BUILD-OPERATE-TRANSFER MODEL FOR INVESTMENT PROJECTS: A COMPARISON WITH SOCIAL BENEFIT-COST ANALYSIS

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Prof. Dr. Alpay ANKARA

Director

I certify that this thesis satisfies all the requirements as a thesis for the degree of Master of Science.

Assoc. Prof. Dr. Çağlar GÜVEN

Chairman of the Deparment

We certify that we have read this thesis and that in our opinion it is fully adequate, in scope and quality, as a thesis for the degree of Master of Science in Industrial Engineering.

Assoc. Prof. Dr. Yıldız ARIKAN

Supervisor

Examining Committee in Charge:

Assoc. Prof. Dr. Yıldız ARIKAN

Assoc. Prof. Dr. Sinan KAYALIGIL

Assoc. Prof. Dr. Murat KÖKSALAN

Assoc. Prof. Dr. Erol SAYIN

Assist. Prof. Dr. Sibel GÜVEN

ABSTRACT

BUILD-OPERATE-TRANSFER MODEL FOR INVESTMENT PROJECTS:
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GÜMÜŞTEKİN, ALİ

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In this thesis, the Build-Operate-Transfer (BOT) model of project financing and implementation has been studied in full detail to give a complete overview of the model and its inherent problems. The thesis also investigates the framework of BOT procedure for power projects in Turkey. Furthermore, the BOT model has been compared with the well known Social Benefit-Cost Analysis (SBCA) procedure of project evaluation to explore under what conditions the two procedures lead to opposite choices. For illustrating the relevant issues a BOT power project for Turkey has been analyzed by both methods and the results have been compared. It has been observed that a project which is acceptable on the BOT basis might not be acceptable when its net social benefits are considered. However, conclusions are highly sensitive on assumptions that do not enjoy a technical precision and social

character. The main contribution of the thesis is to supply and classify a coherent set of documentation on the BOT model of project financing and to provide quantitative support to certain issues of interest.

Keywords: Build-Operate-Transfer Model, BOT, Social Benefit-Cost Analysis, Project Appraisal.

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ÖZ

YATIRIM PROJELERİ İCİN YAP-İŞLET-DEVRET MODELİ: SOSYAL FAYDA-MALİYET ANALİZİ İLE BİR KARŞILAŞTIRMA

GÜMÜŞTEKİN, Ali

Yüksek Lisans Tezi, Endüstri Mühendisliği Anabilim Dalı

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Bu tezde, proje finansmanı ve uygulamasında yararlanılan Yap-İşlet-Devret (YİD) modeli tüm ayrıntılarıyla ve içerdiği sorunlarla birlikte incelenmiştir. Ayrıca tezde, Türkiye'de enerji projelerinin gerçeklestirilmesi için geliştirilmiş YİD yapısına da yer verilmiştir. Buna ek olarak, Yap-İşlet-Devret modeli iyi bilinen bir proje değerlendirme yöntemi olan Sosyal Fayda-Maliyet Analizi ile de karşılaştırılmış ve proje seçimleri açısından farklı tercihlere neden olan koşullar araştırılmıştır. Konuyla ilgili problemleri incelemek amacıyla Türkiye için bir YİD projesi her iki yöntemle de değerlendirilmiş ve sonuçlar karşılaştırılmıştır. Görülen odur ki, YİD modeli çerçevesinde yapılmasına karar verilen bir projenin sosyal fayda ve maliyetler göz önüne alındığında reddedilmesi mümkün olmaktadır. Ancak, yine görülmüştür ki bu karar teknik hassasiyetinden çok sosyal içeriği önemli olan pek

çok varsayıma bağlıdır, dolayısıyla farklı varsayımlar altında farklı kararlara ulaşmak mümkündür. Tezin ana katkısı Yap-İşlet-Devret proje finansman modelini tüm ayrıntılarıyla inceleyen bir doküman oluşturması ve bu modelle ilgili bazı önemli konuları sayısal sonuçlara dayandırarak irdelemesidir.

Anahtar Kelimeler: Yap-İşlet-Devret Modeli, YİD, Sosyal Fayda-Maliyet Analizi, Proje Değerlendirilmesi.

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CHAPTER I

INTRODUCTION

All countries but especially the developing countries have financial troubles in their economic development and they also face the basic economic problem of allocating limited resources such as labour, capital, land and other natural resources as well as foreign exchange to many different uses such as current production of consumer goods and public services or investment in infrastructure, industry, agriculture, education, and other sectors. Using limited resources in one direction (for example, investment in infrastructure) reduces the resources available for use in another direction (for example, investment in agriculture), thus producing adverse effects in these sectors.

It is in this context, that a new method called BOT (Build - Operate-Transfer) was created for the developing countries for implementing the public projects by the private sector to solve the financing issues they are facing when dealing with investment projects.

In fact, BOT is not a new method for the developed countries. It has been used in those countries since 1955s. For example, in France, the public power

adapted the BOT model to its economy and implemented the required infrastructure projects (Selwan, 1990: 147-150).

On the other hand, the BOT model is new to developing countries and it has been adapted for providing the required financing and technical development to implement the infrastructure projects. Indeed, in addition to financing of the projects without increasing the external debt, another purpose of using BOT was to import new technology into those countries and to provide training for the local staff in order to deal efficiently with this technology.

The principles of BOT method is rather simple. The host government requiring an infrastructure project asks for private investors to build the project with the financing provided mainly by them. In order to implement the project from the construction to the operation period, a corporation called joint venture is created by the project promoters, in which the shareholders are the promoters, the constructors and the operators. The joint venture is legally the entity dealing with the project. It has to find the required loans to complete the financing scheme.

The host government provides a contract called a concession contract in which the joint venture is given the right to build and operate the project for a given period. The length of the period is based on the revenues

level the joint venture needs to repay the debt service (principal and interest), equity service and the return on the investments for the shareholders. It should be a sufficient length of time to recoup the project's costs and make profits.

As risks (uncertainties) are common to any project, BOT projects also faced with risks such as financing risk, technical risk and political risk. There are a number of ways to deal with these risks. These vary from necessary precautions taken by the joint venture by adequate geological, technical and market studies to the guarantees provided by the host government to the joint venture in case of any risks that are out of control of the joint venture during the concession period. Those guarantees concern the political decisions that could affect the project's profitability or the transfer of funds and exchange rates or the transfer of ownership at the end of the concession period. Since these guarantees are provided to minimize the losses of the joint venture in case of risk, they reduce the overall benefits, hence the desirability of the BOT projects from the host government point of view and they require special attention in evaluating the projects.

Turkey is an example of a developing country which seems to be the country that is most interested in BOT process. The main purposes behind the movement to the BOT process were to attract foreign investors and to

reduce the government's involvement in the financing of the public infrastructures in view of the country's large foreign debt.

Turkey has already built some infrastructure projects relying on foreign financing like the Bosphorus Bridge. Turkey's need for electricity has led the government to promote the BOT model to build and operate the power plants by the private sector without increasing the external debt.

The BOT procedure for formulating and evaluating projects is a rather new tool for governmental decision making. Given the limitation of resources, choices must be made among the competing uses of resources based on the extent to which they help the country to achieve its fundamental objectives. One of the known methods of presenting this choice between competing uses of resources in a suitable and comprehensible fashion is called "Social Benefit-Cost Analysis". Social benefit-cost analysis has been used in many countries since 1930s at varying extents. Social benefit-cost analysis is not a technique but is an approach. It provides a rational framework for project choice in the light of national objectives like aggregate consumption, income redistribution, growth rates of national income and employment level.

The present thesis describes and analyzes the BOT model with all the purposes, risks, role and

responsibility of every actor, but it also studies the relative merits of the BOT method and social benefit-cost analysis for project choice. A BOT hydro-electric power project for producing electricity has also been evaluated by social benefit-cost analysis to make a comparison of the two procedures under different assumptions to see if they yield any contradictory results leading to opposite choices.

Chapter 2 of the thesis provides an extensive literature survey on the BOT model of project financing with the description of the process, steps in the creation of the projects and the risks associated with the projects. It also describes the BOT model in Turkey and examines the BOT principles applied for the power projects in the country.

Chapter 3, gives a short description of social benefit-cost analysis underlining the main reasons of its use in the developing countries. It also presents the UNIDO methodology for social benefit-cost analysis.

Chapter 4, presents the application of the BOT procedure to a power project (Dongel hydro-electric power project) performed by the project company.

Chapter 5 includes the application of social benefit-cost anaysis criteria to the Dongel hydro-electric power project which has already been analyzed with the BOT method by the joint venture company. This

evaluation is carried out in successive stages of approximation in which corrections over various cost and benefit items are progressively introduced. Moreover, the analysis of the project has also been performed by assuming changing shadow price of investment instead of the constant shadow price of investment over time and also taking into account government guarantees. The results have been compared with those of BOT evaluations.

Chapter 6 provides concluding remarks on BOT model of project financing and the obtained results.

Appendix A and B presents the derivation of the shadow price of investment when national parameters (marginal rate of saving and marginal rate of capital) are assumed to be constant over time and change with time, respectively. The mathematical verification of the net present value function (NPVF) which passes through a minimum value when shadow price of investment changes with respect to the selected "to" period, is included in Appendix C. Finally, Appendix D presents a FORTRAN program for the evaluation of the projects with the social benefit-cost analysis.

CHAPTER II

BUILD-OPERATE-TRANSFER MODEL OF PROJECT FINANCING

The BOT model can be defined as a sort of project financing technique to build the public projects and then run them for a sufficient length of time to allow the financial amortization of the whole project by private organizations and at the end of the operation period transfer the ownership of them to the public power.

The BOT model has been devised by governments as a way of funding large public infrastructure projects without increasing the external debt.

In order to implement the projects through private companies, a concession contract (specifies the project's operation lenght of time) must be signed by the host government and the project promoter (or sponsor). During the concession period, the project promoter will own the project. The length of the concession period is based upon expected cash flows from operations. In order to have a feasible project, expected cash flows must reach a certain level. That is, they should be enough to recoup the costs and make profits.

After the concession period, if there is an

agreement between the host government and the project promoter for a new concession contract then the private organizations will continue to operate the built facility. Another alternative is to sell the equipment or plant to the local private investors by the host government (BOO-Build-Operate-Own scheme). If there is no agreement on the above cases then the ownership of the project will be transferred to the host government depending on the clauses in the concession contract (BOT-Build-Operate-Transfer).

BOT is not a completely new method. Examples of BOT structures can be traced back to Victorian times in the United Kingdom when municipal works such as for electricity and water expansion or modernization schemes, were built and operated by private companies before being sold to the local town councils. These structures were also applied in Germany in the late nineteenth century (Indosues, 1898). However, it is new to the developing world particularly in relation to infrastructure projects. Developing countries see BOT as a way of reducing their external debt and at the same time promoting direct foreign investments in their country's infrastructure or industrial projects.

There are six main parties involved in the BOT projects. The project promoter also called the project sponsor, the constructor, the operator, the public power, the investors and finally the lenders. In the following

sections, the role of these parties in the BOT model will be defined.

2.1 Purposes Behind BOT

The reasons why BOT model is used in the public projects, are different depending on the country where the BOT projects will be implemented is a developed or a developing country. Therefore, the purposes behind the BOT model will be discussed in two parts, for developed and developing countries.

2.1.1 Developed Countries

Now, in developed countries, goverments are looking for the privatization of the public projects. There are two main purposes for such a move. First, the state can reduce its involvement in the financing of the infrastructure projects. This will allow public power to concentrate on other expenses in different fields like social services or education. Second, this strategy allows the private sector's managers to take advantage of such opportunities in order to prove their skills for such projects management when working in international markets (Selwan, 1990:21).

2.1.2 Developing Countries

The developing countries face with the financial

problems in their economic development. They have a lot of infrastructure projects that need to be implemented. However, they do not have the required financing. They are the debtor of the developed countries. Their external debts are important and they want to reduce their debts. Therefore, the developing countries use BOT as a way of reducing their external debt. If they have a limited debt level, they can use this debt for other purposes than project financing as the projects will be financed by the foreign private sector. By this way, investment will be increased in the country while the debt level stays the same. There are also pressures on the developing countries from the international lenders such as the International Monetary Fund or the private banks for reducing their external debt.

Another purpose in using BOT, is to provide an efficient private management for a higher yield. There is a feeling that the private sector does the implementation of projects better. The public sector's management is always delayed because of bureaucratic slowness. And finally, by this privatization programme, new technology and new equipments may be transferred to the developing countries by the foreign contractor and as a result of this transfer, the local staff will be trained for better operation of new equipments.

2.2 Main Parties Involved in BOT Process

There are six main parties that come together for the implementation of the BOT projects (as can be seen in the Figure 2.1). They are the project promoter (or project sponsor), the operator, the constructor, the host government, investors (shareholders) and lenders (banks). Among these parties, the most important actor is the project promoter. He is the creator of the project. The operator is also an important actor in BOT and plays a number of roles for a successful project. He will have to manage the project very well during the concession period. In the following sections, the roles and responsibilities of each party will be discussed.

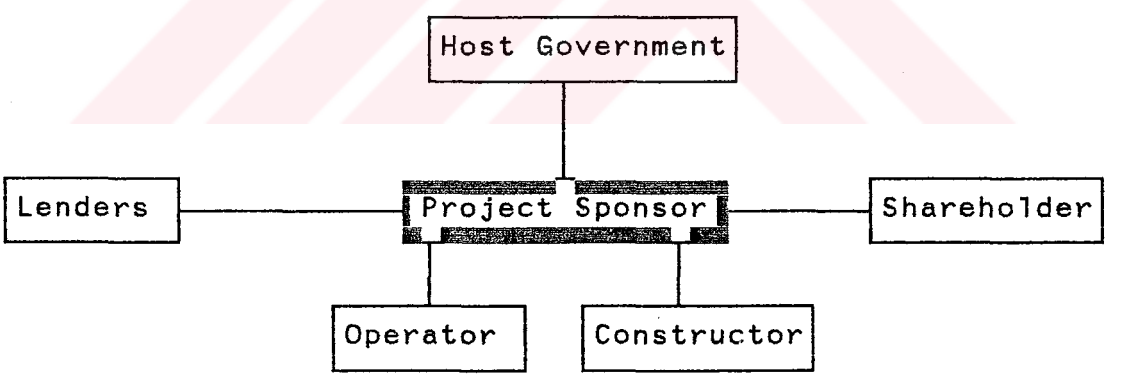

Figure 2.1. Main Parties Involved in BOT Projects

2.2.1 The Host Government

BOT was developed for the financing of public projects by private organizations instead of the host

government. In order to implement the projects successfully, the public power (the host government) must prepare the necessary conditions and regulate the different stages. He should first of all authorize the location and the operation of the project. Then, he should determine how the transfer of the funds generated should be done in order to repay the loans, the dividends and the capital to the resident investors and the lenders (Selwan, 1990:24).

The public power should also regulate the contracts that need to be signed by the operator and the public companies like TEK (Turkish Electricity Board) in case of power projects.

The host goverment should give some guarantees to the private companies and the lenders for the risk of foreign exchange and money transfer as well as political risks.

2.2.2 The Project Sponsor

As it was mentioned before, the project sponsor is the most important actor in the BOT process. His technical and financial ability would play an important role to attract the investors and lenders. His reputation and previous experience on projects of the same kind and size are also taken into consideration by the investors and lenders. He should negotiate favourable concession

agreements from the host government and he should also raise equity and borrow loans during the implementation phase.

2.2.3 The Constructor

The constructor is responsible for the construction part of the project. He should provide a final construction cost estimate that considers possible changes that can occur during the construction period. This estimate will help the project sponsor in computing the final costs.

2.2.4 The Operator

The operator has a major effect on the success of the project. He has to have an adequate technical ability to operate the equipments. Since the loans are repaid from the project's revenues during the concession period, operation side of the project is very important for the sponsor to attract the investors.

The intervention of the operator in the pre-study phase brings some advantages that allow the creation of best conditions for an efficient operation stage which is a guarantee for a possible yield.

If the operator is also the sponsor of the project or very close to him, this will give more confidence to the investors and the lenders.

2.2.5 The Shareholders (Investors)

The shareholders are looking for an investment that brings to them as much as possible return in regard to the bearing risk and the length of the investment.

They will examine the project's expected revenues and offered technical and commercial securities. Experience and reputation of the promoter and the operator also affect the investors' decisions.

2.2.6 The Lenders (Banks)

The lenders who provide the loans should bear some risks. Their only security is the project itself. Therefore, they will concentrate their attention on the economic and financial feasibility of the project which is provided by the promoter. In fact, the banks prefer to have their own study done. They should be satisfied with these studies by reducing the uncertainty in the project's feasibility. If they enter the project then they will analyze the interest rate and the length of the loans they intend to provide.

In case of a politically unstable country, the lenders will try to guarantee their investments by private or public insurance companies like OPIC (Overseas Private Investment Corporation).

2.3 BOT Project Phases

There are five phases in a typical BOT project . These are pre-investment, implementation, construction, operation and transfer phases (Figure 2.2).

In order to implement the BOT project succesfully, the promoter must be able to provide a complete study adapted to the country the project is aimed to. The roles and responsibilities of the project sponsors at each phase of the project can be as follows:

(1) as consultants to carry out the feasibility study during the pre-investment phase and engineering design during the implementation phase.

(2) as project sponsors to negotiate favourable concession agreements from the government and as project promoters to raise equity and borrow loans during the implementation phase.

(3) as constructors to build the facility, usually on a fixed price turnkey basis, during the construction phase.

(4) as operator and owner of the facility, using the project revenues to repay the loans during the operation phase (Tiong, 1990).

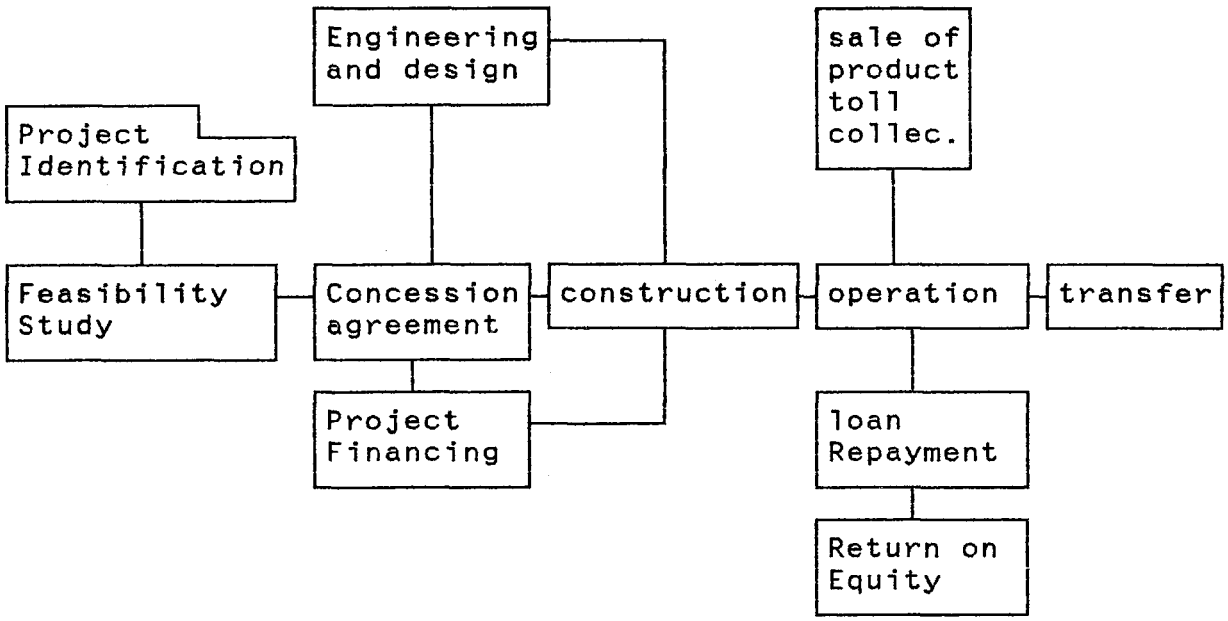

Figure 2.2. Typical BOT Project Phases

2.4 Steps in the Creation of BOT Projects

2.4.1 Pre-Investment Phase

Pre-investment phase is also called pre-study phase in which a list of projects are open for the application of private companies by the government. After choosing the projects the promoter will study the feasibility of the project. There are two stages in this phase ; project identification and the feasibility study of the project.

2.4.1.1. Project Identification

In this stage, the government should first identify the need for the product or service provided by the project. For example, the host government might realize that electricity demand will continue to rise for the coming years. So, it will ask for a power plant to be built by the private companies. Companies are free in selecting the projects either from the goverment's project list or to bring their own projects.

After the identification of the project to be implemented, the project promoter will propose a study about the project to the government. First, the study must include the technical description of the project and the investment cost. Second, the promoter should also give the financing plan and a detalied specification list for the operating stage in his proposal. The financing plan must be based on realistic hypotheses concerning the study of the commercial feasibility. Finally, the promoter should propose a concession period for the project. This period must be optimum for all parties involved in the BOT scheme.

2.4.1.2. Feasibility Study of the Project

The results of technical, economical and financial evaluations of the projects determine if they are to be realized or not. These feasibility studies are

also required to be able to ask for investors and lenders to be part of the project. Generally, these studies are made by a specialized corporation which is well known in this type of work.

The feasibility report should analyze all the factors that might affect the project's yield. In order to fix the price of the goods or services provided, some of these factors are as follows:

(1) the cost of the primary source of energy needed to use the equipment built should be considered in the study.

(2) second factor is concerned with operating charges that may be affected by the changes in the legislation concerning the staff (foreign or local) working in the project.

(3) another factor is to care for the possible changes in the fiscal regulations that might happen after the contracts are signed.

(4) dealing with the responsibility of the host government concerning the changes in exchange rates between the local currency and the currency of the loans used to finance the project.

(5) a protection against any local public product that might compete with the product of the BOT project. This may cause reduction in the revenues of the BOT project.

All these factors should be considered in the determination of the product's price. In addition to these factors, the risk of construction and operation cost overruns should also be taken into consideration during the financial feasibility studies.

2.4.2 Implementation Phase

After the proposal submittal from the project sponsor to the country's authorities, the host government will evaluate the project in terms of technical, economical and financial feasibility. If the project is proved to be feasible from all aspects then an implementation agreement is signed by the government and the joint venture company which is a corporation relying on international and local legal councils, created to run the project from the construction to the operation for the length of the concession period.

In this phase, the created joint venture should carry out the engineering and design studies, negotiate favourable concession agreement with the government as described above and should also provide the necessary financing.

2.4.2.1. The Roles and Responsibilities of the Joint Venture

The joint venture is a corporation created for the project itself, consists of the different entities established in the host country to run the project effectively. The sponsor has to gather the different investors that are going to be part of the joint venture by participating in the equity of the corporation.

In general, what seems to be a good level of equity for a successful BOT joint venture is equal to twenty to thirty percent of the total cost of the project (Selwan, 1990:39). The need for lenders will be reduced by this important equity. In fact, lenders are needed because, to finance the project all by the investors is not easy. Debt is also cheaper to service than equity. This is due to the fact that it has priority claim on the revenues, earlier recovery and greater availability than equity funds. By this way, the operation cost can be reduced for final consumers of the goods or services provided.

As far as the creation of the capital of the joint venture is concerned , a good distribution in percentages of the total cost of the project would be the following:(Selwan, 1990:40-41)

(1) 5% by the promoter of the project in order to prove his confidence in the project's yield.

(2) 10% by the constructor and the operator to prove the quality of their work and the service they provide.

(3) 15% by the investors who are looking for a high return on their investments. The intervention in the equity of international investors like IFC (International Finance Corporation) would prove that the project is an important one for the host country's economy and that it seems to be financially viable. This would provide incentives for the private investors to be part of the joint venture.

In case the public power wishes to enter the equity of the joint venture, this may be an advantage for the company. It may profit from this by having some special favors as a different tax regulation. However, from the company's point of view, the percentage of the equity of the local public investors should be less than the percentage of the private investors, in order to prevent any main intervention of the host government in the management of the project.

After the equity formation of the joint venture, he has to sign the contract (implementation agreement) with the host government for the concession period and also sign the construction and operation contracts with the constructor and operator respectively to complete the

project. Then, he has to find the required loans to finance the project. In order to attract the financers, he should provide guarantees to the lenders for the construction and operating phase. This can be done by issuing performance bonds provided by the constructor and the operator to the joint venture.

2.4.3 Contract Negotiation With the Constructor

The implementation agreement signed by the host government and the joint venture forms the basis for the construction contract. The promoter, in order to have some liberty in the choice of the constructor that is going to build the facility, should at the pre-investment phase hire well known engineering offices to help him create the BOT project. This will enable him to reach all the companies able to build this kind of infrastructures without being forced to choose one because of the lack of competition (Selwan, 1990:44).

In some cases, however the project sponsor prefers to work with the constructor in the pre-investment phase. It is believed that an early relation would give a better project conception. The constructor has an advantage that he knows he will be chosen if the implementation agreement is signed. So, he will have to participate in the costs that come from the complete study of the project.

Moreover, there may be several advantages if the constructor enters the equity of the joint venture. First, this is to ensure that the constructor will be bound to the project. The constructor as a part of the joint venture and part of the project from the creation will be more likely to propose a competitive final cost for the construction part of the contract (Selwan, 1990: 44-48).

