
- Payback Period.
- Incremental Payback Period.
- Random Selection.

The conclusions reached were as follows.

- When there is capital rationing the method employed to rank capital investment does have an impact on the future net value of the firm.

- The incremental criteria perform better than their non incremental counterparts, and the payback period criteria is inferior.

No other conclusions were reached about the effectiveness of ranking criteria.

2.3. Problems in Capital Budgeting

2.3.1. Capital Rationing

In the above mentioned methods of evaluation of investments, firms are assumed to lend and borrow funds at a given market rate of interest, thus accept independent investments when the investments have positive net present worth at this market rate of interest. There are two distinctly different situations in which the assumption may not hold.

1- External Capital Rationing

2- Internal Capital Rationing

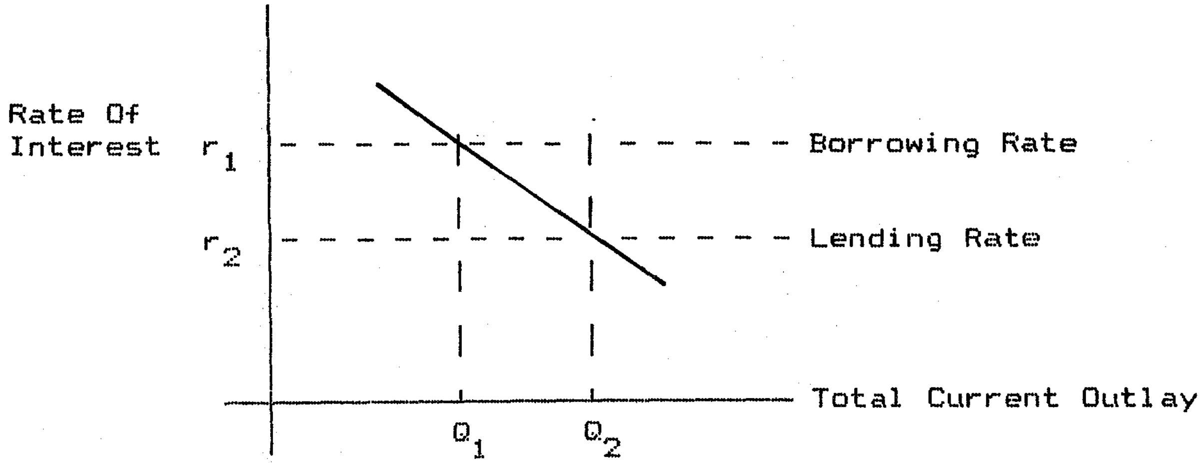
There are approximate solutions to the problem and analytical situations that require detailed knowledge of future investments which are usually not available.

2.3.1.1. External Capital Rationing

This situation occurs when there is a difference between the market rate of interest at which firm can borrow money and rate at which it can lend. It is referred as external capital rationing by Bierman and Smidt. [1988]

There is an approximate solution for the problem with external capital rationing.

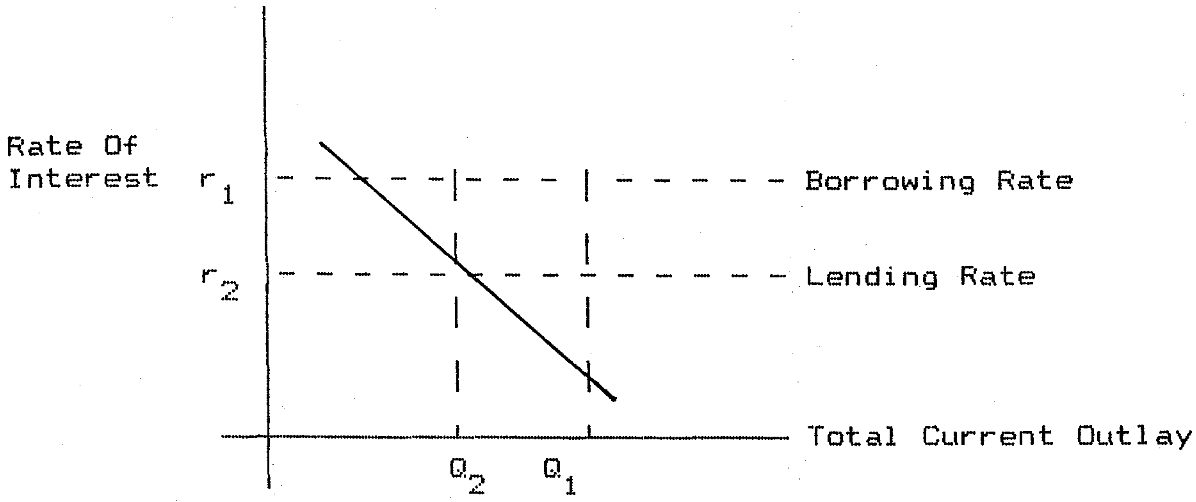
FIGURE 2.3.1.1.



If the firm has Q_1 amount of money available, it can borrow a maximum amount of $Q_2 - Q_1$ amount of money and still have an investment with positive net present worth which is computed at market's borrowing rate.

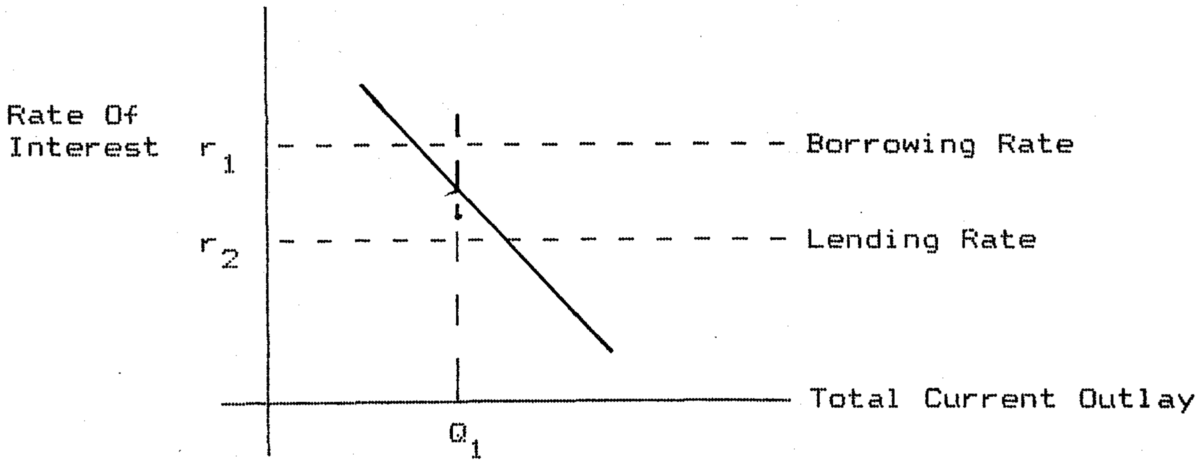
This situation can be seen in figure 2.3.1.1

FIGURE 2.3.1.2.



The situation of the firm being able to lend a maximum of $Q_1 - Q_2$ amount of money or invest in externally is presented in figure 2.3.1.2. In this situation the investment has a positive net present worth which is computed with the market's lending rate.

FIGURE 2.3.1.3.



The situation of firm having investment alternatives which have positive net value when computed with market's lending rate is presented in Figure 2.3.1.3.

The main weakness of the solution is that, there is no indication of future borrowing, lending rates and firm's relative position to the future borrowing, lending rates.

2.3.1.2. Internal Capital Rationing.

This situation arises because of a decision to limit the total amount of investment or a decision to set a higher criteria for acceptance where some of the rejected alternatives are still advantageous by using the market interest rate and referred as internal capital rationing by Biermann and Smidt. [1988]

Under capital rationing, ranking the investments by net present worth may lead to mistakes because net present worth method does not consider the size of the initial investment. Another mistake can be caused by the use of wrong time value of money.

Internal rate of return method is also not applicable because of the scale problem.

Profitability index has also severe weaknesses for ranking under capital rationing the method ignores the size of the investment although it uses the time value of money concept.

The best of the ranking criteria under capital rationing is net present worth technique if the rate of discount used is an appropriate opportunity cost for the future time periods.

2.3.2. Indivisibility

For some technological reasons some investments must be undertaken on at least at a certain minimum scale, large enough so that the operation of the project would change the market prices of one or more of the inputs purchased or of the products being produced.

There may be situations where a series of small incremental investments are not feasible technologically. These constraints are referred an indivisibility.

2.3.3. Capital Budgeting and Certain Inflation

In literature a consensus had been reached about the effects of certain inflation on capital budgeting. According to Fisher who first studied the relationship, in the presence of a positive inflation, the nominal rate of interest can be thought to have two components, a real return and an adjustment for inflation. This relation ship is called the "Fisher Effect" and given as.

$$r = (1 + j)\ (1 + j) - 1 \qquad (2.3.1.)$$

$$r = j + i + ij \qquad (2.3.2.)$$

where r is the nominal rate, j is the rate of inflation and i is the real rate of interest in taxless environment.

A modification to Fisher effect is called the "Darby Effect" which predicts that in the presence of expected inflation nominal interest rates will rise enough so that the expected after tax return of tax paying investors will remain constant. The effect was first described by Darby [1975] and formed the base of below equation.

$$i(t) = \frac{r(1 - t) - j}{(1 + j)} \qquad (2.3.3.)$$

where i(t) denotes the after tax real rate of interest, j denotes the rate of inflation, r denotes the nominal interest rate and t denotes the tax rate.

The Fisher and Darby relations do not provide a simple answer to the questions how after-tax real discount rate will be affected by the changes in the expected rate of inflation, but they provide, upper and lower limits for the possible values. The predicted nominal rate from Darby effect equation will be equal or greater than the predicted nominal rate from Fisher effect and take a value between $[j + i + ij]$ and $[j/(1 - t) + i + ij]$ under an assumed tax rate t.

Nelson [1976] brought new ideas to the impact of inflation on aspects of the capital budgeting decision relating to the optimal level of investment, the choice of technology, the ranking of competing projects, optional durability and replacement policy, using an environment with tax. The five propositions given on the impact of inflation on capital budgeting are summarized as follows.

<u>Proposition A:</u> The optimal level of capital investment will depend in general on the rate of inflation. The amount invested will typically be smaller the higher the rate of inflation is.

<u>Proposition B:</u> The rate of inflation will influence the firm's choice of technologies of production through its choice of capital/labour ratio. Higher rates of inflation will be typically associated with lower capital/labor ratios.

Proposition C: The net present value rankings of mutually exclusive projects will depend in general on the rate of inflation.

Proposition D: Net present value rankings of mutually exclusive projects which differ with respect to durability will depend on the rate of inflation. Typically rankings will change in favor of projects with lower durability at higher rates of inflation.

Proposition E: Replacement policy will depend in general on the rate of inflation. The higher the rate of inflation the more likely replacement will be deferred to a future period.

Moon K.Kim [1979] tried to test Nelson's first proposition [1976] where the principal reason behind the decrease in investment while the inflation rate rises is the overstatement of net income before tax due to historical depreciation charges. The real net present value becomes smaller because of the inflation tax paid over the inflated income. He agreed that Nelson's propositions under the perfect NOI (Net operating income) sensitivity to inflation. Then he relaxed the perfect NOI (Net operating income) sensitivity to inflation. He developed a model regarding the inter-firm differences in investment activities under inflation and tested it empirically. His results showed that the NOI (Net operating income) sensitivity and the size of depreciation are two major determinants of inter-firm differences in investments under inflation.

John R.Ezzell and William A.Kelly Jr, [1984] stated that when the effects of inflation are uniform on cash flows then

i) Inflation will raise net present values.

ii) The appropriate discount rates for nominal cash flows will be less than (1 + j) (1 + i)

iii) Discount rate appropriate for valuing real cash flows will fall as the inflation rate rises. The results imply that if the cost of capital that was appropriate with zero inflation is grossed up by the inflation rate and used to discount nominal cash flows. This procedure would lead to rejection of some projects which would raise the firm's levered value.

2.4. Capital Budgeting and Uncertainty

Until here the main assumption behind the analysis was the certainty. With the introduction of uncertainty decision maker becomes unaware about what will happen in the future.

Bierman and Smidt [1988] classified the techniques to deal with uncertainty into several groups.

One of those attempts to consider the alternative sequences of cash flows. State preference approach fits into this group. It is parallel to net present worth analysis only distinguishes the timing of the cash flows but state preference technique distinguishes the state combinations at which the cash flows occur as well as the timing of cash flows. This technique allows to calculate the RAPV (Risk adjusted present worth) of any investment which brings into scene the RAPVF (Risk adjusted present worth factor). Once RAPVF (Risk adjusted present worth factor) is calculated, the net present worth calculations are analogous to the calculations made under the assumption of certainty.

