OPTIMAL CAPITAL STRUCTURE FOR BUILD-OPERATE-TRANSFER POWER PROJECTS

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ERDEM ARICI

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Prof. Dr. Canan Özgen
Director

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

Prof. Dr. Mustafa Tokyay
Head of Department

This is to certify that I 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.

Asst. Prof. Dr. Metin Arıkan
Supervisor

Examining Committee Members

Asst. Prof. Dr. Metin ARIKAN
Asst. Prof. Dr. İrem DİKMEN
Inst. Dr. Engin ERANT
Nadi BAKIR (MSc. in CE)
Tuncay ALTUNSU (MSc. in CE)

ABSTRACT

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ARICI, Erdem

M.S. Department of Civil Engineering

Supervisor: Asst. Prof. Dr. Metin ARIKAN

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Observing the deficiencies of traditional methods in meeting the demands of today's infrastructure development has been motivating countries towards privatization of these sectors. However, due to the differences in these sectors as compared to other businesses, privatization can not be performed without strict regulations. Today, concession agreements like BOT models seem the best way for solving the problems.

Financing of concession agreements plays a key role. In Turkey, most BOT projects are financed by capital structure that has a maximum debt ratio, which is allowed by the law.

The objective of this study is to examine whether the maximum amount of debt ratio is the optimum amount of debt ratio. Optimization is carried out by analyzing the trade off between benefits of tax shield and the loss due to financial failure as a result of change in leverage, assuming other things are the same.

A theoretical framework is developed for the analysis by selecting Adjusted Present Value Method as a financial tool. Energy generation sector in Turkey is analyzed, stock market data in Turkey is used for the analysis, and a bankruptcy prediction model is proposed for BOT projects in Turkey. Finally, by using the theoretical framework, an actual BOT model hydro electric power plant proposal is analyzed for optimization of capital structure.

Keywords: BOT, Concession, Capital Structure, Optimization, Financial Engineering.

ÖZ

YAP – İŞLET – DEVRET MODELLİ ENERJİ PROJELERİNDE OPTİMUM FİNANSMAN YAPISI

ARICI, Erdem
Yüksek Lisans, İnşaat Mühendisliği Bölümü
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Bugünün altyapı gelişim ihtiyacının karşılanmasında geleneksel yöntemlerin eksiklerinin anlaşılması, ülkeleri bu sektörlerin özelleştirilmesi yoluna itmektedir. Ancak, sektördeki farklılıklardan dolayı, özelleştirme, sıkı düzenlemeler olmadan gerçekleştirilememektedir. Bugün, YİD modeli gibi imtiyaz sözleşmeleri bu problemlerin çözümü için en uygun yol olarak gözükmektedir.

İmtiyaz sözleşmelerinde finansman kilit rol oynamaktadır. Türkiye'de çoğu YİD projeleri, kanun tarafından izin verilen maksimum borç oranı ile oluşturulan finansman yapısı ile finanse edilmektedir.

Bu çalışmanın amacı, maksimum borç oranının, en uygun borç oranı olup olmamasını incelemektir. Optimizasyon, diğer faktörleri eşit tutarak, değişen borç oranı ile vergi muafiyetinden doğan kazanç ile mali başarısızlık dolayısıyla oluşan kaybın analiz edilmesi yoluyla yapılmıştır.

Model için Uyarlanmış Bugünkü Değer Metodu seçilmiştir. Türkiye'deki enerji sektörü analiz edilmiş, Türkiye'deki borsa verileri kullanılmış ve Türkiye'de yapılmakta olan YİD projeleri için bir mali başarısızlık tahmin metodu tasarlanmıştır. Son olarak, bu model, gerçek bir YİD modelli hidroelektrik enerji santrali projesi teklifine uyarlanarak finansman yapısının optimizasyonu gerçekleştirilmiştir.

Anahtar Kelimeler: YİD, İmtiyaz, Finansman Yapısı, Optimizasyon, Finansal Mühendislik.

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To

My Mother and My Father

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APV	Adjusted Present Value
BOT	Build Operate Transfer
CAPM	Capital Asset Pricing Model
DSCR	Debt Service Coverage Ratio
EBIT	Earnings before Interest and Taxes
EBITDA	Earnings before Interest, Taxes, Depreciation and Amortization
ECA	Export Credit Agencies
ESA	Energy Sales Agreement
FTE	Flow to Equity
HEPP	Hydroelectric Power Plant
IPP	Independent Power Producers
IRR	Internal Rate of Return
LIBOR	London Interbank Offered Rate
MDB	Multilateral Development Banks
MM	Modigliani and Miller
NPV	Net Present Value
O&M	Operation and Maintenance
PBIT	Profit before Interest and Taxes
PPA	Power Purchase Agreement
PPP	Public Private Partnerships
PURPA	Public Utility Regulatory Policy Act
PV	Present Value
VAT	Value Added Tax
WACC	Weighted Average Cost of Capital

CHAPTER 1

INTRODUCTION

As it is observed that efficiency in infrastructure development is vital for countries' growth and community welfare, a more innovative way of developing infrastructure projects have been sought for decades. There has been a recent trend towards privatization, especially in the last decades, for these kinds of projects. There are lots of examples for infrastructure sector being owned and operated by private sector in the last century. And the trend for infrastructure privatization can be thought as if it is a part of privatization-nationalization cycle. However, researchers consider that, the trend towards privatization of infrastructure sector is as stronger than ever and it is not a part of another cycle.

Both budget limitations of countries and inconveniences of public sector in meeting today's requirements motivate the trend through privatization of infrastructure. Especially for developing countries, concession agreements are considered as an only way for innovative and efficient infrastructure development.

In its recent form, concession agreements have been applied in Turkey, with law no 3096 in power generation under the name as Build Operate Transfer (BOT) projects since 1980's. BOT projects have been one of the most discussed topics since that time.

These projects have been financed mostly by debt and the portion of the debt is limited by implementation contracts or by the law. In this study, BOT projects are analyzed financially, to examine whether maximum amount of debt is the best choice or not.

In the second chapter, infrastructure privatization is discussed briefly. It begins with the deficiencies in the traditional method, in which infrastructure projects are owned and operated by public sector. Benefits of privatization of infrastructure sector are mentioned next. Concession agreements, definitions and history of BOT model both in Turkey and in the world constitute the remaining part of the chapter.

Third chapter is composed of financial rules and theories to be followed throughout the analysis. It begins with financial evaluation alternatives. NPV method and its competitors are discussed in this section. And the section continues with comparisons of the alternatives of financial analysis tools and the reasons for NPV selection in financial evaluation. The importance of setting a precise discount rate and CAPM theory are discussed in this chapter.

Then, capital structure is mentioned. Analyzing and optimization of capital structure, both of which form the main body of the theoretical framework, are discussed in detail in this part.

BOT projects differ from usual investments by private sector. In the forth chapter BOT is analyzed considering the model in project finance concept. It starts with definitions, history and characteristics of project finance. The structure, risks and government guarantees in project finance are discussed comprehensively in this part.

Next chapter is about financial engineering in power generation. Due to differences of power sector as compared to other infrastructure sectors, these differences are discussed. Specifically, hydropower business is studied while comparing it with other type of power generation. History, characteristics of hydropower and hydropower in Turkey constitute the section.

Sixth chapter is for optimization of capital structure in BOT projects. Theoretical framework is constructed in this chapter, with the guidance of all other chapters before.

A case from an actual hydroelectric power plant proposal is analyzed according to the model developed. Finally, the results from the analysis are compared with the actual situations in practice.

CHAPTER 2

PRIVATIZATION OF INFRASTRUCTURE SECTOR AND BOT

2.1 Deficiencies of the Traditional Method in Energy

Understanding the importance of the provision of adequate and efficient energy in economic growth and community welfare, countries have been seeking a more efficient way to improve energy infrastructure development. Together with realizing the negative effect of insufficient electricity in countries' industry development that can be well summarized with Indira Gandhi's famous words as "There is no power more expensive than no power", especially developing countries have been forced to find an innovative way of energy infrastructure development (Dunkerley, 1995).

For decades, electricity sector (with almost all infrastructure sectors) is in the public sector. Some factors that affect governments' ability to reach necessary financial sources and also political interest of governments in this sector cause inefficiency in the infrastructure development.

According to researches, US$60 – 100 billion investment per year is required for electric power sectors (Jechoutek, Lamech, 1995). In the case of Turkey, annual average increase in electricity consumption has been 8-10 per cent and it is expected to be the same in the following years. With this growing rate, it is required to have US $ 3-4 billion per year for new energy projects (Altınbilek, 2000). However, there are difficulties in external financing particularly in developing countries. As external debt and debt service ratios rose, countries have encountered external finance limits. Due to that, borrowing from abroad became much more difficult relative to the situation in early decades. As a result, raising huge amount of capital for infrastructure development by public becomes harder.

In addition to financial considerations, being one of the most attractive sectors in a country, it is hard to believe that political interest can be kept away from energy sector.

With the changing global point of view about economy and politics, it is realized that private firms have stronger motivation than public utilities to build and operate infrastructure businesses effectively (Irwin *et al.*, 1997). Also cost of services being taken from taxpayers to end-users brings additional pressure to privatize infrastructure development. As a result, government controlled under-pricing tariffs are replaced with the cost-covering tariffs managed by private firms[a].

2.2 Energy Sector Privatization

In the late nineteenth century and early twentieth centuries, power systems were initially privately owned, operated and financed (Klein, Roger, 1994). Wars and recessions stimulated the nationalization and regulation in the sector especially in 1940s and 1950s.

[a] Electricity tariffs in developing countries being just over one –half of tariffs in the OECD countries in the late 1980’s can be an example for this situation (Dunkerley, 1995).

Also there are sector specific properties that results in this public takeover. Due to inherent characteristics of power sector, there occurs a pressure for regulation, as there becomes monopoly in firms. The regulation reduces profitability, therefore discouraging new investment and maintenance in the sector. With declining quality and efficiency, the firm is nationalized by the government. Due to low prices, the government has to subsidize the plant. But, subsidization brings additional inefficiency. Consequently, subsidies and inefficiency force government to increase price and privatize the utility, which is also the starting point of the above described cycle (Fig 2.1).