Another advantage is that the constructor will try to provide the best service at the lowest cost because of his participation in the equity of the joint venture. He will get extra payment for lower cost and would have higher return on investment from the project's operation.

2.4.3.1. Contracts

In general, two types of contracts for BOT projects are realized, the cost plus fee contract and the lump sum contract.

2.4.3.1.1. The Cost Plus Fee Contract

The cost plus fee contract is a contract in which the project sponsor will pay all the construction expenses. In general, the sponsor will choose this type of contract if he relies on a quantity surveyor. The quantity surveyor is the one who will be in charge of accounting for the quantities of material used.

This cost plus fee contract is very suitable for

joint ventures in developing countries because this contract will allow some flexibility in case of the changes in raw material costs, wages or fiscal regulations.

2.4.3.1.2. The Lump Sum Contract

The lump sum contract is a contract in which the project sponsor agrees to pay the constructor a fixed sum. Then, the constructor will be free to use the money as he wants to construct the facility. There isn't any quantity surveyor to control the constructor.

The project promoter gives some incentives to the constructor for the better performance. A percentage of profits will be given to the constructor if he performs better than expected.

2.4.4 Contract Negotiation With the Operator

As stated before, an operation contract is signed by the joint venture and the operator after the implementation agreement like the construction contract. Early involvement of the operator in the pre-investment phase might be beneficial as the operator would give his knowledge and advice to determine the technical characteristics of the project in order to get the maximum out of it. The operator can participate to the equity of the joint venture as the constructor does, to show his

interest to the project.

Some points must be specified in the operation contract. First of all, the contract should specify the operating cost, the operator should stick to. To get the best out of the operating stage, the operator should have incentives if the project's revenues is higher than expected. Those incentives can be as increase in the profits. In fact, what generally appears to happen is that the incentives are given to the operator only one or two years later in order not to have a lower level efficiency as soon the bonus is distributed.

The project sponsor should have some security in case the operator does not act as expected. For this, like in the construction phase performance bonds are issued. They include the replacement of the operating company during the operation phase.

2.4.5 Participation of the Lenders

The last actor to enter BOT projects is the lenders. They provide the needed loans to run the project and they are expected to look to the revenues generated from the completed project as the main source of security for repaying the debts.

The lenders will be willing to be part of the financing of the BOT project if the promoter is able to provide them with all the information and all the

advantages such a project might have. What the lenders would like to have insurance on is the fact that the cost of the project is the optimal one. They wish that the construction cost is the lower one, that it offers the best ratio quality/price/security. The other clause will be that the operating contract guarantees that the operation of the equipments will give the maximum possible output.

The lenders see BOT as an advantage for them in case the feasibility study is accurate, then the project provides a relatively secure cash inflow over a long period with a relatively good guarantee against local inflation.

However, there may be a disadvantage in case of intervention of the public power by controlling the cost of goods or services in order not to harm the final consumers. By this way, the concession period may be lengthened.

2.4.5.1. Agreements With the Lenders

Lenders want to protect themselves from any bad situation. They should ask for guarantees to secure their investments during the construction phase and the loans repayment phase (operation phase).

Therefore, in order to give some security for the lenders, some agreements should be signed by the

lenders and the joint venture such as offshore escrow agreement, standby loan agreement and senior credit agreement. These agreements will be discussed in the following sections (Risks in the BOT projects).

In Figure 2.3., the required contracts and agreements with the project company can be seen for the project to succeed.

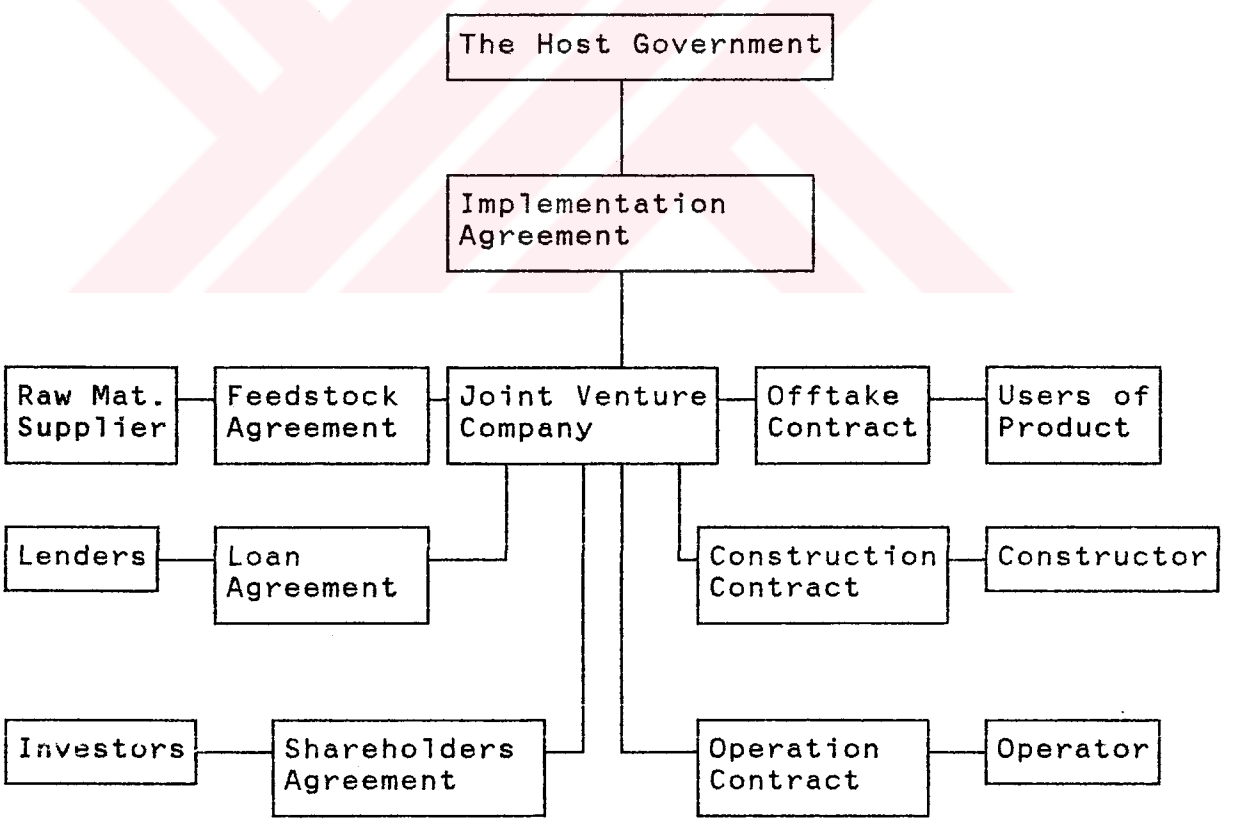

Figure 2.3. Contractual Network in a BOT Security Package

2.5 Risks and Securities in the BOT Process

Risks (uncertainties) are common to all projects. Therefore, in the first instance, the risks associated with the project must be minimized by adequate geological, technical and market studies. Then the different parties involved in a BOT project, the promoter, the constructor, the operator, the investor and the lenders must share the risks of the project.

In this section, the risks associated in each of the project phases will be studied. There are mainly four phases in the BOT: the pre-investment (feasibility study)phase, the implementation phase (creation of the joint venture), the construction phase and the operation phase. There are three major categories of risks that would occur in each phase namely, the financing risk, the political risk and the technical risk. These risks together with the related securities and solutions against them will be presented in the next sections.

2.5.1 Pre-Investment Phase

In this early phase, the feasibility studies are carried out by the project promoter who is the only financer. The only risk is the risk of nonrealization of the project. The promoter may ask the public power for financial help. He cannot get any aid from the lenders and insurance companies because the project is not yet defined.

2.5.2 The Implementation Phase

During this phase, a joint venture is created before the implementation agreement. Capital formation of the joint venture constitutes the equity of the project. The costs for any studies like engineering and design made by the promoter and the different entities of the joint venture should be reimbursed. It can be done by issuing of stocks to those entities with advantage like a possibility to buy other shares.

There may be another solution for this case. The earlier stockholders can ask for securities from the insurance agencies regarding any political decisions from the host public power or for any natural risk that may forbid the implementation agreement to be signed.

2.5.3 Risks and Solutions in the Construction Phase

The construction phase is very important in the life of the project because all the investments are done at this phase. Therefore, to have a profitable project, possible risks must be minimized by accurate study and well coordination among the different parties.

There are mainly three types of risks associated with the construction phase: cost overruns, completion delays and the risk of unsuited equipments. In the following sections, they are discussed seperately.

2.5.3.1. Cost Overruns

The risk of cost overruns means finishing the construction of the project with higher cost than expected (specified). Many recent projects have faced cost overruns as high as 100% of the expected cost estimates such as the Channel Tunnel project (Selwan, 1990:72).

There are three major factors causing cost overruns: Technical inability of the constructor, Force Majeure and political decisions.

2.5.3.1.1 Technical Inability of the Constructor

The reasons that could lead to the technical inability of the constructor are as follows:

(1) estimating the amount of raw material needed and the labour required incorrectly,

(2) troubles in getting the local subcontractors and the local labor used to the new technology the project requries.

Solution to this risk, from the constructor's point of view, is to carefully follow the program and notice when the first problems arise and try to solve them immediately. The project promoter will use the performance bonds that were issued by the construction company.

2.5.3.1.2. Force Majeure

The Force Majeure events are out of the control of the constructor. They may be earthquakes, inundation or a war. These events may change the final cost.

The solution to these events is to take the required insurance policies that would guarantee to work against these risks.

2.5.3.1.3. Political Decisions

After the implementation agreement is signed, there may be some new decisions or new regulations that lead to a change in the construction specifications in the host country, or a technological embargo on foreign imported goods, or even a limitation on the number of foreign workers entering the country or a request for the constructor to hire more local workers. Moreover, the political decisions may cause a war. All those different cases may increase the construction cost.

The usual way to eliminate the political risks, in this phase, is to ask for the constructor to take the required insurance policies that would guarantee the construction work against those unexpected events.

2.5.3.2. Completion Delays in the Construction Phase

The delays in the completion are as common as

cost overruns. The completion delays can range from as short a time as a month to a long period as 20 months and sometimes the projects are abondoned.

There are mainly four factors leading to delays in the completion: the inability of the contractors or subcontractors, stockholders' failure, force majeure and political decisions.

2.5.3.2.1. The Inability of the Contractors or Subcontractors

In this case, the only reason for the delays is the inability of contractors or subcontractors. To prevent this risk, contractors should provide completion guarantees and assume responsibilities for delays arising within their control. They should be asked to provide the performance bonds by the joint venture.

2.5.3.2.2. Stockholders' Failure

The stockholders provide the equity of the joint venture. During the construction phase, if they do not provide their part of the capital, the construction would be stopped due to insufficient financing and this may lead to delays in completion.

In order to prevent this risk, the stockholders will have to provide the funds effectively to an offshore account (an account into which all the project revenues, loans and the equity should be paid).

2.5.3.2.3. Force Majeure

Delays in the completion may occur due to an unavailability or unacceptability of raw materials received or due to any other technical problem.

Not to face with the problem related to raw materials, a contract is signed with the supplier that is called "supply or pay" contract. This forces the supplier to provide the raw materials at a certain price and required quality over a period of time. In case of the technical problems joint venture will be allowed to use the performance bonds.

2.5.3.2.4. Political Decisions

There are three main reasons causing delay in this case:

(1) A decision from the government to delay the project,

(2) A decision to start a new project that may be economically less expensive for the country,

(3) The new regulations (fiscal regulations or a veto on the loans provided by the local banks)

The only solution to this political risk is to have some insurance from agencies like OPIC.

2.5.3.3. Unsuitable Equipments After the Construction

There are three factors that might have caused this risk. These are the inability of the constructor, the unsuitable raw materials or bad output and the political decisions.

2.5.4 Risks and Solutions During the Operation Phase

The operation phase is a very sensitive phase because new technology may be transferred to the developing country and the local staff generally may not be trained for the new technology. This phase determines the profitability of the project which depends on the output level, operating cost and market prices for the product.

The risks in this phase may be technical or financial for the operator or they may come from the market.

2.5.4.1. Technical and Financial Risk

There are a number of causes for technical and financial risks. First, there may be a technical problem that does not allow the operator to work efficiently such as shortage of raw material or unsuitable equipments. Second, the operator may not be well experienced to handle the equipments. Third, the troubles in repaying the debts, not guarantee of foreign exchange convertibility and

finally, there may be some changes in the regulations of the host country.

2.5.4.1.1. Technical Problems

Technical problems may be shortage of raw materials (there is not adequate raw material), difficulty in finding local staff and the unsuited equipments.

The shortage in raw materials could be covered by the feedstock contract (supply or pay) which guarantees the supply of the required raw materials.

2.5.4.1.2. Technical Inability of the Operator

The operator may be unable to run the equipment efficiently. This may affect the profitability of the project: the project will not work in the way that revenue exceeds the running costs.Not to face these problems, the operator should be chosen very carefully by the joint venture. The operator must have adequate experience.

If the operator contributes to the joint venture equity, this will force him to work carefully. Moreover, the joint venture should ask for performance bonds which allow the corporation to have another operator in case the original operator has failed.

2.5.4.1.3. The Problem of Foreign Exchange Convertibility

Loans made available for projects in developing countries are generally in foreign currency. Therefore, the repayment would also have to be made in foreign currency. Since the project's revenues will be in local currency, they should be converted to foreign currency to repay the foreign loans. There may be some problems in convertibility of local currency to foreign currency. To avoid these problems, a flexible price formula linked to foreign currency movement would be appropriate or the project sponsor should negotiate the foreign exchange guarantees from the central bank of the host country.

2.5.4.1.4. Political Decisions

The political decisions such as the changes in fiscal agreement, the changes in the regulations in the host country may affect project profitability. The project sponsor should get guarantees against the political decisions. If the host government does not provide any guarantee then, the only way to cover the risk would be to ask for the public insurance agencies' help.

2.5.4.2. Market Risk

Market risk is tied to the following question: Will the project's output be at a sufficient price and

sufficient volume to service the debt and realize a reasonable return on equity?

A shortage in raw material delivery and a rapid inflation in the host country may lead to the increase in the operation and maintenance costs so that the project's product price increases. However, it may happen that the increase is so important that the good or service is no longer competitive and leads to market risk.

Solution to the market risk problem may be the detailed market study, offtake agreement (take or pay contract) with the buyer of the output. Another solution may be joint venture with offtaker. Finally, the joint venture should ask for the public power to pay the difference in order to reach the equilibrium point.

2.5.5 The Responsibilities of the Project Sponsor

Given the complexity of such schemes and the magnitude of funds involved, it is important for the project sponsor to establish and adhere to the following principles in structuring the BOT projects:

(1) Identify the key risks,

(2) Evaluate the level of acceptability of each risk,

(3) Allocate the risks to the different parties involved (Tiong, 1990: 319).

2.5.6 Allocation of Projects' Risks

The allocation of project risks to the different parties involved in BOT is a tremendously complex process. Each of the actors in BOT should have meaningful contractual incentives and guarantees to solve the unforeseen difficulties that will emerge over the course of a 20 or 30 year project. This means that all the project's risks must be adequately covered.

As mentioned before there are three basic categories of risks, namely the financing risks, the political risks and the technical risks that require very careful consideration by the project sponsor. Now, these risks will be discussed separetely.

2.5.6.1 Financing Risks and Guarantees

As it was mentioned before, BOT is a sort of project financing technique. In fact, commercial and financial considerations are likely to be the determinants in a successful proposal for a BOT project. Raising of finance is very important for implementing the BOT projects successfuly. However, the project financing actor, the lenders are asking for guarantees to secure their investment during the construction and operation phase, which is the difficult issue faced by the project promoter in raising the finance for the projects in developing countries. Therefore, in order to attract

financing, some government guarantees are required although the projects are in the private sector.

There are some unsuccessful BOT projects due to insufficient financing. For example, the $ 652 million Akkuyu reactor plant project in Turkey has stagnated with no one prepared to finance it because of insufficient government guarantees.

The following guarantees and incentives from the host government should be negotiated by the project sponsors before the implementation agreement.

2.5.6.1.1. Offshore Escrow Account

The offshore escrow account is an account into which all the project revenues and foreign loans should be paid. That is, it is the whole capital of the corporation.

During the concession period, all the operation costs, the principal and interest of the debt will be repaid from this account. In addition, the account will be used for the payment of dividends for the stockholders after the repayment of the debt. This is a security for lenders because dividend portions of the stockholders are held within the escrow account until the repayment of the loans.

The rights and obligations of the local bank to deal in foreign currencies should be spelled out in an

agreement with the central bank. This will ensure smooth flow of capital and revenues to all parties concerned during the concession period (Tiong, 1990:323).

2.5.6.1.2 Foreign Exchange Guarantees

The project revenues are generally in local currencies. On the other hand, loans made available for the projects in developing countries would generally be in foreign currency. Therefore, repayments of loans would also have to be made in foreign currencies. However, there might be problems in converting local currencies to foreign currencies and thus difficulty in repaying the principal and interest of the loans.

There is another problem related to inflation: the inflation may increase rapidly and this increase may not be offset by changes in the official or market rates of exchange for the local currency.

Thus, the remittance guarantees would be necassary to enable the project sponsors to remit freely all project revenues including dividends. Guarantees of foreign exchange convertibility and availability should also be obtained from the host government or its Central Bank. For example, in the Malaysian $ 18 billion North-South expressway, the government provided the operating company with the guarantee that it would make up the shortfall if the exchange rate dropped by more than 15 %

against the rates at the time of drawdown of funds (Tiong, 1990:323). However, if the host government does not provide this kind of guarantee the only way to cover this type of risk will be to rely on the insurance the joint venture has applied for.

2.5.6.1.3. Reserve Account

Reserve account is an account which is required to have a minimum balance in the joint venture's available cash. If the project revenues from the operation are lower than expected, then the reserve account will be used to repay the operating costs and the debt.

This account will have a minimum balance fixed by the lenders and the cash is provided by a part of the joint venture's capital, the excess in cash during the operating phase if the revenues are higher than expected and by the nondistributed dividends if the debt repayment has not been effective .

2.5.6.1.4. Subordinated Loan Agreement

Subordinated loan agreement is a contract which is signed by the public power and the joint venture for public power to provide the necessary cash to repay the debt in case the reserve account was insufficient to do so during the construction or operation phase because of events out of control of the joint venture. This agreement

is another security for the lenders.

2.5.6.1.5. Stand-By Loan Facility

Stand-by loan facility should be arranged by the lenders for financing the cost overruns. This facility will be used in case the reserve account cannot provide the necessary cash.

Although it is not easy to arrange a stand-by loan facility, it provides a security for the completion of the project.

2.5.6.1.6. Stockholders' Dividends Dependence

To provide an additional security for the lenders, an agreement (stokholders'dividends dependence) is signed by the stockholders and the joint venture. It states that the stockholders will not receive any dividends from their investment if the project revenues are insufficient to provide the minimum balance of the reserve account.

2.5.6.1.7. Offtake Agreement

In industrial projects, lenders want to make sure that the sale of the product could generate sufficient revenues to pay their loans. The government could guarantee the obligations under such take-or-pay or take-and-pay contracts to purchase the product on defined

terms and price formulae. The government should pay the agreed upon amounts and transfer them to the offshore escrow account of the joint venture.

This offtake agreement is very useful. For example, in case of the electrical power plant, the public company will buy the agreed amount of power stated in the contract if he does not need it. This agreement is a guarantee in case a new, less expensive plant is built.

However, in infrastructure projects,this level of security of cash is not possible. Lenders and investors have to look to demand projections and revenue sensitivity in relation to various market scenarios to form their judgement of security and return. In those cases, the public power could guarantee a minimum demand or minimum operating income. For example, in the Malaysian expressway project, the public power is willing to pay the amount necassary if the traffic volume falls below projection in the first 17 years of operation.

These contractual undertakings and assistances would help to attract financing although there would be no direct government guarantees for repayment of the project loans.

2.5.6.1.8. Equilibrium Aid

This equilibrium aid is another guarantee for the lenders. If the project revenues are less than

expected, then the host government is willing to pay the amount needed to cover the operating costs and the debt repayment.

2.5.6.1.9. Feedstock Agreement

The feedstock agreement is a feedstock contract which is signed by the supplier of the raw materials and the joint venture. By this way, the risk of raw materials being unavailable or unacceptable is eliminated. For example, in the Chineese power plant project the host government agreed to arrange the supply of coal over the concession period at a fixed price per ton (Tiong, 1990:324).

2.5.6.2. Political Risks and Guarantees

The political risk is a very important type of risk faced in the BOT projects that covers all the decisions or acts which may appear out of the control of the project sponsors. It has also a significant impact on all the other risks to be considered.

In some developing countries, labour unrest, a technical embargo on foreign imported goods, the outright expropriation or even an act of war can be accepted as a political risk. Moreover, construction companies could be forced into bankruptcy by a political decision to stop work on a project at a critical stage.

For example, during the first few years of the Iran-Iraq war, many projects had to be cancelled or abandoned and banks had to write off millions in development costs. One such project was the $4.5 billion Bandar Khomeni Petrochemical complex in Iran which was abandoned after successive air raids and Mitsui Bank of Japan had to write off $1 billion against the project in 1987 (Evans,1988).

There are four ways for the project companies to protect themselves against the political risk, especially in potentially unstable countries:

(1) Form a consortium of international investors and lenders so that expropriation of the project facility will result in default of a number of the international loans and jeopardize the country's credit rating to an unacceptable degree (Nevitt,1983).

(2) Sign a concession agreement with the host government which gives a guarantee to the project sponsors freely to run the project for a given period of time.

(3) Take the required political risk insurance from the government agencies like the USA's Overseas Private Investment Corporation (OPIC) and the UK's Export Credits Guarantee Department (ECGD).

(4) Financial aids from the host government in

the event of Force Majeure to pay the debt and other expenses.

2.5.6.3. Technical Risks and Guarantees

The project sponsors should give basic guarantees for the completion and the operation risks that are within their control. That is, the lenders and the investors must be satisfied that the project will be run efficiently,will attract enough customers and will not run into technical difficulties. The project sponsors would cover the following risks.

2.5.6.3.1. Delays in Completion

The inability of contractors may be the only cause of delays in completion. The project sponsors could take some undertakings against the completion delays caused by the contractor's failure. This could be achieved through lump-sum contracts to experienced turnkey contracts using proven technology and within an agreed time period.

For example, in the Chinese project the sponsor, Hopevell Holding of Hong Kong,offered in its winning bid to build the plant on a turnkey basis and on a shorter time period than the other proposals even though it had no previous experience in power plant projects. It then negotiated a turnkey contract with a consortium of

equipment suppliers and contractors and completed the project 6 months ahead of schedule (Lum,1988).

To prevent delays in completion, contractors should also be asked to provide performance bonds by the project sponsors. These bonds should allow the joint venture to ask for the entities that are guaranteeing the bonds to be responsible for the work to be done .

2.5.6.3.2. The Risk of Operation and Maintenance

During the operation phase, the inability of the operator or technical failure of the project may lead to inefficiencies in production or stoppages.

For the efficient operation and management of the facility, the following factors should be taken into account:

(1) proven technology,

(2) qualified staff,

(3) experienced operator,

(4) valid government licences.

The following two figures show the cash flows within the whole organization during the construction (Figure 2.4) and during the operation (Figure 2.5) phase.