Second group attempts to provide a concise summary description of the asset that can be summarized as:

- Risk adjusted discount rate
- Capital asset pricing model
- Option pricing model
- Certainty equivalent approach

All of the techniques under this group aim to produce an estimated market valuation for the investment proposal.

Robinchek and Myers [1966] pointed out the conceptual problems in the present worth calculation with risk adjusted discounted factors. They showed that the attempts to solve for the risk adjusted discount factor assumes a known present value and then the calculation of the present worth is done using the discount factor which was calculated by using the above method.

Later Myers, Stuart and Turnbull [1977] showed that CAPM (Capital asset pricing model) can be applied easily with simple formulas. They also showed that discounted cash flow and risk adjusted discount rates are not exact but provides close results if expected market return and systematic risk (β) are known.

Another approach to the valuation of uncertain future cash flow, hence the valuation of the asset which provide the cash flow came from Brennan [1973]. His model is a multi-period capital market equilibrium developed from an optimizing model of the individual's life time portfolio selection problem due to Merton [1969]. His computation of the net present worth came from the solution of a different equation.

Gary Smith [1988] showed real cash flows are typically sensitive to inflation and that outside of the 1950's and 1960's in US, real interest rates have not been very stable or close to zero in his empirical research. He proposed that a neglect of inflation and interest rates would have caused substantial present worth errors in the firm's investment decisions.

Kevin Chen and Rene Manes [1986] brought another aspect in uncertainty. Their hypothesis was about the impacts of uncertain lifetime of the project. As they propose, the use of the life distribution, instead of the expected life of the project will decrease the level of bias on net present worth introduced by the overestimation of the project life. They also investigated the sensitivity of bias to the discount rate, cash flow patterns and income taxes. The magnitude of bias was found relatively small for cash flow patterns but the bias was too large to be ignored in certain combinations of high rates, large variance in life distribution and a decreasing trend of cash flows.

Other than the above aspects of uncertainty in capital budgeting, the effect of uncertain inflation was also analyzed by different researchers.

A.H. Chen and A.J. Boness [1975] tried to incorporate the consideration of uncertain inflation in the traditional capital asset pricing models. Their purpose was to analyze the firm's investment and financing decision in the presence of uncertain inflation within the context of equilibrium market valuation models. The basic assumptions behind their model were:

- A competitive market where the investors are price takers should exist.

- Investors have homogeneous expectations about the distributions of future rates of return or risky assets and the rate of inflation.

- Investors are risk averse and single period expected utility of wealth maximizers.

The results of the research showed that the investment by the firm tends to be lower if uncertain inflation is expected and it tends to be higher if uncertain deflation is expected.

Menta, Curley and Fung [1984] stated that the discount rate estimate whether in nominal or real terms is not a simple task when the inflation is expected to under go changes. They also pointed out that the uneven impact of inflation on the financial market benchmarks namely the real rate and market rate of return leads to a change in the required rate of real return or disproportionate change in the nominal rate of return for the project in question. They suggested a logically appropriate method for incorporating the inflation.

They formulated that

$$V = \sum_{t=1}^{n} \frac{(R_t - C_t)(1 - T) + T\,Dep_t}{(1 + K_n)^t} \qquad (2.4.1.)$$

where

V = Present Value.
R_t = Revenue at time t.
C_t = Cost at time t.
T = Tax rate.
K_n = Nominal risk adjusted discount rate.
Dep_t = Depreciation at time t.

and K_n is incorporated with inflation.

Son Nan Chen [1984] investigated the inflationary impact on single cash flow and he developed the valuation of multi-period cash flow under inflationary uncertainty. In his research, he stated that the failure to account explicitly for the impact of uncertain inflation may lead to a serious error in capital budgeting. Without admitting uncertain inflation, traditional models may not provide a close approximation to the exact value provided by the true model derived under uncertain inflation. He assumed that one period asset pricing model under inflationary uncertainty developed by Chen and Boness [1975] holds true in every period and accepted the formula derived by them [1975]

$$E(\tilde{R}_{jt}) = R_{ft} + \lambda_t \, [\mathrm{Cov}(\tilde{R}_{jt}, \tilde{R}_{mt}) - \mathrm{Cov}\,(\tilde{R}_{jt}, \tilde{I}_t)] \qquad (2.4.2)$$

where R_{ft} is the risk free rate of interest in the period t, $\tilde{R}_{jt}$ is the random nominal rate of return in period t, $\tilde{R}_{mt}$ is the random nominal market rate of return in period t, λ_t is the market price risk and $\tilde{I}_t$ is the random rate of inflation in period t.

His analysis explained that uncertain inflation influences risk adjusted discount rates, CE (Certainty equivalent) factors and the market value of multi-period cash flows. Risk adjusted discount rates and certainty equivalent factors reflect risks due to possible revisions of investors' expectations regarding the expected values of future cash flows. The revised expectations regarding the expected future cash flows are greatly influenced by the changes in the inflation rate and market conditions over time.

He also stated that the magnitude of risk adjusted discount rates and CE (Certainty equivalent) factors depend on the characteristics of multi-period cash flows. The risk adjusted discount rates for inflation preferred cash flows tend to be smaller than those of inflation averse cash flows. An opposite conclusion applies to certainty equivalent factors.

III. METHODOLOGY

3.1. The System

In order to analyze the effectiveness of the capital investment ranking criteria, a research connected to a discrete simulation model for an IBM compatible personal computer was prepared.

The reasoning behind the preparation of a simulation model for a multi-period capital investment decision was to observe and analyze the differences caused by using different capital investment ranking criteria consistently for a given period of time.

The simulation model was chosen to be discrete because of the discontinuity of investment data which was provided.

The whole capital investment process was conceived as a system and the simulation model was prepared taking care of the items in the system.

The capital investment system can be summarized as follows:

3.1.1. Entities Of The System

- Mutually Exclusive Investment Alternatives.
- Funds For Investment.
- Consumer Price Index.
- Wholesale Price Index.
- Wages.
- Foreign Exchange Selling and Buying Rates.

3.1.2. Attributes Of The System

- Availability of funds for investment.
- Availability of investment alternatives.
- Income of each investment.
- Expense of each investment.
- Net Funds caused by each investment.

3.1.3. Activities Of The System

- Generation of the alternatives of investment.
- Calculation of net value of mutually exclusive alternatives according to the criteria selected.
- Selection of the best alternatives, process of investment.

- Calculation of the net value of the firm.

3.2. Research Settings

The capital investment system which is described above is designed as a computer model. The computer model contains 5 different types of capital investment ranking criteria on which all of the research were carried.

The decision criteria are:

- Random Selection of Alternatives.
- Payback Period.
- Profitability Index.
- Present Worth.
- Future Worth.

These criteria were selected from the set of criteria that apply or that does not apply time value of money.

Namely, profitability index, present worth, and future worth apply time value of money where payback period does not apply. Random selection was chosen in order to understand the reasoning behind using capital investment ranking criteria.

The results that will be obtained at the end of simulation runs can be evaluated in many ways but the evaluation criteria in this research was restricted as:

- Net Present Worth of the firm at the end of the simulation run in terms of the beginning year of simulation.

- Profitability of initial investment calculated on year basis.

3.3. Preliminary Research

Before the beginning of the research the data and the computer model to be used were prepared.

3.3.1. Data Used

The data used in the simulation model is being generated by computer which takes the data of 5 feasibility reports that were prepared for real investors by Türkiye Sınai Kalkınma Bankası A.Ş. For the sake of privacy the reports were provided nameless but it was insured that the feasibility studies were for different investment proposals in different sectors ranging from tourism to textile industry.

The data provided contained different investment sizes, expense and income structures. It was edited according to the computer model and the data given in section IV were obtained.

3.3.2. The Computer Model Used

The computer model was designed for IBM compatible personal computer using LOTUS 123 programming language version 2,0 because of its ease in calculation of mathematical, financial and statistical data.

In general, the model is composed of 5 different types of investment each having 4 mutually exclusive alternatives. All of the other parameters of the computer model can be user defined during the use of the program. For this reason the program can be used for different analysis.

The detailed information about the logic of the simulation is given in figure 3.3.2.1. and the detailed information about program and parameters are given in part 3.4.

3.4. The Program And Parameters

3.4.1. Setting Of Evaluation Criteria

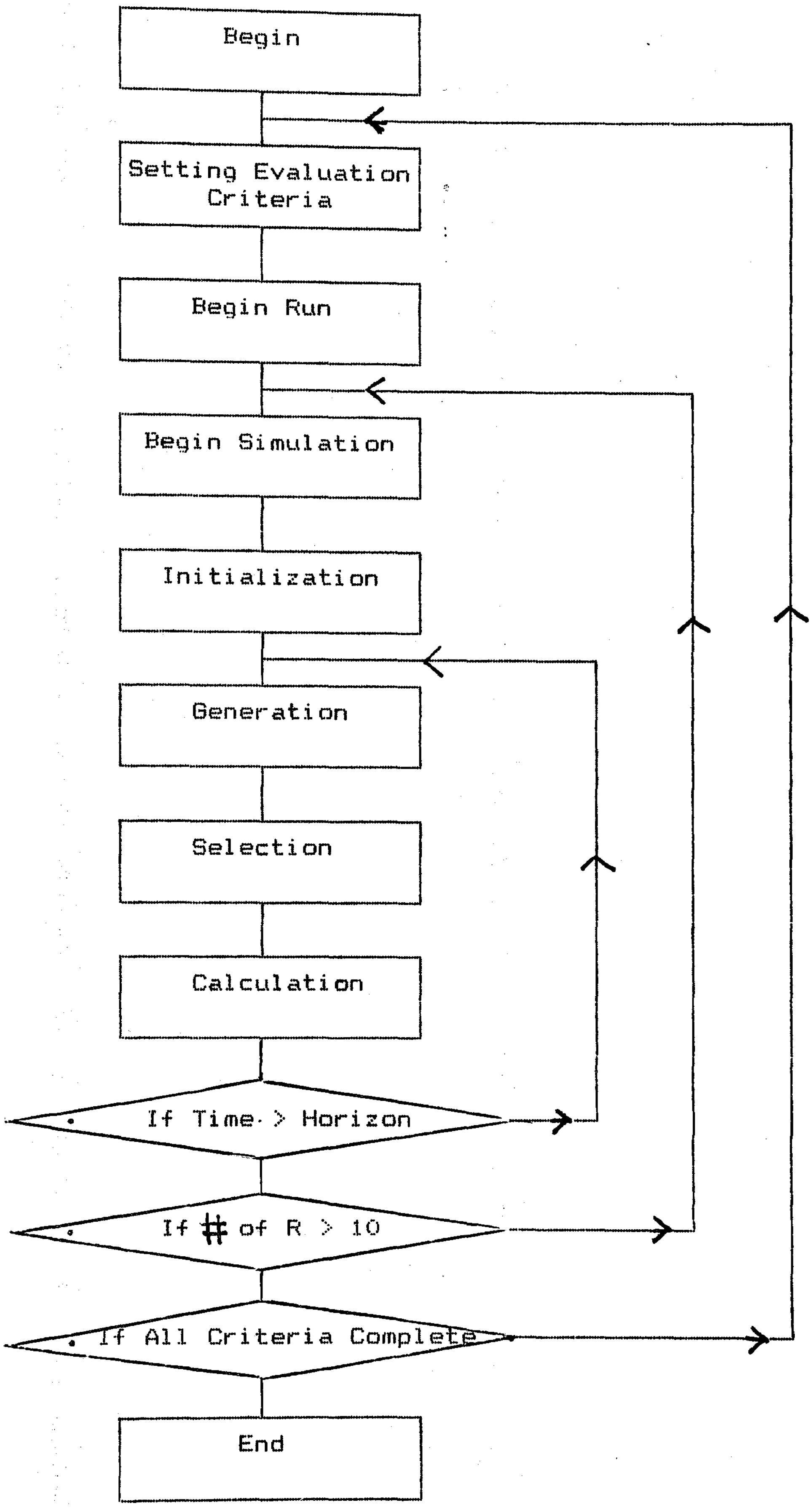
Setting of evaluation criteria are easily done by changing the program diskettes that were prepared for each ranking criterion of the research.

Yearly income and ending net value of the firm can be saved on diskettes.

3.4.2. Beginning Of Simulation

Only one simulation run is carried each time the computer model runs. The meaningful statistical data was obtained by running the program 10 times for each criterion.