The cycle has been repeated several times in infrastructure sectors. The trend in the last years towards privatization is regarded as stronger than ever and in literature it is not considered to be a part in the cycle.

However, bringing privatization is not so easy in the electricity infrastructure development. In some countries, strategic economic sectors are thought as if they should not be privatized. In some others, sectors that show natural monopoly characteristics are considered to be managed by government. Also regarding power production as a public service is also a barrier for privatization process of the sector. Nevertheless, the term “public service” itself has never been described exactly and it is often used subjectively (Guislain, 1997).

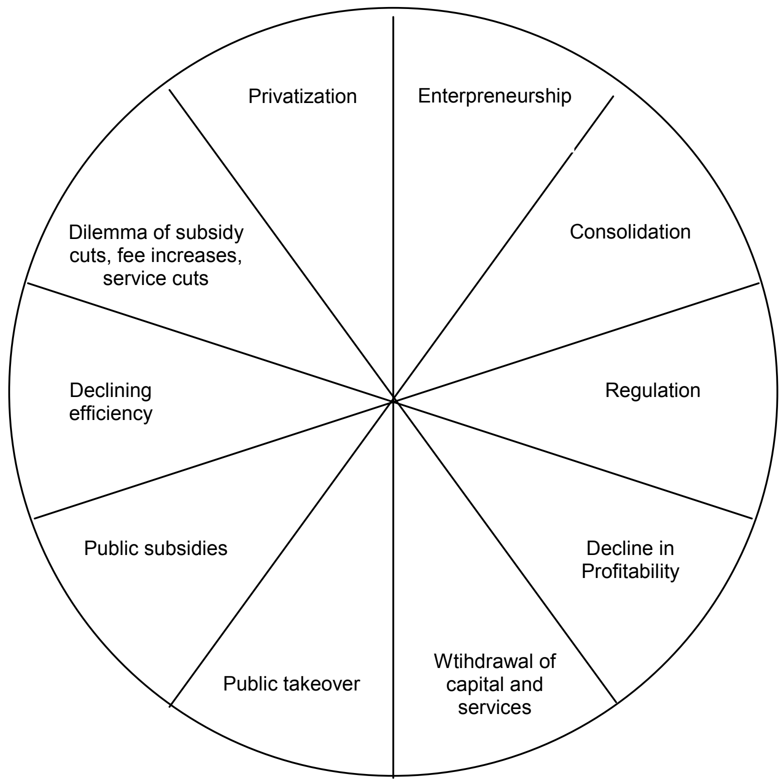

Fig 2.1 Privatization – Nationalization Cycle

(Gomez-Ibanez and Meyer (1993), cited in Klein and Roger 1994)

As mentioned above, natural monopoly concept is one of the major difficulties in regard to privatization of a sector. Natural monopoly occurs where a single supplier is able to meet market demand. Power sector shows natural monopoly characteristics due to high voltage transmission lines and local distribution networks for electricity (Infrastructure Regulation, 1994). In almost all situations, it would be misleading to allow additional supplier for these services, as it would not be economically feasible. There are examples of competition by unbundling the power sector as generation, transmission and distribution to encourage competition. Experiences show that competition is possible in the sector also particularly in the generation phase. However monopolies may be inevitable in some cases. For such cases, establishing relevant regulations and laws can still solve above-mentioned problems related to traditional public financed-operated method. These laws and regulations must address the problem both to impose limits on the power of the executive to act arbitrarily and also insulate the business from the government to protect from political interest (Irwin *et al.*, 1997). The objectives of regulations can also be summarized as promotion of efficiency by satisfaction of demand, promoting investment; protection of consumers against monopoly; protection of competition and protection of investors against opportunistic government action as well (Guislain, 1997).

The objective of regulation in most of developed countries has been about prices and profits. Different from other sectors, in infrastructure sector, regulation is carried out by limiting tariffs and/or rate of return on the investment. On the other hand, for developing countries, the primary objective may be shifted from limiting prices and profitability to meet the urgent demand for services. Due to that, primary objective of regulations in these countries reflects the problem to meet demand at the moment and also in the future.

2.3 Concession Agreements and BOT Concept

The concession or license addresses the point described in the previous section. These agreements, which constitute public private partnerships (PPP), enable the private firm to provide public services under conditions of a contract or contracts. These contracts let the entrepreneurs to provide public services with determined tariffs for some specific duration or perpetuity as well.

According to Peirson and McBride (1996) (cited in Grimsey and Lewis, 2002), PPP's can take many forms and may incorporate some or even all of the following characteristics:

- The public sector entity transfers facilities to the private sector body with or without payment in return;
- The private sector body builds, extends or renovates the facility;
- The public sector body specifies the operating characteristics of the facility;
- The private sector body provides services using the facility for a defined period of time, usually with regulations on operations and pricing;
- The private sector body agrees to transfer the facility to public sector entity with or without transfer payment at the end of concession agreement.

Origins of concession agreements can be found in 17th century in privately financed and operated French canals and bridges (Kumaraswamy, Zhang, 2001). French concession contracts to supply drinking water to Paris and railways and power companies in the USA can also be examples of these agreements. Since 17th century, concession agreements have been used widely to solve above-mentioned problems in infrastructure projects.

Concession agreements have been applied in Turkey for almost a century. According to the law accepted in 1910, council of ministers is authorized to award a concession contract. The initial form of this law was far from meeting today's requirements (Günday, 2002). For electric power generation, law no 3096 was accepted in December 4, 1984. With the acceptance of this law, private firms can be authorized to generate electric power to be purchased by government for some specific duration and the concession form of agreements has gain a new form as Build – Operate – Transfer (BOT), the term first coined by Turgut Özal, former prime minister of Turkey.

In literature, BOT model project is more or less defined as a project based on granting of a concession by a client (generally public utility) to a private sector consortium or concessionaire who is required to Build (including financing, design, performing project procurement and construction), Operate (including managing, operating the facility and carrying out maintenance, delivering product or service and receiving payments to repay financing and investment costs and to make an acceptable return to investors) and Transfer the facility or plant in operational condition and with no obligation to third parties at the end of concession period (Kumaraswamy, Zhang, 2001).

As stated by the law no 3096, a concession agreement is prepared between private firm and Ministry of Energy and Natural Resources. The period of the concession agreement can be at most 99 years, and generally the duration takes place between 15-20 years. The plant is transferred to the government without any obligations related with the project, after the agreed period.

Many urgent infrastructure projects planned to be implemented by BOT model could not be realized as planned due to the poor organization of government agencies in packaging the projects, insufficient legal agreements, lack of coordination between private and public sectors and unwillingness of Turkish Government to provide guarantees against the risks arising because of unstable economical and political environment experienced in Turkey (Birgönül, Özdoğan, 1998). As a result, there had not been any project implemented as planned by this law until the early 1990s. The scope of the model was soon expanded to almost every type of infrastructure development under law no 3996, dated 08 June 1994.

In fact, thinking BOT only as a method for infrastructure development is misleading. As a financial model, there are examples of BOT model in other sectors as well (Çal, 1998). According to that, the commissioning entity does not have to be a public utility. A private sector body may also grant a project company to construct a building on commissioning entity's land and operate for a specified period.

CHAPTER 3

FINANCIAL EVALUATION AND OPTIMAL CAPITAL STRUCTURE

3.1 Financial Evaluation Alternatives

Analyzing an investment, managers and/or shareholders have to use an evaluation technique to examine whether the investment increases the value of shares. There are different methods to perform the evaluation. In literature, the most frequently used financial tools are Internal Rate of Return (IRR), Net Present Value (NPV) and Payback techniques. According to Kumaraswamy and Zhang (2001), these three methods are used for evaluating BOT-type projects as well.

Among them, despite being a simple tool for describing a project, payback rule is the least frequently used method due to its deficiencies. Briefly, payback is the period where the cumulative forecasted cash flow in that period is equal to the initial investment. Relying on results of payback rule may result in problems, since the rule ignores all cash flow after the payback period and timing of the flow within the period is irrelevant. Few large corporations use the method in their evaluation as a primary measure (Brealey, Myers, 2000). A survey shows that small firms are relatively more likely to use payback rule (Graham, Harvey, 2001). Discounted-payback rule method is used to overcome the shortcomings regarding the time value for money concept in the period, but it still discards the cash flow after the period.

The most frequently used methods in evaluating projects are the NPV and IRR methods. Basically, NPV measures the value of the investment by discounting the cash flow with an appropriate discount rate, whereas IRR is the project’s expected rate of return.

According to the survey cited above, large firms rely heavily on IRR and NPV methods and they are more likely to use NPV method. Although one is able to find outcome that is easy to interpret via IRR method, the method itself has some deficiencies.

First of all, in order to use IRR method, alternatives have to be mutually exclusive. In other words choosing one alternative must not affect the decision about other. Moreover, when selecting an alternative is considered, their sizes have to be the same. An alternative, which is small in size and has greater IRR, may have a smaller NPV.

IRR can be considered as only a root of polynomial expression, which makes NPV zero. To interpret outcome, there have to be positive cash flow all the time after some initial negative cash flow.

Besides, different discounting rates in the cash flow results in another problem. With the IRR method, there exists a single outcome that represents the whole project’s return. However, short-term discounting rate need not to be the same as long term discounting rate, or to be more general, cost of capital may vary through the project’s lifetime.

Finally, timing of the cash flow is also important. With IRR method, future cash inflows are assumed to earn the IRR; whereas in NPV method, cash inflows earn the cost of capital (Finnerty, 1996). Nevertheless, earning the project's IRR through reinvestment of the cash flow to another investment is not possible all the time. The problem arises when there is a timing difference between alternatives. The one with cash flow having average time of payment smaller and having IRR higher may have a smaller NPV even they are similar in size of investment.

3.2 Calculating Discount Rate

After deciding, NPV method, as a proper financial analytical tool, discount rate (hurdle rate, opportunity cost of capital or time value for money) is to be calculated for a project evaluation. Setting appropriate discount rate for expected cash flow is crucial for financial analysis. If too high cost of capital is applied in project valuation, a large amount of valuable projects are rejected, on the other hand using too low rate results in investing in projects that decrease shareholders value due to decrease in profitability (McNulty *et al.*, 2002)

The major determinant in assessing discount rate is the risk. Risk must be compensated by an increase in cash inflow. That is, discount rate must increase with the risk.