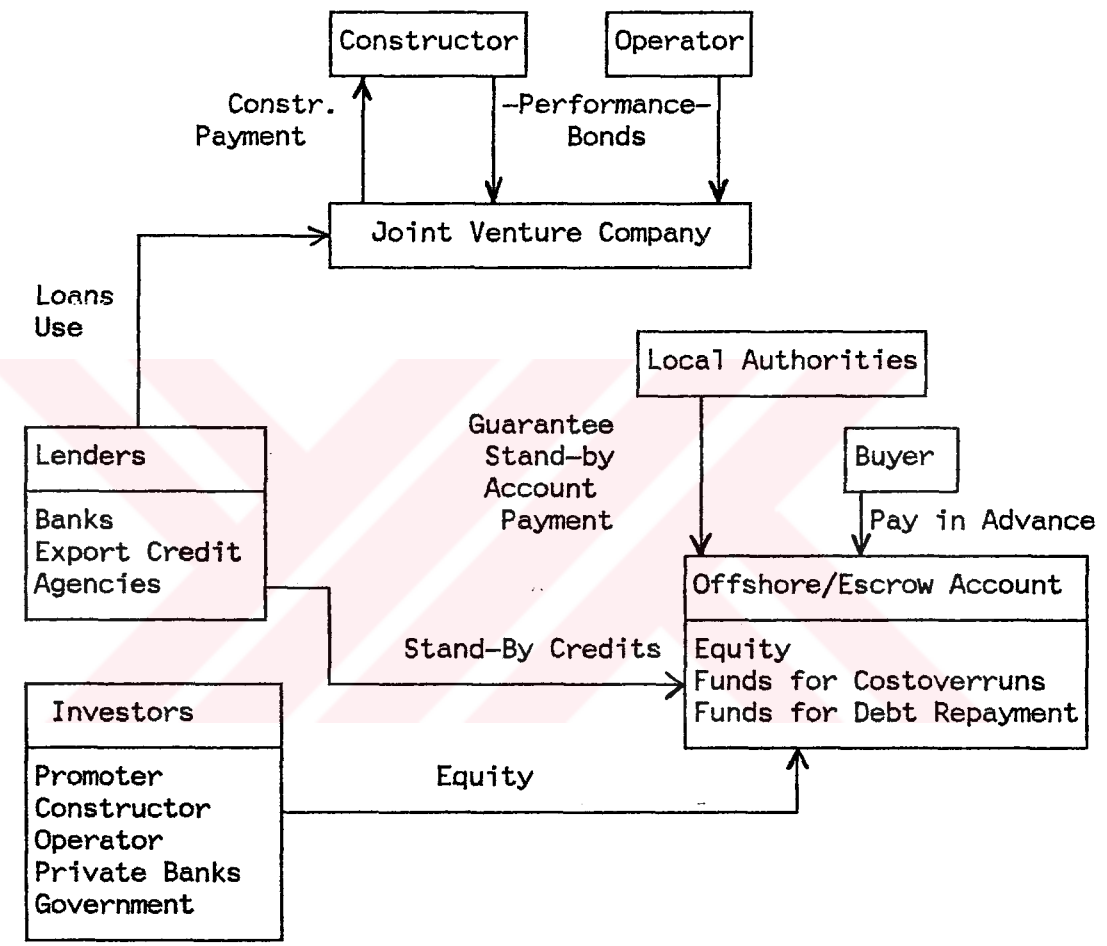

Figure 2.4. Cashflows in the Construction Phase

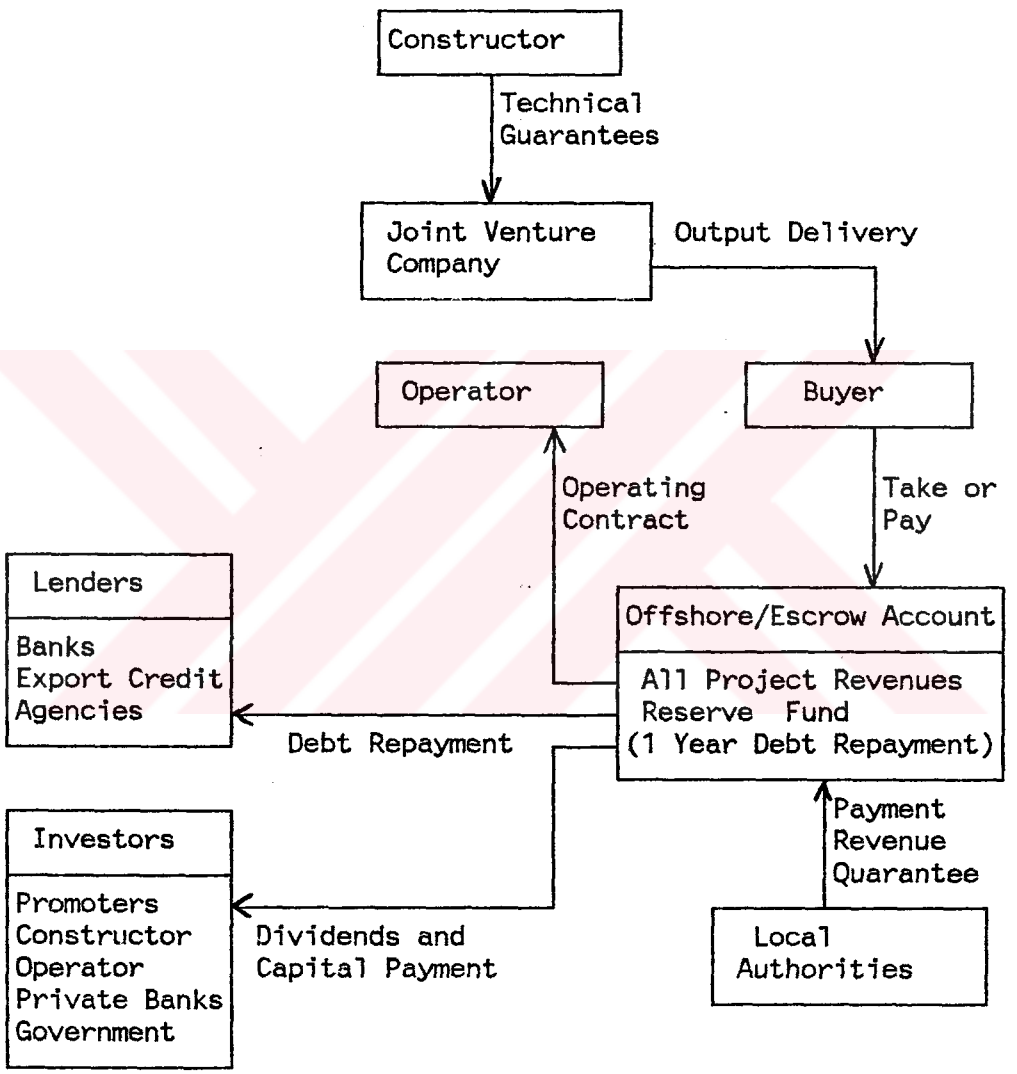

Figure 2.5. CashFlows in the Operation Phase

2.6 The BOT Model in Turkey

The Build-Operate-Transfer model was first made up by the Turkish Prime Minister Turgut Ozal in 1984 within the framework of the privatization of Turkey's public projects (Bueker,1988).

The purposes behind the BOT were to attract foreign investors and to reduce the goverment's involvement in the financing of the public infrastructures to reduce external debt. In addition, by this process new and advanced techonology is expected to be transferred to the country by the foreign private sector and especially by the international construction companies that might be interested.

The BOT model has been adapted by the Turkish government. It was aimed to provide a basis for all the future projects to be done under the BOT model. The main terms and conditions of the BOT model have been established under the supervision of the FID (Foreign Investment Directorate) of the S.P.O (State Planning Organization). This organization is, among other tasks, in charge of approving foreign investments in Turkey.

All the projects like hydroulic dams, power stations, airports, trade centers, free trade zones, metros, port and railway projects are intended to be realized under the BOT model.

2.6.1 General Turkish BOT Principles

The general principles of the BOT model in Turkey have been set in 1987 by the Turkish government:

(1) The first step is the creation of the joint venture company to implement the projects. Foreign contractors and operators of the projects can be members of the joint venture.

(2) All the required financing will be arranged by the joint venture (This comprises both the equity of the joint venture and the debt). The debt/equity ratio should not be less than 80/20 , because the financing by the debt is always cheaper than by equity and a higher involvement of the export credit agencies may be possible.

(3) To construct the facilities, a turnkey fixed price contract is used by the joint venture company. The turnkey contract is a contract in which the constructor builds the plant for a given price and within a given period. The joint venture has the responsibility for the construction cost overruns that are not caused by any force majeure or government default. In this case the joint venture should ask for the constructor to provide performance bonds.

(4) The secondary funds can be used to repay the

debt by the joint venture. These are as follows:

(a) The joint venture should arrange a stand-by loan facility. This account should cover the debt service for at least a twelve month period.

(b) The funds may also be provided by the available insurance proceeds.

(c) Subordinated loans can be used to cover the debt service for the same twelve month period.

(5) Products or services provided by the project will be purchased by the related Turkish state utility, regardless of the needs of the system.

(6) The price of the product or service provided by the project will be calculated based on the agreed upon annual amount provided by the project. In the calculations, the operating cost, the debt and dividends will be taken into consideration.

(7) Dividends are the payments that include the return on equity. This return is the one that is sufficient to provide an internal rate of return of the joint venture's equity adequate to attract investors. It was limited during the negotiations to be set between fifteen and twenty five percent by

the Turkish government.

(8) The joint venture's equity will be repatriated after all the principal and interest of the loans has been repaid.

(9) After all the loans have been repaid and the equity has been repatriated then, the facility should be transferred to the local authorities. If both parties agree, the facility may be operated for another concession period by the joint venture.

2.6.2 BOT Model Applied for Power Sector in Turkey

Turkey is a developing country with almost fifty percent dependence on imported energy, particularly oil. For this reason, the sixth five year development plan (1990-1994) attributes great emphasis on the energy sector and the main objective is to utilize economical indigineous and imported energy resources and make use of all financial and investment capabilities of public and private sectors (Şen,1990).

In order to achieve this objective and in the context of liberalization of the Turkish economy, law no 3096, named "Respecting Authorization to the Institutions other than Turkish Electricity Authority for Generation, Transmission and Trade of Electricity "has been put into effect and is in force since December, 1984 (Şen, 1990).

The aim of the above Law is to form the legal basis for the local and foreign private enterprises so as to take part in the power sector.

There are two main activities covered by the Law. The first one is related with granting permission to the power companies, other than TEK (Turkish Electricity Board) for construction and operation of power plants and the other is related with the creation of new regional utilities.

Three different regulations have been prepared and put into force to help the application of the Law no:3096. The first one is related with the power companies, the second one with the creation of the new regional utilities and the third one with listing the provinces which can become regional utilities.

In parallel to these legislation studies, two committees had been set up, one technical, one decision making committee for the evaluation of BOT power projects offers. The members of the committees are Ministry of Energy and Natural Resources, Undersecretariat of State Planning Organization, Undersecretariat of Treasury and Foreign Trade and General Directorate of Turkish Electricity Authority. In about five years time, the technical committee set up the basic principals applying to BOT concept and prepared the project documents necassary for implementing BOT power projects (Şen, 1990).

2.6.2.1. BOT Principles for the Power Sector

The principles applying to BOT power projects are as follows:

(1) All the power generated will be purchased by the related public company, in this case TEK, regardless of the needs of the system.

(2) All financing (debt and equity) for a BOT project will be arranged by the joint venture company.

(3) Contract will have a term covering construction period plus an agreed upon operation period (generally fifteen years)

(4) Operation cost, principal and the interest of the debt, agreed return on equity and repatriation of the equity will be included in the tariff calculations.

(5) Average tariff rate for the specified years of operation will be set up such that the shares of the joint venture will be transferred to the Ministry at zero cost at the end of the concession period. The joint venture may operate the plant for another concession period if both parties agree on this situation.

In return to these principles, the joint venture company should provide the following technical guarantees:

(a) Designing and constructing a power plant

which is operable for its economic life under normal working conditions.

(b) Making power available based on committed capacity factor.

(c) If the plant is a coal fired thermal power plant then the coal consumption must be based on an average heat rate.

(d) Confirming with the environmental regulations.

After the creation of the joint venture, an implementation agreement is signed by the Ministry and the joint venture. The implementation agreement which is based on the above principles and the technical guarantees, is the main project document and forms the basis for the other agreements to be signed with other related actors like TEK, lenders, constructor and operator contractor.

Detailed discussions of the BOT principles related with financing, tariff calculations and risk/reward principle are explained in the following sections.

2.6.2.1.1. Financing

All financing will be arranged by the joint venture company during the construction and operation phases. The possible financing sources are the loans and equity. A typical mix of funding sources could be the one

given in the following table;

Table 2.1. Financing Structure

	SOURCE	PERCENTAGE
EQUITY	Promoter,operator constructor	15%
DEBT	Export credit agencies	60%
	Multi-credit agencies	10%
	Commercial loans	15%

The Turkish authorities advises the sponsors before any negotiation takes place to include in the lenders of the project, export credit agencies like USA Eximbank, Eximbank Japan or Credit Export Belgium. They wish them to be part of the financing because those agencies' involvement is often a security concerning the project's feasibility. On the other hand, the Multi-lateral agencies such as the European Investment Bank, the World bank, International Finance Corporation would also have to particapate in financing. The involvement of Export Credit Agencies and Multi-Lateral agencies is often seen as a catalyst that brings in other lenders.

The joint venture company should also arrange a stand-by loan facility against the cost overruns due to project company default or for all purposes including cost overruns resulting from the events of force majeure or

agreed changes on the project. This stand-by loan facility is a security for the completion of the project.

2.6.2.1.2. Tariff Structure

The power tariff per kilowatt hour is calculated by dividing the deemed costs by the guaranteed minimum available annual net generations. Varying tariff rate is applied to enable the payment of coal cost (in case of coal fired thermal power plant), operation and maintenance expenses, debt and equity services. This structure can be seen in Figure 2.6. By this tariff structure, the lenders are secured as the project revenues are based on the debt service repayment.

When the annual power generated is above the guaranteed generation level, then a different pricing mechanism is used for the excess power. The pricing strategy is based on the actual operating cost required to produce this extra power and on an acceptable return on equity for the investors.

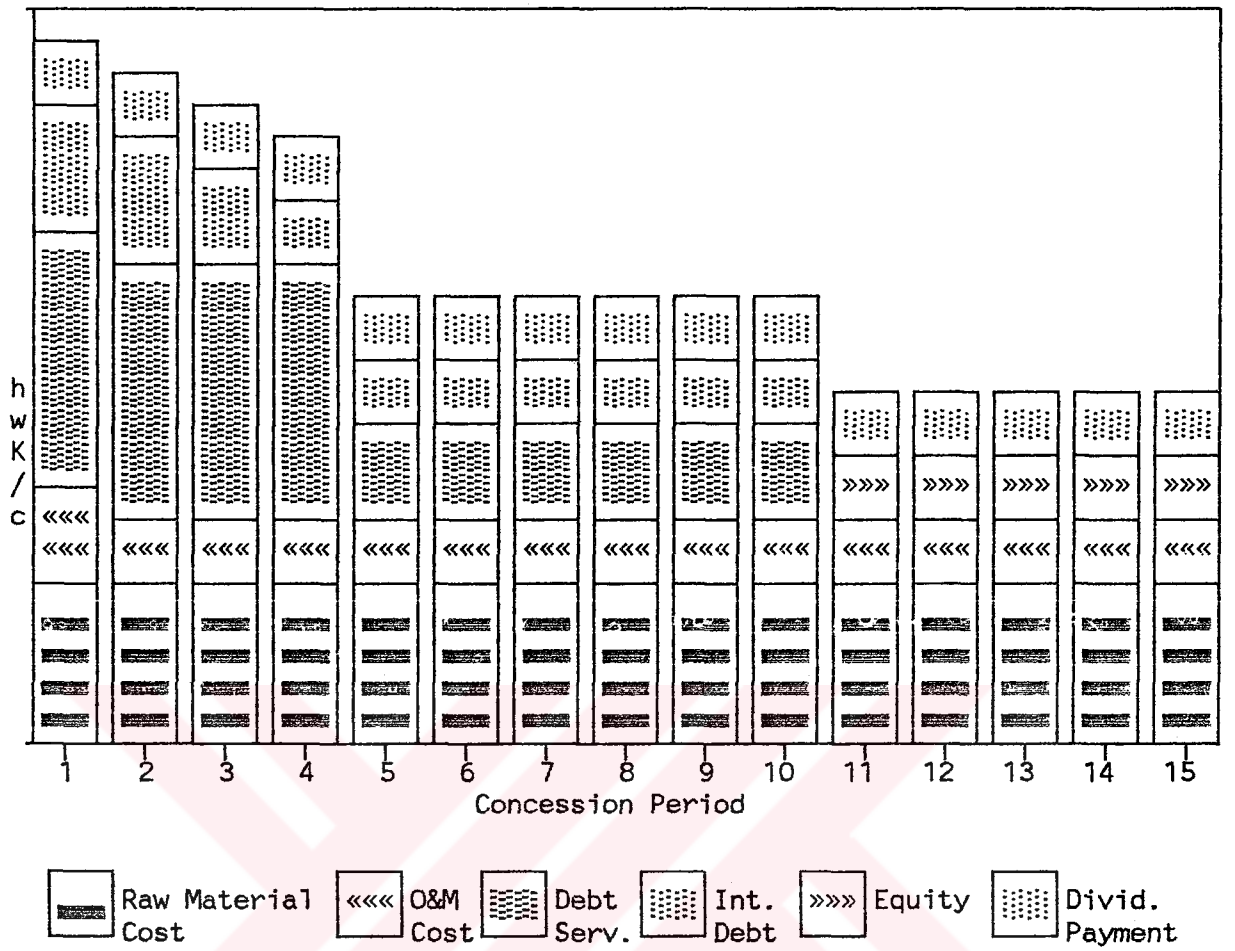

Figure 2.6. Tariff Structure for BOT Power Projects

2.6.2.1.3. Risk/Reward Principle

When the annual power generated is below the guaranteed level then, the joint venture is automatically penalized, since the revenues will be below the level programmed for that year. In this case, the shareholders, a member of the joint venture , will bear the repayment risk. They will not receive any dividends before the debt

service is paid. If the low annual power output was the result of the government default or a force majeure act then, the government would repay the debt service by providing the subordinated loans.

In case the power plant is operating at a better output level than expected, the government gets some benefits from this excess power because the energy above the guaranteed level costs less to the country than the guaranteed energy that is to be provided. The reason for this is the different pricing of the excess power in that only the production cost is taken into account without considering any debt service repayment.

This risk/reward principle is a security for the lenders.

2.6.2.2. BOT Project Documents

After setting the above principles and technical guarantees, the implementation agreement is signed by the government and the project company. This agreement is the main project document and forms the basis for other agreements to be signed with other related actors like TEK, lenders, constructor and operator as can be seen in Figure 2.7.

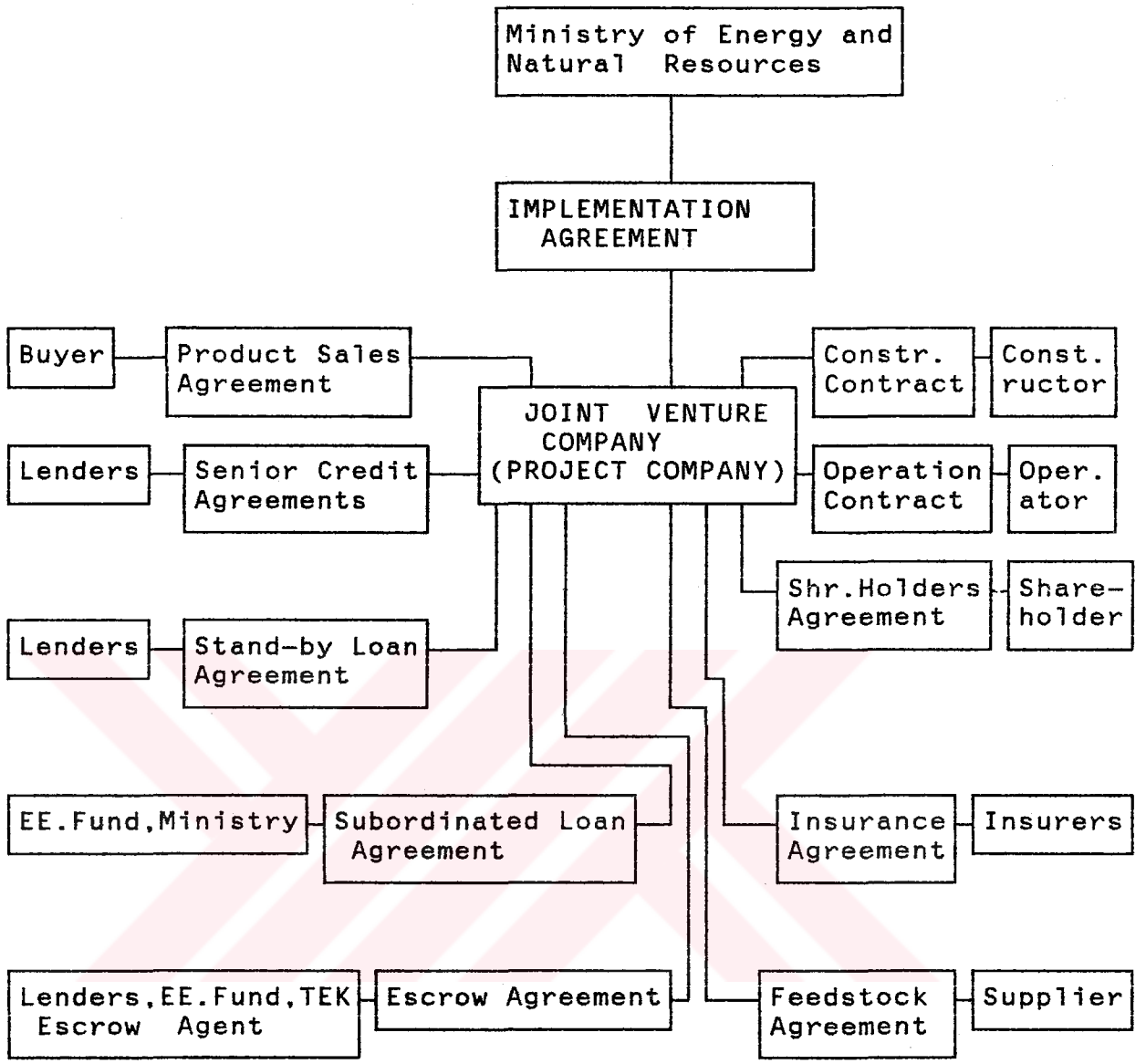

Figure 2.7. BOT Project Documents

The basic agreements which are energy sales agreement, reserve fund, escrow account agreement and subordinated loan agreement, are explained in more detail in the following section.

2.6.2.2.1. Energy Sales Agreement

The energy sales agreement is co-signed by TEK and the project company (joint venture company). This agreement states that all the power the project provides will be purchased even if TEK does not need it. The contract is a take or pay contract. The Turkish government guarantees all TEK obligations concerning the purchase of the energy including to provide the necassary funds to TEK in order to allow him to pay for all the generated power.

The annual price of the power will be calculated by dividing total costs (including the operating cost, the debt service and the return on equity) with the guaranteed annual power level. But TEK will purchase the power with constant energy tariff (overall average energy rate at that year). If the price of power calculated by the joint venture is greater than TEK's purchase price then, TEK will pay the difference to the project company. On the other hand, in case it is lower, the joint venture will pay the difference to the Electrical Energy Fund (EEFUND) which has been established by the government to help raise the financing needed in BOT power projects. In fact, the joint venture will be selling the generated power at the calculated price. However, if the project's average power price is less than the fixed tariff rate set by TEK, then TEK will gain some extra funds because TEK sells the power to the final consumers at the aggreed purchase price of the project company's power.

2.6.2.2.2. Reserve Fund

Reserve fund is a fund which has established by the joint venture from the beginning of the project. The equity of the shareholders initially forms the reserve fund. After the operation begins, the project revenues will also help to constitute this fund. However, the project revenues will go to the reserve fund after all the expenses (debt service and operation costs, not the return on equity) are repaid. The profits of the shareholders will be kept in the reserve fund until there is sufficient fund to cover all the debt services at the date of the first installment of the export credit agreements and two six month period debt service within three years following the commissioning. This minimum fund must be available at any time.

This reserve fund is a guarantee for the host government and the lenders. It gives a guarantee for the government that the shareholders (the promoters of the project) are dependent on this account. Since they are the last party to receive their return on investment, they will have to operate the plant efficiently. It gives a guarantee for the lenders as to repay the debt service for one year.

2.6.2.2.3. Escrow Account Agreement

The escrow account agreement is an account into which all the project revenues (foreign loans and the equity of the joint venture company) should be paid. The funds can either be in local currency or in foreign currency depending on who provides them.

This account is another security for the lenders. In the power projects, the energy tariff payments directly are paid by TEK to the escrow account, then it is used to repay many different items. It should be used for the payment of imported equipments, the operating costs, the debt service, the replenishment of the reserve fund if necassary, the payment of the return on equity for the shareholders and finally for the repayment of the Turkish subordinated loan in the event this loan was made available.

This account does not provide any guarantee to any actors in BOT. But it allows to keep track of every transaction that happens during the operating phase like a record account.

The escrow account agreement should be signed by TEK, the joint venture, the lenders and the electrical energy fund (EE Fund).

2.6.2.2.4. Subordinated Loan Agreement

The subordinated loan is a loan which has to be provided by the Turkish government in case of insufficient project revenues to repay the debt service or operating expenses. For this purpose, the electrical energy fund (EE Fund) has been established by the government to help raise the finance needed in BOT power projects through the subordinated loan agreement.

This subordinated loans are guaranteed by the Undersecretary of Treasury and Foreign Trade and are another security for the lenders. The provided subordinated loans will be paid pack to the EE Fund by the joint venture as soon as it was able to do so. There are two cases in which the subordinated loans should be provided: in the first case, the government default, the force majeure or the political decisions can lead to decrease in the project revenues. In these events the reimbursement will born only in the energy tariff. In the second case, any other event than the goverment default or the force majeure can affect the revenues of the project. This time, the subordinated loans should be repaid immediately before the repayment of the return on equity to the shareholders.

The subordinated loan agreement covering EE Fund's obligations is to be prepared and signed by the EE Fund administration and the joint venture company.

2.7 Concluding Remarks

The BOT model is an alternative project financing technique used to implement the public projects by the private sector. Developed countries have been using this technique for a long time, although it is recently adapted to developing countries.

When BOT is applied on public projects successfuly there will be certain advantages that the host country will obtain. The involvement of the host government in financing of the infrastructure projects will be reduced and this will allow the host government to finance other projects related to social or educational goals. With BOT projects, the total investment level will also increase in the country. Concerning the developing countries the BOT projects will also bring in foreign management skills, and new technologies.