FIGURE 3.3.2.1.



Flow Diagram Of The Program

3.4.3. Initialization Step

In this step the parameters which were used to generate and evaluate alternatives are initialized.

There are two types of parameters as explained below.

3.4.3.1. Environmental Parameters

(i) Investment Budget

The investment budget for the first and second years are entered at this stage. There is no possibility of borrowing from the market.

(ii) Randomness Level

All of the investment parameters were used to generate mutually exclusive alternatives using the randomness level and the estimated model for each of it.

(iii) Duration For Simulation

The duration of simulation can be user defined up to 15 years.

3.4.3.2. Investment Parameters

(i) First Cost

The first cost of investments are defined by the user. This variable is not random but increases at a given percentage in order to cover some portion of inflation.

It was defined as 25 % in the computer model.

(ii) Amount Of Working Capital Needed

The amount of working capital needed for investments are user defined and it is a fixed parameter.

(iii) Expenses

. Raw Material

The cost of raw material was thought to be dependent on the increase of wholesale price index, the increase of foreign exchange selling rate and the random factor incorporated by the randomness parameter.

The analysis of wholesale price index is given in Appendix A and the model for raw material cost is given in Appendix E.

. Import Percentage

It was thought as a fixed parameter that defined the import percentage of raw material cost which was affected by the increase of foreign exchange selling rate. The analysis of foreign exchange selling currency are given in Appendix B.

. Wages, Personnel

This cost was thought to be dependent on the increase of general wage level in the country and the random factor incorporated by randomness parameter.

The analysis of wage increases are given in Appendix C and the model is given in Appendix E.

. Operational Expenses

The operational expenses were thought to be dependent on the increase in wholesale price index and the random factor incorporated by the randomness parameter.

The analysis of the increase in wholesale price index are given in Appendix A and the model used is given in Appendix E.

. Selling Expenses

The selling expenses were thought as dependent on the consumer price index and the random factor incorporated by the randomness parameter like the operational expenses.

The detailed analysis for consumer price index are given in Appendix D and the model is given in Appendix E.

. Other Expenses

Other Expenses were also modeled in the way of operational and selling expenses.

The detailed model is given in Appendix E.

(iv) Income

. Cash Sales

Cash sales were thought to be dependent on the increase in consumer price index, foreign exchange buying rate and the random factor of increase incorporated by the randomness level.

The analysis of consumer price index are given in Appendix D and the model to determine sales are given in Appendix E.

. Export Percentage

It is the percentage of sales that were considered to be export. It formed the part which was affected by the increase in foreign exchange buying rate.

Foreign exchange buying rate was defined as 96 % of foreign exchange selling rate that will be generated by the program.

. Receivables

This is the amount of sales which will be collected next year. It was also modeled as sales including export percentage. It was assumed that firms could export on credit for more than 1 year.

The model used for receivables is given in Appendix E.

. Collections

Collections were modeled to be some with receivables with a lead time of one year.

. Closing Value

This is the salvage value of the firm. It was thought to be dependent on the increase in consumer price index and the random factor incorporated.

The detailed model is given in Appendix E.

(v) Duration Of Investment

It was thought as a variable uniformly distributed in the range [5,15] years. It's generated for each alternative each year.

3.4.4. Generation Step

The generation of 4 mutually exclusive alternatives under 5 types of investment alternatives are done in this step by the calculation of above parameters.

In this step, total expense, total income, and net income are generated for 20 alternatives and the net value of the alternatives are calculated according to the pre-set criterion.

3.4.5. Selection Step

In this step the best of each group of mutually exclusive alternatives are selected and then the selected 5 alternatives are ranked. The investment decision is also made in this step taking care of the net funds available at hand.

At this step the divisibility of the alternatives are forbidden.

3.4.6. Calculation Step

Net funds available at hand for the next years and the funds that can be invested in the following year are calculated.

The funds that can be invested in the following year was thought to be the income of the following year calculated in this year plus any funds remained from the investment decisions of this year which was thought to be invested at an interest rate of 10 % per year.

3.4.7. Statistics

The statistics can be gathered by running the model as much as needed. When all of the ranking criteria are simulated the model for testing the effectiveness of capital investment ranking criteria under uncertain inflation ends.

IV. THE DATA AND THE PROCEDURE TO USE

4.1. Environmental Parameters

4.1.1. Initial Investment Level

For each type of ranking criterion, consecutive 10 runs in three initial investment level were carried.

These initial investment levels are:

(i)	First Year	: 50,000,000 TRL
	Second Year	: 30,000,000 TRL
(ii)	First Year	: 40,000,000 TRL
	Second Year	: 20,000,000 TRL
(iii)	First Year	: 30,000,000 TRL
	Second Year	: 10,000,000 TRL

The results are analyzed in section V

4.1.2. Randomness Level

All of the research was carried with 25 % of randomness level.

For test purposes, it was changed to 50 % from 25 % for present worth and payback period methods. The results are analyzed in section V.

4.1.3. Duration Of Simulation

All of the research was carried with a duration of 5 years.

For test purposes, it was changed to 10 years from 5 years for present worth and the results of this change is analyzed in section V.

4.2. Investment Parameters

The investment parameters for all of the investment types are given in Table 4.2.1.1.

TABLE 4.2.1.1.

INVESTMENT PARAMETERS

	INVESTMENTS				
	1.	2.	3.	4.	5.
First Cost of Invest.	6,000	2,500	6,500	22,000	1,250
Working Capital Needed	5,000	700	1,200	1,000	800
Expenses					
Raw Material	2,250	2,500	5,500	0	0
Import Percentage	0,00 %	15 %	15 %	10 %	0 %
Wages	20	150	350	0	0
Operational	2,000	500	500	0	0
Selling	750	100	2,500	0	0
Other Expenses	200	20	0	4,000	2,250
Income					
Cash Sales	10,000	4,000	12,000	12,000	2,800
Export Percentage	33 %	25 %	0 %	0 %	50 %
Receivables	2,500	350	2,000	0	1,400
Collections	2,500	350	2,000	0	1,400
Closing Value	6,000	1,100	2,000	7,500	0
Duration Of Investment	To be generated during simulation				

4.3. The Procedure To Use The Computer Model

The computer simulation model was designed for IBM compatible PC's by using LOTUS123 version 2.0

There are 5 double side double density, floppy, five and a quarter inches diskettes are prepared for each investment ranking criterion.

The names of the files and the methods used respectively are given below.

1. PRESENT.WK1

This is the name of the file for present worth analysis.

2. FUTURE.WK1

This is the name of the file for future worth analysis.

3. PROFIT.WK1

This is the name of the file for profitability index analysis.

4. PAYBACK.WK1

This is the name of the file for payback period analysis.

5. RANDOM.WK1

This is the name of the file for random selection method.

After loading LOTUS123 the diskette of the criterion to be used is put in the driver and the program is retrieved by /File, Retrieve command.

When entered into the file, the text part of the program describes the actions to take. There are two macros defined in the program.

1- Alt-B

This macro invokes menu with the right choice from the macro menu parameters for the environment and the alternatives can be entered.

This macro also enables the user to save the current file.

2. Alt-A

This macro starts the simulation run. At the end of this macro, a print out for the end result of the firm is produced. For this reason it is important to make the printer ready during the operation of this macro.

V. FINDINGS

The findings of the research were analyzed under four main headings. The first part is "findings regarding the effect of change in the amount of initial investment". The second part is "findings regarding the comparison of capital investment ranking criteria under each initial investment level". This part is followed by the "findings regarding the effects of the change in randomness level" and the final part is "findings regarding the effects of change in the duration of simulation".

5.1. Findings Regarding The Effect Of Change In The Amount Of Initial Investment

In this section the information about Net Present Worth of the firm, Profitability Per Year on Initial Investment, Total Number Of Investments during simulation and Average Life Of Investments for each type of capital budgeting ranking criteria are summarized and then the effects of the changes in investment levels are explained.

5.1.1. Random Selection

In Table 5.1.1.1., the findings about the net present worth of the firm at the end of the run in terms of beginning year and other findings are summarized.

Table 5.1.1.1.

DATA OF RANDOM SELECTION

	Randomness : 25 % Simulation Time : 5 Years	Initial Investment Level		
		50,000*	40,000*	30,000*
	Sample Standard Deviation	2.608 %	2.547 %	2.969 %
3.	Average Life Of Investment	10.669	10.403	10.532
	Sample Standard Deviation	0.976	0.910	1.020
4.	Average Number Of Investment	21.900	19.500	17.100
	Sample Standard Deviation	2.608 %	2.547 %	2.969 %
3.	Average Life Of Investment	10.669	10.403	10.532
	Sample Standard Deviation	0.976	0.910	1.020
4.	Average Number Of Investment	21.900	19.500	17.100
	Sample Standard Deviation	1.101	1.080	1.663

Sample Size = 10

The rough investigation of results in Table 5.1.1.1. shows that there is an increasing tendency in Profitability/Year on initial investment as the amount of initial investment decreases. The other points which can be noticed in the stability of average life of investment.

In Tables 5.1.1.2., 5.1.1.3., 5.1.1.4, 5.1.1.5 the results about the comparisons regarding the differences caused by initial investment level are presented.

*Initial Investment Levels and Net Present Worth row are expressed in millions of TRL.

Table 5.1.1.2.

RESULTS OF PAIRED SAMPLES
T - TEST
(Net Present Worth)

	50 - 40 (billions)	40 - 30 (billions)	50 - 30 (billions)
Difference (Mean)	2,021.7	7,304.5	9,326.2
Standard Deviation	12,692.47	12,329.97	12,683.26
Standard Error	4,013.71	3,899.07	4,010.80
T-Value	0.5037	1.8734	2.3253
Degrees Of Freedom	18	18	18
2 Tail Probability (= 0.025)	2.1009	2.1009	2.1009
Significance	No	No	Significant

It can be suggested from Table 5.1.1.2. that although the change in net present worth of the firm was not statistically significant for 50 - 40 billions and 40 - 30 billions pairs, big amount changes in initial investment level like 30 - 50 billions pair may cause statistically significant changes in the net present worth of the firms.

Table 5.1.1.3.

* RESULTS OF PAIRED SAMPLES
T - TEST
(Profitability Per Year)

	50 - 40 (billions)	40 - 30 (billions)	50 - 30 (billions)
Difference (Mean)	- 4.656	- 5.785	-10.441
Standard Deviation	3.645	3.912	3.952
Standard Error	1.153	1.237	1.250
T-Value	- 4.039	- 4.677	- 8.355
Degrees Of Freedom	18	18	18
2 Tail Probability (= 0.025)	2.1009	2.1009	2.1009
Significance	Significant	Significant	Significant

It can be suggested from Table 5.1.1.3. that the increase in the amount of initial investment significantly decreases the profitability per year obtained from the investment decision.

Table 5.1.1.4.

RESULTS OF PAIRED SAMPLES
T - TEST
(Average Life Of Investment)

	50 - 40 (billions)	40 - 30 (billions)	50 - 30 (billions)
Difference (Mean)	0.266	- 0.129	0.137
Standard Deviation	1.344	1.367	1.412
Standard Error	0.422	0.432	0.446
T-Value	0.630	- 0.299	0.307
Degrees Of Freedom	18	18	18
2 Tail Probability (= 0.025)	2.1009	2.1009	2.1009
Significance	No	No	No

It's seen from Table 5.1.1.4. that there is no statistically significant change when there is a change in the initial amount of investment. This result may also be cause by the uniform distribution of the life of investment which has a mean of 10 years.

Table 5.1.1.5.

RESULTS OF PAIRED SAMPLES
T - TEST
(Total Number Of Investments)

	50 - 40 (billions)	40 - 30 (billions)	50 - 30 (billions)
Difference (Mean)	2.4	2.4	4.8
Standard Deviation	1.522	1.983	1.994
Standard Error	0.488	0.627	0.631
T-Value	4.921	3.827	7.611
Degrees Of Freedom	18	18	18
2 Tail Probability (= 0.025)	2.1009	2.1009	2.1009
Significance	Significant	Significant	Significant

It can be suggested from Table 5.1.1.5. that the number of investments decrease as the amount of initial investment decreases.

5.1.2. Payback Period

The simulation cycles for payback period criteria was done for 3 times. The first cycle was a simulation of 5 years at 25 % randomness level. The second cycle was for the change in randomness level and the last was for the change in the duration of simulation.

Tables 5.1.2.1., 5.1.2.6., contain the net present worth and other findings at the end of the run for each cycle.

Table 5.1.2.1.