Different categories of investments require different discount rates. Basically, discount rate may be set as below (Brealey, Myers, 2000);

Table 3.1 Discount Rates for Different Categories of Investment[a]

Category	Discount Rate
Speculative Ventures	30 %
New Products	20 %
Expansion of Existing Businesses	15 %
Cost Improvement, Known Technology	10 %

Although above table gives valuable information about the discount rates, setting a more precise discount rate is required for a well-developed financial analysis. Besides, arithmetic average historical return and investors' expectations may also be a factor in estimating expected return. But researches indicate that Capital Asset Pricing Model, 'CAPM' is by far the most frequently used technique in determining cost of equity (Graham, Harvey, 2001).

The logic behind the rule is measuring risk of a security by its covariance with stock market return.

$$\sigma_{im} = \text{cov}(r_i, r_m) = \frac{\sum (r_i - \overline{r_i})(r_m - \overline{r_m})}{n} \qquad (3.01)$$

Where,

σ_{im} : covariance of security with market

r_i : return on asset

r_m : return on market

n : number of observations

[a] The values in the table are for general information. They may not reflect the actual condition all the time.

Beta (β), is the ratio of covariance of the stock's return with the market return divided by variance of the market return.

$$\beta_i = \frac{\sigma_{im}}{\sigma^2_m} \tag{3.02}$$

In the above formula i and m denote the stock and market return respectively. According to the model, expected equity premium, which is the difference between the expected return of the security and risk-free rate, is directly proportional to beta.

$$r - r_f = \beta \, (r_m - r_f) \tag{3.03}$$

Where, r_f stands for the risk-free rate.

As indicated by the model, securities that are more sensitive to the change in return of market have higher expected returns that are relatively less sensitive to market fluctuations. And expected premium on security (i.e. equity) directly varies linearly with its sensitivity to market fluctuation.

The convention for calculating beta is using returns over the previous 60 months. The relationship between stock returns and beta being statistically significant at very low levels (Chen, 2002) confirms the accuracy of the method.

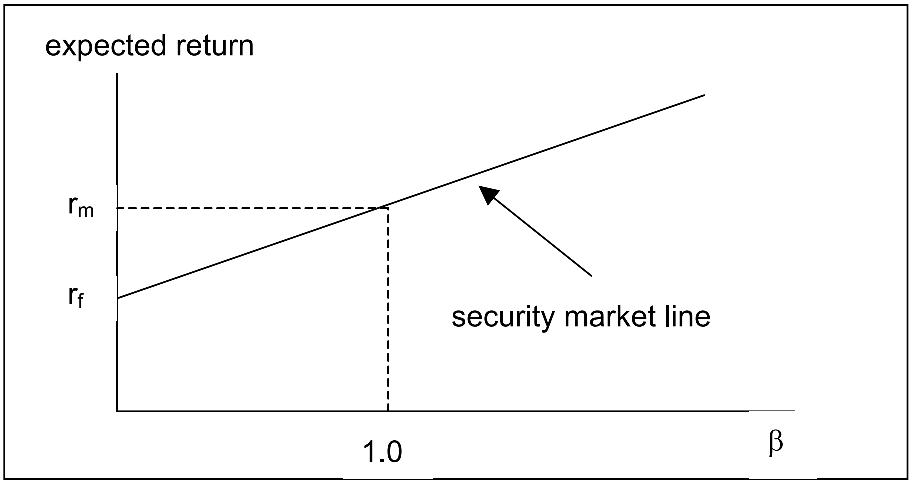

Fig. 3.1 Return vs β (security market line)

As discussed, riskier assets must earn higher returns to compensate the risk. With CAPM, only the covariance of assets with the market is analyzed, the variability of the asset is not analyzed. Groups that are financing a project (either debt or equity) can be considered as large groups that achieve full diversification on market (Neumann, 2000). In other words, a project's investors are assumed to have securities in other projects as well.

When a portfolio consisting of n individual assets is considered, the variance of it can be computed as;

$$\sigma^2_p = \sum_{i=1}^{n} w_i^2 \sigma_i^2 + \sum_{i=1}^{n} \sum_{j \neq i}^{n} w_i w_j \sigma_i \sigma_j \rho_{ij} \qquad (3.04)$$

Where;

w : weight of the asset in portfolio

ρ : correlation coefficient of two different assets

In other words, variance of the portfolio's return consists of variances of each asset and their pair wise covariances. When the number (n) of assets is increased, the equation becomes mainly composed of covariances.

For example, when a portfolio consists of 10 different assets, the equation includes 10 variance terms and 10×9=90 covariance terms and the significance of variance becomes much greater through an increase in number of individual assets.

Since this is the fact, only non-diversifiable portion of the risk must be measured since diversifiable (unsystematic) risk can be compensated through diversification. As a result, non-diversifiable (systematic) risk is the risk that must be compensated with higher expected return.

3.3 Capital Structure and Optimization

Capital structure is defined as the firm's mix of different securities. Mainly two types of securities exist as debt and equity, and optimization of capital structure has objective to maximize the value of the firm, corporation or project by adjusting proportion of their amounts.

Assessment of the cost of capital and optimization of the capital structure has attracted the attention since late 1950s with the work of Modigliani and Miller (MM) in 1958 (Philiosophov, Philiosophov, 1999). According to their theory, in perfect markets, financing decision is irrelevant. Changing a firm's capital structure simply changes the ways of net operating cash flow, which is divided between different classes of investors (Romano, *et al.*, 2000).

Perfect market stated above is an ideal case where there are no taxes, bankruptcy or other transaction costs and all information is publicly available. According to the definition, in practice there is no such a case where perfect capital market exists. However, MM's theory still forms a base for optimization in practice.

As stated by the theory, weighted average cost of capital (WACC) or as it is simply called cost of capital does not change with leverage.

$$WACC = r_D \times \frac{D}{V} + r_E \times \frac{E}{V} = r_A \qquad (3.05)$$

Similarly;

$$\beta_A = \beta_U = \beta_D \times \frac{D}{V} + \beta_E \times \frac{E}{V} \qquad (3.06)$$

Where;

r_A : expected return on asset

r_D : expected return on debt

r_E : expected return on equity

D : debt amount

E : equity amount

V : total value (debt plus equity)

β_A : asset beta

β_U : unlevered beta

β_D : debt beta

β_E : equity (levered) beta

In other words, return on equity is increased with leverage so as to keep WACC constant. By rearranging above equation, expected return on equity of a levered asset can be found as;

$$r_E = r_A + \frac{D}{E} \times (r_A - r_D) \qquad (3.07)$$

As a firm borrows more, debt becomes risky, while some of the risk that equity holders bear has transferred to debt holders. With default risk, borrowing rates tend to be positive functions of leverage (Stapleton, 1975). As rate of interest increases, the term '$r_A - r_D$' becomes less and change in expected return on equity turns out to be less sensitive to change in leverage as illustrated in Figure 3.2 (Brealey, Myers, 2000);

People may think that, as debt is a cheap source of financing as compared to equity, increasing leverage is better in investments. However, any change in capital structure of a project can also be done by investors. The theory assumes there is no cost for borrowing and both personal interest rate and corporate interest rate are the same. Investors may also borrow on their personal account to purchase additional shares. As they have a right to take action, they would not pay an additional premium for project's change in leverage. This is another way of thinking to come to the same conclusion that the value does not change with leverage. It is true that, leverage increases the expected return on equity but it also increases the risk of the equity that exactly balances the increase in return.

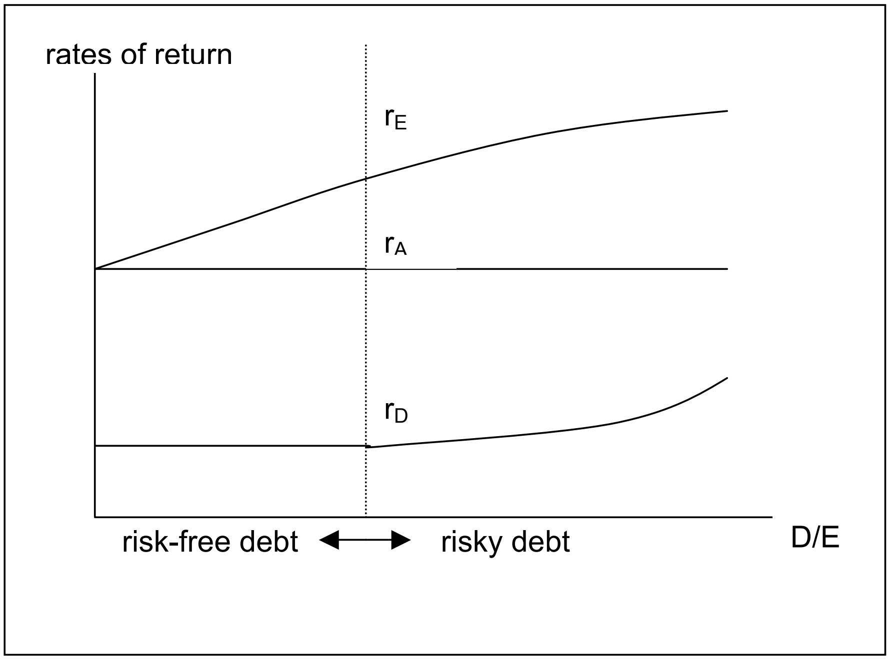

Fig. 3.2 Changes of Rates of Return with Debt to Equity Ratio

It would be beneficial to relate MM's theory with Capital Asset Pricing Model for further analysis (Brealey, Myers, 2000):

The present value (PV) of a cash flow or value V_1, which occurs at the end of period '1', can be computed as below;

$$PV = \frac{V_1}{1+r} \qquad (3.08a)$$

Or,

$$1 + r = \frac{V_1}{PV} \qquad (3.08b)$$

Where ‘r’ denotes the discount rate.