For BOT to be implemented successfuly, the main parties involved in this process, the project sponsor, the constructor, the operator, the host government, the investors and the lenders must actively participate to achieve the target. They should bear all the risks that can be faced in the BOT projects. The other requirement for the success is the government's support to attract the finance because the investors and the lenders want to be guaranteed for their investment. But these securities should not be direct sovereign guarantees, if they should,

then there is no need to the BOT model. The indirect governmental supports proved to be vital in attracting the finance (Tiong, 1990: 107). The length of the concession period is also an important factor in the BOT model. It must be optimal for all the parties. It must be of sufficient lenght to allow the financial amortization of the whole project.

From the point of view of the joint venture company, there are three main advantages with a longer concession period:

(1) The joint venture will then be able to provide the service or product at a very low thus, attractive price without altering the rate of return the investors are expecting.

(2) It will allow some flexibility in case there are delays in the construction or in the operating phase. If the period is longer than the minimum (the minimum length is the length required to repay all the interests and principal as well as the dividends and the equity), there will be a security cushion for the joint venture.

(3) It will allow some securities in regard with the dividends distributed to the stockholders of the joint venture. The profits will be secured because of the longer period that gives higher revenues. It

will also allow some increase in the equity of the company in case the project is sold to other investors like insurance companies.

In fact, the longer concession period may also be advantageous for the host country. The cost of the product or service will be lower. The host country may not be able to provide the same low cost if it was to operate the project itself.

On the other hand, a longer concession period can be a disadvantage for the local government as it would delay the transfer of ownership. The government is losing money (in fact, he is not earning money from the operation except for the taxes) as he is not highly involved in the project. If the transfer of ownership is done earlier, the government can hope to earn some money as he will be operating the equipments and earning the expected profits.

From the point of view of the consumers, the question of who owns an industry is of far less significance than the competitive and/or regulatory environment in which it operates. Consumers will gain primarily from any reduction that is achieved in average generating costs (current tariff rate). The longer concession period is disadvantage for the final consumers. Although the cost will be lower, the average generating costs will not change until the transfer of the ownership. If the transfer is done earlier, the

average generating costs may be lowered, thus, the final consumers will benefit from any reduction in the average generating costs earlier.

Chapter V will provide some numerical results for a quantitative discussion of these points about the length of the concession period.

CHAPTER III

PROJECT ANALYSIS

All countries, but especially the developing countries are faced with the basic economic problem of allocating limited resources such as labour at all levels of skill, management and administrative capacity, capital, land and other natural resources, and foreign exchange, to many different uses such as production of consumer goods and public services or investment in infrastructure, industry, agriculture, education, and other sectors (Squire and Tak ,1975 :26).

However, these different uses of resources are not the final aim in the allocation process rather, they are used to satisfy the fundamental objectives such as the raising of the standard of living or the reduction of inequalities in income distribution.

Using limited resource such as capital in one direction (for example, investment in infrastructure) reduces the capital available for use in another field like social welfare or education. Therefore, a choice must be made among competing uses of resources to achieve the fundamental objectives. These objectives such as growth in the aggregate consumption and redistribution of income,

can be satisfied by the projects which are the building blocks of the investment plans. So, the evaluation of the projects to reach the predefined targets in the economy is a very important task.

Project analysis is a method of presenting this choice between competing uses of resources in a suitable and comprehensible fashion. In other words, project analysis assesses the benefits and costs of a project and reduces them to a common denominator. If benefits exceed costs then the project is acceptable, if not, the project should be rejected.

Project choice for a private commercial entrepreneur is a rather simple exercise. All he has to do is to choose the project which satisfy his objectives best. But, for a planner it is not an easy task. In choosing projects, the planner has to take care of which project best satisfies the interest and objectives of the nation.

The procedure described before, the so called BOT (Build-Operate-Transfer) procedure for formulating and choosing projects is a relatively new tool for governmental decision making. On the other hand, there is a well known procedure which is called social benefit-cost analysis and it has been used in many countries since 1930s at varying extends. Therefore, it is extremely important to study the relative merits of both BOT and

SBCA procedures for project choice. In this context, it becomes necessary to make a comparison of these procedures under different assumptions and find out if they yield any contradicting choices. Social benefit-cost analysis of project evaluation is briefly described in the next section.

3.1 Social Benefit-Cost Analysis of Project Evaluation

Social Benefit-Cost analysis provides a rational framework for project choice in the light of national objectives like aggregate consumption, income redistribution, growth rates of national income and employment level.

From the social perspective, the selection of a project rather than the others has consequences for employment generation, consumption, savings and foreign exchange, income distribution and other things relevant to national objectives. It is, therefore, obligatory to use methods which adequately take into account the national objectives and institutional constraints in order to undertake a realistic appraisal.(Fığlalı, 1989:6).

The main reason for performing social benefit-cost analysis in project evaluation is to subject project choice to a consistent set of general objectives of national policy. The choice of a particular project must be viewed in the context of its total national impact and

this impact has to be evaluated in terms of a consistent and appropriate set of objectives (Dasgupta, Sen and Marglin, 1972:11).

Social benefit-cost analysis is not a technique but an approach. It differs from commercial profitability in taking into consideration of all the national goals rather than profit maximization, in taking the market prices with social opportunity cost and in taking the rate at which future benefits are discounted.

Commercial profits measure the difference between the value of earnings and costs measured by market prices in a certain time period (Dasgupta, Sen and Marglin, 1972:22). However, market prices in developing countries are generally unreliable indicators of the real worth of goods and services because of market distortions (Powers, 1981:5).

Even the choice of a rate of interest to discount future social benefits reflects a particular compromise of the conflicting interests of different generations. For a commercial firm the rates of interest may simply reflect the rates at which it can lend or borrow. But to a planner, interest rates must be viewed as a method of apportioning benefits and costs to different time periods, and possibly between different generations. He has to compare the value of benefits today with that of benefits in the future (Dasgupta, Sen and Marglin, 1972:12).

Furthermore, a project may have influences that work outside the market, i.e "externalities". These do not enter into the calculations of commercial profits, whereas they are obviously relevant for social choice and provide a sufficient argument for rejecting commercial profitability as a guide to public policy. (Dasgupta, Sen and Marglin, 1972:23).

3.1.1 Main Reasons for Using Social Benefit-Cost Analysis in Developing Countries

Social benefit-cost analysis is extensively used by developing countries where market imperfections, distortions and externalities are most likely to be present. On the other hand, since in developed countries where the price mechanism works in such a way that profits are a reasonable measure of net benefit, it is not necassary to use social benefit-cost analysis as a project evaluation method.

There are a number of reasons for the application of social benefit-cost analysis in developing countries. These are explained in the following sections.

3.1.1.1. Inflation

High inflation is more common in developing countries, because the desire to develope rapidly in these countries, generally results in a constant tendency for demand to outrun supply: Furthermore, lagging supply in

the sectors which are most resistant to change, particularly agriculture causes the sectoral price rises which tend to transmit themselves across the board, as a result, the monetory authorities may even increase total money demand to avoid a recession of activity.

The actual prices would still be good for measuring the real costs and benefits if inflation proceeded uniformly so that relative prices were unaffected. But this is seldom the case because of some institutional and political reasons. For example, governments in such circumstances will often use price controls in selected fields where they can in practice be operated. This makes activity in these fields relatively or absolutely unprofitable, without regard to the net benefit of such activities. A particular case of such control concerns the price of foreign exchange which brings us to the next reason which is currency overvaluation (Little and Mirrlees, 1974: 29-30).

3.1.1.2. Currency Overvaluation

In almost all countries, the government manages the price of foreign exchange. With inflation and unaltered exchange rate, domestic prices get out of line with world prices. This implies that on the average, domestic prices of imports and exports are too low relative to those of nontraded goods. If the currency is not devalued then the demand for foreign exchange for

imports and other purposes will exceed the supply and the government will be forced to restrict imports. This results in large gaps between the market prices and the real cost of goods. But some governments choose the other way which is devaluating the currency rather than import restrictions.

If inflation is high and the government devalues currency periodically but not very frequently, then the currency inevitably be undervalued and overvalued, alternately. If inflation is slow, the government usually avoids devaluation and long periods of currency overvaluation are likely (Little and Mirrlees, 1974:30).

3.1.1.3. Wage Rates and Underemployment

In perfect competition, the market wage rate is the appropriate shadow price for labour, just as any market price is the appropriate shadow price for a good or service. But, in many developing countries, because of monopoly power and immobility, there are undoubtedly serious imperfections in the labour markets which cause major intersectoral distortions of the production pattern, and in turn, prevents the wages from being equal to the marginal product of labour (the extra output resulting from the employment of a small extra amount of labour) (Little and Mirrlees, 1974:31).

Furthermore, there is a big difference between the wages paid to the labour in modern sectors of the

economy - including modern industry and commerce, government and plantations - and the labour in the traditional sectors. This difference is usually much greater than the difference in the cost of living between these two sectors. Therefore, the cost of employing people in the modern sectors is apparently much greater than the loss of rural production, assuming that such rural earnings are a fair measure of labour's marginal contribution to production.

Another cause of the imperfections and distortions in the labour market is underemployment which means that men are unable to contribute as much to production as they consume while working (Akın, 1985: 7-8).

3.1.1.4. Imperfect Capital Markets

Capital market imperfections appear in the form of differential interest rates. If profits are to measure net social benefits, interest rates on loans should be equal for equal risks. In many developing countries, interest rates have very wide ranges. Therefore, it is difficult to suggest that they reflect different levels of risks. Factors such as government intervention, ignorance and monopoly elements in the supply of capital may cause to widen the interest range from low to almost astronomical rates (Little and Mirrlees, 1974:32).

3.1.1.5. Large Projects

In many developing countries, large projects are undertaken so that they have an important effect on profits elsewhere in the economy. This shows that the profitability of the project itself cannot be regarded as a good measure of net social benefit.

3.1.1.6. Inelasticity of Demand for Exports

In most of the developing countries, a large part of export revenues consists of one, two or three export commodities. If the country also accounts for a considerable part of total world production, then it can behave like a monopolist to affect the price it obtains by restricting sales. As a result, the free market price cannot correctly measure the benefit. This, in turn, implies that the country would gain by allocating less resources to producing primary commodities and more to others or to industrialization. This situation can be best corrected by suitable export taxes on the commodities (Little and Mirrlees, 1974:32).

3.1.1.7. Protection in the Form of Quotas and Tariffs

It is very common in many developing countries that domestic industry is protected by interfering with the price mechanism. This protection is achieved by applying tariffs and import quatos. By this way, the

domestic price of the output is kept above the import price.

However, the output of one industry is used as input of another. As a result, when an industry under protection decides to export its commodities, it finds that the protection provided for it at the domestic market causes a clear disadvantage at the export markets. Thus, tariff protection like currency overvaluation, implies that the domestic price obtainable for an export underestimates the social value of that export.

Another reason for the relative gap between domestic and world prices of some industries, is extensive use of import quotas. The balance of payments problem of a country can be controlled by restricting imports of the least essential goods. The result may be a growth of domestic industry behind protective quotas which bears little relation to the long-run comparative advantage of the country (Little and Mirrlees, 1974:33)

3.1.1.8. Deficiency of Savings and Government Income

Investments are required for the economic development of countries. It is stated that economic theory treats savings and investment as of equal value. Therefore, a government which has the objective of development, prefers savings rather than consumption. Thus, it will employ policy instruments to encourage

private savings and mobilize investable resources in the public sector. Governments can reduce aggregate private consumption and thus increase savings, by taxation. However, this has administrative and political costs.

Furthermore, there is a problem of determining the interest rate to discount the future benefits. While the market interest rate may be a point of reference for medium or large scale industrial borrowing, this can hardly ever be the case for the society as a whole. If the government selects a discount rate for projects which is lower than the market rate of interest, this is in turn to say that it considers future consumption to be more valuable than what it would worth under the valuation of the market interest rate. In other words, the government considers present savings to be more valuable than present consumption of private people (Fığlalı, 1989: 16).

Although the problem of the distribution of benefits, as between the present and future has arisen in the context of developing countries, it arises also in the context of developed countries.

3.1.1.9. The Distribution of Wealth

The problem of inequality which can be expressed as a problem of the distribution of benefits today, is also faced in many developing countries. In this case, there is a dilemma because inequality tends to promote

savings and help future generations. This is especially true for corporations: company profits belong mainly to the rich, but they are one of the main sources of savings. The dilemma can be partly overcome insofar as public savings can, by increased taxation, take the place of the savings of the rich but there is a limit to this and some element of dilemma remains (Little and Mirrlees, 1974:35)(1).

3.1.1.10. External Effects

Discrepancies between social and private cost lead to externalities which are the costs or benefits of a transcation that are incurred or received by members of the society but are not taken into account by the private enterpreneur (the buyer and the seller). In other words, the effects that work outside the market are called "externalities" such as industries causing water pollution.

Some economists and planners believe that externalities are of special importance in developing countries. This implies that some industries have beneficial or harmful effects on others, which are not reflected in the prices of the products they produce.

It can be seen obviously that externalities are another justification for using social benefit-cost

(1): For more detailed discussion on inequality refer to Little and Mirrlees, 1974: 52-60.

analysis as a project evaluation method.

3.1.2 Methodologies for Social Benefit-Cost Analysis

The practical use of cost-benefit analysis started with water resource development in the United States in 1930s (Little and Mirrlees, 1974:27). Since then, many methodologies for social benefit-cost analysis had been developed by the International Development Agencies such as the World Bank (IBRD), the United Nations, especially the United Nations Industrial Development Organization (UNIDO) and the Organization for Economic Cooperation and Development (OECD).

In the following sections, the procedures for social benefit-cost analysis will be presented according to the UNIDO guidelines.

3.1.2.1. UNIDO Approach to Social Benefit-Cost Analysis

There are mainly four steps in the evaluation of a project by social benefit-cost criteria by referring to the UNIDO guidelines.

First step is the identification of the social objectives.

Second step is the identification of the net economic benefits and costs of the project and the measurement of them according to the defined objectives.

In the third step, each cost and benefit item is discounted back to the present using appropriate social rate of discount by assuming that all the relevant parameters remain constant during the lifetime of the project.

In the final step, discounted benefits and costs are assessed in a common denominator. If there are any resources that their market prices do not reflect their social opportunity costs then, corrections for those resources are applied. For example, the market prices of foreign exchange, unskilled labour and investment may require adjustments in developing countries.

3.1.2.1.1. Identifying the Relevant National Objectives

As it was stated before, social benefit-cost analysis is carried out in the light of national objectives such as increased aggregate consumption, income redistribution, growth of national income, and employment creation. In other words, the evaluation of a project according to social benefit-cost analysis begins with an explicit statement of the relevant social objectives.

Among these objectives, aggregate consumption objective can be defined as raising of the standard of living which can be measured by aggregate consumption per head, is the primary objective for measuring the net benefits of the projects with respect to UNIDO approach.

According to the UNIDO approach, the primary criterion in estimating the aggregate consumption benefit is the "consumers' willingness to pay". The approach relies heavily on consumers' surplus analysis which reflects the amount that consumers are willing to pay instead of losing the opportunity to consume a particular commodity.

In the UNIDO guidelines, income distribution and merit wants are treated as externalities and introduced as separate elements in the welfare function. These externalities would have to be weighted individually for their relative importance with respect to aggregate consumption objective, but since it would be difficult to obtain objective estimates of the relevant weights, UNIDO recommends to use sensitivity analysis for alternative sets of weights (Fığlalı, 1989: 44).

3.1.2.1.2 Identifying the Relevant Benefits and Costs

After the identification of the objectives the proposed procedure is to go directly to the core of the matter and see what changes in the economy the project will bring about. This is the identification of the net output that the project under review will make available to the economy and the resources (inputs to the project) of the economy it will consume.

The net output of the project is defined as the

goods and services made available to the economy that would not have been available in the absence of the project. However, if the goods and services produced by the project do not add to the supply available in the economy, but instead substitute for an alternative source of supply, leaving the total supply constant, then the net output of the project is really reflected by the resources released from the alternative source of supply.

By the same token, the costs of a project consist of its "net input" which may be defined as the goods and services withdrawn from the rest of the economy that would not have been withdrawn in the absence of the project.

After the identification of the relevant net output and the net input of the project correctly then, comes measuring the aggregate benefits and costs of the project according to the consumers'willingness to pay.

Since aggregate consumption is the basic component of the welfare function to be maximized, the evaluation of the costs and benefits of the project is performed with reference to its contribution to final demand. In measuring the value of the intermediate goods the value of the change in output flows of the consumer goods attributable to the changes in the availability of intermediate goods should be determined. The same criterion can be utilized in assessing the values of both

inputs and outputs. This implies that all commodities and resources that enter the project's evaluation and whose total availability is not affected by the project should analyzed directly or indirectly at the demand margin (Fığlalı, 1989: 45).

If the total availability of commodities produced or resources used is changed after the implementation of the project, their value should be measured in terms of the opportunity cost of the resources consumed in supplying the additional units. This is, in UNIDO's terminology, the evaluation at the supply margin (Fığlalı, 1989 :46).

3.1.2.1.3. Evaluation of the Aggregate Consumption Benefits

The evaluation of the net aggregate consumption benefits of a project is most clearly carried out in successive stages of approximation according to UNIDO guidelines.

The first step is to assess the benefits and costs under the assumption that market prices adequately represent social opportunity costs. Then, a sequence of corrections to this first approximation is applied wherever the market prices do not reflect adequately the social costs and benefits involved in the use or provision of the goods and services. In other words, the market prices of some goods or services may not be good

indicators of the willingness to pay, and should be adjusted to reflect this willingness by using shadow prices.

According to UNIDO guidelines, the most important shadow prices are those of foreign exchange, investment and unskilled labour. All of these are referred to as "national parameters" that could ideally be supplied by the central planners and because of macro-economic considerations they would apply to all projects (Fığlalı, 1989 :46).

Shadow prices can be defined as the value of the contribution to the country's basic socioeconomic objectives made by any marginal change in the availability of related commodities or factors of production. Thus, shadow prices will depend on both the fundamental objectives of the country and the economic environment in which the marginal changes occur (Squire, Van Der Tak, 1975:26).

3.1.2.1.4. Comparing Costs and Benefits

Finally, all the benefits and costs of aggregate consumption are added up to arrive at a net value of aggregate consumption for each year of the project. Then, to come up with a net present value of aggregate consumption, these net returns for each year are discounted back to the present at the appropriate discount

rate by net present value (NPV) criterion.

The net present value criterion is given by the following formula:

$$Bo=Ro+\frac{R1}{(1+r1)}+\frac{R2}{(1+r1)*(1+r2)}+---+\frac{Rn}{(1+r1)***(1+rn)} \quad (3.1)$$

where Bo is the present value of net returns Ro, R1,...,Rn, over the finite time horizon, n, discounted by the expected interest rates r1,r2,...,rn .

When these interest rates are assumed to be constant throughout the project lifetime, equation (3.1) simplifies to :

$$Bo = Ro + \frac{R1}{(1+r)} + \frac{R2}{(1+r)^2}+.....+\frac{Rn}{(1+r)^n} \quad (3.2)$$

Net present value criterion is used in deciding whether a project represents a good use of resources. If the net present value of the project is negative, the project represents a bad use of resources and it should be rejected. On the other hand, in practice, projects with a positive net present value should not necessarily be accepted for two reasons:

First, the shadow prices of some inputs such as land or site value or mineral resources are virtually impossible to estimate independent of the project appraisal process itself. Consequently, the opportunity

cost of such inputs may be seriously underestimated because their best alternative use may not have been identified. In addition, it should be borne in mind that a high net present value may reflect an inadequate search for alternative projects rather than a potentially valuable project.

Second, there are many projects that by their nature are mutually exclusive: if one is chosen, the other cannot be undertaken. In all cases of mutually exclusive projects it is not sufficient to choose a project with a positive net present value rather, the project with the highest net present value among the mutually exclusive alternatives should be selected. The analysis should not assume too easily that such mutually exclusive alternatives do not exist (Squire and Van Der Tak, 1975: 39-40).

CHAPTER IV

AN APPLICATION OF THE BOT PROCEDURE TO A POWER PROJECT

The BOT principles set by Turkish authorities for the selection of power projects is best understood by means of an example. Therefore, a power project has been evaluated by using these principles to illustrate the framework of choice. The same project has also been evaluated by social benefit-cost analysis to be able to compare the two methods for their implications on project selection.

4.1 Description of the Project

A new power project, named as DÖNGEL hydro-electric power plant will be built to produce electricity on the stream called Tekir. The construction period of the project is two years beginning in 1988. The production was commissioned to start in year 1990. The concession period is taken as fifteen years. At the end of the year 2004, the ownership of the plant will be transferred to the Turkish government depending on the clauses in the concession contract.

4.2 Financial Aspect of the Project

The total investment requirement of the project is estimated as $ 8,626,000, 36 percent of which will be met through equity capital. The remaning financial requirements of the total investment cost (that is $ 5,500,000) will be met by foreign exchange credit.

The foreign loan is to be amortized over a five year period following the completion of the project with an effective interest rate of 10 percent.

4.3 Evaluation of the Project

In the BOT procedure, firstly, a concession period is chosen for the evaluation of the project. In the present project, this period is fifteen years. As mentioned in Chapter II, the concession period (operation period by the private sector) need to be a sufficient length of time to recoup the project's costs and make profits.

Secondly, the project's product price (i.e, the price of electricity) is determined by the project company for every operation year taking into account the operating expenses, debt repayment, interest on the credit, the repatriation of the equity, the return on equity and the taxes. By this way the investors will get a predefined rate of return on equity after all the expenses are repaid. Table 4.1 shows the structure of the selling

price of electricity. The calculation of the price is explained in section 4.4. After setting the annual power price for all the operation years then comes the comparison of this price with the current tariff rate which is related to the overall average generating cost of the publicly owned power plants. The public power rate includes 10 % of the average costs as a contribution to the "Public Partnership Fund". Therefore, this amount is also added to the power price of the project company.

The comparison is done as follows:

(1) If the average of the power price for the concession period is greater than the tariff rate set by the government, then the project is not accepted because it is more expensive than the public power plants.

(2) If the project's average power price is less than the fixed tariff rate then the project is accepted for that concession period.

This average power price comparison will be tied to the procedure involving the EE Fund explained in section 4.5.

4.4 Fund Flow Table for the Power Project

The fund flow table (Table 4.1) is prepared for the determination of the power tariff of the company. The power tariff per kilowatt-hour is calculated based on the expenditures the project will require. It is

calculated by dividing the deemed costs during one period by the guaranteed minimum available number of kilowatt-hours.

The deemed costs for the project include the following items that can be seen in Table 4.1:

1-the repayment of the loan (Item 17)

2-the interest on the credit (Item 6)

3-a return on investment for the shareholders (Item 19)

4-the repatriation of the equity (Item 18)

5-the taxes (Item 9,10,11 and 12)

6-the legal reserves (Item 13)

7-operation cost (Item 4)

Table 4.1 Fund Flow Table of Döngel Hydro-Electric Power Plant ($ 1000)

ITEM	YEARS 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1-SELLING PRICE (=3/2)	3.24	5.99	5.61	5.23	4.95	4.41	2.07	2.08	2.08	2.08	2.08	2.08	2.13	2.18	2.18
2-ENERGY PRODUCTION (Input)	40.41	40.41	40.41	40.41	40.41	40.41	40.41	40.41	40.41	40.41	40.41	40.41	40.41	40.41	40.41
3-PROJECT INCOME (=4+5)	1310	2423	2264	2114	2004	1784	839	841	841	841	841	841	863	882	882
4-PROJECT EXPENSES (Input)	771	771	771	771	771	595	588	579	579	579	579	579	464	362	362
5-PROJECT PROFIT (=6+7)	539	1652	1493	1343	1233	1189	251	262	262	262	262	262	399	520	520
6-INTEREST ON CREDIT (Input)	550	538	428	318	208	98	-	-	-	-	-	-	-	-	-
7-PROFIT BEFORE TAXES (=9)	(11)	1114	1065	1025	1025	1091	251	262	262	262	262	262	399	520	520
8-RECKON OF LOSS	-	(11)	-	-	-	-	-	-	-	-	-	-	-	-	-
9-INVESTMENT REDUCTION (=14/0.84)	-	1103	1065	1025	1025	1091	251	262	262	262	262	262	399	520	520
10-WITHOLDING TAX (=9*0.103)	-	114	110	106	106	112	26	27	27	27	27	27	41	54	54
11-CORPORATE TAX ASSESMENT	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
12-CORPORATE TAX	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
13-%5 LEGAL RESERVES (=9*0.05)	-	55	53	51	51	55	13	13	13	13	13	13	20	26	26
14-NET PROFIT (=16-15)	(11)	945	902	861	861	917	211	220	220	220	220	220	335	437	437
15-DEPRECIATION (Input)	600	600	600	600	600	424	417	408	408	408	408	408	293	191	191
16-TOTAL FUND (=17+19)	589	1545	1502	1461	1461	1341	628	628	628	628	628	628	628	628	628
17-CREDIT LOAN (Input)	120	1100	1100	1100	1100	980	-	-	-	-	-	-	-	-	-
18-EQUITY (Input)	-	-	-	-	-	-	267(1)	267	267	267	267	267	267	267	267
19-YEARLY FUND	469(2)	445(3)	402(4)	361(5)	361	361	361	361	361	361	361	361	361	361	361
20-CUMULATIVE FUND	469	914	1316	1677	2038	2399	2760	3121	3482	3843	4204	4565	4926	5287	5648
21-VALUE ADDED TAX (=3*0.12)	157	291	272	-	-	-	-	-	-	-	-	-	-	-	-

(1): (=[Equity Capital - (157+291+272)] / 9]
(2): (=Equity Capital *0.15)
(3): (=Equity Capital - 157)*0.15)
(4): (=Equity Capital - [157+291]*0.15)
(5): (=Equity Capital - [157+291+272]*0.15)
Equity Capital = 3126

4.5 Rent-Fund Relation Table

In this rent-fund relation table (Table 4.2), a comparison of the power tariff (calculated by the project company) with the current tariff rate (set by the government) is performed for every operation year. The power tariff of the company also includes a charge of that 10 percent of the power price of the year, needed to be paid to the "Public Partnership Fund" as mentioned before.