DATA OF PAYBACK PERIOD

	Randomness : 25 % Simulation Time : 5 Years	Initial Investment Level		
		50,000*	40,000*	30,000*
1.	Average Net Present Worth*	129,131.9	112,754.4	81,140.7
	Sample Standard Deviation	14,530.6	7,263.0	13,183.4
2.	Average Profitability/Year	13.702 %	16.811 %	17.442 %
	Sample Standard Deviation	2.672 %	1.505 %	3.966 %
3.	Average Life Of Investment	10.377	10.591	10.646
	Sample Standard Deviation	0.744	1.099	0.825
4.	Average Number Of Investment	21.4	18.7	17.6
	Sample Standard Deviation	1.430	1.767	1.713

Sample Size = 10

The rough investigations of the results in table 5.1.2.1. shows that there is an increasing tendency in net present worth and average number of investments and a decreasing tendency in profitability per year as the amount of initial investment increases.

In Tables 5.1.2.2., 5.1.2.3., 5.1.2.4., 5.1.2.5., the results about comparisons regarding the differences caused by initial investment level are presented.

*Initial Investment Levels and Net Present Worth row are expressed in millions of TRL.

Table 5.1.2.2.

RESULTS OF PAIRED SAMPLES

T - TEST

(Net Present Worth)

	50 - 40 (billions)	40 - 30 (billions)	50 - 30 (billions)
Difference (Mean)	16,377.5	31,613.7	48,179.2
Standard Deviation	16,244.7	15,051.7	19,619.9
Standard Error	5,137.0	4,759.8	6,204.4
T-Value	3.1881	6.6419	7.7654
Degrees Of Freedom	18	18	18
2 Tail Probability (= 0.025)	2.1009	2.1009	2.1009
Significance	Significant	Significant	Significant

It can be suggested from Table 5.1.2.2. that the increase in the amount of initial investment increases the net present worth of the firm.

Table 5.1.2.3.

RESULTS OF PAIRED SAMPLES

T - TEST

(Profitability Per Year)

	50 - 40 (billions)	40 - 30 (billions)	50 - 30 (billions)
Difference (Mean)	- 3.109 %	- 0.631 %	- 3.740 %
Standard Deviation	3.067	4.242	4.782
Standard Error	0.970	1.341	1.512
T-Value	- 3.206	- 0.470	- 2.473
Degrees Of Freedom	18	18	18
2 Tail Probability (= 0.025)	2.1009	2.1009	2.1009
Significance	Significant	No	Significant

It can be suggested from Table 5.1.2.3. that the increase in the amount of initial investment either decreases or keeps the profitability on initial investment per year.

If results of Table 5.1.2.2., 5.1.2.3. are analyzed together it can be seen than although the firm increases the net present worth, the profitability per year decreases which means less efficiently placed funds. The decrease of capital rationing causes the decrease in profitability per year.

Table 5.1.2.4.

RESULTS OF PAIRED SAMPLES
T - TEST
(Life Of Investment)

	50 - 40 (billions)	40 - 30 (billions)	50 - 30 (billions)
Difference (Mean)	- 0.214	- 0.055	- 0.269
Standard Deviation	1.327	1.374	1.111
Standard Error	0.420	0.435	0.351
T-Value	- 0.510	- 0.127	- 0.766
Degrees Of Freedom	18	18	18
2 Tail Probability (= 0.025)	2.1009	2.1009	2.1009
Significance	No	No	No

The analysis of the results shown in Table 5.1.2.4 shows that there is no significant relation between the increase in the amount of initial investment and the life of investment like the results shown in Table 5.1.1.4.

Table 5.1.2.5.

RESULTS OF PAIRED SAMPLES

T - TEST

(Total Number Of Investment)

	50 - 40 (billions)	40 - 30 (billions)	50 - 30 (billions)
Difference (Mean)	2.7	1.1	3.8
Standard Deviation	2.273	2.461	2.231
Standard Error	0.719	0.788	0.706
T-Value	3.756	1.414	5.385
Degrees Of Freedom	18	18	18
2 Tail Probability (= 0.025)	2.1009	2.1009	2.1009
Significance	Significant	No	Significant

It can be suggested from Table 5.1.2.5. that the increase in the amount of initial investment causes either an increase in the number of investment or at least keeps the number of investment that could be covered using the previous initial investment level.

This result also shows that there is a decrease in capital rationing as initial investment increases.

Table 5.1.2.6

DATA OF PAYBACK PERIOD

	Randomness : 50 % Simulation Time : 5 Years	Initial Investment Level		
		50,000*	40,000*	30,000*
1.	Average Net Present Worth*	40,712.1	32,777.8	26,894.2
	Sample Standard Deviation	8,352.7	5,419.1	6,389.4
2.	Average Profitability/Year	-8.58	-6.73	-4.56
	Sample Standard Deviation	2.714	2.357	1.218
3.	Average Life Of Investment	10.785	10.428	10.305
	Sample Standard Deviation	0.876	0.639	0.491
4.	Average Number Of Investment	21.5	16.2	14.1
	Sample Standard Deviation	1.398	1.865	2.061

Sample Size = 10

*Initial Investment Levels and Net Present Worth row are expressed in millions of TRL.

The rough investigations of the results in Table 5.1.2.6. shows that there is an increasing tendency in net present worth and average number of investment while the profitability per year is less than 1 as the amount of initial investment increases.

In tables 5.1.2.7., 5.1.2.8., 5.1.2.9., 5.1.2.10., the result about comparisons regarding the differences caused by the initial investment level when the randomness level is changed to 50 % from 25 % are presented.

Table 5.1.2.7.

RESULTS OF PAIRED SAMPLES
T - TEST
(Net Present Worth)

	50 - 40 (billions)	40 - 30 (billions)	50 - 30 (billions)
Difference (Mean)	7,934.3	5,883.6	13,817.9
Standard Deviation	9,956.6	8,378	10,516.3
Standard Error	3,148.6	2,649.4	3,325.5
T-Value	2.52	2.221	4.155
Degrees Of Freedom	18	18	18
2 Tail Probability (= 0.025)	2.1009	2.1009	2.1009
Significance	Significant	Significant	Significant

It can be suggested from table 5.2.1.7. that the present worth of the firm increases as the amount of initial investment increases.

Table 5.1.2.8.

RESULTS OF PAIRED SAMPLES
T - TEST
(Profitability Per Year)

	50 - 40 (billions)	40 - 30 (billions)	50 - 30 (billions)
Difference (Mean)	- 1.85	- 2.17	- 4.02
Standard Deviation	3.595	2.653	2.974
Standard Error	1.137	0.839	0.941
T-Value	- 1.627	- 2.586	- 4.24
Degrees Of Freedom	18	18	18
2 Tail Probability (= 0.025)	2.1009	2.1009	2.1009
Significance	No	Significant	Significant

Although the difference between 50 and 40 billion levels of initial investment is not significant, it can be still suggested from Table 5.1.2.8. that the profitability per year increases as the initial investment decreases.

Table 5.1.2.9.

RESULTS OF PAIRED SAMPLES
T - TEST
(Average Life Of Investment)

	50 - 40 (billions)	40 - 30 (billions)	50 - 30 (billions)
Difference (Mean)	0.447	0.123	0.57
Standard Deviation	1.084	0.806	1.004
Standard Error	0.343	0.255	0.318
T-Value	1.304	0.483	1.795
Degrees Of Freedom	18	18	18
2 Tail Probability (= 0.025)	2.1009	2.1009	2.1009
Significance	No	No	No

There is not enough evidence that the average life of investment is statistically different.

Table 5.1.2.10.

RESULTS OF PAIRED SAMPLES
T - TEST
(Total Number Of Investment)

	50 - 40 (billions)	40 - 30 (billions)	50 - 30 (billions)
Difference (Mean)	5.3	2.1	7.4
Standard Deviation	2.331	2.780	2.490
Standard Error	0.737	0.879	0.788
T-Value	7.191	2.389	9.396
Degrees Of Freedom	18	18	18
2 Tail Probability (= 0.025)	2.1009	2.1009	2.1009
Significance	Significant	Significant	Significant

It can be suggested from table 5.1.2.10. that average number of investment increases as the initial level of investment increases.

5.1.3. Profitability Index

In Table 5.1.3.1., the findings about the net present worth of the firm at the end of the run in terms of beginning year and other findings are summarized.

Table 5.1.3.1.

DATA OF PROFITABILITY INDEX

	Randomness : 25 % Simulation Time : 5 Years	Initial Investment Level		
		50,000*	40,000*	30,000*
1.	Average Net Present Worth*	98,380	78,527	87,548
	Sample Standard Deviation	10,480.6	26,144	13,002
2.	Average Profitability/Year	7.684 %	10.91 %	19.494 %
	Sample Standard Deviation	2.320 %	2.827	3.429
3.	Average Life Of Investment	10.520	10.748	11.015
	Sample Standard Deviation	0.639	0.878	0.837
4.	Average Number Of Investment	21.6	16.1	12.500
	Sample Standard Deviation	1.430	1.197	1.080

Sample Size = 10

The rough investigation of results in Table 5.1.3.1. shows that there is an increasing tendency in profitability per year as the amount of initial investment decreases. Stability of the average life of investment can be observed as well.

In Table 5.1.3.2., 5.1.3.3., 5.1.3.4., 5.1.3.5 the results about comparisons regarding the differences caused by initial investment level are presented.

*Initial Investment Levels and net Present Worth row are expressed in millions.

Table 5.1.3.2.

RESULTS OF PAIRED SAMPLES
T - TEST
(Net Present Worth)

	50 - 40 (billions)	40 - 30 (billions)	50 - 30 (billions)
Difference (Mean)	19,583	- 9,021	10,562
Standard Deviation	28,166.5	29,198.6	16,700.1
Standard Error	8,907	9,233.4	5,281.1
T-Value	2.1986	- 0.976	2.0000
Degrees Of Freedom	18	18	18
2 Tail Probability (= 0.025)	2.1009	2.1009	2.1009
Significance	Significant	No	No

It can not be suggested from Table 5.1.3.2. that net present worth of the firm increases as the amount of initial investment increases.

Table 5.1.3.3.

RESULTS OF PAIRED SAMPLES
T - TEST
(Profitability Per Year)

	50 - 40 (billions)	40 - 30 (billions)	50 - 30 (billions)
Difference (Mean)	- 3.226	- 8.584	-11.63
Standard Deviation	3.657	4.444	4.140
Standard Error	1.156	1.405	1.309
T-Value	- 2.790	- 6.110	- 8.883
Degrees Of Freedom	18	18	18
2 Tail Probability (= 0.025)	2.1009	2.1009	2.1009
Significance	Significant	Significant	Significant

It can be suggested from Table 5.1.3.3. that the rate of return on initial investment decreases as the amount of initial investment increase. This situation can be an indication of decreasing capital rationing.

Table 5.1.3.4.

RESULTS OF PAIRED SAMPLES
T - TEST
(Average Life Of Investment)

	50 - 40 (billions)	40 - 30 (billions)	50 - 30 (billions)
Difference (Mean)	- 0.228	- 0.267	- 0.495
Standard Deviation	1.086	1.213	1.053
Standard Error	0.343	0.384	0.333
T-Value	- 0.664	- 0.696	- 1.486
Degrees Of Freedom	18	18	18
2 Tail Probability (= 0.025)	2.1009	2.1009	2.1009
Significance	No	No	No

It's seen from Table 5.1.3.4. that there is no statistically significant change in the average life of investment when there is a change in the amount of initial investment.

Table 5.1.3.5.

RESULTS OF PAIRED SAMPLES
T - TEST
(Total Number Of Investments)

	50 - 40 (billions)	40 - 30 (billions)	50 - 30 (billions)
Difference (Mean)	5.5	3.6	9.1
Standard Deviation	1.865	1.612	1.792
Standard Error	0.590	0.510	0.567
T-Value	9.326	7.061	16.058
Degrees Of Freedom	18	18	18
2 Tail Probability (= 0.025)	2.1009	2.1009	2.1009
Significance	Significant	Significant	Significant

It can be suggested from Table 5.1.3.5. that the number of investments decrease as the initial investment decreases.

Table 5.1.4.2.

RESULTS OF PAIRED SAMPLES
T - TEST
(Net Present Worth)

	50 - 40 (billions)	40 - 30 (billions)	50 - 30 (billions)
Difference (Mean)	26,803.8	12,057.1	38,860.9
Standard Deviation	12,973.7	12,293.9	9,205
Standard Error	4,102.7	3,887.7	2,910.9
T-Value	6.5333	3.1014	13.35
Degrees Of Freedom	18	18	18
2 Tail Probability (= 0.025)	2.1009	2.1009	2.1009
Significance	Significant	Significant	Significant

It can be suggested from Table 5.1.4.2. that net present worth of the firm increases as the amount of initial investment increases.