With CAPM formula (3.03), explained above;

$$1 + r = 1 + r_f + \beta\,(r_m - r_f) \tag{3.09}$$

so;

$$\frac{V_1}{PV} = 1 + r_f + \beta\,(r_m - r_f) \tag{3.10}$$

By definition;

$$\beta = \frac{\text{cov}(r, r_m)}{\sigma^2{}_m} = \frac{\text{cov}(\frac{V_1}{PV} - 1\ ,\ r_m)}{\sigma^2{}_m} \tag{3.11}$$

As PV is not an unknown, which covaries with r_m, above expression can be arranged as;

$$\beta = \frac{\text{cov}(V_1, r_m)}{PV \times \sigma^2{}_m} \tag{3.12}$$

Replacing β in the formula (3.10) with above derivation gives;

$$\frac{V_1}{PV} = 1 + r_f + \frac{\text{cov}(V_1, r_m)}{PV \times \sigma^2{}_m} \times (r_m - r_f) \tag{3.13}$$

The term $(r_m - r_f) / \sigma^2{}_m$ is known as market price of risk and is symbolized by λ. Adjusting the expression gives

$$PV = \frac{V_1 - \lambda.\text{cov}(V_1, r_m)}{1 + r_f} \tag{3.14}$$

It could be derived from the formula that if the cash flow is risk free (i.e. covariance with market is zero), then it should be discounted with risk-free rate. Increase in covariance of the asset with the market or increase in market price of risk results in a deduction from the numerator that causes a decrease in PV, both of which are the expected results.

When leverage is considered, the investor borrows an amount of risk-free debt (D) to repay the principal and interest ($D+D.r_f$) next year. Due to that equity holders expect to receive V_1 - $(1+r_f).D$ at the end of the period. So the value of the equity can be written as below;

$$E = \frac{V_1 - (1+r_f).D - \lambda.cov[V_1 - (1+r_f).D, r_m]}{1+r_f} \qquad (3.15)$$

As the term $(1+r_f).D$ is known and does not covary with market return, the term $cov(V_1,r_m)$ may be substituted for $cov[V_1-(1+r_f).D,r_m]$ and above equation can be rearranged as follows;

$$E = \frac{V_1 - (1+r_f).D - \lambda.cov(V_1, r_m)}{1+r_f} \qquad (3.16)$$

$$= \frac{V_1 - \lambda.cov(V_1, r_m)}{1+r_f} - D \qquad (3.17)$$

By adding debt amount D to both sides, E+D becomes the value of the project and the equation becomes;

$$V = \frac{V_1 - \lambda.cov(V_1, r_m)}{1+r_f} \qquad (3.18)$$

That is exactly the same expression given in equation (3.14), which means the total value does not change with leverage.

3.4 Analyzing Why and How Capital Structure Matters

Although above discussed materials show that theoretically capital structure is irrelevant under specific assumptions, it is found that debt ratios do not vary randomly from firm to firm or industry to industry (Brealey, Myers, 2000). Moreover many sectors are found to rely heavily on borrowing.

MM's theory assumes perfect markets and perfect competition where firms operate without taxes, any transaction costs and all information is available without cost (Romano, *et al.*, 2000).

3.4.1. Existence of Tax Shield

One major assumption for the theory is the absence of taxes. It is clear that in perfect markets value of the project or firm is independent of the proportions of the way of finance. However, there is another party apart from debt holders and equity holders, holding a claim in that value which is not mentioned in the MM theory. Government's share in the value, that is the 'tax' cannot be neglected in practice. Anything that decreases the amount of that portion would put all security holders in a more advantageous position.

Interest paid to debt holders is tax deductible as it is considered as an expense. Due to that borrowing increases total inflow to both debt holders and equity holders as the firm makes profit[a]. Since interest payments act

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[a] Actually it depends on the related accounting rules. A firm does not have to make profit for each period to use tax advantage. Even the firm does not make profit; losses can be carried forward to make a deduction in the taxable profit in following years also.

as a shield for tax payments, firms have an incentive to increase leverage.

Due to that instead of weighted average cost of capital, after-tax weighted average cost of capital is used to discount an investment's cash flow.

$$WACC = r_D\,(1-T) \times \frac{D}{V} + r_E \times \frac{E}{V} \qquad (3.19)$$

Where,

T : corporate tax rate

The most widely used technique for financial evaluation is discounting the cash flow by weighted average cost of capital both in literature and practice (Babusiaux, Pierru, 2001). Nevertheless, to use above formula for discounting rate for an investment requires debt to be rebalanced every period to have a constant leverage ratio. With significant change in debt ratio in periods, calculating NPV with the WACC produces misleading outcomes.

BOT structure is one of the examples for this situation. Debt ratio is not fixed during the lifetime of BOT projects. Borrowing occurs at initial phases and both interest payments and principal payments are made during the concession without additional borrowing under normal conditions.

Moreover as BOT agreements are performed with off-balance sheet financing, accounting loss from the project cannot be deducted from the taxable profits of the firms' other investments. This brings an additional difficulty in evaluating BOT agreements via discounting the cash flow by WACC.

Flow to Equity Method (FTE) and Adjusted Present Value Method (APV) would be best to solve the above-mentioned two problems (Brealey, Myers, 2000).

With FTE method, only the cash flow from the equity holders' point of view is determined. NPV is calculated by discounting cash flow to equity, after interest and taxes, by the cost of equity. If the debt ratio of the company or project is rather stable for the life of the company or project, it is simple to use the method. However, cost of equity must be adjusted when leverage changes through the life of the investment.

With APV, project is considered as if it is all-equity-financed. Present value of tax savings is added to the term and other side effects of leverage (issue costs, etc.) are also added to obtain the final evaluation:

$$APV = NPV\text{ (as if unlevered)} + PV\text{ (tax shield)} + \text{other side effects} \quad (3.20)$$

As displayed by the new formula, cost of capital directly decreases with leverage. That is not caused by the fact that debt has a lower rate of return as compared to equity, rather the cost of capital is decreased by leverage due to its tax shield. Also with FTE and APV methods leverage increases value due to tax savings from interest payments.

3.4.2. Existence of Financial Distress

Above explained conditions lead to having valuable results in investments with additional borrowing. However, debt is limited when financial distress cost is considered as leverage increases the probability of financial distress (Morellec, 2001). The firm's choice of debt level is where there is equilibrium between tax advantage of debt and a cost associated with the event of bankruptcy (Jou, 2001). Due to that management considers the trade off between higher return by leverage and potential decrease in financial strength and solvency (Luoma, Spiller, 2002).

So far, while discussing the advantage of borrowing in investments, debt is taken as risk-free. In other words, the projects are assumed to pay its obligations as principal plus interest every period with operating income. However, in practice it is not the case. There is always (almost always) a probability of failure to repay debt obligations. When this situation occurs, firms enter in a financial distress and become bankrupt. After bankruptcy decision is taken, debt holders have to pay bankruptcy costs to take the ownership of the firm.

In the case of firms with shareholders who have limited recourse to firms/projects, bankruptcy costs are important for debt holders' concern. There is a significant decrease in the value of repayment of debt when bankruptcy cost is present. The case for one period project is illustrated in Fig 3.3 (Dias, Ioannou, 1995):

X denotes operating income at the end of period and D symbolizes the value of debt. Where the probability of financial distress exists, theoretically, debt holders expect to receive payments as it is shown on the left graph. However, when bankruptcy occurs it is not reasonable to claim the repayment of debt when the income is less than some certain amount (b). Moreover debt holders receive an amount, which is the difference of the theoretical value of repayment and the bankruptcy costs until it reaches the promised level (d).

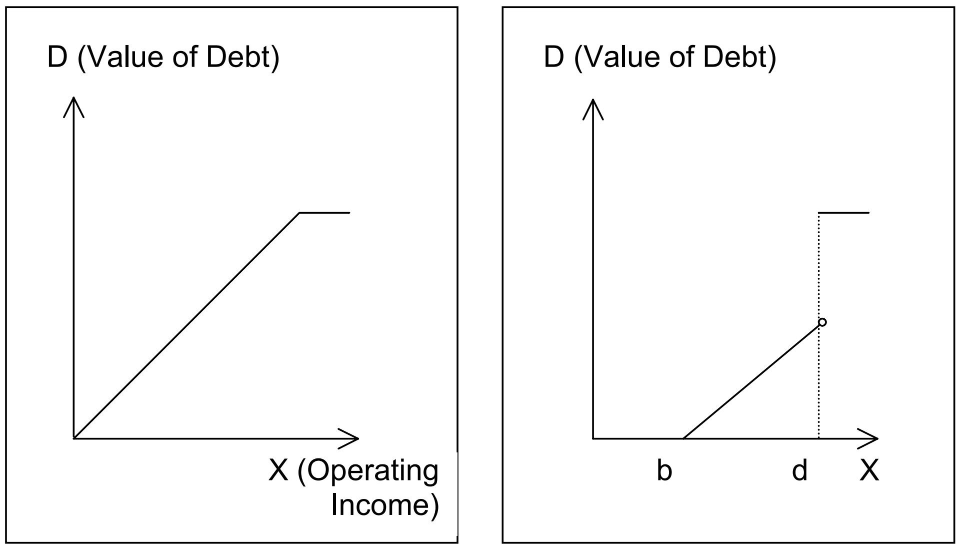

Fig. 3.3 Theoretical and Actual Value of Debt
(without and with bankruptcy cost)

Analyzing cost of financial distress for optimization of debt ratio, both bankruptcy costs and also the probability of distress have to be considered. In fact, deciding on bankruptcy is not a must for firms that have financial distress. According to the loan agreement, firms may postpone bankruptcy, as they are able to pay the interest amount.

There are two types of bankruptcy costs as direct and indirect costs. Direct costs include legal and administrative costs related to bankruptcy. For infrastructure projects; legal fees, trustee fees, referee fees and time lost by executives in litigation constitutes direct costs (Dias, Ioannou, 1995). As there may occur several troubles in managing a bankrupt firm, indirect costs occur with difficulties in continuity of services as before. As it is less secure to cooperate with distressed or bankrupt organization; customers, suppliers and also staff would hesitate to do business with the firm[a] (Branch, 2002).