If the tariff rate set by the government is higher than the power tariff of the company, the project company will pay the amount resulted from the differences between the tariff rates multiplied by the produced power, to the "Electrical Energy Fund". If otherwise is true, the resulted amount is paid to the project company from the Electrical Energy Fund.

At the end of the concession period, if there is some cash accumulation in the Electrical Energy Fund, this means that the average power tariff rate is less than the current tariff rate and leads to the acceptance of the project. With the project analyzed here, the project company will pay $ 5,765,000 as a rent to the fund during the concession period. Therefore, it is concluded that, the power produced by the project company costs less than the government's tariff rate.

Table 4.2 Döngel Hydro-Electric Power Plant
Rent-Fund Relation Table

($ 1000)

YEAR	COMPANY POWER TARIFF	COMPANY POWER TARIFF (including public fund)	CURRENT TARIFF	FUND
1	3.24	3.56	4.50	379
2	5.99	6.58	4.50	-841
3	5.61	6.17	4.50	-675
4	5.23	5.75	4.50	-505
5	4.95	5.45	4.50	-384
6	4.41	4.85	4.50	-141
7	2.07	2.28	4.50	897
8	2.08	2.29	4.50	893
9	2.08	2.29	4.50	893
10	2.08	2.29	4.50	893
11	2.08	2.29	4.50	893
12	2.08	2.29	4.50	893
13	2.13	2.34	4.50	872
14	2.18	2.40	4.50	849
15	2.18	2.40	4.50	849

TOTAL :5765

The project company will pay 5,765,000 $ as a rent to the fund during the concession period.

CHAPTER V

APPLICATION OF THE SOCIAL BENEFIT-COST ANALYSIS TO A BOT POWER PROJECT

In this chapter, first, the presented methodology of social benefit-cost analysis is applied to the BOT power project. Next, the results of this evaluation are compared with the results of BOT procedure of project evaluation.

5.1 Benefits of the Project

Cash inflows of the project introduced in Chapter IV comprises of the revenues obtained from selling the electricity produced. The feasibility report shows that a total of 40.41 Gwh electricity will be produced as it is given in Table 5.1. However, the annual output of DONGEL hydroelectric power plant is expected to substitute for electricity produced by fuel oil plants. Therefore, for social benefit-cost analysis the net output of the project would correspond to the same amount of energy production saved from fuel oil plants. Hence the project benefits should be calculated based on the generation costs of fuel oil plants.

The costs of firm and secondary energy for the

fuel oil power plants using gas turbines during peak power demands are also given in Table 5.1. These figures are used in the calculation of project benefits which is found to be $ 1,208,000 as shown in Table 5.2. In the calculations 2.5 percent of the firm energy is subtracted from the project output to account for the interior consumption of the power plant.

Table 5.1. Output of Dongel Hydro-electric Power Plant (Gwh)

	Year		
PRODUCT	1988-1989	1990-2004	Cost (cent/Kwh)
(1) Firm energy	0	13.17	4.38
(2) Secondary energy	0	27.24	2.37
TOTAL	0	40.41	

Table 5.2 Social Value of the Output of Dongel Hydro-Electric Power Plant ($ 1000)

	Year
PRODUCT	1990-2004
(1) Firm energy(4.38cent/Kwh)	576,8
(2) Energy losses (% 2.5 from firm energy)	14,4
(3) NET VALUE (1-2)	562,4
(4) Secondary energy (2.37 cent/Kwh)	645.5
TOTAL FOREIGN EXCHANGE SAVED (3+4)	1,208

5.2 Costs of the Project

The relevant economic costs of the project can be summarized in terms of the following items:

(1) Investment costs

(1-a) Production machinery, equipment and construction period expenses.

(1-a-i) Imported machinery (Foreign currency)

(1-a-ii) Domestically obtained equipment.

(1-b) Interest and taxes

(2) Operation costs

(2-a) Repair and maintenance costs

(2-b) Personnel salaries.

(3) Working capital.

Investment costs are related with the costs incurred during the construction period. The resources used in construction can be seen in Table 5.3 and 5.4. Table 5.5 gives the annual operation costs of the project.

In the project company's cost accounts (the fund flow table) there are such cost items as interest payment, loan repayment, taxes and depreciation allowances during the operation period. Since these payments do not represent direct claims on the resources used in the project and they merely reflect a transfer of the control over resource allocation from one sector of the society to another, these items are excluded from the cost stream for social benefit-cost calculations.

Table 5.3 Foreign Exchange Component of Construction Costs ($ 1000)

ITEM	Year 1988	1989	TOTAL
(1) Buildings,structure and civil works	-	133	133
(2) Hydro-electric power facilities	-	2215	2215
(3) Interest	-	130	130
TOTAL	-	2478	2478

Table 5.4 Domestic Component of Construction Costs ($ 1000)

ITEM	Year 1988	1989	TOTAL
(1) Buildings,structures and civil works	1343	3357	4700
(2) Welfare and housing	53	-	53
(3) Hydro-electric power and auxiliary facility	-	512	512
(4) Taxes (Value Added Tax)	160	464	624
(5) Interest (10%)	30	175	205
(6) Working capital	-	54	54
TOTAL	1586	4562	6148

Table 5.5 Project Annual Operating Costs
($ 1000)

ITEM	Year 1990-2004
(1) Buildings,structure and civil works (including machinery and maintenance)	45
(2) Hydro-electric power facilities (including skilled and unskilled labour)	126
TOTAL	171

5.3 Evaluation of the Net Aggregate Consumption Benefits

The evaluation of the net aggregate consumption benefits of DONGEL hydro-electric power plant is carried out best in successive stages of approximation. The first step is to assess the benefits and costs under the assumption that market prices adequately reflect social opportunity costs and, therefore, the consumption benefits of the project consist of items (1), (3) and (6), the consumption costs include items (2), (4a), (4b) and (5) of Table 5.6.

Table 5.6 Resource Flows of the Project
($ 1000)

ITEM	YEAR							
	1988	1989	1990	1991	1992	1993	1994-2003	2004
(1) Output (Foreign Exch.)	-	-	1208	1208	1208	1208	1208	1208
(2) Working Capital (Domestic)	-	54	-	-	-	-	-	-
(3) Scrap Value (Domestic)	-	-	-	-	-	-	-	1933
(4) Construction Costs								
(4a) Imported m/c (Foreign Exch.)	-	2478	-	-	-	-	-	-
(4b) Domestic m/c	1586	4508	-	-	-	-	-	-
Total	1586	6986	-	-	-	-	-	-
(5) Operation Costs (Domestic)	-	-	171	171	171	171	171	171
(6) Working Capital (Domestic)	-	-	-	-	-	-	-	54

The market value of net consumption benefits in any given year of the project is, therefore, given by

$$MC=(1)-(2)+(3)-(4a)-(4b)-(5)+(6) \qquad (5.1)$$

where MC represents the first approximation to the aggregate consumption benefits of the project in market prices.

The second approximation involves the adjustment of the market prices of specific resources wherever these prices do not reflect their "social opportunity costs". In the evaluation of the present project only one resource is chosen for price adjustment: foreign exchange. It is assumed that all the remaining resources of the project are correctly priced by the market mechanism.

In the case of foreign exchange, because of trade distortions one unit of foreign exchange is worth substantially more than the official exchange rate. Therefore, the opportunity cost of foreign exchange relative to its official market price will be denoted by (1+@). That is to say, @ represents the foreign exchange premium, which is currently positive in Turkey and which is assumed to remain constant over the lifetime of the project.

After incorporating the opportunity cost premium the net consumption benefits in a given year of the project can be expressed as:

$$SC=MC+@F \qquad (5.2)$$

where F=(1)-(4a) (5.2a)

SC is obtained by adding one term to the first approximation, MC. The term corrects MC for the opportunity cost of foreign exchange by multiplying the net foreign exchange component of benefits and costs, F, by the (positive) foreign exchange premium, @.

The third and final approximation to the aggregate consumption benefits of the project can now be applied. This involves identification of the net effect of the project on the mix of consumption and investment. The idea is that some of the returns obtained from the project will be reinvested rather than being immediately consumed and produce future benefits which will augment the value of consumption benefits. Therefore, the social value of aggregate consumption benefits of the project corrected for the investment considerations can now be written as:

$$C=[(1-s)+sP^{inv}]SC \qquad (5.3)$$

where s is the fraction of returns which, in general, be reinvested and P^{inv} is the shadow price of investment. C is obtained by correcting the second approximation, SC, for reinvestment.

5.4 Evaluation of the Project

Various parameters are required to evaluate the project in terms of the approximations given in the previous section. In principle each of these parameters is a function of time and the appropriate values may

therefore change according to the year in which the benefits and costs are being measured. To simplify the computations, however, it will, first, be assumed that the value of each parameter remains constant over the entire lifetime of the project. Table 5.7 presents those national parameters with their corresponding numerical values. An alternative evaluation with some of the parameters assumed to change with time, will be given in section 5.6.

Table 5.7 Values of National Parameters

(1)	Foreign Exchange premium	@=0.14
(2)	Marginal productivity of capital	q=0.23
(3)	Marginal rate of savings	s=0.25
(4)	Social rate of discount	i=0.08,0.1,0.12
(5)	shadow price of investment	P^{inv}=7.67,4.06,2.76

Calculation of the shadow price of foreign exchange involves a high degree of theoretical and practical detail which by itself can be the subject of a thesis (Johnston, 1963; Goldstein and Khan, 1978). Therefore, it has been left out of the scope of this study. Its value has been obtained from a previous study in which it was found to be worth 14 percent higher than its value at the official exchange rate (Fığlalı, 1989: 113).

Marginal productivity of capital is calculated

by using the following formula (Mashayekhi, 1980: 29):

$$q = \Delta O/\Delta K - (\Delta E/\Delta K * \Delta W/\Delta E) \qquad (5.4)$$

where O is the Gross Domestic Product at factor cost;

K is the value of total fixed investment;

E is the amount of employment and W represents wages paid.

$\Delta O/\Delta K$ is the inverse of incremental capital-output ratio (ICOR) which has been estimated as 4 indicating an incremental output -capital ratio of 0.25[2] .

$\Delta E/\Delta K$ represents the incremental employment-capital ratio and can be approximated by using the inverse of labour productivity. The labour productivity of Turkey for 1987 was calculated to be 1651 TL using the productivity figure for 1976 and the annual % changes in productivity given in OECD, Economic Survey Of Turkey, 1987/1988.

$\Delta W/\Delta E$ denotes the incremental wage-employment ratio (i.e marginal labour productivity) and the legal minimum wage rate which is 38,640 TL/month in 1987 can be taken as a rough approximation. Using the above data marginal productivity of capital, q, is found to be :

$$q = 0.25 - \left(\frac{1}{1651} * (10)^{-3} * 38640\right) = 0.23$$

---

(2): This figure was taken from the Sixth Five Year Development Plan and Annexes.

In Turkey, previous studies revealed that the marginal rate of savings varies between 0.24 and 0.26 (3). In the evaluation of this project the marginal propensity to save is assumed to be 0.25 as in Fığlalı, 1989.

The shadow price of investment (P^{inv}) is calculated by using the following simple formulae of UNIDO approach if marginal rate of savings, marginal productivity of capital and social rate of discount are assumed to be constant during the lifetime of the project:

$$P^{inv} = \frac{(1-s)}{(i-sq)} \qquad (5.5)$$

Given the values of parameters and given all the relevant cash flows over time, it is now possible to calculate the net benefits of the project by substituting into the appropriate equations derived in the previous section.

Since all the relevant parameters are assumed to be constant, it is not necessary to make separate calculations for each year of the project. Instead, all the cost flows in Table 5.6 can be converted into their equivalent present values by discounting back to year 0 at the common rate of discount, and the present values of each flow item can then be substituted into the equations

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(3): This figure was obtained from the sixth five year development plan and annexes.

given earlier to compute the project's net benefits. (Dasgupta, Sen and Marglin, 1972:287-288).

The evaluation of the project has also been done with three different concession periods (10,20 and 30 years) to see the effect of alternative concession periods on the project profitability. Similarly, three different social rates of discount has been utilized to capture the sensitivity of the project choice to the employed rate of discount.

To compare the results of social benefit-cost analysis with those of BOT procedure, under different concession period and discount rate assumptions, the BOT calculations have also been repeated with the above mentioned concession periods and discount rates.

The resource flow table for social benefit-cost analysis and fund flow table for BOT procedure are presented for only the concession period of 15 years which is the chosen period by the government in BOT power projects. But, present values of net benefits of the project according to both methods for each concession period are given in Tables 5.8 - 5.23.

Table 5.8 Present Values in Year 1988 of Items in Table 5.6 for Concession Period of 10 Years

($ 1000)

ITEM	Social rate of discount 8%	10%	12%
(1) Output (foreign exchange)	7505	6747	6094
(2) Working Capital (Domestic)	50	49	48
(3) Scrap Value (Domestic)	1243	1016	833
(4) Construction Cost	8054	7937	7824
(4a) Imported m/c(Foreign Exch.)	2294	2253	2213
(4b) Domestic m/c	5760	5684	5611
(5) Operation Costs	1062	955	862
(6) Working Capital	23	19	16

Table 5.9 Present Values of Net Benefits of the Project for Concession Period of 10 Years

($ 1000)

ITEM	EQUATION	Social rate of discount 8%	10%	12%
MC	MC=(1)-(2)+(3)-(4a)-(4b)--(5)+(6)	-395	-1159	-1791
F	F=(1)-(4a)	5211	4494	3881
SC	SC=MC+@*F	334	-529	-1247
C	$C=[(1-s)+sP^{inv}]*SC$	890	-932	-1795

Table 5.10 Present Values in Year 1988 of Items in Table 5.6 for Concession Period of 15 Years
($ 1000)

ITEM	Social rate of discount 8%	10%	12%
(1) Output (foreign exchange)	9574	8353	7346
(2) Working Capital (Domestic)	50	49	48
(3) Scrap Value (Domestic)	564	420	315
(4) Construction Cost	8054	7937	7824
(4a) Imported m/c(Foreign Exch.)	2294	2253	2213
(4b) Domestic m/c	5760	5684	5611
(5) Operation Costs	1355	1182	1040
(6) Working Capital	16	12	9

Table 5.11 Present Values of Net Benefits of the Project for Concession Period of 15 Years
($ 1000)

ITEM	EQUATION	Social rate of discount 8%	10%	12%
MC	MC=(1)-(2)+(3)-(4a)-(4b)--(5)+(6)	695	-383	-1242
F	F=(1)-(4a)	7280	6100	5611
SC	SC=MC+@*F	1714	471	-456
C	$C=[(1-s)+sP^{inv}]*SC$	4581	840	-741

Table 5.12 Present Values in Year 1988 of Items in Table 5.6 for Concession Period of 20 Years
($ 1000)

ITEM	Social rate of discount 8%	10%	12%
(1) Output (foreign exchange)	10981	9349	8056
(2) Working Capital (Domestic)	50	49	48
(3) Scrap Value (Domestic)	191	131	89
(4) Construction Cost	8054	7937	7824
(4a) Imported m/c(Foreign Exch.)	2294	2253	2213
(4b) Domestic m/c	5760	5684	5611
(5) Operation Costs	1554	1321	1140
(6) Working Capital	11	7	5

Table 5.13 Present Values of Net Benefits of the Project for Concession Period of 20 Years
($ 1000)

ITEM	EQUATION	Social rate of discount 8%	10%	12%
MC	MC=(1)-(2)+(3)-(4a)-(4b)--(5)+(6)	1525	181	-861
F	F=(1)-(4a)	8687	7097	5844
SC	SC=MC+@*F	2741	1174	-42
C	$C=[(1-s)+sP^{inv}]*SC$	7311	2069	-60

Table 5.14 Present Values in Year 1988 of Items in Table 5.6 for Concession Period of 30 Years

($ 1000)

ITEM	Social rate of discount 8%	10%	12%
(1) Output (foreign exchange)	12592	10352	8688
(2) Working Capital (Domestic)	50	49	48
(3) Scrap Value (Domestic)	0	0	0
(4) Construction Cost	8054	7937	7824
(4a) Imported m/c(Foreign Exch.)	2294	2253	2213
(4b) Domestic m/c	5760	5684	5611
(5) Operation Costs	1782	1465	1229
(6) Working Capital	5	3	2

Table 5.15 Present Values of Net Benefits of the Project for Concession Period of 30 Years

($ 1000)

ITEM	EQUATION	Social rate of discount 8%	10%	12%
MC	MC=(1)-(2)+(3)-(4a)-(4b)--(5)+(6)	2711	905	-410
F	F=(1)-(4a)	10298	8099	6476
SC	SC=MC+@*F	4152	2038	496
C	$C=[(1-s)+sP^{inv}]*SC$	11075	3591	714

Table 5.16 Present Values in Year 1988 of Items in BOT Fund Flow Table 4.1 for Concession period of 10 Years ($ 1000)

ITEM	Social rate of discount 8%	10%	12%
(1) Output	12138	11034	10067
(2) Construction Cost	8054	7937	7824
(3) Working Capital	50	49	48
(4) Operating Cost	1062	955	862
MC=(1)-(2)-(3)-(4) Net Benefits:	2972	2093	1333

Table 5.17 Present Values in Year 1988 of Items in BOT Fund Flow Table 4.1 for Concession period of 15 Years ($ 1000)

ITEM	Social rate of discount 8%	10%	12%
(1) Output	12825	11447	10282
(2) Construction Cost	8054	7937	7824
(3) Working Capital	50	49	48
(4) Operating Cost	1355	1182	1040
MC=(1)-(2)-(3)-(4) Net Benefits:	3366	2279	1370

Table 5.18 Present Values in Year 1988 of Items in BOT Fund Flow Table 4.1 for Concession period of 20 Years ($ 1000)

ITEM	Social rate of discount 8%	10%	12%
(1) Output	13398	11804	10496
(2) Construction Cost	8054	7937	7824
(3) Working Capital	50	49	48
(4) Operating Cost	1554	1321	1140
MC=(1)-(2)-(3)-(4) Net Benefits:	3740	2498	1485

Table 5.19 Present Values in Year 1988 of Items in BOT Fund Flow Table 4.1 for Concession period of 30 Years ($ 1000)

ITEM	Social rate of discount 8%	10%	12%
(1) Output	14273	13057	12050
(2) Construction Cost	8054	7937	7824
(3) Working Capital	50	49	48
(4) Operating Cost	1782	1465	1229
MC=(1)-(2)-(3)-(4) Net Benefits:	4387	3616	2949

Table 5.20 Comparison of the Net Present Value of Benefits for Concession Period of 10 Years ($ 1000)

APPROACH	Social rate of discount 8%	10%	12%
MC	-395	-1159	-1791
SC	334	-529	-1247
C	890	-932	-1795
BOT	2972	2093	1333

Table 5.21 Comparison of the Net Present Value of Benefits for Concession Period of 15 Years ($ 1000)

APPROACH	Social rate of discount 8%	10%	12%
MC	695	-383	-1242
SC	1714	471	-456
C	4581	840	-741
BOT	3366	2279	1370

Table 5.22 Comparison of the Net Present Value of Benefits for Concession Period of 20 Years ($ 1000)

APPROACH	Social rate of discount 8%	10%	12%
MC	1525	181	-861
SC	2741	1174	-42
C	7311	2069	-60
BOT	3740	2498	1485

Table 5.23 Comparison of the Net Present Value of Benefits for Concession Period of 30 Years ($ 1000)

APPROACH	Social rate of discount 8%	10%	12%
MC	2711	905	-410
SC	4152	2038	496
C	11075	3591	714
BOT	4387	3616	2949

5.5 Comparison of the Results

The figures in the tables indicate that the net present value of benefits varies depending on the social rate of discount and the concession period (evaluation period) as it would be expected, regardless of the analysis method used.

As the discount rate decreases, the net present value of benefits increases for all the cases. But, in the case of the concession period this is vice versa (refer to Figure 5.1). That is, the longer the concession period, the higher is the net present value of benefits. This is because, the longer the concession period means the longer the operating phase that is the phase in which the revenues (and therefore, the profits when existing) are considered. In other words, since the revenues are computed based on the operating costs and debt service, and since the initial investment expenditure does not change with the concession period, the longer the concession period is, the higher the profits are obtained.

The change in the net present value of benefits from one concession period to another or from one discount rate to another is higher in case the Social Benefit-Cost Analysis is used than the BOT method. This indicates a higher sensitivity of the results of social benefit-cost analysis to concession period length and social rate of discount. Table 5.24 and 5.25 show the percent change in

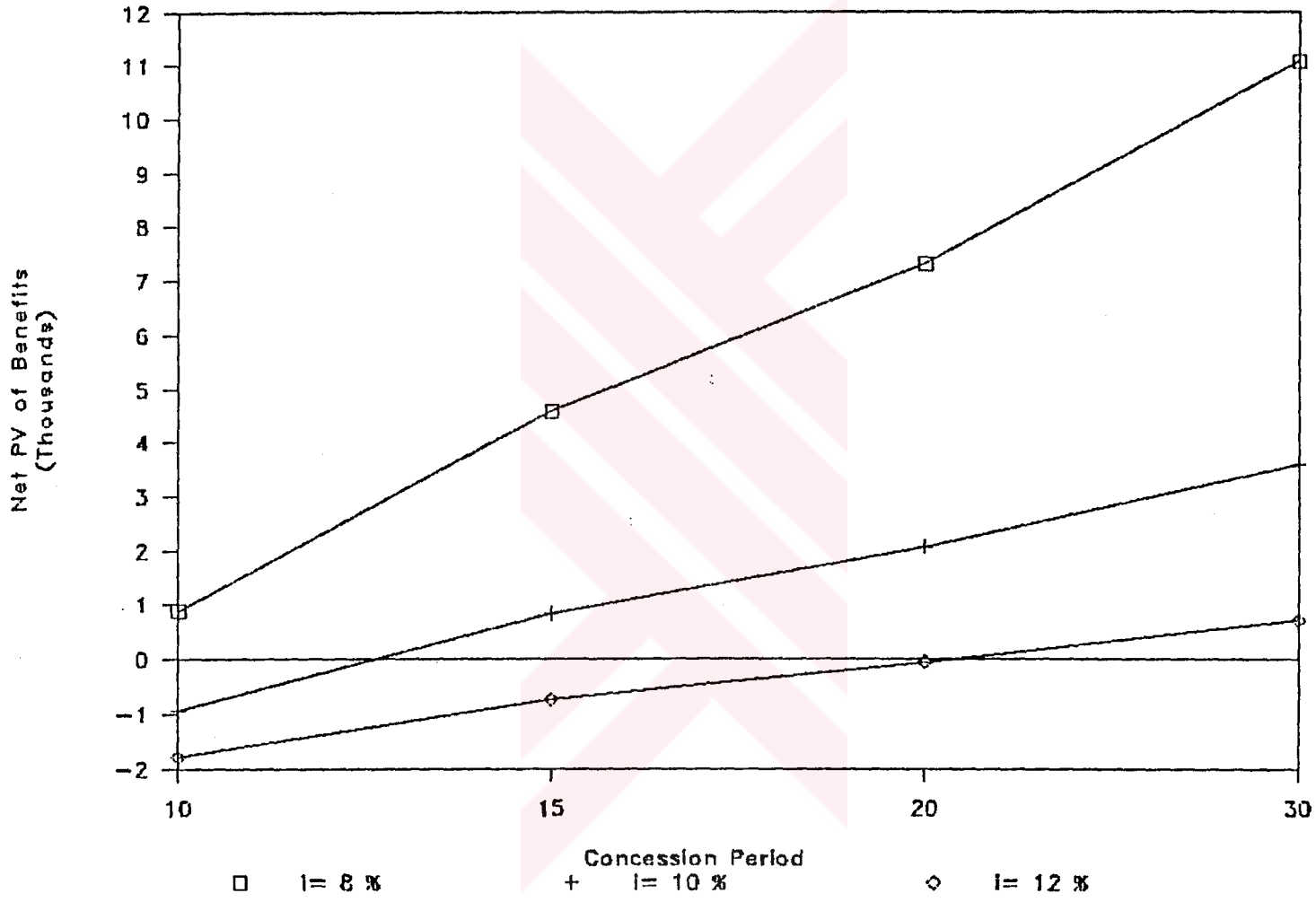

Figure 5.1 NPVF (SBCA) Under Alternative i and Concession Period Assumptions

net benefits (C) as social rate of discount and concession period varies, respectively.

Table 5.24 Percent Change in Net Benefits(C) as Social Rate of Discount Varies
Concession Period=15 years.