Table 5.1.4.3.

RESULTS OF PAIRED SAMPLES
T - TEST
(Profitability Per Year)

	50 - 40 (billions)	40 - 30 (billions)	50 - 30 (billions)
Difference (Mean)	- 1.813	- 6.859	- 8.672
Standard Deviation	2.172	2.267	1.598
Standard Error	0.687	0.717	0.505
T-Value	- 2.64	- 9.567	-17.162
Degrees Of Freedom	18	18	18
2 Tail Probability (= 0.025)	2.1009	2.1009	2.1009
Significance	Significant	Significant	Significant

It can be suggested from table 5.1.4.3. that the profitability of initial investment per year decreases as the amount of initial investment increases.

Table 5.1.4.4.

RESULTS OF PAIRED SAMPLES

T - TEST

(Average Life Of Investment)

	50 - 40 (billions)	40 - 30 (billions)	50 - 30 (billions)
Difference (Mean)	- 0.022	0.05	0.028
Standard Deviation	1.200	1.192	1.253
Standard Error	0.379	0.377	0.396
T-Value	- 0.058	0.137	0.07
Degrees Of Freedom	18	18	18
2 Tail Probability (= 0.025)	2.1009	2.1009	2.1009
Significance	No	No	No

It's seen from Table 5.1.4.4. that there is no statistically significant change in the average life of investment when there is a change in the amount of initial investment.

Table 5.1.4.5.

RESULTS OF PAIRED SAMPLES

T - TEST

(Total Number Of Investment)

	50 - 40 (billions)	40 - 30 (billions)	50 - 30 (billions)
Difference (Mean)	7.3	5.9	13.2
Standard Deviation	4.170	5.730	2.463
Standard Error	1.319	1.812	0.779
T-Value	5.54	3.256	16.94
Degrees Of Freedom	18	18	18
2 Tail Probability (= 0.025)	2.1009	2.1009	2.1009
Significance	Significant	Significant	Significant

It can be suggested from Table 5.1.4.5. that the number of investments decrease as the amount of initial investment decrease.

5.1.5. Net Present Worth

The simulation cycles for present worth criteria was done for 3 times. The first cycle was a simulation of 5 years at 25 % randomness level. The second cycle was for the change in randomness level and the last was for the change in the duration of simulation.

Tables 5.1.5.1., 5.1.5.6., 5.2.5.11. contains the net present worth and other findings at the end of the run for each cycle.

Table 5.1.5.1.

DATA OF PRESENT WORTH

	Randomness : 25 % Simulation Time : 5 Years	Initial Investment Level		
		50,000*	40,000*	30,000*
1.	Average Net Present Worth*	160,894.6	139,881.6	121,040.9
	Sample Standard Deviation	12,915.3	9,830.6	6,129.8
2.	Average Profitability/Year	18.865 %	21.943 %	27.517 %
	Sample Standard Deviation	1.904	1.697	1.322
3.	Average Life Of Investment	10.665	10.421	10.36
	Sample Standard Deviation	0.866	0.692	0.651
4.	Average Number Of Investment	20.7	18.7	11.0
	Sample Standard Deviation	1.57	1.636	1.491

Sample Size = 10

*Initial Investment Levels and Net Present Worth row are expressed in millions of TRL.

The rough investigation of the results in Table 5.1.5.1. shows that the increasing tendency of number of investments and the net present worth and the decrease of profitability per year as the amount of initial investment increases still continues like Table 5.1.4.1.

In Table 5.1.5.2., 5.1.5.3., 5.1.5.4., 5.1.5.5. the results about comparisons regarding the differences caused by the initial investment are presented.

Table 5.1.5.2.

RESULTS OF PAIRED SAMPLES
T - TEST
(Net Present Worth)

	50 - 40 (billions)	40 - 30 (billions)	50 - 30 (billions)
Difference (Mean)	21,013	18,840.7	39,853.7
Standard Deviation	16,214.7	11,585.1	14,296.1
Standard Error	5,127.5	3,663.5	4,520.8
T-Value	4.098	5.143	8.816
Degrees Of Freedom	18	18	18
2 Tail Probability (= 0.025)	2.1009	2.1009	2.1009
Significance	Significant	Significant	Significant

It can be suggested from table 5.1.5.2. that the present worth of the firm increases as the amount of initial investment increases.

Table 5.1.5.3.

RESULTS OF PAIRED SAMPLES

T - TEST

(Profitability Per Year)

	50 - 40 (billions)	40 - 30 (billions)	50 - 30 (billions)
Difference (Mean)	- 3.078	- 5.574	8.652
Standard Deviation	2.55	2.151	2.318
Standard Error	0.807	0.680	0.733
T-Value	- 3.816	- 8.194	-11.804
Degrees Of Freedom	18	18	18
2 Tail Probability	2.1009	2.1009	2.1009
(= 0.025)			
Significance	Significant	Significant	Significant

It can be suggested from Table 5.1.5.3. that the profitability of initial investment per year decreases as the amount of initial investment increases.

Table 5.1.5.3. and 5.1.5.2 together forms a sort of indication about capital rationing and high rate of returns when the amount of initial investment is low.

Table 5.1.5.4.

RESULTS OF PAIRED SAMPLES

T - TEST

(Average Life Of Investment)

	50 - 40 (billions)	40 - 30 (billions)	50 - 30 (billions)
Difference (Mean)	0.244	0.061	0.305
Standard Deviation	1.109	0.950	1.083
Standard Error	0.351	0.300	0.343
T-Value	0.696	0.203	0.890
Degrees Of Freedom	18	18	18
2 Tail Probability	2.1009	2.1009	2.1009
(= 0.025)			
Significance	No	No	No

It's clearly seen from Table 5.1.5.4. that there is no statistically significant change in the average life of investment when there is an increase or decrease in the amount of initial investment.

Table 5.1.5.5.

RESULTS OF PAIRED SAMPLES
T - TEST
(Total Number Of Investment)

	50 - 40 (billions)	40 - 30 (billions)	50 - 30 (billions)
Difference (Mean)	2.0	7.7	9.7
Standard Deviation	2.267	2.213	2.165
Standard Error	0.717	0.700	0.685
T-Value	2.789	11.000	14.167
Degrees Of Freedom	18	18	18
2 Tail Probability (= 0.025)	2.1009	2.1009	2.1009
Significance	Significant	Significant	Significant

It can be suggested from Table 5.1.5.5. that the number of investments decrease when the amount of initial investment increases.

Table 5.1.5.6.

DATA OF PRESENT WORTH

	Randomness : 50 % Simulation Time : 5 Years	Initial Investment Level		
		50,000*	40,000*	30,000*
1.	Average Net Present Worth*	63,524.3	51,846.2	42,758.6
	Sample Standard Deviation	9,865.6	12,787.5	17,312.4
2.	Average Profitability/Year	0.103 %	1.509 %	3.403 %
	Sample Standard Deviation	1.724	1.040	1.922
3.	Average Life Of Investment	11.215	10.352	10.206
	Sample Standard Deviation	0.754	0.835	0.984
4.	Average Number Of Investment	21.8	17.4	15.3
	Sample Standard Deviation	1.776	2.147	1.487

Sample Size = 10

The rough investigation of Table 5.1.5.6 shows that there is an increasing tendency in present worth and average number of investment and decreasing tendency is profitability per year as the initial investment level increases.

In Tables 5.1.5.7., 5.1.5.8, 5.1.5.9., 5.1.5.10., the results about comparisons regarding the differences caused by the initial investment are presented.

*Initial Investment Levels and Net Present Worth row are expressed in millions of TRL.

Table 5.1.5.7.

RESULTS OF PAIRED SAMPLES
T - TEST
(Net Present Worth)

	50 - 40 (billions)	40 - 30 (billions)	50 - 30 (billions)
Difference (Mean)	11,678.1	9,087.6	20,765.7
Standard Deviation	12,787.5	21,523.0	19,926.1
Standard Error	4,043.8	6,806.2	6,301.2
T-Value	2.888	1.335	3.296
Degrees Of Freedom	18	18	18
2 Tail Probability (= 0.025)	2.1009	2.1009	2.1009
Significance	Significant	No	Significant

Although there is no significant difference in the present worth of the firm in 40 billions and 30 billions level of initial investment it can be suggested from Table 5.1.5.7. that there is a significant increase in present worth when initial investment level increases.

Table 5.1.5.8.

RESULTS OF PAIRED SAMPLES
T - TEST
(Profitability Per Year)

	50 - 40 (billions)	40 - 30 (billions)	50 - 30 (billions)
Difference (Mean)	- 1.406	- 1.894	- 3.3
Standard Deviation	1.916	2.189	2.582
Standard Error	0.606	0.691	0.816
T-Value	- 2.32	- 2.74	- 4.04
Degrees Of Freedom	18	18	18
2 Tail Probability (= 0.025)	2.1009	2.1009	2.1009
Significance	Significant	Significant	Significant

It can be suggested from table 5.1.5.8. that profitability per year decreases as the initial investment level increases.

Table 5.1.5.9.

RESULTS OF PAIRED SAMPLES
T - TEST
(Average Life Of Investment)

	50 - 40 (billions)	40 - 30 (billions)	50 - 30 (billions)
Difference (Mean)	0.863	0.146	1.069
Standard Deviation	1.125	1.291	1.240
Standard Error	0.356	0.408	0.392
T-Value	2.425	0.358	2.727
Degrees Of Freedom	18	18	18
2 Tail Probability (= 0.025)	2.1009	2.1009	2.1009
Significance	Significant	No	Significant

The significant difference in the average life of investment is suggested to occur because of the high randomness factor introduced in the run.

Table 5.2.5.10.

RESULTS OF PAIRED SAMPLES
T - TEST
(Total Number Of Investment)

	50 - 40 (billions)	40 - 30 (billions)	50 - 30 (billions)
Difference (Mean)	4.4	2.1	6.5
Standard Deviation	2.786	2.612	2.316
Standard Error	0.881	0.826	0.732
T-Value	4.993	2.543	8.874
Degrees Of Freedom	18	18	18
2 Tail Probability (= 0.025)	2.1009	2.1009	2.1009
Significance	Significant	Significant	Significant

It can be suggested from Table 5.2.5.10. that average number of investments increase as the initial investment level increase.

Table 5.1.5.11.

DATA OF PRESENT WORTH

	Randomness : 25 % Simulation Time : 10 Years	Initial Investment Level		
		50,000*	40,000*	30,000*
1.	Average Net Present Worth*	80,173.0	57,328.5	42,579.6
	Sample Standard Deviation	13,499.2	10,023.7	7,671.4
2.	Average Profitability/Year	3.46 %	2.06 %	3.48 %
	Sample Standard Deviation	1.913	1.728	2.051
3.	Average Life Of Investment	10.676	10.784	10.272
	Sample Standard Deviation	0.595	0.728	0.560
4.	Average Number Of Investment	36.3	30.7	25.8
	Sample Standard Deviation	1.711	1.524	2.703

Sample Size = 10

The rough investigation of Table 5.1.5.11. shows that there is an increasing tendency in present worth and number of investment as the amount of initial investment increases.

In Table 5.1.5.12., 5.1.5.13., 5.1.5.14., 5.1.5.15. the results about comparisons regarding the differences caused by the initial investment are presented.

*Initial Investment Levels and Net Present Worth row are expressed in millions of TRL.

Table 5.1.5.12.

RESULTS OF PAIRED SAMPLES
T - TEST
(Net Present Worth)

	50 - 40 (billions)	40 - 30 (billions)	50 - 30 (billions)
Difference (Mean)	22,844.5	14,748.9	37,593.4
Standard Deviation	16,813.8	12,622.4	15,526.7
Standard Error	5,317	3,991.6	4,910.0
T-Value	4.30	3.70	7.66
Degrees Of Freedom	18	18	18
2 Tail Probability (= 0.025)	2.1009	2.1009	2.1009
Significance	Significant	Significant	Significant

It can be suggested from Table 5.1.5.12. that the present worth of the firm increases as the initial investment amount increases.

Table 5.1.5.13.

RESULTS OF PAIRED SAMPLES
T - TEST
(Profitability Per Year)

	50 - 40 (billions)	40 - 30 (billions)	50 - 30 (billions)
Difference (Mean)	1.40	- 1.42	- 0.02
Standard Deviation	2.578	2.682	2.805
Standard Error	0.815	0.848	0.887
T-Value	1.718	- 1.674	- 0.023
Degrees Of Freedom	18	18	18
2 Tail Probability (= 0.025)	2.1009	2.1009	2.1009
Significance	No	No	No

It can be suggested from Table 5.1.5.13. that there is no significant increase in profitability as the amount of initial investment increases.