Bankruptcy costs vary with the sector the firm performs, more specifically with the type of asset owned by the firm. When a firm with tangible assets is considered, total bankruptcy cost mostly contains legal expenses. If a firm performs in a business where its assets are mainly composed of intangible assets like investment opportunities, technology and/or human resources, further costs are added to the legal and administrative expenses (Brealey, Myers, 2000).

According to result of a research, it is found that average direct costs of bankruptcy is about 3 percent of total assets and 20 percent of the market value of the equity in the year prior to bankruptcy (Weiss 1990, cited in Brealey, Myers, 2000). An extensive study estimated direct costs around 3.5% of the predistressed firm value (Betker 1997, cited in Branch, 2002).

Another research states that total bankruptcy costs are about 15% of predistressed firm value for industrial firms and about 7% for retailers (Altman 1984, cited in Branch, 2002). Distressed and highly levered firms

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[a] Branch's investigation states that, staff costs may increase between 17 to 35 percent and this would bring an additional bankruptcy cost about 1 percent of the firm's predistressed value.

come up with estimated costs of financial distress between 10 and 20 percent of the firm's market value without financial distress (Andrade, Kaplan 1998, cited in Brealey, Myers, 2000).

Since borrowing increases both the corporate tax shield due to interest payments and the likelihood of financial distress, theoretical optimum capital structure occurs where the present value of tax shield is offset by the present value of financial distress. The theory is called the "trade-off theory" of capital structure and can be illustrated as below (Brealey, Myers, 2000):

According to the trade-off theory of capital structure, the objective is to maximize the value (value of the firm) in below written expression;

Value = value if all-equity-financed + PV (tax shield) – PV (costs of financial distress) (3.21)

For initial phases of leverage, value of the firm increases as firm borrows more. At this phase, value of the tax shield governs the increase in value, as probability of financial distress is low. But after some level of borrowing, the probability of distress increases rapidly and value of costs of financial distress becomes significant. Furthermore, additional advantage of debt decreases and finally disappears, as the firm cannot be sure of benefiting from tax shield. Hence, optimum is reached where the increase in value of costs of distress is compensated by benefits of value of tax savings from additional borrowing.

According to the theory, high profitable firms with tangible assets have higher optimum debt ratios than those unprofitable ones, having assets mostly intangible and performing in more volatile and risky sectors.

Moreover, increase in corporate tax rate increases optimum debt ratio, since tax savings from interest payments becomes more valuable.

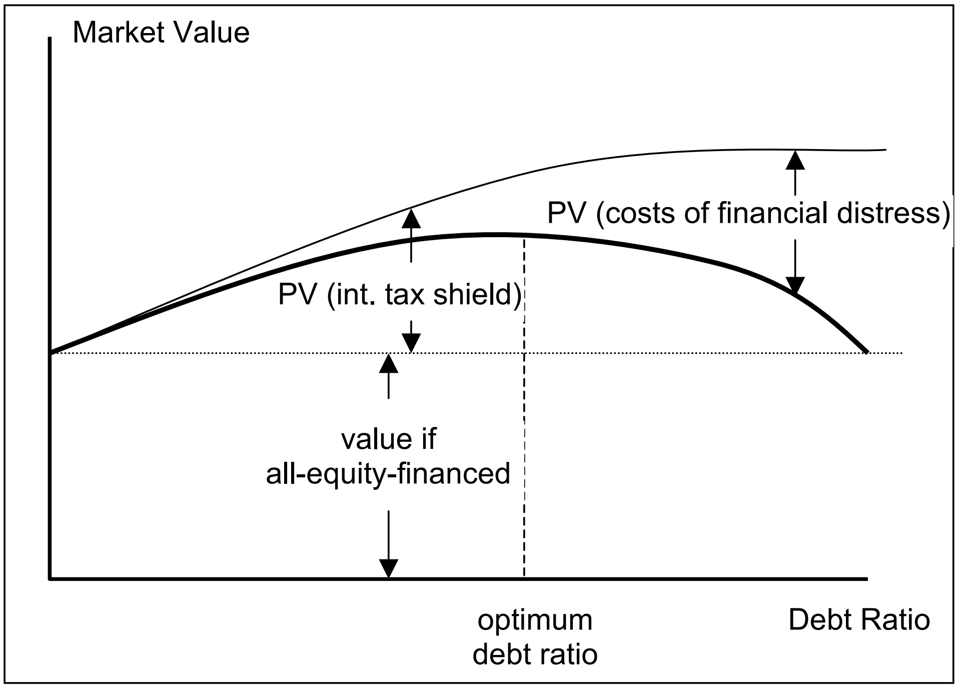

Fig. 3.4 Trade-off Theory and Optimal Capital Structure

However, the theory does not reflect the actual case in practice all the time. According to the “Pecking Order Theory”, at first, firms use internal finance and when it is not enough for further investment, debt is preferred as external finance up to the level of limit that debt holders or some financial constraints impose. Finally, external equity is used after the limit is exceeded. Even though it does not fit to the analysis about both project finance concept and BOT structures, brief explanation about the theory would be beneficial for understanding why the trade off theory of capital structure does not correspond to the real cases all the time.

As pecking order theory states, external finance is more expensive than internal finance (i.e. retained earnings) because there exist asymmetries of information between investors (Mayer, Sussman, 2002). Asymmetries of information indicate that managers know more about their firms' prospects, risks and values than outside investors (Brealey, Myers, 2000). Outside investors think that firms issuing equity are the ones that are not sure about the opportunities, and they are in a more risky and low profitable situation as compared to the ones issuing debt. Due to that, issuing equity generally decreases actual market value of share, which produces additional cost of capital. For such situations, when there is a need for external capital, borrowing is preferred initially. After some point, where probability of financial distress is considerably high, both debt holders and financial managers are aware of the increase in risk; therefore new equity issues would be the only way to maintain additional finance.

High profitable firms having low debt to equity ratios can be explained with this theory. They do not need external finance since there is an adequate amount of retained earnings. Also in accordance with the same logic behind the theory, low profitable firms must rely on debt finance, as they cannot produce sufficient finance to meet their demands.

Philosophov and Philosophov (1999) have developed another method for optimization of capital structure by maximizing share value. According to their approach, maximizing share value is achieved by considering probability of default (λ). This probability is determined as the percentage of corporations operating at the beginning of the time interval and become bankrupt during that period[a].

The probability of bankruptcy for the first year is $P_b(1) = \lambda_1$. So the probability of bankruptcy during second year is the product of probability of not becoming bankrupt and probability of bankruptcy during second year:

$$P_b(2) = (1 - \lambda_1) \times \lambda_2 \tag{3.22}$$

More generally probability of becoming bankrupt during nth year is:

$$P_b(n) = (1 - \lambda_1)(1 - \lambda_2) \ldots (1 - \lambda_{n-1}) . \lambda_n \tag{3.23}$$

If the bankruptcy probability does not vary for years, the formula can be simplified as:

$$P_b(n) = (1 - \lambda)^{n-1} . \lambda \tag{3.24}$$

As share value is calculated as present value of dividends, below formula can be used to evaluate the value of shares.

$$V = \sum_{i=1}^{\infty} \frac{D_i}{(1+r)^i} \tag{3.25}$$

Where D_i denotes the dividend payment for the corresponding year i and r is the discount rate. With constant amount of dividend each year, sum of the series is:

$$V = \sum_{i=1}^{\infty} \frac{D}{(1+r)^i} \tag{3.26}$$

$$= \frac{D}{r} \tag{3.27}$$

[a] As cited in Philosophov and Philosophov (1999), in Dun & Bradstreet reports (1989), it is stated that in 1981-1988, probability of bankruptcy in U.S. is ranged between 0.6 – 1.2%.

When considering probability of bankruptcy, the sequence of payments ceases at the year when bankruptcy occurs. Assuming same amount of dividend is obtained each year and having bankruptcy at the nth year, share value becomes a series with finite terms:

$$V_n = \sum_{i=1}^{n-1} \frac{D}{(1+r)^i} \qquad (3.28)$$

More generally value of share becomes as below when probability of bankruptcy is taken into account, where liquidation dividend is neglected:

$$V = \sum_{i=1}^{\infty} P_b(n).V(n) \qquad (3.29)$$

$$= \sum_{n=1}^{\infty} (1-\lambda)^{n-1}.\lambda.\sum_{i=1}^{n-1} \frac{D_i}{(1+r)^i} \qquad (3.30)$$

After some algebraic calculations, the equation becomes:

$$V = \frac{D.(1-\lambda)}{r+\lambda} \qquad (3.31)$$

Or, with relatively small bankruptcy probabilities, the formula becomes:

$$V = \frac{D}{r+\lambda} \qquad (3.32)$$

Without probability of bankruptcy, it is just the ratio of dividend (D) divided by the cost of capital (r). In other words, existence of financial distress decreases the value, by adding the rate of probability to denominator.

In practice, bankruptcy rate and also the amount of dividend payments are not constant each period. Nevertheless, above derivation still illustrates how the existence of bankruptcy decreases the value.

Bankruptcy probability is taken as bankruptcy rate for the business for above mentioned explanations and derivations. Factors that result in this bankruptcy are called external factors. As cited in Philosophov and Philosophov (1999), Altman (1982) classified these factors as economic growth activity, money supply, capital market activity and new business formation rate.

Philosophov and Philosophov also relate bankruptcy rate to the change in gross national product (GNP) as follows:

$$\Delta\lambda = -0.51 \times \Delta GNP \quad (3.33)$$

Where $\Delta\lambda$ and ΔGNP represent the percentage change in bankruptcy rate and GNP respectively.

As stated before, external factors determine the bankruptcy rate, and these factors are not under the control of the firm. For more precise analysis, bankruptcy probability must be determined by considering the factors that are firm specific. As stated by Aktaş (1993) internal factors have 95% importance among the factors that cause financial failure. An observation made by Arditi, *et al.* (2000) that mostly sharp decline in sales due to recession, loss of an important customer, shortage of raw materials, deficiencies of management causing financial failure also emphasizes the significance of internal factors among all.

More generally; internal factors increasing the probability of financial failure may be listed as below[a] (Akgüç, 1977):

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[a] Some of the items in the list are not appropriate for BOT structures. The list is prepared for general purpose, the difference for BOT structures will be discussed in the next chapter.