	Changes in Social Rate of Discount	
Method	8% - 10%	10% - 12%
BOT	-%47	-%66
SBC	-%450	-%226

Table 5.25 Percent Change in Net Benefits as Concession Period Varies
Social Rate of Discount= 8%

	Changes in Concession Period		
Method	10 - 15	15 - 20	20 - 30
BOT	%13	%11	-%4
SBC	%413	%59	%51

The net present value of benefits according to the BOT method is always positive and does not vary too much with respect to the discount rate and the concession period (refer to Figure 5.2). This is because, the

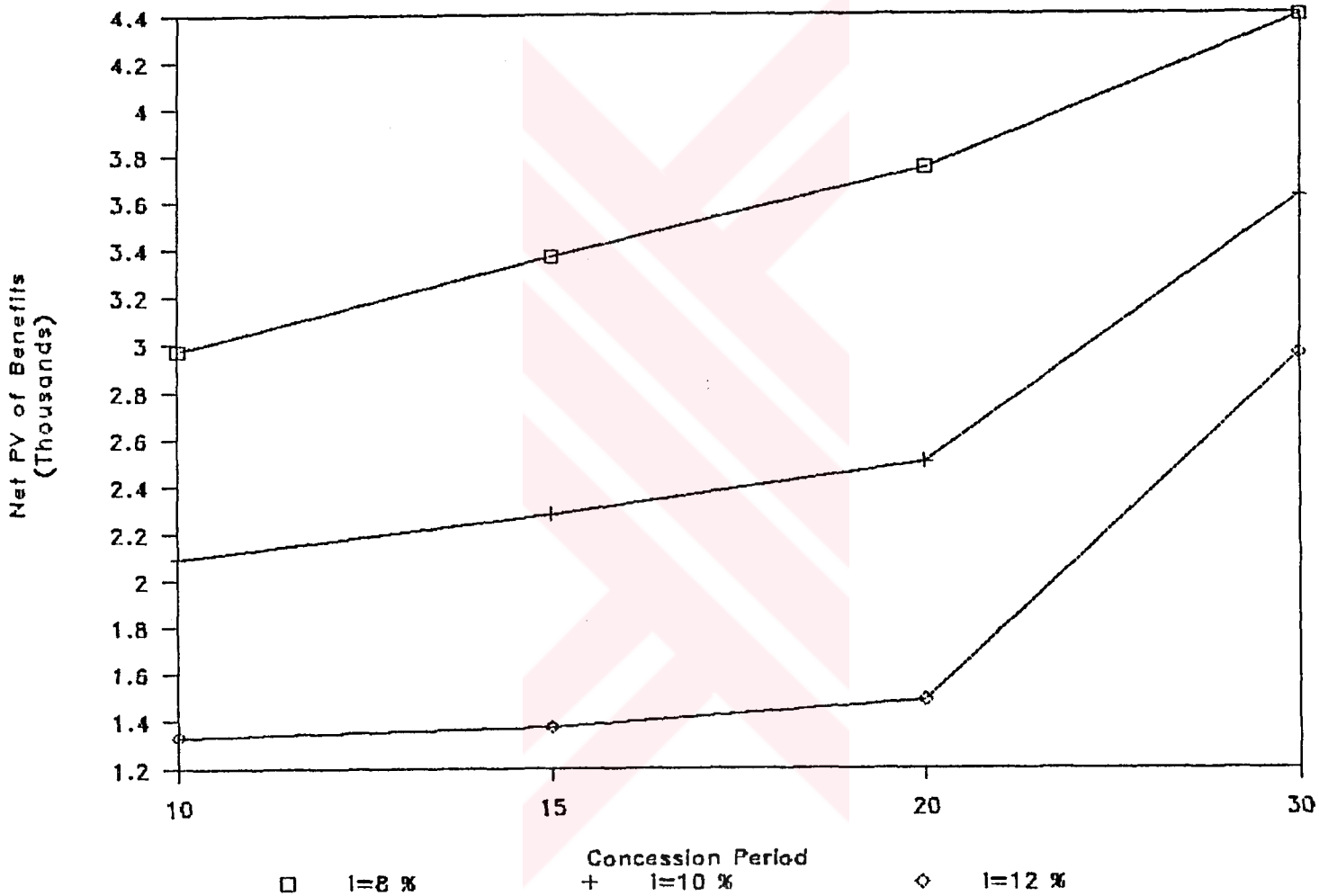

Figure 5.2 NPVF (BOT) Under Alternative i and Concession Period Assumptions

operating cost and the debt and equity service are taken into considerations in the determination of the price of the product or service (in this case energy) provided by the project. The rate of return from the project, the investors expect, does not change with respect to the concession period.

If the concession period is 10 year, the Social Benefit-Cost analysis (C:third approximation) gives negative net present value of benefits for all the discount rates except 8 percent in which case it is positive but very small. If the discount rate is 12 percent, the above result is valid for all the concession periods except for the evaluation with 30 years.

As a conclusion it can be stated that, with the assumption of constant National parameters during the concession periods, the evaluation of DONGEL Hydro-Electric power project within the framework of Social Benefit-Cost analysis shows that the project has positive net contributions to the aggregate consumption objective if the conditions of a) the concession period is 15 years or higher and b) the discount rate is 10 percent or lower are both satisfied at the same time (with again the exception of 8 percent discount rate when the concession period is 10 years).

5.6 Social Benefit-Cost Analysis When National Parameters (s and q) Change Over Time

Up to this point, all the national parameters that determine the social value of investment -the rate of savings, the marginal productivity of capital and the social rate of discount - are assumed to remain constant over time. If any of these parameters change over time, the simple formulae for Pinv (equation 5.5) used earlier in the evaluation of the project no longer suffice, and, moreover, P^{inv} will not itself remain constant over time. That is, the social value of next year's investment in terms of next year's consumption will differ from the social value of present investment in terms of present consumption.

To calculate P^{inv} without the simplifying assumption of constant s and q is not an impossible task. It is merely more cumbersome. However, to estimate the value of s and q in each year is not an easy task. To come over this difficulty an alternative approach is considered (Dasgupta, Sen and Marglin, 1972: 194-198). In this approach which is given in Appendix B, first, it is assumed that there exist a period of "to" during which the economy will close the gap between the nominal marginal productivity of capital (q) and the social rate of discount (i). Once q and i become equal, the shadow price of investment will become equal to its nominal price. With this assumption, it becomes necassary to find the

estimates of the parameters s and q over a period of "to" years rather than over an infinite horizon. This assumption simplifies the shadow price calculation but the problem of estimating s and q and "to" may still be a difficult task for many planning organizations. Therefore, as a second simplifying procedure, it is assumed that s and q remain at their current values until "to". This assumption results in the P^{inv} formula given below. Now, only three parameters (in addition to i) s, q, and "to" must be estimated.

$$P_u^{inv} = \left[\frac{(1-s)q}{i-sq}\right]\left[1-\left(\frac{1+sq}{1+i}\right)^{to-u}\right]+\left(\frac{1+sq}{1+i}\right)^{to-u} \qquad (5.6)$$

where u is any year for which P^{inv} is calculated ("to" $\geq$ u).

The assumptions to justify the use of marginal productivity of capital becoming equal to the social rate of discount after t="to" require the basic assumption of optimal growth to prevail after "to". This is to assume that the path the economy will follow over time will be the best of all feasible paths. "Under conditions of optimal growth, the marginal productivity of capital properly valued, is the social rate of discount, because the logic of optimization dictates that investment be carried to the point where the net (social) return on capital is just sufficient to compensate for the lower value placed on marginal future consumption relative to

marginal present consumption, which is to say the point at which the marginal productivity of capital equals to the social rate of discount" (Dasgupta, Sen and Marglin, 1972: 164). "To impute optimally to the future path of economic development projected for any economy, planned or unplanned, is not a reasonable assumption. Planning commissions are quite satisfied with their efforts if they can produce a single plan that is internally consistent and if this plan is debated in the country at large the debate revolves primarly around its feasibility rather than its optimality"(Dasgupta, Sen and Marglin, 1972:130).

For these reasons, it seems more appropriate to choose a large "to" assuming that the time after which optimal growth will prevail is quite far from present day. However, with this modified Pinv formula, the net consumption benefits of the project has been calculated for a whole range from 0 to 35 years to capture the effects of the choice of "to" on the results, while keeping the concession period equal to 15 years.

Figure 5.3 shows the variation in the shadow price of investment over the years according to the selection of "to" period.

Table 5.26 gives the present values of net benefits of the project for a number of values for "to".

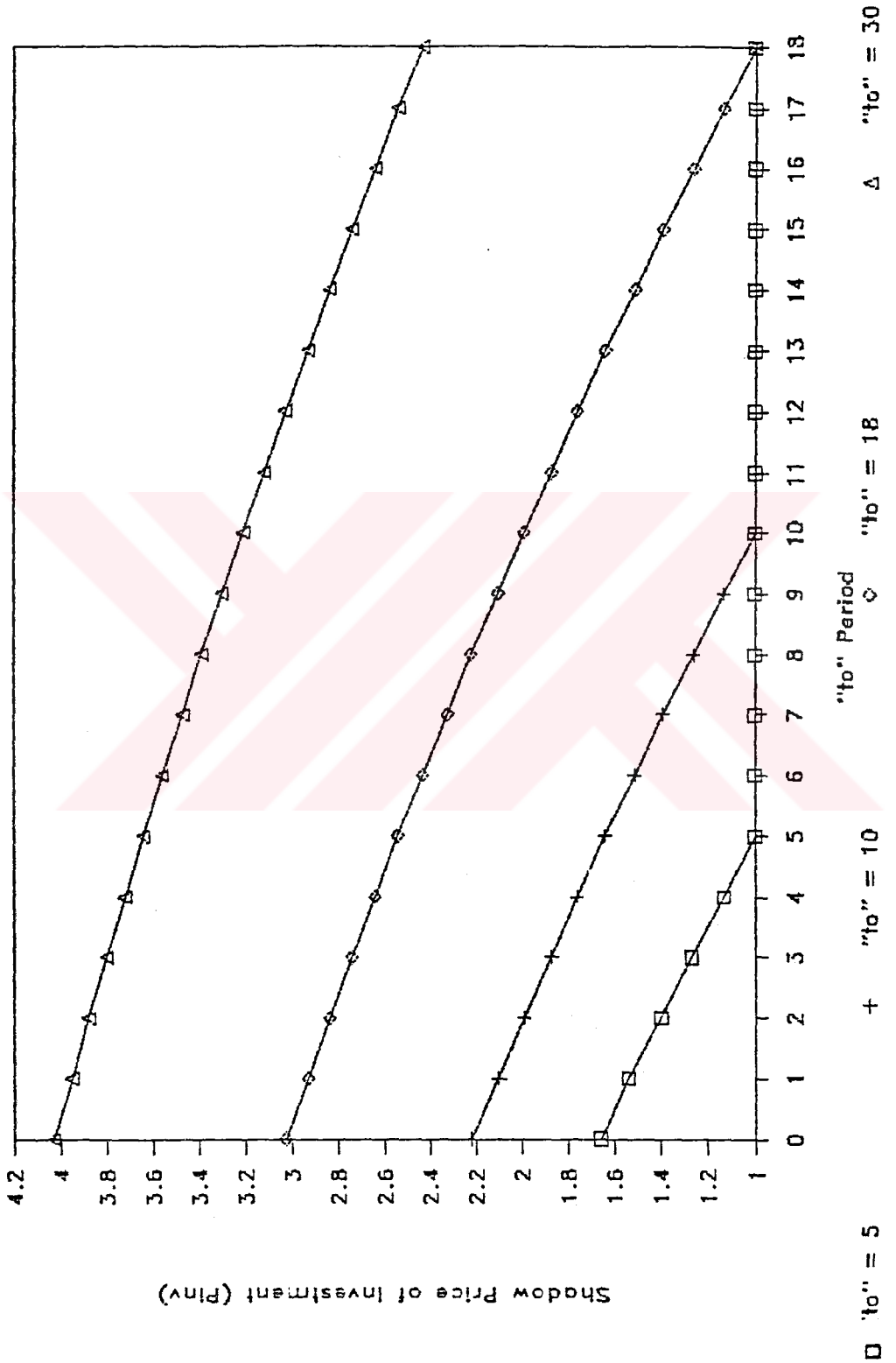

Figure 5.3 Change in Pinv Under Alternative Period "to" (i= 8%)

Table 5.26 Present Value of Net Benefits When Shadow Price of Investment Changes : Final Correction ($C=[(1-s)+s*P^{inv}]*SC$)

($ 1000) Concession period=15 years

"to" PERIOD(year)	Social rate of discount 8 %	10 %	12 %
5	736	-328	-1160
8	391	-590	-1357
10	287	-667	-1411
12	263	-683	-1422
18	578	-481	-1294
30	1471	18	-1023

The net aggregate consumption benefits is negative when the social rate of discount is equal to 10 and 12 percent for all the different "to" cases except for "to"=30 years and i=10 %, at which it is positive but very close to zero. On the other hand, the net aggregate consumption benefits are all positive when the social rate of discount is 8 percent.

Results with different "to" assumptions showed that the net consumption benefits go through a minimum value at "to"=12 years for all discount rates. The net benefit function is nonlinear with respect to "to" and it can be shown that there exists a "to" value which minimizes this function. Appendix C gives the proof.

Choosing "to" small is to assume that the gap between q and i will be closed in a short period of time and the shadow price of investment will be equal to its nominal value of unity. The assumption that "to"=0 corresponds to applying no correction for the shadow price of investment. On the other hand, choosing "to" large means that this gap will be closed over a long period after which optimal growth will prevail in the economy. Figure 5.4 shows the variation in the net consumption benefits as "to" varies from 0 to 30 years under three different discount rate assumptions.

In recognition of the political and institutional constraints on the government's control over the economy as well as the technological constraints, it seems more appropriate to postpone optimal growth to a far future and to choose "to" large.

Figure 5.5, 5.6 and 5.7 presents, in terms of bar charts, the net consumption benefits as a function of "to" at different discount rates. From Figure 5.5, it is seen that using a constant P^{inv} (result shown as C) or a changing P^{inv} does not change the sign of the net benefits at i=8 %. Therefore, if it is believed that the social rate of discount is most likely to be 8%, to assess the benefits of the BOT project it is necassary to compare the benefits calculated according to the BOT procedure with the corrected results (case C or result with "to"=30 or above) and check which one is greater.

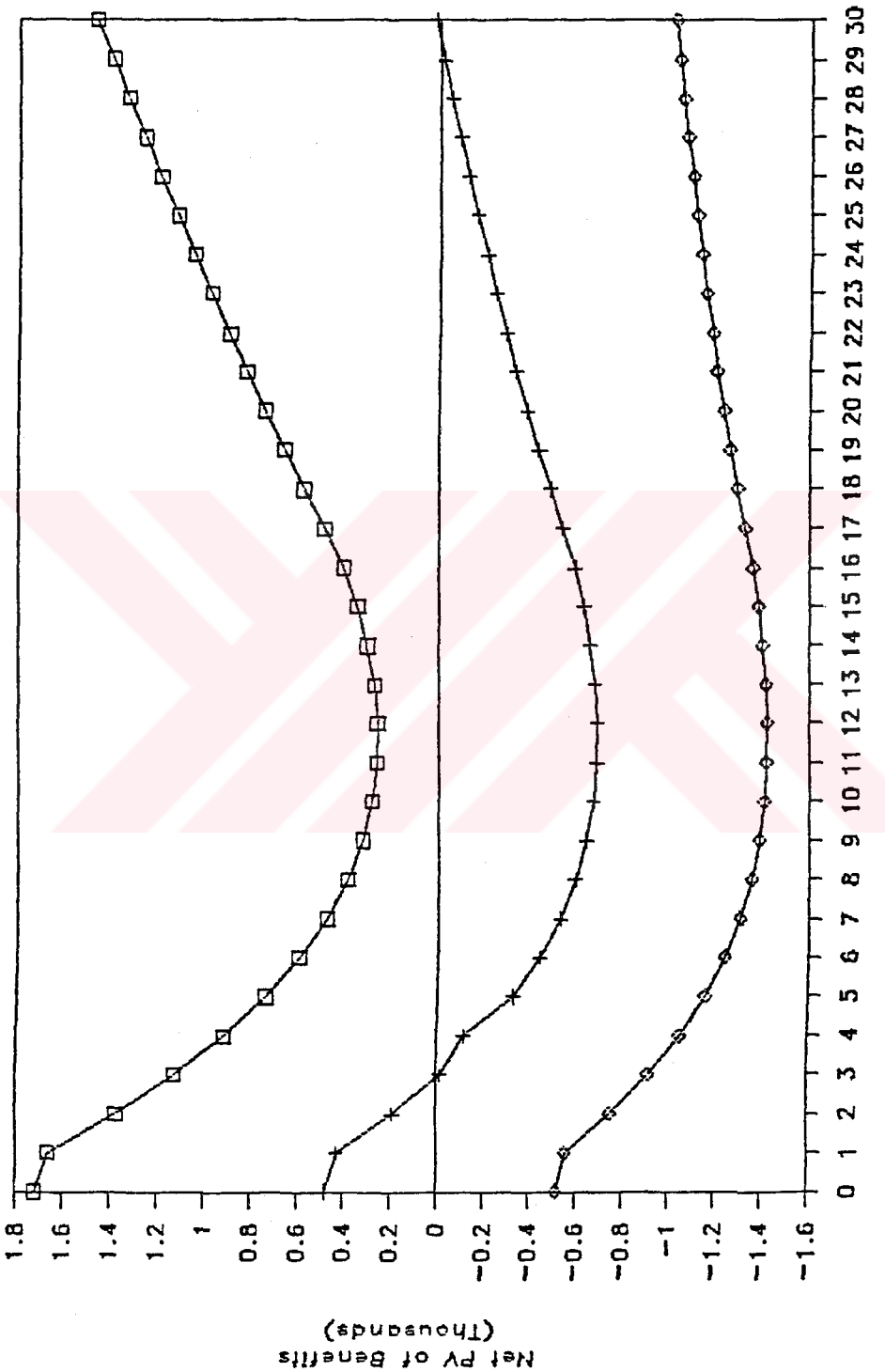

Figure 5.4 NPVF (SBCA) When Pinv Changes Under Alternative i and "to" Period

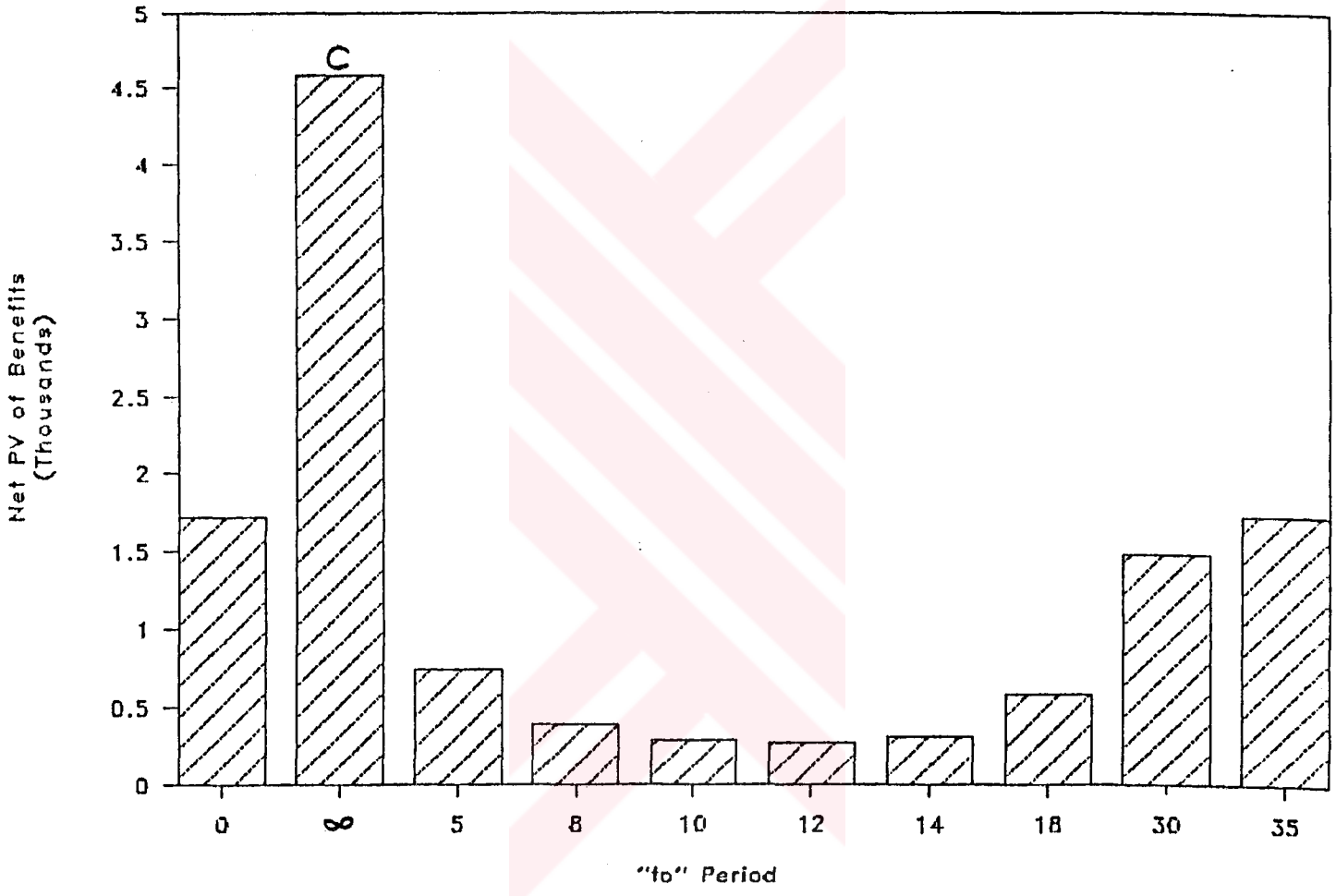

Figure 5.5 NPVF (SBCA) When Pinv Changes Under Different "to" Period (i= 8%, C.P=15)

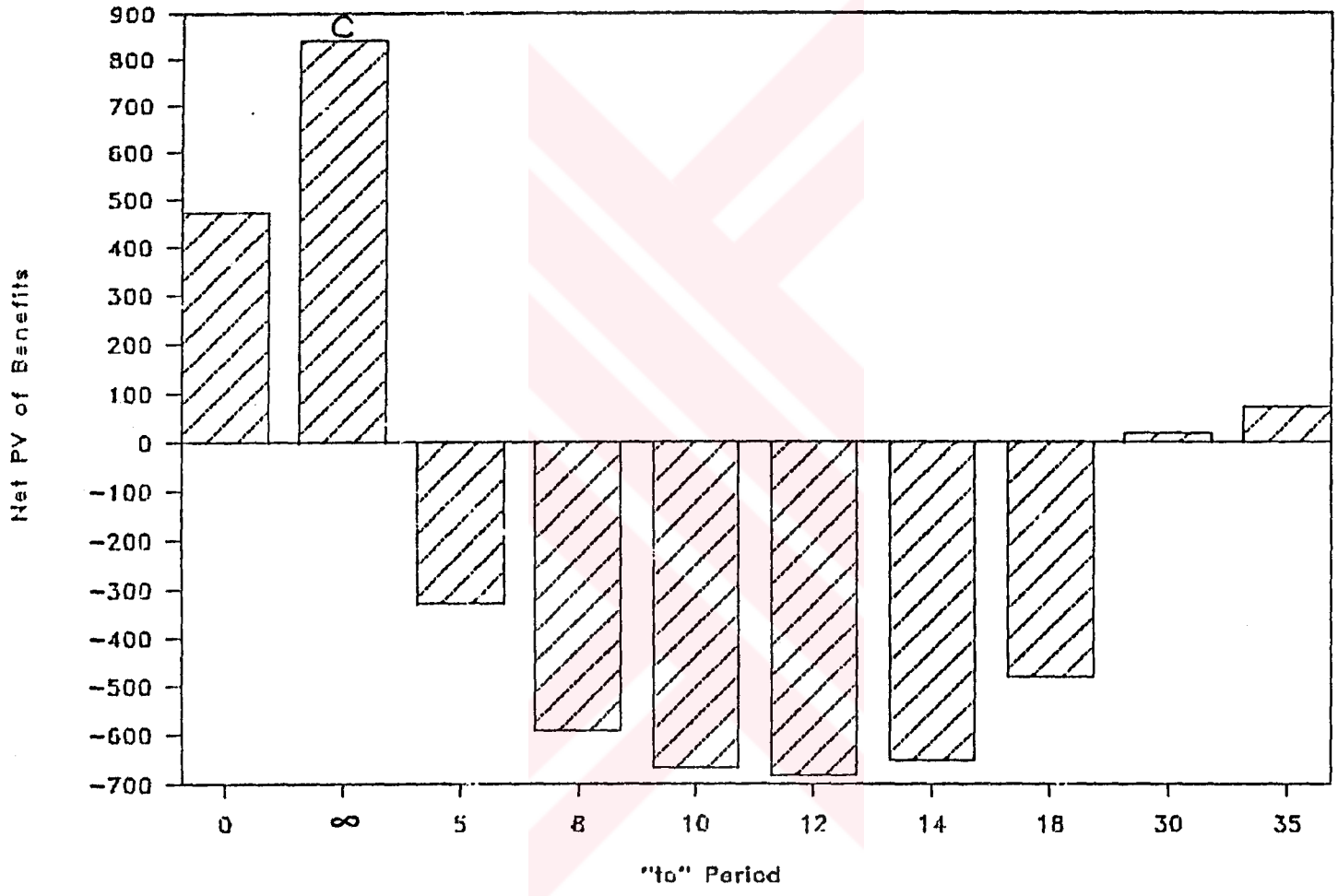

Figure 5.6 NPVF (SBCA) When Pinv Changes Under Different "to" Period (i=10 %, C.P=15)