Table 5.1.5.14.

RESULTS OF PAIRED SAMPLES

T - TEST

(Average Life Of Investment)

	50 - 40 (billions)	40 - 30 (billions)	50 - 30 (billions)
Difference (Mean)	- 0.108	0.512	0.404
Standard Deviation	0.940	0.918	0.817
Standard Error	0.297	0.290	0.258
T-Value	- 0.363	1.763	1.563
Degrees Of Freedom	18	18	18
2 Tail Probability (= 0.025)	2.1009	2.1009	2.1009
Significance	No	No	No

It can be suggested from Table 5.1.5.14. that there is no significant change in the average life of investment as the amount of initial investment increases.

Table 5.1.5.15.

RESULTS OF PAIRED SAMPLES

T - TEST

(Total Number Of Investment)

	50 - 40 (billions)	40 - 30 (billions)	50 - 30 (billions)
Difference (Mean)	5.6	4.9	10.5
Standard Deviation	2.29	3.10	3.199
Standard Error	0.724	0.981	1.011
T-Value	7.729	4.994	10.379
Degrees Of Freedom	18	18	18
2 Tail Probability (= 0.025)	2.1009	2.1009	2.1009
Significance	Significant	Significant	Significant

It can be suggested from Table 5.1.5.15. that the number of investments increases as the amount of initial investment increases.

5.2. Findings Regarding The Comparison Of Capital Investment Ranking Criteria Under Each Initial Investment Level

In this section findings about the comparison of net present worths, rate of return, average life of investment and total number of investments occurred by using each capital investment ranking criteria in each initial investment level are presented Parameters for these cycles were 25 % randomness level and simulation time of 5 years.

5.2.1. Net Present Worth

In Table 5.2.1.1. the findings about the comparisons regarding the effect of using present worth or future worth in making capital investment decisions are presented.

Table 5.2.1.1.

NET PRESENT WORTH VS FUTURE WORTH

	50 - 50 (billions)	40 - 40 (billions)	30 - 30 (billions)
Net Present Worth			
Difference (Mean)	- 2,440.2	3,350.6	- 3.433
T-Value	- 0.523	0.724	1.342
Significance	No	No	No
Profitability Per Y.			
Difference (Mean)	- 0.689	0.576	- 0.711
T-Value	- 1.006	0.713	- 1.25
Significance	No	No	No
Average Life			
Difference (Mean)	- 0.002	- 0.268	- 0.279
T-Value	- 0.005	- 0.799	- 0.806
Significance	No	No	No
Average Investment			
Difference (Mean)	- 1.0	4.3	2.5
T-Value	- 1.243	3.393	3.822
Significance	No	Yes	Yes

Sample Size = 10

2 Tail Probability = 2.1009, = 0.025, 18 D.O.F.

It can be suggested from Table 5.2.1.1. that there is no statistical evidence that use of present worth method or future method in capital investment decision differs. They have almost the same effect on present worth of the firm and profitability received from investing.

As expected, there is no significant difference in the average life of investments which is caused by the uniform distribution of life of investment.

The only significant difference observed occurs in the average number of investment. Future worth method seems to invest less than present worth method. This situation is an indication of the amount of investment per project. Future worth method can be said to be biased for projects with higher initial investment costs.

It Table 5.2.1.2. the findings about the comparisons regarding the effect of using present worth or profitability index in making capital investment decisions are presented.

Table 5.2.1.2.

NET PRESENT WORTH VS PROFITABILITY INDEX

	50 - 50 (billions)	40 - 40 (billions)	30 - 30 (billions)
Net Present Worth			
Difference (Mean)	62,514.6	61,354.6	33,492.9
T-Value	11.9	6.9	7.4
Significance	Yes	Yes	Yes
Profitability Per Y.			
Difference (Mean)	11.181	11.033	8.027
T-Value	11.781	10.581	6.907
Significance	Yes	Yes	Yes
Average Life			
Difference (Mean)	0.145	0.327	0.015
T-Value	0.426	0.833	0.045
Significance	No	No	No
Average Investment			
Difference (Mean)	- 0.9	2.6	- 1.5
T-Value	- 1.34	4.06	- 2.576
Significance	No	Yes	Yes

Sample Size = 10

2 Tail Probability = 2.1009, = 0.025, 18 D.O.F.

It can be suggested from Table 5.2.1.2. that there is a difference in the profitability and present worth of the firm at the end of a given time period if present worth method and profitability index are used. Present worth method seems to be significantly better than profitability index.

As seen in 5.2.1.2., there is no difference in the average life of investments.

There is a significant difference in the number of investments.

In 30 billions level more investments were made in profitability index than present worth. In 40 billions level present worth seems to invest more.

In Table 5.2.1.3. the findings about the comparisons regarding the effect of using present worth or payback period in making capital investment decisions are presented.

Table 5.2.1.3.

NET PRESENT WORTH VS PAYBACK PERIOD

	50 - 50 (billions)	40 - 40 (billions)	30 - 30 (billions)
Net Present Worth			
Difference (Mean)	31,762.7	27,127.2	39,900.2
T-Value	5.167	7.018	8.679
Significance	Yes	Yes	Yes
Profitability Per Y.			
Difference (Mean)	5.163	5.132	10.075
T-Value	4.978	7.155	7.621
Significance	Yes	Yes	Yes
Average Life			
Difference (Mean)	0.288	- 0.17	- 0.286
T-Value	0.798	- 0.414	- 0.861
Significance	No	No	No
Average Investment			
Difference (Mean)	- 0.7	0.0	- 6.6
T-Value	- 1.042	0.0	- 9.190
Significance	No	No	Yes

Sample Size = 10

2 Tail Probability = 2.1009, = 0.025, 18 D.O.F.

It can be suggested from Table 5.2.1.3. that there is a significant difference in the profitability and present worth of the firm at the end of a given period if present worth method and payback period are used. Present worth method seems to be significantly better than payback period.

As seen in Table 5.2.1.3. there is no difference in the average life of investments.

In Table 5.2.1.4. the findings about the comparisons regarding the effect of using present worth or random selection in making capital investment decisions are presented.

Table 5.2.1.4.

NET PRESENT WORTH VS RANDOM SELECTION

	50 - 50 (billions)	40 - 40 (billions)	30 - 30 (billions)
Net Present Worth			
Difference (Mean)	84,197.6	65,206.3	53,670.1
T-Value	16.780	15.687	15.933
Significance	Yes	Yes	Yes
Profitability Per Y.			
Difference (Mean)	16.018	14.44	14.229
T-Value	15.687	14.92	13.845
Significance	Yes	Yes	Yes
Average Life			
Difference (Mean)	- 0.004	0.018	- 0.172
T-Value	- 0.005	0.05	- 0.449
Significance	No	No	No
Average Investment			
Difference (Mean)	- 1.2	- 0.8	- 6.1
T-Value	- 1.979	- 1.29	- 8.72
Significance	No	No	Yes

Sample Size = 10

2 Tail Probability = 2.1009, = 0.025, 18 D.O.F.

It can be suggested from Table 5.2.1.4. that there is a significant difference in the profitability and present worth of the firm at the end of a given time period if present worth method and random selection are used. Present worth method is significantly better than random selection method.

As seen in Table 5.2.1.4. there is no difference in the average life of investments.

Present Worth method seems to be superior to other capital investment ranking criteria in all level of initial investment except Future Worth method. There is no enough evidence that Present Worth and Future Worth Methods differ.

5.2.2. Future Worth

In Table 5.2.2.1. the findings about the comparisons regarding the effect of using future worth or profitability index in making capital investment decisions.

Table 5.2.2.1.

FUTURE WORTH VS PROFITABILITY INDEX

	50 - 50 (billions)	40 - 40 (billions)	30 - 30 (billions)
Net Present Worth			
Difference (Mean)	64,955	58,004	36,926
T-Value	16.204	6.481	8.197
Significance	Yes	Yes	Yes
Profitability Per Y.			
Difference (Mean)	11.87	10.457	8.732
T-Value	14.782	9.691	7.589
Significance	Yes	Yes	Yes
Average Life			
Difference (Mean)	0.147	- 0.059	- 0.376
T-Value	0.424	- 1.567	- 0.979
Significance	No	No	No
Average Investment			
Difference (Mean)	0.1	- 1.7	- 4.0
T-Value	0.128	- 1.397	- 7.046
Significance	No	No	Yes

Sample Size = 10

2 Tail Probability = 2.1009, = 0.025, 18 D.O.F.

It can be suggested from Table 5.2.2.1. that there is a significant difference in profitability per year and present worth of the firm at the end of a given period if Future Worth and Profitability Index methods are used. Future Worth method is significantly better than profitability index.

As seen in Table 5.2.2.1. there is no significant difference in average life of investments.

Table 5.2.2.2. the findings about the comparisons regarding the effect of using Future Worth or Payback Period in making capital investment decisions.

Table 5.2.2.2.

FUTURE WORTH VS PAYBACK PERIOD

	50 - 50 (billions)	40 - 40 (billions)	30 - 30 (billions)
Net Present Worth			
Difference (Mean)	34,202.9	23,776.6	43,333.2
T-Value	6.682	5.763	9.509
Significance	Yes	Yes	Yes
Profitability Per Y.			
Difference (Mean)	5.852	4.556	10.784
T-Value	6.461	5.923	8.219
Significance	Yes	Yes	Yes
Average Life			
Difference (Mean)	0.290	0.098	- 0.007
T-Value	0.790	0.228	- 0.018
Significance	No	No	No
Average Investment			
Difference (Mean)	0.3	- 4.3	- 9.1
T-Value	0.385	- 3.347	-12.881
Significance	No	Yes	Yes

Sample Size = 10

2 Tail Probability = 2.1009, = 0.025, 18 D.O.F.

It can be suggested from Table 5.2.2.2. that there is a significant difference in the profitability and present worth of the firm at the end of a given period if future worth and payback period methods are used. Future worth method is significantly better than payback period.

As seen in Table 5.2.2.2. there is no significant difference in average life of investments.

Average number of investments made by future worth method is significantly less than the payback period method which shows that future worth method is biased to higher initial investment costs and suffer more from capital rationing.

In Table 5.2.2.3. the findings about the comparisons regarding the effect of using future worth or random selection in making capital investment decisions.

Table 5.2.2.3.

FUTURE WORTH VS RANDOM SELECTION

	50 - 50 (billions)	40 - 40 (billions)	30 - 30 (billions)
Net Present Worth			
Difference (Mean)	86,637.8	61,855.7	57,103.1
T-Value	23.509	14.065	17.725
Significance	Yes	Yes	Yes
Profitability Per Y.			
Difference (Mean)	16.707	13.867	14.978
T-Value	18.837	13.772	14.756
Significance	Yes	Yes	Yes
Average Life			
Difference (Mean)	- 0.002	0.286	0.107
T-Value	- 0.005	0.745	0.251
Significance	No	No	No
Average Investment			
Difference (Mean)	- 0.2	- 5.1	- 8.6
T-Value	- 0.276	- 4.228	-12.385
Significance	No	No	Yes

Sample Size = 10

2 Tail Probability = 2.1009, = 0.025, 18 D.O.F.

It can be suggested from Table 5.2.2.3. that there is a significant difference in the profitability per year and present worth of the firm at the end of a given period if future worth and random selection methods are used. Future worth method is significantly better than random selection.

As seen in Table 5.2.2.3. there is no significant difference in the average life of investments.

Average number of investments made by future worth method is significantly less than random selection method supporting the analysis of Table 5.2.2.1. and 5.2.2.2.

Future Worth method seems to be superior to other capital investment ranking criteria except present worth method in all levels of initial investment.

5.2.3. Profitability Index

In Table 5.2.3.1. the findings about the comparison regarding the effect of using profitability index or payback period in making capital investment decisions.

Table 5.2.3.1.

PROFITABILITY INDEX VS PAYBACK PERIOD

	50 - 50 (billions)	40 - 40 (billions)	30 - 30 (billions)
Net Present Worth			
Difference (Mean)	-30,751.9	-34,227	6,407.3
T-Value	- 5.428	- 3.989	1.094
Significance	Yes	Yes	No
Profitability Per Y.			
Difference (Mean)	- 6.018	- 5.901	2.052
T-Value	- 5.378	- 6.601	1.266
Significance	Yes	Yes	No
Average Life			
Difference (Mean)	- 0.228	0.157	0.369
T-Value	- 0.735	0.353	0.993
Significance	No	No	No
Average Investment			
Difference (Mean)	0.2	- 2.6	- 5.1
T-Value	0.313	- 3.852	- 7.964
Significance	No	Yes	Yes

Sample Size = 10

2 Tail Probability = 2.1009, = 0.025, 18 D.O.F.

It can be suggested from Table 5.2.3.1. that there is a significant difference in the profitability and present worth of the firm at the end of a given period for the investment levels of 50 billions and 40 billions if payback period and profitability index methods are compared. The payback period method is significantly better than profitability index.