- Insufficient financial plan, inconsistency between financial needs and resources, financing fixed value investment with short term fixed dates,
- Over-enlargement of the firm and accordingly getting into too much debt and facing with insufficient capital; in other words, high financial risk of the firm that is financed speculatively,
- High fixed cost of the firm,
- Mistakes in investment decisions, allocating firm resources to insufficient and unprofitable investment,
- Carelessness about fulfilling the responsibilities, and not taking the precautions on time,
- Over profit distribution politics of the firm and ignoring auto-finance,
- Lack of connection between sale and product services of the firm,
- Not developing new products,
- Not reducing business risk by differentiation,
- Not following the developments in the sector and not benchmarking the rivalries,
- Problems associated with delays in payments as a result over-enlargement of credit sales without collecting enough information about the customers,
- Paying no attention to search for new markets,
- Wrong pricing strategy,
- Meeting the products and services with one or limited number of customers,
- Having a few number of buyers,
- Lack of harmony in firm activities due to disagreements among top managers in relation to basic problems,
- Insufficient coordination in managerial activities,
- Lack of technical information of managers,

- Executing all the firm activities with one authority. In other words, one manager makes all managerial decisions,

According to results of a survey, the effect of financial distress following leverage recapitalization is found to be significant (Denis, Denis, 1995). These recapitalizations are selected in those firms that increase their leverage with payout to common shareholders by additional borrowing. Payouts in those firms are made through special dividends, share repurchases and exchange offers made up of debt, cash and/or new common shares. Financial distresses are defined here as restructuring of debt claimants or decision to go bankrupt. And restructuring of debt is made by reduction in stated repayment amount, extension of debt maturity and granting equity to debt holders. The results are as expected. Average debt ratios for distressed firms have found to be more than average debt ratios for nondistressed firms. Another result is about the ratios of pre-recapitalization operating income to post-recapitalization interest payments. The median ratio of non-distressed firms is more than twice of ratios of those firms that have encountered with financial distress.

According to the correlations of increase in probability of financial failure with low reservoir of financial sources, low cash inflow from operations, large expenditures for operations and high amount of debt by Arditi, *et al.* (2000), highlight the effect of financial position in bankruptcy.

Managers and creditors use several methods to measure the probability of financial distress. Generally, financial conditions of the firm are the key factors in determining the probability.

Aktaş (1993) mentions alternative methods used by financial institutions such as time of declaration of financial statements and age of the firm, in literature the importance is given to financial position. Van Horne (1980) emphasizes the significance of financial ratios in evaluating financial condition and performance of a firm.

There are lots of financial ratios used in practice such as liquidity ratios, profitability ratios, coverage ratios etc. Univariate analysis is the name of the method in which only one of the ratios for analysis is selected. Among them, coverage ratios would be the best to measure the firm's ability to repay debt. Most reliable bond rating services make extensive use of these ratios (Van Horne, 1989).

Two most frequently used and easily interpreted ratios are interest coverage ratio and debt service coverage ratio. Interest coverage ratio indicates the risk that the firm is unable to cover interest payments. It is calculated by earnings before interest and taxes (EBIT), which is the amount available to pay interest, divided by interest amount for that period.

$$\text{Interest Coverage Ratio} = \frac{\text{EBIT}}{\text{interest}} \tag{3.34}$$

Debt service coverage ratio (DSCR) accounts for all debt service obligations. As cited by Altman (2000), Beaver (1967) concluded that, cash flow to debt ratio is the best bankruptcy predictor. It is calculated by taking principal payments into account. The ratio is obtained by the following formula:

$$\text{DSCR} = \frac{\text{EBITDA}}{\text{interest} + \text{principal}} \tag{3.35}$$

EBITDA denotes the necessary fund to repay principal payment as earnings before interest, tax, depreciation and amortization. A DSCR of 1.0 is called a breakeven cash flow since the total fund available is just enough to cover debt service. As can be understood from the formulas, the higher being the coverage ratios the lower being the probability of financial distress.

Univariate analysis has advantages when compared with different methods since they are easy to implement. However, they are criticized for some deficiencies since contradictions between ratios may occur. Multi dimensional models are able to measure performance of a company more efficiently (Aktaş, 1993).

Altman (2000) also underlines the importance of multivariate analysis as their primary advantage in analyzing entire variable profile of the firm at once rather than analyzing several ratios one after the other. He has developed a multivariate analysis by considering 22 financial ratios of firms when analyzing bankrupt. Five of them have been chosen, as their influences in prediction were more significant. After having evaluated their importance in prediction, corresponding weights are given to the ratios to finalize the model as Z-score model:

$$Z = 0.012X_1 + 0.014X_2 + 0.033X_3 + 0.006X_4 + 0.999X_5 \quad (3.36)$$

Where,

X_1 : working capital / total assets

X_2 : retained earnings / total assets

X_3 : EBIT / total assets

X_4 : market value of equity / book value of total liabilities

X_5 : sales / total assets

Z : overall index

Variables for X_1 through X_4 are used as a percentage. (50 for 50% but in X_5 it is expressed as 0.5).

Higher Z-score means lower probability of financial distress, and as Z-score decreases, the probability of bankruptcy increases. According to the tests that are to evaluate the model, it predicts approximately 90% of the firms that goes bankrupt by using a cutoff score of 2.675 (Altman, 2000).

Although Altman's model is effective in assessing the risk of financial distress of a firm, it is incapable of providing a probability. Another model called "logit analysis" is developed to determine the probability of failure. This model is considered as more robust as compared to multivariate analysis (Lo, 1986, cited in Gibson, 1998). As cited in Gibson (1998), Stickney (1996) argues that there is a trend in using logit analysis in favor of multivariate analysis during 1990s.

According to the model, seven financial ratios with their corresponding coefficients are used to obtain a value 'y'. This value is used to estimate the probability as below:

$$P_b = \frac{1}{1+e^{y}} \tag{3.37}$$

Where, P_b denotes the probability of financial failure.

According to the model, financial ratios and their corresponding coefficients are shown in Table 3.2.

Table 3.2 Financial Ratios and Their Coefficients in the Logit Analysis

Coefficient	Ratio
+ 0.239	1
- 0.108	Average Inventories / Sales
- 1.58	Average receivables / Average Inventories
-10.8	(Cash + Marketable Securities) / Total Assets
+ 3.07	Quick Assets / Current Liabilities
+ 0.486	Income / (Total Assets – Current Liabilities)
- 4.35	Long Term Debt / (Total Assets – Current Liabilities)
+ 0.110	Sales / (Net Working Capital + Fixed Assets)

CHAPTER 4

BOT MODEL AS PROJECT FINANCE

4.1 Definitions

BOT models are special type of financial agreements that are not carried out with classical type of financial methods. Mostly, BOT agreements are performed according to a special form of financing method called as Project Finance[a].

Finnerty (1996) defines project financing as raising of funds to finance an economically independent capital investment project, where the providers of funds look primarily to the cash flow from the project as the source of funds to service their loans and provide a return of and a return on their equity invested in project.

As cited in Pollio (1998), Nahlik (1992) defines project finance as a way of developing a large project through a risk-management and risk-sharing approach while limiting the downside impact on the balance sheets of the developers or sponsors. In Pollio's article, Harries (1990) describes project financing as lending to a project in which the lender expects to be repaid only from the cash flow generated by the particular self-liquidating

[a] There are exceptions in BOT model infrastructure projects that are not financed by project financing (Günay, 2001). Gebze Power Plant that is financed by BOT model can be an example for this situation since it was performed according to classical corporate financing methods.

project. The sole collateral for the loan are the assets and the revenues of the project. According to Pollio, Buckley (1996) defines project finance as a highly leveraged project financing facility established for a specific undertaking, the creditworthiness and economic justification of which are based upon that undertaking's expected cash flow and asset collateral.

According to Kleimeier and Megginson (1999), project finance is limited or non-recourse financing of a newly developing project through the establishment of a separate incorporation.

As stated by Shah and Thakor (1987), project financing is an arrangement whereby a sponsor or group of sponsors incorporates a project as a legally separate entity, with project cash flows kept segregated for financing purposes from its sponsors.

As can be understood from the definitions; different from conventional financing methods, project finance is a way of financing method by a separate corporation (mostly in the form of joint venture) with limited or no recourse to share holders, to implement a certain project that is capable of functioning as an independent economic unit. The details will be analyzed in the following parts of the chapter while comparing the method with conventional direct financing.

4.2 History of Project Finance

Project finance method has long been used to finance large-scale infrastructure projects. In fact project financing is not a new financing method. As stated in Gimpel (1976) cited in Finnerty (1996) in the 13th century, the English Crown borrowed a loan from an Italian merchant bank to develop silver mines. According to the loan agreement, the bank would be entitled to control the operations of the mines for one year and the bank could extract as much silver ore as it can during that year. There was not any type of guarantee that English Crown provided about quantity and quality of silver during that period. The loan agreement was the initial form of what is called today as a production payment loan.

In its modern form for large-scale infrastructure development, project finance was first used to develop North Sea oil fields in 1970s (Kleimerer, Megginson, 1999). This was a high scale and high-risk project that any single firm is insufficient to cope with. After observing the success in the way of financing technique, project financing has been used extensively for infrastructure development mostly in natural resources, power and transportation sector.

4.3 Differences in Project Finance

First of all, the firm or corporation is a separate legal entity -that owns the project- has a finite life (in almost all cases) unlike traditional method of financing. The entity is characterized only with the project it owns, and the scope of the entity is strictly defined under contracts.

According to the traditional method, cash flow from operations can be held for financing purposes. However in project finance, since the entity is characterized by the project only, it cannot be held for any reason. Free cash flow is distributed to security holders as debt repayment and return on and return of equity. So the equity holders themselves decide on reinvestment of free cash flow.

From creditors point of view, in traditional methods, the emphasis is given to the credibility of the borrower such as its debt capacity, balance sheet, type of assets as collateral, business the firm is involved in etc. Failures in projects are not important as long as debt repayment is done. The major concern is the entire portfolio the firm holds as the creditors have full recourse to them. However in project finance, the major concern is the repayment of the loan by the revenue stream of the specific project. So the importance is given to the cash flow from project, risks that the project is exposed and also collateral for the project.