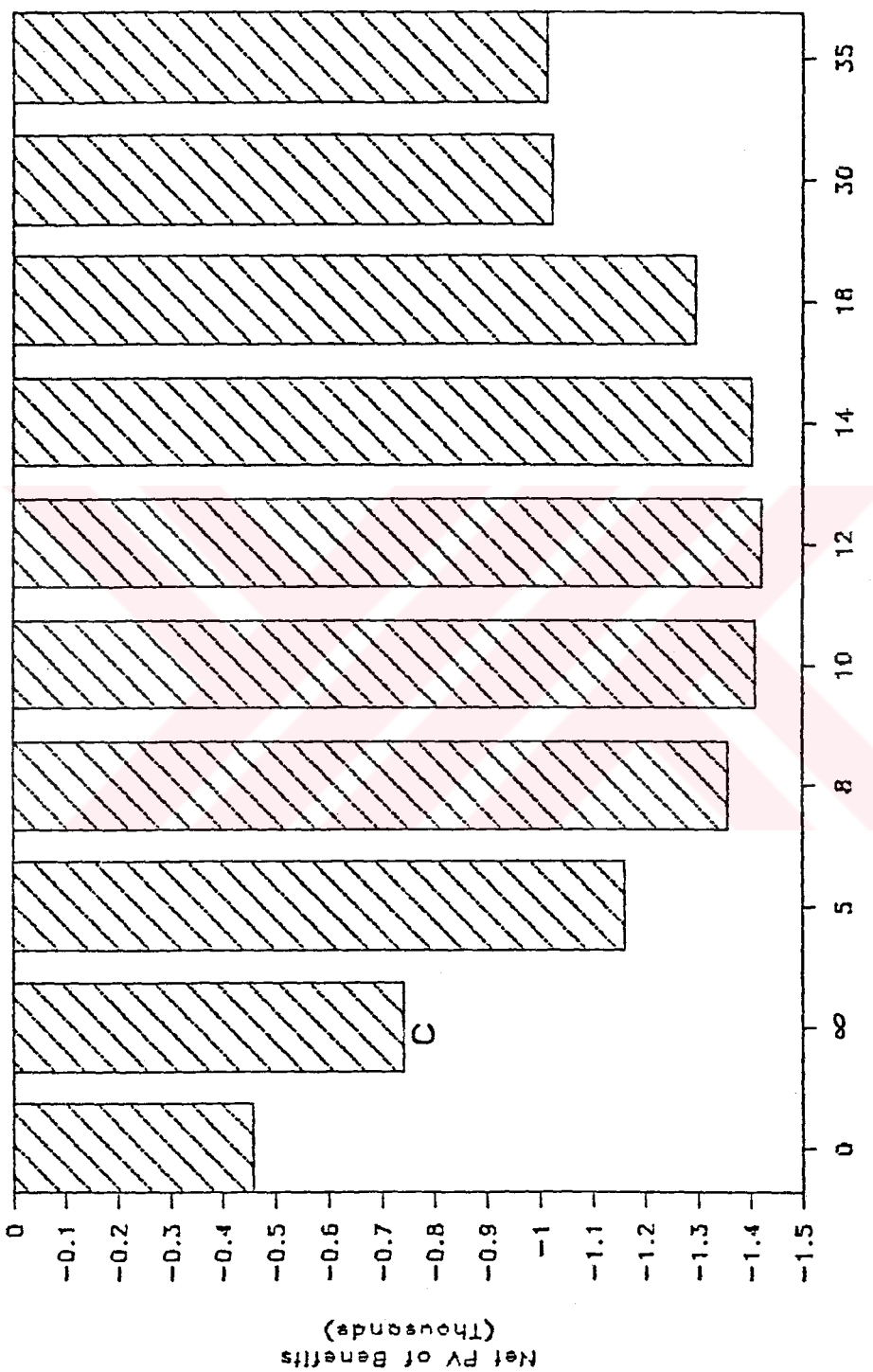

Figure 5.7 NPVF (SBCA) When Pinv Changes Under Different "to" Period (i=12 %, C.P=15)

On the other hand, for i= 10 % while constant P^{inv} yields positive net benefits, for changing P^{inv} with "to"=30 years the benefits are near zero. In this case the problem is to decide on which formulation -constant P^{inv} ("to"=∞) or changing P^{inv} ("to"=30)- is more realistic and appropriate to the choice. The answer to this problem depends upon the subjective estimates about the adjustment capabilities of the economy (adjustment taking place in 30 years or never ("to"=∞) and therefore left to the decision makers in higher echelons of the planning offices.

When the social rate of discount is taken as 12 % both corrections (constant P^{inv} and changing P^{inv}) indicates negative net benefits therefore, the BOT project should be rejected.

In conclusion, sensitivity analysis with changing "to" showed that the net consumption benefits is a nonlinear function of "to" which goes through a minimum value for a "to" value between 0 and 35 years and acceptance or the rejection of the projetc depends upon the social rate of discount as well as what type of correction with respect to shadow price of investment (changing or constant P^{inv}) has been employed.

5.7 Evaluation of the Project: The Case with Government Guarantees

BOT projects involve financing, political and technical risks as explained in Chapter II. Within the BOT principles applied for power projects, Turkish government provides some guarantees to the joint venture company. Table 5.27 gives the security tool, the conditions and date limit for the government's provision.

Table 5.27 Turkish Government Guarantees

Security	Subordinated Loans
Amount	. 12 months debt service + operating expenses + return on equity
Conditions	. If cost overruns or low operation and Escrow accounts not sufficient . Political risks . Force Majeure risks
Date Limit	. 3 years of operation or the second Escrow account is equal to one year debt service . No limit if political risks

Turkish government accepted to share some of the project risks by providing subordinated loans to the joint venture under certain conditions.

As it can be seen from Table 5.27, if the plant is not operating as expected as far as output is concerned or if there have been construction cost overruns or in

case of political risks and force majeure events that are out of control of the joint venture company, government agrees to provide the subordinated loans in case Escrow accounts are not enough to repay the owed amount.

The subordinated loan will cover to repay the 12 months debt service, operating expenses and return on equity.

The securities given by the Turkish government through subordinated loans can be considered in two groups:

(1) The Turkish government will provide loans that cover all the losses (not only the debt service) during the first three years of operation.
(2) It will provide the loans any time in the event of political changes or force majeure events.

These two types of guarantees imply additional opportunity costs of the funds spared for these purposes. Therefore, they have been included in the resource flows of the project as additional costs which are shown as items 7 and 8 in Table 5.29. Item 7 is the subordinated loan provided by the host government to cover the debt service and the return on equity in foreign currencies. Item 8 is the subordinated loan provided by the government to cover the operating cost in domestic currencies.

Turkish government will provide loans that cover all the losses (not only the debt service) during the first three years of operation, but after three years of operation, it will provide the loans only in the event of political changes or force majeure events. Therefore, the first components (items (7a) and (8a)) of the guarantees is for the first 3 years of operation and the other components (items (7b) and (8b)) is for the remaining operation years.

Incorporation of these items in the resource flow table (Table 5.6) results in Table 5.29. Using the resource flows given in Table 5.29, Social Benefit Cost analysis has been repeated to see the effect of the given guarantees on the results.

Three cases have been considered here:

(1) Present values of net benefits of the project when the probability of providing subordinated loans after 3 years of operation is zero. (p(7b)=p(8b)=0 and p(7a)=p(8a)=1).

Table 5.28 Present Values of Net Benefits of the Project in Year 1988 ($ 1000)
Concession Period=15 Years
Case (1)

ITEM	EQUATION	Social rate of discount 8%	10%	12%
MC	MC=(1)-(2)+(3)-(4a)-(4b)-(5)+(6)-(7a)-(8a)	-4117	-5015	-5703
F	F=(1)-(4a)-(7a)	2908	1893	1560
SC	SC=MC+@*F	-3709	-4749	-5484
C	$C=[(1-s)+sP^{inv}]*SC$	-9893	-8370	-7896

Table 5.29 Resource Flow of the Project in Case of Government Guarantees

$ (1000)

ITEM	YEAR 1988	1989	1990	1991	1992	1993	1994-2003	2004
(1) Output (Foreign Exch.)	-	-	1208	1208	1208	1208	1208	1208
(2) Working Capital (Domestic)	-	54	-	-	-	-	-	-
(3) Scrap Value (Domestic)	-	-	-	-	-	-	-	1933
(4) Construction Costs								
(4a) Imported m/c (Foreign Exch.)	-	2478	-	-	-	-	-	-
(4b) Domestic m/c	1586	4508	-	-	-	-	-	-
Total	1586	6986	-	-	-	-	-	-
(5) Operation Costs (Domestic)	-	-	171	171	171	171	171	171
(6) Working Capital (Domestic)	-	-	-	-	-	-	-	54
(7) Subordinated Loan (Foreign Exch.)								
(7a) For the First 3 Years	-	1139	2083	1930	-	-	-	-
(7b) After 3 Years	-	-	-	-	1793	1683	1453	375
Total	-	1139	2083	1930	1793	1683	1453	375
(8) Subordinated Loan (Domestic)								
(8a) For the First 3 Years	-	171	171	171	-	-	-	-
(8b) After 3 Years	-	-	-	-	171	171	171	171
Total	-	171	171	171	171	171	171	171

(2) Present values of the net benefits of the project when the probability of political risk is 1. (p(7b)=p(8b)=1 and p(7a)=p(8a)=0).

Table 5.30 Present Values of Net Benefits of the Project in Year 1988 ($ 1000)
Concession Period=15 Years
Case (2)

ITEM	EQUATION	Social rate of discount 8%	10%	12%
MC	MC=(1)-(2)+(3)-(4a)-(4b)-(5)+ +(6)-(7b)-(8b)	-5343	-5685	-5927
F	F=(1)-(4a)-(7b)	2315	1710	1229
SC	SC=MC+@*F	-5018	-5445	-5754
C	$C=[(1-s)+sP^{inv}]*SC$	-13385	-9596	-8156

(3) The net benefits of the project when there is 100 percent political risk (p(7b)=p(8b)=1) and 100 percent risk of providing the subordinated loan during the first 3 years of operation (p(7a)=p(8a)=1).

Table 5.31 Present Values of Net Benefits of the Project in Year 1988 ($ 1000)
Concession Period=15 Years
Case (3)

ITEM	EQUATION	Social rate of discount 8%	10%	12%
MC	MC=(1)-(2)+(3)-(4a)-(4b)-(5)+ +(6)-(7a)-(8a)-(7b)-(8b)	-10155	-10316	-10388
F	F=(1)-(4a)-(7a)	-2057	-2496	-2822
SC	SC=MC+@*F	-10442	-10665	-10783
C	$C=[(1-s)+sP^{inv}]*SC$	-27854	-18797	-15284

The results show that the net benefits of the project decreases substantially when more extensive government guarantees are taken into account. Furthermore, it is observed that even with the minimum guarantee the net benefits change from being positive to negative in the case of i= 8 % and 10 % implying a need to reject the project. This is reasionable because, the given guarantees are considered as cost items that the project will demand from the economy.

5.8 A General Comparison of the Results Obtained From the Social Benefit-Cost Analysis and BOT

The purpose of this section is to make a general comparison of the obtained results from the social benefit-cost analysis point of view and BOT procedure to reach a final conclusion. For this purpose, three extreme cases of SBCA have been selected (from already obtained results) in addition to the BOT analysis performed by the project company.

The first case of SBCA is the base case with incorporating the shadow price of investment and foreign exchange and assuming that they remain constant during the evaluation period. In this case, it is also assumed that there are no government guarantees in case of any risk (case C1).

In the second case, instead of the assumption of constant shadow price of investment, a changing shadow

price of investment during the life of the project is accepted. For this purpose the appropriate shadow price with "to" =30 years has been employed (case C2).

The third case comprises of the government guarantees. For the comparison, among the three cases of government guarantees in section 5.7, now the first case is chosen because it gives the most positive net present worth of benefits (since it is the least risky case).

BOT analysis can be considered as financial evaluation because the project is evaluated at market prices. The results of the three cases (C1,C2,C3) of SBCA with BOT analysis are summarized in Table 5.32.

Table 5.32 Comparison of the Net PV of Benefits ($ 1000) Concession Period=15 years

APPROACH	Social rate of discount 8%	10%	12%
C1 (base case with constant P^{inv} and no government guarantees)	4581	840	-741
C2 (with changing P^{inv} "to"=30)	1471	18	-1023
C3 (with government guarantees when no political risk and 100 percent risk of providing loan during the first 3 years of operation)	-9893	-8370	-7896
BOT	3366	2279	1370

As it can be seen from Table 5.32, the net present value of benefits is positive for all the three discount rates according to the BOT method. When the social rate of discount is 12 percent, all the three different cases of SBCA give the negative net benefits for the project. In the other discount rates, 8 and 10 percent, only the results of C1 and C2 yield positive net benefits in decreasing order from C1 to C2 and negative in C3 (refer to Figure 5.8).

From these results, it can be concluded that the assumption of changing shadow price of investment with time and the inclusion of government guarantees reduces the net benefits calculated by using Social Benefit-Cost analysis. According to the first approach (C1) which takes into consideration of constant shadow price of investment and no government guarantees, the BOT project seems to be beneficial to the country, especially at the 8 percent of social discount rate. Assumption of constant shadow price of investment means that the gap between marginal rate of capital and the social rate of discount will never close and hence an optimal growth pattern will never be reached. However, in the second approach (C2), with changing shadow price of investment as time passes, the growth in the economy will be towards closing this gap and after "to", there will be no difference between making investment and consumption. With respect to this case, the Net PV of benefits when period "to" is taken as 30 years,

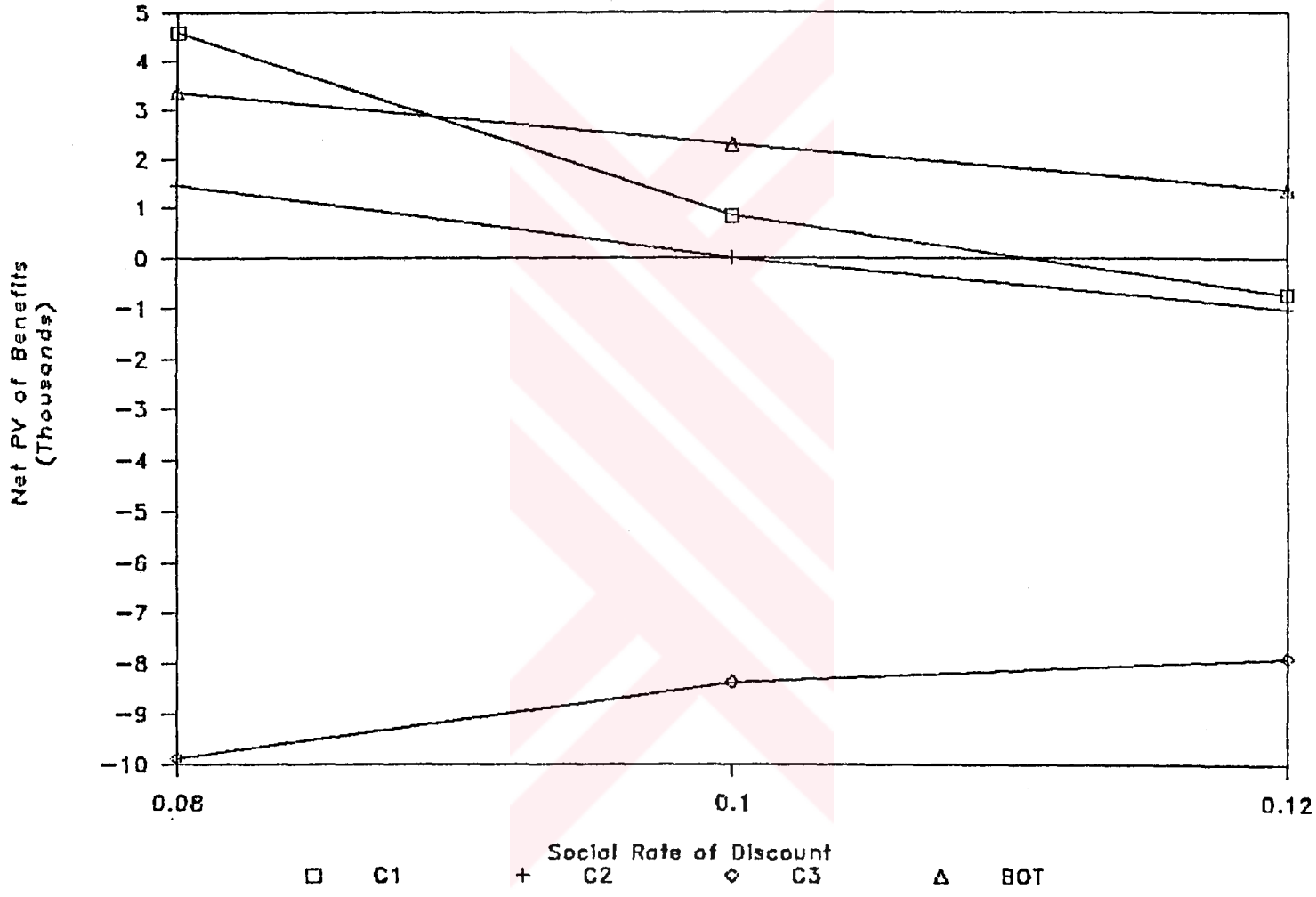

Figure 5.8 A General Comparison of the NPVF Obtained From SBCA and BOT

is less than the first case and less than the BOT result.

The conclusion with respect to the third approach (C3) is that the security package provided by the Turkish government, is a heavy burden on the government itself and cancels the advantages that the BOT scheme will provide to the country.

CHAPTER VI

CONCLUSION

The main purpose of the present thesis has been to describe the issues involved with the Build-Operate-Transfer model for investment projects in the developing countries and to study the relative merits of the Turkish BOT model for power projects by comparing the results with those obtained by using social benefit-cost analysis.

The BOT model provides an alternative project financing technique for both developed and developing countries. Although it has been used in developed countries for a long time, it is new to developing countries. A literature survey on the subject showed that there is only a small number of publications with some level of academic quality. However, with pure chance it has been possible to spot a master of science thesis completed at the Massachusetts Institute of Technology in May 1990 (Selwan Fadi, 1990). This thesis also helped to see that the available reference publications are very much limited and the subject provides an unexplored field of study as we anticipated. For these reasons the first part of the thesis has been devoted to the description of the BOT model using the gathered material to provide a

complete overview and reference document for further studies.

The main advantage of the BOT model is to reduce the involvement of the governments in the financing of the public projects. This allows the governments to concentrate more on expenditures related with the achievement of the national objectives such as the improvement of social health and educational services. The effect of BOT project financing is to increase the total investment level in the country. Those over concerning the developing countries, their external debts will be reduced by decreasing the demand for foreign loans and new technologies will be transferred with much ease by the foreign contractors.

BOT model of project financing has its specific problems. It is obvious that for its successful implementation in the developing countries where the political and economical environment is generally unstable, the host government as the manager of the project should formulate certain regulations and take part in the process. On the other hand, the lenders and investors require some guarantees from the government for their investment against political risks. Those guarantees concern the exchange rates and the transfer of the revenues into foreign countries, the level of revenues that may be affected by local political changes and the standby accounts for cost overruns during construction.

These securities constitute the source of problem for the host government and they should not be in the form of direct sovereign guarantees. If they should, as shown in the analysis of BOT scheme for power projects, all the advantage of the BOT model to the country would be cancelled. The associated risks for the BOT projects should be shared among the main parties involved in the BOT process; the project sponsor, the constructor, the operator, the host government, the investors and the lenders.

The application of the social benefit-cost analysis principles to revaluate a BOT project has revealed many important problems. The benefits of a project is always positive when evaluated by using the BOT principles because it allows the investors to finance all of their costs and make a given rate of profit. When the same project is evaluated using social benefit-cost analysis, alternative assumptions leads to a wide range of results varying from rejecting the project to the acceptance of it in yielding considerable net positive benefits.

Among the most important variables social rate of discount, the shadow price of foreign exchange, the shadow price of investment and finally the concession period and government guarantees play a dominant role on the results. The project benefits are totally sensitive to these variables. Therefore, depending upon the assumptions

made for social benefit-cost analysis, the benefits indicated by SBCA may be negative or positive and when positive less than or greater than the benefits calculated by the BOT principles. This whole thing complicates the matter of comparison yet also illustrate how unreliable a single result is to accept a project on the BOT basis.

The obtained results of SBCA indicate that the use of shadow price of foreign exchange increases the net benefits under all social rates of discount and concession period assumptions. The same is true with the use of shadow price of investment (constant P^{inv}) for those social rates of discount (i=8 % and 10 %) for which the net benefits after correcting for the shadow price of foreign exchange is positive. When the mentioned net benefit is already negative (as with i=12 %), the correction for shadow price of investment amplifies the negative result.

When it is assumed that the shadow price of investment varies, the net benefits go through a minimum value depending upon the time period over which it is assumed that the gap between social rate of discount and the productivity of capital will close. In this case, comparisons of the project's net benefits with that given by the BOT model presents additional difficulties. These difficulties arise because of the uncertainities about the social rate of discount, the period "to" over which q will become equal to i and after which the economy will follow

an optimal growth path.

Another conclusion drawn from the analysis is that taking into account of the government guarantees has a pronounced negative effect on the total net benefits. The results revealed the fact that if the government provides direct sovereign guarantees, then there is no need to BOT model because it will not bring any advantage to the country.

However, the social benefit-cost analysis results should be assessed on the basis of assumptions made in the estimation of national parameters. The calculation of shadow prices depends on the national parameters which, in turn, depend on the value judgments of the government and the national objectives.

The evaluation of a given BOT project by social benefit-cost analysis with all the sensitivity analysis as described in the thesis provide a wide range of data for the decision makers. It is their responsibility then, to estimate the most likely values for the main national parameters which are the social rate of discount, the social productivity of capital, total savings rate and the adjustment period "to".

Having observed that a beneficial BOT project may not be beneficial when revaluated by SBCA, the following question arises: Since the government sets the rules for BOT model, how can this model be reshaped so

that it results in projects the selection of which are also acceptable with the social benefit-cost criteria? This is a difficult further work because in the BOT model there are mainly two parties involved, the host government and the project company and depending upon the conditions they may end up with conflicting interests. So the problem is to find a strategy which is acceptable by both parties. In other words, this is to say that the BOT model should be revised so that a project beneficial to a private firm is also beneficial to the country as a whole. This will require an acceptable level of comprimise for the two parties.

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APPENDICES

APPENDIX A

DERIVATION OF THE SHADOW PRICE OF INVESTMENT (P^{inv}) WHEN NATIONAL PARAMETERS ARE CONSTANT OVER TIME

The shadow price of investment, P^{inv}, is by definition the net present value of the aggregate consumption stream resulting directly and indirectly from a unit of marginal investment.

In the simplest model, with no reinvestment of benefits, there are only direct benefits to take into consideration and the shadow price of investment depends only on capital productivity and the social rate of discount at which returns are converted into present equivalents and is given by

$$P^{inv} = \frac{q}{i} \qquad (A1)$$

In more realistic models, a fraction, s, will in general be reinvested, and only the remainder, (1-s), will be consumed. Therefore, the shadow price of investment must also reflect the consumption produced indirectly by the reinvestment of a portion of the immediate output of investment. Thus, the marginal propensity to save enters as an additional determinant of the shadow price of investment.

If reinvestment from the returns of an initial one unit of investment leads to an accumulated investment of A_t in year t, the overall- direct and indirect- return from this investment will be qA_t

Assuming the fraction (1-s) of this return is consumed, the contribution to aggregate consumption in year t is $(1-s)qA_t$

The shadow price of investment, the present value of the entire stream of consumption, is thus

$$P^{inv} = \sum_{t=1}^{\infty} \frac{(1-s)qA_t}{(1+i)^t} \qquad (A2)$$

To evaluate (A2), we must have a way of expressing A_t in computable terms. This is readily at hand, since A_t depends only on the marginal propensity to save, s, and the marginal productivity of capital, q.

In year 1, the accumulated capital is still the original stake of one unit: $A_1=1$

In year 2, however, the original stake is augmented by the reinvestment of sq unit, the fraction of the first year's return (q) assumed to be plowed back into capital formation.