As seen in Table 5.2.3.1. there is no significant difference in the average life of investments.

Average number of investments made with profitability index criteria is less than payback period method because of the bias of payback period model to the lower initial cost investments.

In Table 5.2.3.2. the findings about the comparison regarding the effect of using profitability index or random selection in making capital investment decision are presented.

Table 5.2.3.2.

PROFITABILITY INDEX VS RANDOM SELECTION

	50 - 50 (billions)	40 - 40 (billions)	30 - 30 (billions)
Net Present Worth			
Difference (Mean)	21,683	3,851.7	20,177.2
T-Value	4.913	0.442	4.077
Significance	Yes	No	Yes
Profitability Per Y.			
Difference (Mean)	4.837	3.407	6.206
T-Value	4.382	2.831	4.327
Significance	Yes	Yes	Yes
Average Life			
Difference (Mean)	- 0.149	0.345	0.483
T-Value	- 0.433	0.863	1.158
Significance	No	No	No
Average Investment			
Difference (Mean)	- 0.3	- 3.4	- 4.6
T-Value	- 0.526	- 6.669	- 7.336
Significance	No	Yes	Yes

Sample Size = 10

2 Tail Probability = 2.1009, = 0.025, 18 D.O.F.

It can be suggested from Table 5.2.3.2. that there is a significant difference in the profitability and present worth of the firm at the end of a given period if profitability index and random selection are compared. Profitability index is significantly better than Random Selection.

As seen in Table 5.2.3.2. there is no significant difference in the average life of investments.

As the result of the analysis above it seems that profitability index method is only superior to random selection method.

5.2.4. Payback Period

In Table 5.2.4.1. the findings about the comparison regarding the effect of using payback period or random selection method in making capital investment decisions.

Table 5.2.4.1.

PAYBACK PERIOD VS RANDOM SELECTION

	50 - 50 (billions)	40 - 40 (billions)	30 - 30 (billions)
Net Present Worth			
Difference (Mean)	52,434.9	38,079.1	13.769.9
T-Value	9.636	10.607	2.756
Significance	Yes	Yes	Yes
Profitability Per Y.			
Difference (Mean)	10.855	9.308	4.154
T-Value	9.193	9.949	2.652
Significance	Yes	Yes	Yes
Average Life			
Difference (Mean)	- 0.292	- 0.188	0.114
T-Value	- 0.752	- 0.417	0.274
Significance	No	No	No
Average Investment			
Difference (Mean)	- 0.5	- 0.8	0.5
T-Value	- 0.876	- 1.222	0.622
Significance	No	No	No

Sample Size = 10

2 Tail Probability = 2.1009, = 0.025, 18 D.O.F.

It can be suggested from Table 5.2.4.1. that there is a significant difference in the profitability and present worth of the firm at the end of a given period of time if payback period and profitability index are compared. Payback period is significantly better than random selection.

As seen in Table 5.2.4.1. there is no significant difference in the average life of investments.

As a whole result of the analysis in this section, the points below can be suggested for capital investment decisions under uncertain inflation.

- The ranking criteria to be applied can be ranked from better to worse as follows

. Present Worth, Future Worth.
. Payback Period
. Profitability Index
. Random Selection

- Future Worth method is biased to high first cost projects.

- Payback period method is biased to low first cost projects.

- Change in the amount of initial investment does not affect the ranking of ranking criteria.

5.3. Findings Regarding The Effects Of Change In Randomness Level

In this section findings about the comparison of net present worths, rate of return, average life and total number of investments occurred by using present worth and payback period criteria under a parametric change of randomness level from 25 % to 50 % are presented.

In Table 5.3.1.1. the findings about the comparison regarding the effect of change in randomness level by using present worth criteria are presented.

Table 5.3.1.1.

PRESENT WORTH VS PRESENT WORTH

(25 %) (50 %)

	50 - 50 (billions)	40 - 40 (billions)	30 - 30 (billions)
Net Present Worth			
Difference (Mean)	97,370.3	88,035.4	78,282.3
T-Value	18.95	17.26	13.479
Significance	Yes	Yes	Yes
Profitability Per Y.			
Difference (Mean)	18.762	20.434	24.114
T-Value	26.954	26.712	32.689
Significance	Yes	Yes	Yes
Average Life			
Difference (Mean)	- 0.55	0.069	0.154
T-Value	- 1.51	0.201	0.413
Significance	No	No	No
Average Investment			
Difference (Mean)	- 1.1	1.3	- 4.3
T-Value	- 1.656	1.523	- 6.457
Significance	No	No	Yes

Sample Size = 10

2 Tail Probability = 2.1009, = 0.025, 18 D.O.F.

It can be suggested from Table 5.3.1.1. that present worth method which was applied with a higher randomness level is significantly worse than present worth method with lower randomness level.

This result is interesting in the sense that although present worth method operates well in certainty it is very sensitive to uncertainty both of the evaluation criteria namely profitability and net present worth of firm are affected significantly from the increase in uncertainty.

In Table 5.3.1.2. findings about the comparison regarding payback period methods under different levels of randomness.

Table 5.3.1.2.

PAYBACK PERIOD VS PAYBACK PERIOD

(25 %) (50 %)

	50 - 50 (billions)	40 - 40 (billions)	30 - 30 (billions)
Net Present Worth			
Difference (Mean)	88,420	79,976.6	54,247
T-Value	16.683	27.909	13.012
Significance	Yes	Yes	Yes
Profitability Per Y.			
Difference (Mean)	22.28	23.541	22.002
T-Value	18.50	26.62	16.77
Significance	Yes	Yes	Yes
Average Life			
Difference (Mean)	- 0.408	0.163	0.341
T-Value	- 1.123	0.405	1.123
Significance	No	No	No
Average Investment			
Difference (Mean)	- 0.1	2.5	3.5
T-Value	- 0.158	3.07	4.130
Significance	No	Yes	Yes

Sample Size = 10

2 Tail Probability = 2.1009, = 0.025, 18 D.O.F.

It can be suggested from Table 5.3.1.2. that payback period method which was applied with a higher randomness level is significantly worse than payback period method with lower randomness level.

Both of the evaluation criteria namely profitability and present worth of the firm are affected significantly from the increase in uncertainty.

The second part that is affected is the average number of investment. Payback period method performing under less uncertain environment invested significantly more than the one that performs under higher uncertainty level.

In Table 5.3.1.3. the findings about the comparison of present worth and payback period are presented for the changed level of randomness.

Table 5.3.1.3.

PRESENT WORTH VS PAYBACK PERIOD

(50 %) (50 %)

	50 - 50 (billions)	40 - 40 (billions)	30 - 30 (billions)
Net Present Worth			
Difference (Mean)	22,812.2	19,068.4	15,864.4
T-Value	5.581	4.342	2.719
Significance	Yes	Yes	Yes
Profitability Per Y.			
Difference (Mean)	8.683	8.239	7.963
T-Value	9.896	10.11	11.07
Significance	Yes	Yes	Yes
Average Life			
Difference (Mean)	0.43	- 0.076	- 0.099
T-Value	1.176	- 0.229	- 0.285
Significance	No	No	No
Average Investment			
Difference (Mean)	0.3	1.2	1.2
T-Value	0.420	1.334	1.493
Significance	No	No	No

Sample Size = 10

2 Tail Probability = 2.1009, = 0.025, 18 D.O.F.

It can be suggested from Table 5.3.1.3. that although present worth method does not perform as well as it performs in more certain environments, still it is significantly superior to payback period both in present worth and profitability per year criteria.

Both of the criteria seems to invest the same number when average number of investment row is investigated.

As a final result, it can be suggested that the increase of uncertainty decreases the efficiency of conventional investment ranking criteria.

5.4. Findings Regarding the Effects Of Change In Simulation Time

In this section the findings about the comparison of net present worths, rate of returns, average lives and total number of investments occurred by using present worth criterion under a parametric change of simulation time from 5 years to 10 years are presented.

In Table 5.4.1.1. the findings about the comparison regarding the change in simulation time are presented for only present worth criterion.

Table 5.4.1.1.

PRESENT WORTH VS PRESENT WORTH
(5 YEARS) (10 YEARS)

	50 - 50 (billions)	40 - 40 (billions)	30 - 30 (billions)
Net Present Worth			
Difference (Mean)	80,721.6	82,553.1	78,461.3
T-Value	13.66	18.594	25.267
Significance	Yes	Yes	Yes
Profitability Per Y.			
Difference (Mean)	15.405	19.883	24.037
T-Value	18.049	25.961	31.151
Significance	Yes	Yes	Yes
Average Life			
Difference (Mean)	- 0.011	- 0.363	0.088
T-Value	- 0.033	- 1.143	0.324
Significance	No	No	No
Average Investment			
Difference (Mean)	-15.6	-12.0	-14.8
T-Value	-21.24	-16.972	-15.161
Significance	Yes	Yes	Yes

Sample Size = 10

2 Tail Probability = 2.1009, = 0.025, 18 D.O.F.

It can be suggested from Table 5.4.1.1. that although present worth method does not perform in the long run under uncertain inflation, it can still be used.

Increasing the number of years simulated increases the uncertainty which in turn reduces the effectiveness of present worth.

If the number of investments for each run are analyzed, there is a significant increase in number of investment in all levels of initial investment.

VI. CONCLUSIONS AND IMPLICATIONS

6.1. Conclusions

In the research reported here, the effectiveness of five different capital budgeting ranking criteria under uncertain inflation were investigated by a computer simulation model. Capital budgeting ranking criteria were tested under three levels of initial investment with a given uncertainty range, changing uncertainty range and changing time of simulation. Five different types of investment data which were the result of a preliminary research in the feasibility reports of Türkiye Sinai Kalkınma Bankası A.Ş. were used.

Investment alternatives were generated according to the models of the parameters at a given randomness level. The cash flows of the investment alternatives were not analyzed in isolation, instead the expenses namely raw material, operating, selling, personnel and other expenses and income namely, sales, receivables, collections and salvage value were generated to form the net cash flows. Cash flows were analyzed and evaluated according to each criterion to make investment decisions and at the end of the simulation run the value of the firm was evaluated to analyze the differences of the ranking criteria.

The analysis of literature reveals that the analysis of the effectiveness of capital budgeting ranking criteria with a computer simulation model are rare. Among these, Smith and White [1986] may be mentioned even though their study does not incorporate certain or uncertain inflation. The logic of the simulation program of Smith and White (1986) was taken as the basis at the very beginning of the research and a computer simulation model with a similar logic which incorporates inflation was developed.

The conclusions to be made as a result of the application of the model will follow the findings regarding effectiveness of ranking criteria under uncertain inflation.

It is observed in this study that the increase in the amount of initial investment increases the present worth of the firm which ever type of capital budgeting ranking criteria is used in making the decision of investment except the random selection method.

Another observation in this stage is that the increase in the amount of initial investment decreases the profitability per year.

At this point, an important factor in capital investment decision comes out. It is obvious from the above result that even though under uncertain inflation, capital rationing is an important factor that effects the firm's investment decisions.

As the amount of initial investment increases, the firms begin to feel free about using the funds which in turn decreases or vanishes capital rationing.

Average life of investments are observed not to be changing as the amount of initial investment increases. This was an expected result at the beginning of the research because of the distribution of investment life which is a uniform distribution.

The findings regarding the number of investments reveals that, it increases as the amount of initial investment increases which conforms the general expectation.

When the all of the ranking criteria are compared to each other, it becomes clear that in general methods that apply time value of money perform better than the approaches that does not apply time value of money and as it was expected, all of the methods are better than random selection technique.

The effectiveness of ranking criteria under uncertain inflation is observed to be as follows:

- Present Worth, Future Worth.
- Payback Period.
- Profitability Index.
- Random Selection.

This ranking becomes surprising enough when the ranking concluded by Smith and White [1986]. According to their study without inflation at all, payback period ranks 8th out of 10 capital investment ranking criteria which is behind profitability index. According to their study, profitability index performs better than present worth, also.