From equity holders point of view, investments financed by project finance have limited or no recourse to them. In other words, debt holders have limited or no recourse to shareholders' other assets in the case of a financial failure. In these situations, equity holders cannot lose more than an amount that is equal to their investment in the specific project[a].

Since project finance is implemented through off balance sheet financing, effects of leverage are different. In traditional way of financing, borrowing uses part of the corporation's debt capacity. But in project finance, the sponsor's debt capacity is highly expanded (up to 70-80% or even higher) due to the existence of credit supports through government guarantees or such other supports by different parties (which will be discussed soon).

Lenders have an advantage of project financing as compared to traditional finance, that is project resources are allocated for project only. By definition, they cannot be used elsewhere within the firm (Pollio, 1998). This brings an additional security for lenders as the money borrowed for the project is used only for the project itself.

[a] There are cases, where debt holders have limited recourse on shareholders assets. Performance bonds or some type of covenants may be required to raise debt.

Due to the fact that project financing requires strict contracts as compared to traditional method, financial flexibility is lower. In project finance, transaction and contracting costs are high. Besides, arranging contracts is highly complex and time-consuming.

As mentioned before, bankruptcy costs are so high that it is one of the major factors that affect borrowing decisions. However, cost of resolving financial distress is lower in project finance (Finnerty, 1996). As trade-off theory states, the costs associated with financial failure limits the amount of borrowing, lower cost of financial distress in project financing would be also be another factor that results in increase in the amount of leverage.

4.4 Participants in Project Finance

There are several participants in a project financing. Each participant has its own objectives that are summarized below (Tinsley, 1996).

Sponsors join together to develop projects by providing land, technology, operations management, construction, financing, local connections, transportation, supply resources and offtake.

There are financial advisers each having different specializations. Main types are investment and merchant banks, country risk specialists, financial analysts, accounting firms, law firms and brokers. They play a key role in project financed investments by providing information about taxes, risk analysis, guidance for access to financiers etc.

Export Credit Agencies (ECA) and Multilateral Agencies (MLA) may be involved in project financing by providing co-financing or complementary financings or through buyer or supplier credits. Political Risk Insurance (PRI) can also be obtained from these institutions.

Independent experts are required from financiers for independent reviews and certification of the work planned. Reviews cover topics related to market, engineering, environmental issues, tax, accounting, reserves and supply.

In addition to their regulatory role, governments are involved in project financed infrastructure development projects by providing guarantee and also as being a direct supplier and/or a buyer (details will be discussed in the guarantees section).

Construction Contractors and Operation and Maintenance (O&M) Companies play an important role in project financing. Construction contractors are involved in engineering, design, procurement and construction itself. Their main objectives are making profit from construction contracts and return on investment if they have a share in investment. O&M companies use their management skills and ability in operation and management to operate the project. Like construction contractors, their objectives are to make profit from operation and return on investment if equity is provided.

Due to high-risk exposure in project financing (discussed below), insurers play a crucial role. Special types of insurances are available for project finance like construction, delay-in-startup, business interruption, environmental, third party and statutory insurances.

Raw materials may be supplied by third parties as suppliers under contracts or under special purchasing agreements. Equipment is obtained through equipment vendors. Generally start-up guarantees, post commissioning performance warranties are required for project financing.

The project's output is sold to offtakers under special type of purchase agreements. The critical point is the reliability of the offtaker for the life of the project.

Depending on the type of the project, both offtakers and suppliers may require transportation facilities such as pipelines, railways, ports, transmission lines etc.

4.5 Sources of Funds and Long-Term Debt Financing

Infrastructure projects are so large investments that necessary finance for investment could not be easily obtained. Normally, sponsors of the project provide the necessary amount for equity. Besides, financial institutions and purchasers of the project's output (including government) may also be involved in providing equity.

David and Fernando (1995) argue that, for BOT projects, equity is relatively easy to obtain but long-term debt is hard to find especially in highly levered projects. Webb (1995) supports this idea by considering limited supply of debt financing due to high-risk exposure and long-term nature of loans. Moreover, as compared to debt, equity is found easily in domestic market[a].

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[a] It is observed by Chowdhry and Titman (2001) that, even when capital markets are open, investors prefer to invest in their home markets.

As Kahn (1995) states, debt investors do not profit beyond a certain level, which is determined by the loan agreement. However, they share in project's failure when returns are not sufficient to cover their repayment. Therefore, they require a high probability of success. On the other hand, by definition, equity holders have limited liability in case of financial failure. But their return is not restrained from project's success. As a result, it is highly probable that risky projects are preferred especially by equity holders.

There is an extensive market for debt financing. Commercial banks, infrastructure funds, multilateral development banks (MDB), export credit agencies (ECA), pension funds and life insurance companies are typical institutions supplying debt. Debt may be in two forms as floating-rate and fixed-interest-rate. Kleimerer and Megginson (1999) find that project finance credits are more likely to use fixed-rate-interest rather than floating-rate-interest loans. Commercial banks provide floating-interest-rate loan whereas life insurance companies and pension funds provide fixed-interest-rate loan.

Availability of funds to a project depends on the profitability. Lenders provide funds as long as the project is able to cover its debt service with a contingency. To measure projects' ability in repaying debt obligations, coverage ratios are used. Projects' risk exposure determines the contingency. Depending on the industry and some other factors, for DSCR, 1.25 – 1.50 levels are considered as suitable for investment-grade projects. In Turkey, preferred minimum average DSCR by international financial authorities is 1.50 (Bakatjan, *et al.*, 2003).

Financing a project, debt holders insist on lending an amount that does not exceed borrowing capacity of the project. Borrowing capacity is determined by present value of the cash flow to cover debt obligations divided by a coverage ratio;

$$D^0 = \frac{PV}{\alpha} \qquad (4.01)$$

Where D^0 denotes the borrowing capacity, PV is present value of the cash flow to service project debt -with a discount rate that is interest rate- and α is the cash flow coverage ratio.

A major requirement for infrastructure project financiability is the availability of long-term debt, because of the reason that long-term assets should be funded through long-term debt (Dailami, Leipziger, 1998). Probability of default decreases with maturity. Therefore, loan amortization schedule should match with the project's lifetime. Interest rate is important for availability of loan. Increase in interest rate increases the lenders incentive in supplying credit. Apart from profitability and risk, there are some other factors affecting interest rate. Lenders are hesitant to finance highly leveraged projects. The more equity is provided by sponsor, the more lenders feel safe and therefore high leverage results in increase in interest rate. Besides, there is a positive relation between loan maturity and interest rate. As project financed investment projects require long loan amortization schedule (8-10 years), it is expected to have interest rates to be 1-2 percent higher than those with relatively shorter maturity. Another factor of determining interest rate is having third-party guarantee. Existence of a reliable guarantor sharing a risk in project finance significantly decreases loan spreads. Also, investing in project that is mostly composed of tangible assets also makes lenders comfortable.

4.6 Risks in Project Finance

As indicated by Tam (1999), unsuccessful experiences in BOT history show that BOT is not a sure-win business. As discussed in Chapter 2, ‘Financial Evaluation and Optimal Capital Structure’, identifying risks associated with project is crucial for a well-developed financial evaluation. Since the project is functioning as an independent economic unit in project financing, factors that affect the success of the project gains further importance.

In corporate finance, risk is determined by the volatility of returns or covariance with the market. However in project finance, risk generally refers to the ways in which actual results may be worse than expected (Irwin *et al.*, 1997). According to this logic, an increase in a risk does not only increase the volatility of returns, but also reduce the expected return.

This fact is also very important from debt holder’s point of view because there is a significant difference between lenders and sponsors. For lenders holding debt rather than equity there is never any potential upside gain in the project. Their major concern is the downside risk, which may result in reducing the ability of the borrower to repay debt obligations (Grimsey, Lewis, 2002).

For BOT projects, upon construction of the facility, the concession period can last for decades. As stated by Yeo and Tiong (2000), during these operational phases, the maintenance of agreements, related with tariff rates, guarantees, regulations etc. is exposed to great uncertainties. Due to that, BOT projects can be classified as high-risk projects.

According to Grimsey and Lewis (2002), from the perspective of project sponsors, Public Private Partnerships (PPP) are project financing, as they are highly levered special purpose company for the project and there is an existence of reliance on direct revenues to pay for operating expenses, repay debt obligations and give a desired return on sponsors. And, much of the risks for PPPs come from the complexity of arrangements itself. Documentation, financing, taxation, technical details and sub-agreements constitute this complexity.

They also mention about the nature of the risk altering over the duration of the project. To be more specific, for infrastructure projects, construction phase of the project is exposed to different types of risks than those in the operating phase. According to Lam (1999), the greatest risk of BOT projects generally appears in the later part of the construction stage and the early part of the operation stage where interest costs start to roll over.

Grimsey and Lewis (2002) classify risks as global risks and elemental risks. Global risks include political, legal, environmental and commercial risks. Risks associated with construction, operation, finance and revenue generation constitute elemental risks.

Risks associated with project finance and/or BOT model projects can also be characterized as technical, economical and political risks. According to Tam (1999), technical is relatively the easiest to manage, financial is harder but is still manageable and political is the most difficult to handle. As the results of a questionnaire designed by Yener (1998) (cited in Özdoğan and Birgönül, 2000) indicate, for BOT projects in Turkey, political and economical instability are significantly important where technical risks is considered as the least important problem. More specifically risks associated with project finance are discussed in detail in the following sections.

4.6.1. Technical and Completion Risks

Özdoğan and Birgönül (2000) list technical factors affecting project success as; project size; reliability and experience of contractor; reliability and experience of operator; reliability and experience of management personnel; economically availability of personnel, materials and machinery; necessity of overly innovative construction and operation methods and necessity of unproved technology.