Thus,

$$A_2 = A_1 + sqA_1 = (1+sq)A_1 = 1+sq \qquad (A3)$$

In year 3, the accumulated capital includes the reinvestment of a fraction of year 2's return as well as the earlier reinvestment. Year 2's return is qA_2 and so the reinvested portion is sqA_2. Thus, the capital accumulated by the year 3 is

$$A_3 = A_2+sqA_2 = (1+sq)A_2 = (1+sq)^2 \qquad (A4)$$

In general, the capital accumulated in year t is the sum of the capital on hand during the previous year, A_{t-1}, and the reinvestment from the returns of the previous year, sqA_{t-1}

Thus,

$$A_t = A_{t-1} + sqA_{t-1} = (1+sq)A_{t-1}$$

Since the same logic holds for year t-1, we have

$$A_{t-1} = A_{t-2} + sqA_{t-2} = (1+sq)A_{t-2}$$

So that

$$A_t = (1+sq)^2A_{t-2}$$

Working backwards to year 1, we have the general formula:

$$A_t = (1+sq)^{t-1} \qquad (A5)$$

of which (1.3) and (1.4) are special cases. Now, we can substitute from (1.5) into (1.2), then

$$p^{inv} = \sum_{t=1}^{\infty} \frac{(1-s)q(1+sq)^{t-1}}{(1+i)^t}$$

or, equivalently

$$P^{inv} = \frac{(1-s)q}{1+sq} \sum_{t=1}^{\infty} \left(\frac{1+sq}{1+i}\right)^t \qquad (A6)$$

The series of terms summed in (A6)

$$\sum_{t=1}^{\infty} \left(\frac{1+sq}{1+i}\right)^t = \frac{1+sq}{1+i} + \left(\frac{1+sq}{1+i}\right)^2 + \ldots + \left(\frac{1+sq}{1+i}\right)^t + \ldots$$

is like the sum

$$\sum_{t=1}^{\infty} \frac{1}{(1+i)^t} = \frac{1}{1+i} + \frac{1}{(1+i)^2} + \ldots + \frac{1}{(1+i)^t} + \ldots$$

a "geometric sum", which can be written in a compact form even though it includes an infinite number of terms.

In strict analogy with the identity

$$\sum_{t=1}^{\infty} \frac{1}{(1+i)^t} = \frac{1}{i}$$

$$\sum_{t=1}^{\infty} \left(\frac{1+sq}{1+i}\right)^t = \frac{1+sq}{i-sq} \qquad (A7)$$

the identity holds whenever i exceeds sq. Thus, substituting from (A7) into (A6), we have

$$P^{inv} = \frac{(1-s)q}{i-sq} \qquad (A8)$$

Formula (A8) expresses the shadow price of investment as the product of the share of consumption in the marginal return from investment, (1-s), and the marginal rate of return, q, divided by the difference between the social rate of discount, i, and the rate at which capital accumulates, sq. As the ratio of (1-s)q to (i-sq), P^{inv} can also be thought of as the present value of the stream of consumption directly attributable to marginal investment, (1-s)q, discounted at an artificial rate of discount i-sq, representing the social rate of discount corrected for reinvestment by substituting the rate of capital accumulation sq from i. To calculate P^{inv}, two values s and q must be estimated for the economy as a whole.

APPENDIX B

DERIVATION OF THE SHADOW PRICE OF INVESTMENT WHEN NATIONAL PARAMETERS CHANGE OVER TIME

Calculation of the P^{inv} with the assumption of changing s and q is not an impossible task. It is merely more cumbersome. The key difference is that in place of the simple formula:

$$A_t = (1+sq)A_{t-1} = (1+sq)^{t-1}$$

We have the more complicated formula:

$$A_t=(1+s_{t-1}q_{t-1})A_{t-1}=(1+s_{t-1}q_{t-1})(1+s_{t-2}q_{t-2})..(1+s_1q_1) \quad (B1)$$

the subscripts denoting rates of marginal saving and productivity specific to each year. In place of the formula for the (constant) shadow price of investment

$$p^{inv} = \sum_{t=1}^{\infty} \frac{(1-s)qA_t}{(1+i)^t} \quad (B2)$$

We have the formula

$$p^{inv}_0 = \sum_{t=1}^{\infty} \frac{(1-s_t)q_tA_t}{(1+i)^t} \quad (B3)$$

This formula is valid only for the present shadow price of investment as zero subscript emphasized.

Substituting from (B2) into (B3) gives the formula:

$$p^{inv}_0 = \sum_{t=1}^{\infty} \frac{(1-s_t)q_t[(1+s_{t-1}q_{t-1})(1+s_{t-2}q_{t-2})..(1+s_1q_1)]}{(1+i)^t} \quad (B4)$$

Analogously, the shadow price of investment in year u, p^{inv}_u, is defined as the present value, discounted to year u, of the consumption stream directly or indirectly attributable to an investment of one unit made in year u. If we denote the capital in year t from investment in year u by $A_{t,u}$ we shall arrive at the formula:

$$p^{inv}_u = \sum_{t=u+1}^{\infty} \frac{(1-s_t)q_tA_{t,u}}{(1+i)^{t-u}} \quad (B5)$$

Since by extending (B5) we have

$$A_{t,u} = (1+s_{t-1}q_{t-1})A_{t-1,u} = (1+s_{t-1}q_{t-1})..(1+s_{u+1}q_{u+1}) \quad (B6)$$

We may write (B5) in the form

$$p^{inv}_u = \sum_{t=u+1}^{\infty} \frac{(1-s_t)q_t[(1+s_{t-1}q_{t-1})..(1+s_{u+1}q_{u+1})]}{(1+i)^{t-u}} \quad (B7)$$

which subsumes (B4) as the special case u=0. Expression (B7) can be simplified by taking advantage of its recursive feature. If we decompose (B7) into two sums by separating the consumption stream before and after "to", we have

$$P^{inv}_{u} = \sum_{t=u+1}^{to} \frac{(1-s_t)q_t[(1+s_{t-1}q_{t-1})..(1+s_{u+1}q_{u+1})]}{(1+i)^{t-u}} +$$

$$+ \sum_{t=to+1}^{\infty} \frac{(1-s_t)q_t[(1+s_{t-1}q_{t-1})..(1+s_{u+1}q_{u+1})]}{(1+i)^{t-u}}$$

If we now factor

$$\frac{(1+s_{to}q_{to})...(1+s_{u+1}q_{u+1})}{(1+i)^{to-u}}$$

out of each term in the second sum, we have

$$P^{inv}_{u} = \sum_{t=u+1}^{\infty} \frac{(1-s_t)q_t[(1+s_{t-1}q_{t-1})..(1+s_{u+1}q_{u+1})]}{(1+i)^{t-u}}$$

$$+ \frac{(1+s_{to}q_{to})...(1+s_{u+1}q_{u+1})}{(1+i)^{to-u}} \sum_{t=to+1}^{\infty} \frac{(1-s_t)q_t[(1+s_{t-1}q_{t-1})..(1+s_{to+1}q_{to+1})}{(1+i)^{t-to}}$$

Now, look closely at everything to the right of the second summation sign; By directly applying (B5) we have

$$P^{inv}_{to} = \sum_{t=to+1}^{\infty} \frac{(1-s_t)q_t[(1+s_{t-1}q_{t-1})..(1+s_{to+1}q_{to+1})]}{(1+i)^{t-to}} \quad (B8)$$

from which it follows that

$$P^{inv}_{u} = \sum_{t=u+1}^{\infty} \frac{(1-s_t)q_t[(1+s_{t-1}q_{t-1})..(1+s_{u+1}q_{u+1})]}{(1+i)^{t-u}} +$$

$$+ \frac{(1+s_{to}q_{to})...(1+s_{u+1}q_{u+1})}{(1+i)^{to-u}} P^{inv}_{to} \quad (B9)$$

Formula (B9) says that the shadow price of investment in year u is equal to the sum of "joint products:" (1) the present value in year u of the consumption stream generated between year u of the capital accumulated at year "to". (2) the present value in year u of the capital accumulated at year "to".

Formula (B9) is particularly useful if national planning is sufficiently organized to provide estimates of the period of time it will take the economy to close the gap between the nominal marginal productivity of capital and the social rate of discount. For once q and i become equal, the shadow price of investment becomes equal to its nominal price. Symbolically, if there exist a time "to" such that

$$q_t = i \qquad t = to+1, to+2, \ldots,$$

then

$$p^{inv}_{to} = \sum_{t=to+1}^{\infty} \frac{(1-s_t)q_t[(1+s_{t-1}q_{t-1})..(1+s_{to+1}q_{to+1})]}{(1+i)^{t-to}} = 1$$

independently of the marginal propensity to save s_t. In this case formula (1.16) becomes

$$p^{inv}_{u} = \sum_{t=u+1}^{to} \frac{(1-s_t)q_t[(1+s_{t-1}q_{t-1})..(1+s_{u+1}q_{u+1})]}{(1+i)^{t-u}} +$$

$$+ \frac{(1+s_{to}q_{to})...(1+s_{u+1}q_{u+1})}{(1+i)^{to-u}} \qquad (B10)$$

But estimates of changes in q and s even over a

limited period of time may be beyond the capacity of planning organizations, including those capable of estimating the period "to" that it will take to close the gap between q_t and i. Therefore, it may be necassary to assume that q and s retain their current values until "to", which reduces formula (B10) to

$$P^{inv}_{u} = \sum_{t=u+1}^{to} \frac{(1-s)q(1+sq)^{t-u-1}}{(1+i)^{t-u}} + \left(\frac{1+sq}{1+i}\right)^{to-u} \qquad (B11)$$

Formula (B11) can be simplified even further by making use of the identity

$$\sum_{t=u+1}^{to} \frac{(1-s)q(1+sq)^{t-u-1}}{(1+i)^{t-u}} = \frac{(1-s)q}{i-sq}\left[1 - \left(\frac{1+sq}{1+i}\right)^{to-u}\right] \qquad (B12)$$

Substituting from (B12) changes (B11) to

$$P^{inv}_{u} = \frac{(1-s)q}{i-sq}\left[1-\left(\frac{1+sq}{1+i}\right)^{to-u}\right]+\left(\frac{1+sq}{1+i}\right)^{to-u} \qquad (B13)$$

If formula (B13) is used to approximate P^{inv}_{u}, only three parameters -in addition to i- must be estimated: s, q and "to".

APPENDIX C

VARIATION OF NET PRESENT VALUE FUNCTION WITH PERIOD "TO"

Net present value of benefits (NPV) passes through a minimum at a certain "to" value as "to" varies from 0 to T years. To show this consider the NPV expression which is a function of "to" as shown below:

$$NPV_{(to)} = \sum_{t=0}^{T} \{(1-s)+s[\frac{(1-s)q}{(i-sq)}(1-(\frac{1+sq}{1+i})^{to-t})+(\frac{1+sq}{1+i})^{to-t}]\}(\frac{B_t-C_t}{(1+i)^t})$$

where

$NPV_{(to)}$: Net present value of benefits as function of "to",

s: Marginal rate of saving,

q: Marginal productivity of capital,

B_t: Total benefit of the project in year t,

C_t: Total cost of the project in year t,

i: Social discount rate,

"to": Aperiod of time at which q=i.

Let

$(1-s) = \alpha$

$$\frac{(1-s)q}{(i-sq)} = \beta$$

$$\frac{1+sq}{1+i} = \mu$$

$$B_t - C_t = a_t$$

Then the equation becomes:

$$NPV_{(to)} = \sum_{t=0}^{T} [\alpha + s(\beta - \beta\mu^{to-t} + \mu^{to-t})] \frac{a_t}{(1+i)^t}$$

Let

$$\frac{a_t}{(1+i)^t} = b_t$$

Then

$$NPV_{(to)} = \alpha \sum_{t=0}^{T} b_t + s\beta \sum_{t=0}^{T} b_t - s\beta\mu^{to} \sum_{t=0}^{T} \mu^{-t} b_t + s\mu^{to} \sum_{t=0}^{T} \mu^{-t} b_t$$

Let

$$\sum_{t=0}^{T} b_t = B \quad \text{and} \quad \sum_{t=0}^{T} \mu^{-t} b_t = D$$

Then

$$NPV_{(to)} = \alpha B + s\beta B + s\mu^{to} D(1-\beta) \quad \text{for to} \Rightarrow t$$

To write it for all t years

$$NPV_{(to)} = \sum_{t=0}^{T} [\alpha + s \text{ Max } \{1 \ , \ \beta - \beta\mu^{to-t} + \mu^{to-t}\}] b_t$$

$$NPV_{(to)} = \sum_{t=0}^{T} [\alpha + s \text{ Max } \{1 \ , \ \beta + \mu^{to-t}(1-\beta)\}] b_t$$

$$NPV_{(to)} = \sum_{t=0}^{to} [a + s(\beta+\mu^{to-t}(1-\beta))]\, b_t + \sum_{t=to+1}^{T} (a + s) b_t$$

where

$$(a + s) = 1$$

This expression is minimum for a certain value of "to". To find this "to", consider a continuous case:

$$NPV_{(to)} = \int_0^{to} [(a + s(\beta + \mu^{to-t}(1-\beta))]\, b_t dt + \int_{to}^{T} b_t dt$$

Take the derivative with respect to "to"

$$[a + s(\beta+(1-\beta)\mu^{to-t}]\, b_{(to)} + \int_0^{to} s(1-\beta) b_t \mu^{-t} \mu^{to} dt - b_{(to)} = 0$$

$$[a + s(1)] b_{to} + \int_0^{to} s(1-\beta) b_t \mu^{-t} \mu^{to} dt = b_{(to)}$$

$$\int_0^{to} s(1-\beta) b_{(t)} \mu^{-t} \mu^{to} dt = 0$$

or

$$\int_0^{to} b_{(t)} \mu^{-t} dt = 0$$

There exist a "to" value which makes this integral equal to zero. That "to" is the value for which $NPV_{(to)}$ is minimum.

APPENDIX D

A FORTRAN PROGRAM FOR SOCIAL BENEFIT-COST ANALYSIS

In this Appendix, a Fortran software is presented for evaluating the projects in terms of Social Benefit-Cost analysis. The evaluation of the projects has been performed with two alternative assumptions:

(1) SBCA with constant shadow price of investment

(2) SBCA with changing shadow price of investment

Maximum evaluation period is 40 years and allowable maximum number of benefit and cost items are 10 for each. National parameters are exogenous data for the program.

```
      INTEGER SEC,T,B,C,MCP,PMC(3),BENEF(10,40),
     * COSTS(10,40),LBB(10,40),LCC(10,40),MC(40),CPRE,L,TO
     * ,SC(40)
      REAL SS(10),RR(10),D1,D2,D3,S,R
      COMMON /ORTAK /CPRE,S,R,SEC,L
      COMMON /ALTP/MC,SC
      DATA BENEF/400*0/,COSTS/400*0/,LBB/400*0/,
     * LCC/400*0/,PMC/3*0/,SS/10*0.0/,RR/10*0.0/
      CPRE=0
C     ************************************************************
C     *                                                          *
C     *   SOCIAL    BENEFIT    COST    ANALYSIS                  *
C     *                    (S B C A)                             *
C     ************************************************************

    2   WRITE (*,1)
    1   FORMAT (1X,24(/))
        WRITE (*,3)
    3   FORMAT (1X,T10,'SOCIAL BENEFIT-COST ANALYSIS',//,
     * 1X,T10,
     * '1.SBCA WITH CONSTANT NATIONAL PARAMETERS',/,1X,T10,
     * '2.SBCA WITH CHANGING NATIONAL PARAMETERS',/,1X,T10,
     * '3.PROGRAM EXIT',/,1X,T10,
     * 'ENTER YOUR CHOICE:')
        READ (*,6) SEC
    6   FORMAT (I2)
        GOTO (1000,1500,3000),SEC
        PAUSE 'PLEASE,ENTER BETWEEN 1-4'
        GOTO 2
C       ************************************************************
C       *                                                          *
C       *          PROGRAM     EXIT     SECTION                  *
C       *                                                          *
C       ************************************************************

3000    WRITE (*,51)
  51    FORMAT (1X,24(/))
        STOP
1500    WRITE (*,*) 'ENTER THE PERIOD "to"'
        READ (*,81) TO
  81    FORMAT (I3)
1000    WRITE (*,8)
   8    FORMAT (1X,T10,'ENTER PROJECT EVALUATION PERIOD AND
     * NUMBER',/,
     * 1X,T10,'OF BENEFITS ITEMS AND COSTS ITEMS')
        READ (*,22) T,B,C
  22    FORMAT (3I2)
        WRITE (*,*) 'ENTER THREE DISCOUNT RATE'
        READ (*,24) D1,D2,D3
  24    FORMAT (3F4.2)
        WRITE (*,*) 'ENTER MARGINAL RATE OF SAVING AND
     * PRODUCTIVITY'
        READ (*,24) S,R
        WRITE (*,*) 'IF ANY CORRECTED ITEM THEN ENTER "1",
     * IF NOT "0"'
```

```
      READ (*,*) L
      IF (L) 200,200,300
200    IF (B .GT. 0) THEN
        WRITE (*,*) 'ENTER THE BENEFIT ITEMS'
        DO 28 I=1,B
        READ (*,44) (BENEF(I,J),J=1,T)
 44     FORMAT (20I4,/,12I4)
 28     CONTINUE
       ENDIF
       IF (C .GT. 0) THEN
        WRITE (*,*) 'ENTER THE COSTS ITEMS'
        READ (*,44) ((COSTS(I,J),J=1,T),I=1,C)
       ENDIF
      CALL MCPRE (D1,BENEF,COSTS,B,C,T)
       IF (SEC .EQ. 2 ) THEN
        CALL CSHA (D1,TO,T)
       ENDIF
      PMC(1)=CPRE
      CALL MCPRE (D2,BENEF,COSTS,B,C,T)
       IF (SEC .EQ. 2 ) THEN
        CALL CSHA (D2,TO,T)
       ENDIF
      PMC(2)=CPRE
      CALL MCPRE (D3,BENEF,COSTS,B,C,T)
       IF (SEC .EQ. 2 ) THEN
        CALL CSHA (D3,TO,T)
       ENDIF
      PMC(3)=CPRE
      WRITE (*,29) D1,D2,D3
 29   FORMAT (1X,T10,/,1X,T20,'SOCIAL RATE OF DISCOUNT:'
     * ,3(2XF4.2))
      WRITE (*,15) PMC
 15   FORMAT (1X,T10,/,1X,T20,'NET PRESENT VALUE (C):'
     * ,3I7)
      STOP
300   WRITE (*,*) 'ENTER THE NUMBER OF CORRECTED BEN.,AND
     * COST ITEM'
      READ (*,*) LB,LC
       IF (LB .GT .0) THEN
        DO 67 I=1,LB
        WRITE (*,*) 'ENTER THE',I,'.CORRECTED ITEMS FOR
     *   BENEFITS '
        READ (*,44) (LBB(I,J),J=1,T)
        WRITE (*,*) 'ENTER THE CORRECTION FACTOR FOR THE'
     *   ,I,'.ITEM'
        READ (*,*) SS(I)
 67     CONTINUE
       ENDIF
       IF (LC .GT. 0) THEN
        DO 52 I=1,LC
        WRITE (*,*) 'ENTER THE',I,'.CORRECTED ITEMS FOR
     *   COSTS.'
        READ (*,44) (LCC(I,J),J=1,T)
        WRITE (*,*) 'ENTER THE CORR. FACTOR FOR THE',I,'.
     *   COST ITEM'
```

```
        READ (*,*) RR(I)
 52     CONTINUE
       ENDIF
       IF ((B-LB) .GT. 0) THEN
        WRITE (*,*) 'ENTER THE UNCORRECTED BENEFITS ITEMS'
        DO 97 I=1,(B-LB)
        WRITE (*,*) 'ENTER THE',I,'.UNCORRECTED BENEFITS
     *  ITEM'
        READ (*,44) (BENEF(I,J),J=1,T)
 97     CONTINUE
       ENDIF
       IF ((C-LC) .GT. 0) THEN
        WRITE (*,*) 'ENTER THE UNCORRECTED COSTS ITEMS'
        DO 98 I=1,(C-LC)
        WRITE (*,*) 'ENTER THE',I,'.UNCORRECTED COSTS
     *  ITEM'
        READ (*,44) (COSTS(I,J),J=1,T)
 98     CONTINUE
       ENDIF
      CALL MCPRE (D1,BENEF,COSTS,(B-LB),(C-LC),T)
      CALL CORE (D1,LBB,LCC,SS,RR,LB,LC,T)
       IF (SEC .EQ. 2 ) THEN
        CALL CSHA (D1,TO,T)
       ENDIF
      PMC(1)=CPRE
       IF (SEC .EQ. 2 ) THEN
        CALL CSHA (D2,TO,T)
        GOTO 234
       ENDIF
      CALL GENE (D2,S,R,SC,T,CPRE)
 234  PMC(2)=CPRE
       IF (SEC .EQ. 2 ) THEN
        CALL CSHA (D3,TO,T)
        GOTO 287
       ENDIF
      CALL GENE (D3,S,R,SC,T,CPRE)
 287  PMC(3)=CPRE
      WRITE (*,29) D1,D2,D3
      WRITE (*,15) PMC
C      IF (TO .LT. 35) THEN
C      GOTO 444
C      ENDIF
      STOP
      END
C     ***************************************************
C     *                                                 *
C     *   S B C A      WITHOUT  CORRECTION              *
C     *                                                 *
C     ***************************************************
       SUBROUTINE MCPRE (D,BENEF,COSTS,B,C,T)
       INTEGER TB(40),TC(40),MC(40),BENEF(10,40),
     * COSTS(10,40),T,B,C,CPRE,SEC,SC(40)
       COMMON /ORTAK/CPRE,S,R,SEC,L
       COMMON /ALTP/MC,SC
       DATA TB/40*0/,TC/40*0/
```

```
      CPRE=0
      DO 34 I=1,40
      MC(I)=0
 34   CONTINUE
      MCA=0
      DO 40 I=1,T
      DO 25 J=1,B
      TB(I)=BENEF(J,I)+TB(I)
 25   CONTINUE
 40   CONTINUE
      DO 42 I=1,T
      DO 26 J=1,C
      TC(I)=COSTS(J,I)+TC(I)
 26   CONTINUE
 42   CONTINUE
      DO 80 I=1,T
      MC(I)=TB(I)-TC(I)
 80   CONTINUE
       IF (L .EQ. 0) THEN
        IF (SEC .EQ. 1 ) THEN
         DO 100 I=1,T
         MCA=MC(I)/((1+D)**(I-1))+MCA
100      CONTINUE
         PINV=((1-S)*R)/(D-S*R)
         CPRE=((1-S)+S*PINV)*MCA
        ENDIF
       ENDIF
      RETURN
      END

C     ***************************************************************
C     *                                                             *
C     *  SBCA WITH CORRECTION AND CONSTANT  SHADOW PRICE            *
C     *                OF INVESTMENT                                *
C     *                                                             *
C     ***************************************************************

      SUBROUTINE CORE (D,LBB,LCC,SS,RR,LB,LC,T)
      INTEGER MC(40),LBB(10,40),LCC(10,40),SCP,SEC,
     * TCC(40),SC(40),TT(40),T,LC,LB,CPRE
      REAL SS(10),RR(10)
      COMMON /ORTAK/CPRE,S,R,SEC,L
      COMMON /ALTP/MC,SC
      DATA TCC/40*0/,TT/40*0/,PINV/0/
      DO 45 I=1,40
      SC(I)=0
 45   CONTINUE
      SCP=0
      CPRE=0
       IF (LB .GT. 0) THEN
        DO 66 I=1,T
        DO 66 J=1,LB
        TT(I)=LBB(J,I)+(SS(J)*LBB(J,I))+TT(I)
66      CONTINUE
       ENDIF
       IF (LC .GT. 0) THEN
```

```
        DO 91 I=1,T
        DO 91 J=1,LC
        TCC(I)=LCC(J,I)+(RR(J)*LCC(J,I))+TCC(I)
 91     CONTINUE
       ENDIF
      DO 33 I=1,T
      SC(I)=MC(I)-TCC(I)+TT(I)
 33   CONTINUE
       IF (SEC .EQ. 1 ) THEN
        DO 102 I=1,T
        SCP=SC(I)/(1+D)**(I-1)+SCP
102     CONTINUE
        PINV=((1-S)*R)/(D-S*R)
        CPRE=((1-S)+S*PINV)*SCP
       ENDIF
      RETURN
      END

      SUBROUTINE GENE (D,S,R,SC,T,CPRE)
      INTEGER SC(40),T,CPRE,CP
      CP=0
      DO 111 I=1,T
      CP=SC(I)/(1+D)**(I-1)+CP
111   CONTINUE
      PINV=((1-S)*R)/(D-S*R)
      CPRE=((1-S)+S*PINV)*CP
      RETURN
      END
C     ************************************************************
C     *                                                          *
C     * SBCA WITH  CORRECTION AND CHANGING  SHADOW  PRICE*
C     *            OF  INVESTMENT                                *
C     ************************************************************
      SUBROUTINE CSHA (D,TO,T)
      INTEGER SC(40),T,SPINV(40),CPRE,TO,SEC,MC(40)
      REAL D,S,R,CPINV(40)
      COMMON /ORTAK/CPRE,S,R,SEC,L
      COMMON /ALTP/MC,SC
      DATA SPINV/40*0/,CPINV/40*0.0/
      CPRE=0
      PINV=((1-S)*R)/(D-S*R)
      DO 79 I=1,T
       IF (I .LT. (TO+1)) THEN
        BPINV=((1+(S*R))/(1+D))**(TO-(I-1))
        CPINV(I)=PINV*(1-BPINV)+BPINV
        ELSE
        CPINV(I)=1
       ENDIF
 79   CONTINUE
      DO 89 I=1,T
      SPINV(I)=((1-S)+S*CPINV(I))*SC(I)
 89   CONTINUE
      DO 83 I=1,T
      CPRE=CPRE+SPINV(I)/(1+D)**(I-1)
 83   CONTINUE
      RETURN
      END
```