Interestingly enough, the conclusion reached about the effectiveness of capital investment ranking criteria under uncertain inflation conforms the first proposition of Nelson [1976] knowing that payback period is biased to low first cost investments.

It is also an important finding that the number of investments made by using payback period is significantly more than other criteria especially at the lowest amount of initial investment level where the capital rationing is high.

Another topic covered by this study was testing the changes in the simulation parameters.

The change, namely the increase in randomness level was applied for present worth and payback period criteria for all levels of initial investment.

Where the comparison of two findings of present worth under different levels of randomness are concerned, it is observed that present worth method performs better under less uncertain environment and the bias of present worth increases as the randomness increases.

The observation regarding the comparison between two payback methods under different levels of randomness reveals that payback period performs better under less uncertain environment.

For both of the methods no significant difference in average life of investment and number of investments was observed.

The comparison of present worth and payback period under higher randomness level the ranking of criteria does not change. Present worth performs better but the number of investment made with payback period is still significantly higher than present worth for lower amounts of initial investment.

The second test for the change of a simulation parameter was increasing the time of simulation for all initial investment levels of present worth.

The comparison of two present worth findings reveal that present worth performs better in the short run than the long run under uncertain inflation.

6.2. Implications For Further Studies

In this study only five of the capital investment ranking criteria were analyzed and evaluated according to the simulation model prepared before.

The simulation model used can be developed and designed to test the other criteria which was not included in this study.

One other point is the project divisibility. It is possible to design a model which permits project divisibility according to the needs that may arise.

Instead of equal lives of investment for each different type of project, the model can be revised to generate alternatives with unequal life and those alternatives can be evaluated according to the replacement needs.

One of the important findings of this study is the decrease in efficiency of present worth and payback methods when there is an increase in uncertainty. In order to analyze and understand this fact, it is possible to carry a sort of sensitivity analysis with different investment ranking criteria.

Another important finding of this study was the decrease in the efficiency of present worth method when the simulation time is increased. It is possible for this subject to carry a sensitivity analysis about for how long the capital investment criteria can be used without biasing the real net value of the project.

It is also possible to investigate about capital rationing and the first costs of investment which was not included in the study. Including first cost of investment will bring a broader view to the subject of bias introduced by using different capital investment ranking criteria under uncertain inflation.

Another possible investigation may occur if the model is revised according to borrowing and lending criteria. In this way the real impact of external capital rationing on capital budgeting under uncertain inflation may be observed.

6.3. Implications For Managers

It is observed in this study that among the five capital investment ranking techniques tested under uncertain inflation with a computer simulation model, the ranking from most efficient to less efficient is obtained:

- Present Worth, Future Worth.
- Payback Period.
- Profitability Index.
- Random Selection.

In case of present worth, which seems to be one of the efficient criteria among the ones that were investigated, the performance and the efficiency of the criterion drops when the profitability per year and net value of the firm are calculated if there is an increase in uncertainty.

Again in case of present worth, same implication can be mentioned if there is a need to evaluate long term projects occur. Present Worth method performs better for short run than it performs for the long run.

Use of profitability index in the evaluation of investment in a uncertain inflationary environment is not advised according to the conclusion reached above.

It is also possible for managers to simulate their own decisions in the model generated. The analysis of the results of the simulation may give a rough idea to the managers.

APPENDICES

APPENDIX A

Wholesale Price Index Analysis

The data gathered are shown in Table A.1.

Table A.1.

ANALYSIS OF WPI

Year	WPI (*)	LOG_{10}(WPI)
1	469.7	2.672
2	779.2	2.892
3	1,460.6	3.165
4	3,152.1	3.499
5	4,134.5	3.616
6	5,386.9	3.731
7	7,298.0	3.683
8	10,358.1	4.015
9	14,938.6	4.174
10	19,454.3	4.289
11	26,835.1	4.429

All of the data are for industrial raw material and semi finished goods.

A regression model with the logarithmic data is proposed for WPI

*Prime Ministry State Institute Of Statistics.
Statistical Year Book Of Turkey, Nov.85,p.385
Statistical Pocketbook Of Turkey,Dec.88,p.233

The model is :

$y = 2.6489 + 0.16981\, x$ where x is the number of years beginning from 1.

The regression model is tested.

$$t\ calc = \frac{|0.986| \times |\sqrt{11-2}\,|}{\sqrt{1-(0.986)^2}}$$

$$= 17.7396$$

$t_{0.975,9} = 2.2622 < t_{calc}$

Accept the model.

WPI Parameter :

WPI_i = (0.75)(Inv Logy)+Trunc [(0.50) (Inv Logy) Random +1] for the ith year.

$$\Delta WPI_i = \frac{WPI_{i+1}}{WPI_i}$$ is the percent increase in WPI

APPENDIX B

Foreign Currency Buying and Selling Rate

The data gathered are shown in Table B.1.

Table B.1.

ANALYSIS OF FX SELLING RATES

Year	SELLING RATE(*)	$LOG_{10}(SR)$
1	18.10	1.258
2	24.63	1.391
3	35.22	1.547
4	77.54	1.890
5	112.81	2.052
6	165.26	2.218
7	230.33	2.362
8	375.10	2.574
9	528.50	2.723
10	680.88	2.833
11	872.51	2.941

A regression model with the logarithmic data is proposed for selling rate.

The model is :

$y = 1.1051 + 0.1762\ x$ where x is the number of years beginning from 1.

*Selling Rate is equal to total import (TL) divided by total import ($) from 1977 to 1987.
Prime Ministry State Institute Of Statistics.
Statistical Pocketbook Of Turkey, Dec.1988 p.218

The regression model is tested.

$$t\ calc = \frac{|0.9938| \times |\sqrt{11-2}|}{\sqrt{1 - (0.9938)^2}}$$

$$= 26.8153$$

$$t_{0.975,9} = 2.2622 < t_{calc}$$

Accept the model.

<u>FX Selling Rate Parameter :</u>

SR_i = (0.75)(Inv Logy) + Trunc [(0.50) (Inv Logy) Random +1] for the ith year.

$$\Delta SR_i = \frac{SR_{i+1}}{SR_i}$$ is the percentage increase in selling rate

<u>FX Buying Rate Parameter</u>

$$BR_i = (0.96) \times (SR_i)$$

$$\Delta BR_i = \frac{BR_{i+1}}{BR_i}$$ is the percentage increase in buying rate.

APPENDIX C

Wage Analysis

The data gathered are shown in Table C.1

Table C.1.

ANALYSIS OF WAGE

Year	AVERAGE WAGE(*)	LOG_{10} (WAGE)
1	146.53	2.17
2	207.93	2.32
3	294.31	2.47
4	426.96	2.63
5	543.84	2.74
6	691.03	2.84
7	944.07	2.98
8	1.307.00	3.12

A regression model with the logarithmic data is proposed for wages.

The model is :

$y = 2.0604 + 0.132976\ x$ where x is the number of years beginning from 1.

*Prime Ministry State Institute Of Statistics.
Statistical Yearbook Of Turkey, Nov. 85 p.203
Statistical Pocketbook Of Turkey, Dec.88 p.97

The regression model is tested

$$t\ calc = \frac{|0.99811| \times |\sqrt{8-2}|}{\sqrt{1-(0.99811)^2}}$$

$$= 39.7844$$

$$t_{0.975,6} = 2.4469 < t_{calc}$$

Accept the model.

<u>Average Daily Wage Parameter</u>

DW_i = (0.75) (Inv Logy) + Trunc [(0.50)(Inv Logy) Random +1]
for the i.th year.

$$\Delta DW_i = \frac{DW_{i+1}}{DW_i}$$

is the percentage increase in average daily wage.

APPENDIX D

Consumer Price Index Analysis

The data gathered are shown in Table D.1.

Table D.1.

ANALYSIS OF CPI

Year	CPI (*)	INCREASE (%)
1982	410.3	
1983	539.1	31.39
1984	800.0	48.39
1985	1.159.6	44.95
1986	1.561.0	34.61
1987	2.167.5	38.85

There is so little data that any type of analysis can not be made.

For the sake of simplicity and heuristic reasons like the current inflation level, CPI is considered as uniformly distributed between [35 %, 75 %] level.

*Prime Ministry State Institute Of Statistics
Statistical Yearbook of Turkey Nov. 1985 p.391
Statistical Pocketbook of Turkey Dev. 1988 p.240

APPENDIX E

Formulas Used For Parameters In The Generation Of Alternatives In Computer Model.

E.1. Expenses

E.1.1. Raw Material Expense.

The raw material expense was thought to be dependent on the increase in WPI and foreign exchange selling rate because of importation of raw material.

$$RM_{i+1} = (1-IP) \times (RM_i) \times (\Delta WPI_i) + (IP) \times (RM_i) \times (\Delta SR_i)$$

RM_i = Raw Material Expense in year i.

IP = Import Percentage.

$$\Delta WPI_i = \frac{WPI_{i+1}}{WPI_i}$$

increase in the wholesale price index from year i to i + 1.

$$\Delta SR_i = \frac{SR_{i+1}}{SR_i}$$

increase in foreign exchange selling rate from year i to i + 1.

E.1.2. Wages and Personnel Expense

The wage and personnel expense was thought to be dependent on the increase in daily wages.

$$WP_{i+1} = (\Delta DW_i) \times (WP_i)$$

WP_i = Wages and Personnel Expense in year i.

$$\Delta DW_i = \frac{DW_{i+1}}{DW_i}$$

increase in average daily wage from year i to i + 1.

E.1.3. Operational Expense.

The operational expense was thought to be dependent on the wholesale price index.

$$OE_{i+1} = (\Delta WPI_i) \times (OE_i)$$

OE_i = Operational Expense in year i.

E.1.4. Selling Expense

The selling expense was modeled as the operational expense, as well.

$$SE_{i+1} = (1 + \Delta CPI_i) \times (SE_i)$$

SE_i = Selling Expense in year i.

ΔCPI_i = Increase in CPI from year i to year i + 1.

E.1.5. Other Expense

The other expense was thought to be dependent on the increase of wholesale price index.

$$OTE_{i+1} = (1 + \Delta CPI_i) \times (OTE_i)$$

OTE_i = Other Expense in year i.

E.2. <u>Incomes</u>

E.2.1. Sales

Sales were thought to be dependent on the increase in consumer price index and foreign exchange buying rate because of exportation of finished goods.

$$S_{i+1} = (1-EP) \times (S_i) \times (1+\Delta CPI_i) + (EP) \times (S_i) \times (\Delta BR_i)$$

S_i = Sales in year i.

EP = Export Percentage.

ΔCPI_i = increase in consumer price index from year i to year i + 1.

$$\Delta BR_i = \frac{BR_{i+1}}{BR_i}$$

increase in foreign exchange buying rate from year i to i + 1.

E.2.2. Receivables

The receivables were thought to be dependent on the increase in consumer price index and foreign exchange buying rate.

$$R_{i+1} = (1-EP) \times (R_i) \times (1 + \Delta CPI_i) + (EP) \times (S_i) \ (\Delta BR_i)$$

R_i = Receivables in year i.

ΔCPI_i = The increase in CPI from year i to i + 1.

E.2.3. Closing Value

The salvage value was thought to be dependent on the increase in consumer price index.

$$SV_{end} = (SV_{beg}) \left(\prod_{i=\text{beggining year}}^{\text{ending year}} (1 + \Delta CPI_i) \right)$$

SV_{end} = Salvage Value of the project at the end of the feasible life of it.

SV_{beg} = Salvage Value of the project in the beginning.

APPENDIX F

Formulas Used In The Calculations Of T-Values

$$\bar{x} = \frac{\sum_{i=1}^{n} x_i}{n}$$ where i is the number of consecutive simulation runs.

$$\sigma_{n-1} = \frac{\sum_{i=1}^{n} (x-xi)^2}{n-1}$$ where i is the number of consecutive simulation runs.

$$\sigma_{\bar{x}_1 - \bar{x}_2} = \sqrt{\frac{\sigma_1^2}{n^1} + \frac{\sigma_2^2}{n^2}}$$ where $\sigma 1$ and $\sigma 2$ are the standard deviations of two different simulation runs.

Hypothesis Testing

$H_0 \quad = \bar{x}_1 - \bar{x}_2 = 0$

$H_1 \quad = \bar{x}_1 - \bar{x}_2 <> 0$ (Two Tailed - Test)

$$\text{Standard Error} = \frac{\bar{x}_1 - \bar{x}_2}{\sigma_{\bar{x}_1 - \bar{x}_2}}$$

If Standard Error > $t_{0,975,18}$

Reject Null Hypothesis

Accept $\bar{x}_1 - \bar{x}_2 <> 0$

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