The most critical factor constituting technical risk is having new technology applied in the facility. If the technology is considered as having a significant performance risk, a risk premium is charged by lenders for firms, which are using the technology (Kahn, 1995). And risk perceptions change with experience. Generally it decreases as technology is proven but sometimes it may increase due to existence of unforeseen events. In the case of untried, unproven technology is used; lenders may require a completion guarantee from the sponsors and warranties from manufacturers during the operational phase in order to decrease their exposure to technical risks (Wolfs, Woodroffe, 2002). Even if the technology is proven; the size of the project may be considerably larger than the existing ones using the same technology, which brings additional technical problem for the project's success.

According to Churchill (1996), technical risks do not have so much importance as others in terms of affecting competitiveness in the sector. Sufficient engineering and technical services are available. Lenders obtain confirming opinions from independent experts that the project facilities can be constructed within the proposed time schedule and cost estimate and upon completion of construction, the facilities can be capable of operating with required performance (Finnerty, 1996). This completion risk is best rest with the construction contractor subject to a fixed price, fixed date, turnkey contract with stipulated liquidated damages, usually enhanced by performance bonds (Webb, 1995).

4.6.2. Economic – Commercial Risks

Having successfully completed the construction and operating with required performance is not enough to generate the proposed revenue. There must be a demand with an acceptable price for the service or product sold. In addition, when raw material is required, economical availability of raw material is necessary. Volatilities in output and raw material prices, demand for output and availability of raw material are serious threats for economical feasibility.

Future and forward contracts best fit to the situation mentioned above. Future contracts are standardized type of contracts whereas forward contracts are tailor-made contracts both of which obligate the contract seller to deliver to the contract buyer a specified quantity of a particular commodity, currency or some other item on a determined future date at a stated price (Finnerty, 1996).

In BOT model projects, there may exist special type of regulations and agreements for these purposes such as third party guarantees[a]. The logic

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[a] Details will be discussed in the government support through guarantees section (4.7)

behind them is the same as future and forward contracts but in a more reliable manner as government stands on the opposite side of contract.

4.6.3. Interest Rate Risk

Interest rate risk (financial risk) occurs when floating-rate debt financing constitute an important portion of financing as increase in interest rates could decrease the ability of project to service its debt obligations. Infrastructure development projects are very sensitive to these changes due to their capital intensive, long-lived asset base.

Grimsey and Lewis (2002) states, financial risk arises from inadequate hedging of revenue streams and financing costs. Although theoretically hedging does not increase value (MacMinn, 2002), it plays an important role in project finance. Mainly two types of hedging instruments that are arranged with third parties are available for interest rate risk as interest rate cap contracts and interest rate swap agreements.

With interest rate cap agreement, purchaser of the contract is paid the difference between LIBOR[a] and the real interest rate by contract seller. By means of this agreement the purchaser is not exposed to changes in interest rate fluctuations, his true interest rate can never exceed the cap rate plus the additional term in floating-rate loan agreement[b].

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[a] LIBOR is London Interbank Offered Rate that is the interest rate in which major international banks lend each other.

[b] For example, if the cap rate is 7% and the interest rate in loan agreement is LIBOR+3, the purchaser is paid the difference between LIBOR and 7% every time when LIBOR exceeds 7%. So at most the purchaser pays the interest rate 10% (that is 7% +3%). But, unless otherwise stated, he cannot benefit from the contract when LIBOR is less than 7%.

Interest rate swap agreements are contracts to exchange interest rate payment obligations. In case project is financed with floating-rate debt, project firms can make an agreement with another financial institution to exchange floating-rate interest payments with fixed rate of interest. With these transactions project firm's floating rate interest payments and receiving are cancelled out and the firm is left with only fixed rate of interest payment.

4.6.4. Currency Risk

Currency risk takes place when projects cash flow is composed of more than one currency. When the currency for revenues depreciates and unit price for output remains the same; difficulties may exist in covering costs, repaying debt and having an acceptable return. Similar to mentioned factor in the interest rate risk section, infrastructure projects, which are capital intensive and have long life, become sensitive to currency risk.

There are forward and future contracts to overcome this problem. In addition, like interest rate swap agreements, currency swap agreements are also available. Another solution is borrowing with the same currency as revenues. According to the research by Graham and Harvey (2001), main reason for firms issuing foreign debt is to provide a natural hedge against foreign currency devaluation.

4.6.5. Regulatory and Political Risks

Legal changes and unsupportive government actions are also serious threats for BOT projects. Political and regulatory risks are generally macroeconomic risks that project firms are unable to cope with. Irwin *et al.* (1997) classifies these risks into three groups as traditional political risks, regulatory risks and quasi-commercial risks.

Traditional risks include risks of expropriation, political violence, currency inconvertibility and currency non-transferability. According to the logic that risk should lie with the party or parties that are best control of it, Ridley (1995) addresses these risks to go to the public sector.

Regulatory risks are related with laws, regulations and contracts. They may be changed by government, which may adversely affect project's success. Changes may occur at either country-specific or project-specific level. These are again under government's control and compensation in case of change is required. As Tam (1999) states, political stability is relatively difficult in developing countries, frequent changes of government is more common and it is usual for a new government to have an intention in reviewing the contracts signed by the previous government. This situation forms one of the major risks for BOT projects whose agreements usually span for decades. Due to that, he considers uncorrupted government as a key factor in the success of BOT projects. As pointed out by Lam (1999), most of the residual risks –that cannot be covered or mitigated- arise from government side. As privatization of infrastructure is politically sensitive, backlashes are seen especially during the change of governments. To some extent, promoters may address the problem by means of political insurance to cover the loss due to the change in government policy.

Quasi-commercial risks are about contractual nonperformance by public utilities in their capacity as suppliers or purchaser. State-owned companies are less creditworthy than the government and investors require government to bear the risk of public- utilities' nonperformance.

Özdoğan and Birgönül (2000) lists political and legal factors affecting BOT project's success as stability of political environment in the host country, government's political will for the realization of the project, government's experience in BOT schemes, adequacy and transparency of procurement system, existence of mature legal framework for the realization of BOT projects, adequacy of public institution's regulatory framework, expropriation risk, existence of bureaucratic delays, government's attitude towards private sector, existence of guarantees for political and legal risks out of control of private investors.

As government being both a party in the concession agreement and also a regulator, it is inevitable to see frequent political and regulatory occurrences affecting projects success negatively. Seeing that local courts are not credible, a neutral arbitrator is required for dispute resolution[a].

In addition, Pollio (1998) drives the attention on pressure of multinational lending institutions on host government. With project finance, multinational lending agencies share the risk in project failure due to political risk. However, they have a greater impact on governments in regulatory decisions. Therefore, borrowing from lending institutions and international agencies brings an additional protection against political and regulatory risks.

[a] In Turkey, international arbitration for concession agreements was accepted in 1999.

4.6.6. Environmental Risks

Environmental risks are related with project's adverse environmental effects having importance in project feasibility. They can also be analyzed in political risk as they are related with regulations about environment. Especially, mining and some types of power generation are faced with these risks as measures for their probable hazards to environment may cause delay and/or redesign of the whole project.

4.6.7. Force Majeure Risks

Force majeure risks are risks about discrete events resulting in impairing or preventing completely the operation for a long time. These discrete events may be war, earthquake etc. or even it may be project specific such as strike or fire. Lenders usually require insurance or third party guarantees in BOT projects for such conditions.

4.7. Government Support through Guarantees

Risks associated with infrastructure development projects are different from those in other businesses. Through the long concession agreement, projects are exposed to several serious risks that the project firms find them hard to cope with. Being exposed to these risks discourages private firms engaging in business within this sector. However low realization rates in infrastructure development projects due to discouragement towards risk is a serious threat for especially developing countries.

Government may provide direct financing, tax incentives and guarantees to promote infrastructure development. Direct financing includes providing long-term loan or even equity contribution by government. According to Dailami and Leipziger (1998) tax incentives can be in a form of favorable tax treatment of income, special depreciation allowances or lowering/exemption of import duties on imported machinery and equipment.

Guarantees are the most important type of government support to promote private firms in infrastructure development projects. They can be defined as formal assurances provided by the host government with the objective of reducing and limiting the potential project risks that may be faced by the participants of a private infrastructure project (Dias, Ioannou, 1995).

Dailami and Klein (1997) argue that the value to the guaranteed party is higher than the cost to guarantor, as long as the guarantor can control the risk better than investor. For this principle, commercial risks are insured by insurance companies, not by the government. As discussed by Irwin *et al.* (1997), the cost of bearing the risk may be higher for a risk-averse entrepreneur than for the government. And this cost of bearing the risk generally passes on to consumers. For this occasion, the choice to provide guarantee depends on a comparison between benefits of not providing guarantee and lower cost of bearing risk to consumers by providing guarantee.

Guarantees in BOT projects decrease the risk of failure significantly; however there is always the risk that the project firm has to cope with. Moreover, Tiong and Alum (1997) drive the attention on the importance of creditworthiness of the guarantor. As observed by them, in some countries, local utilities are in so poor financial and credit standing conditions that their guarantee about purchase agreement do not have any value in BOT projects.

According to Kumaraswamy and Zhang (2001), various types of government guarantees to promote private sector involvement can be listed as below;

- minimum revenue stream guarantee
- foreign exchange rate guarantee
- repatriation of revenues
- guarantees against high inflation and interest rates
- government compensation in case there is a change in the monetary laws or new regulations affecting the investment[a]
- extension of concession period in case of force majeure
- emergency loan facilities
- tariffs/tolls adjustment mechanism
- guarantees of raw material supply
- guarantee of output purchase[b]

As discussed, effects of change in inflation, interest rate, and foreign exchange rate are critical for infrastructure projects. These risks are country specific and without hedging, project firm cannot cope with these risks. To eliminate private sectors exposure to those risks, government may provide inflation linked price escalation, purchase agreements with foreign currency and compensation for interest rate fluctuations.

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[a] Izmit Su Water Treatment Plant and Pipeline, Turkey.

[b] Birecik Hydro Power Plant, Turkey.

One of the major guarantees is used to overcome revenue risk of private firms. Revenue risk includes both demand risk and price risk. As concession agreements span for long time and precise demand analysis may not be properly handled by project firms, off-take agreements that guarantee revenue of the project (either to a certain extent or completely) are required by private investors.

Mainly, two types of agreements are used as take-and-pay and take-or-pay contracts. In take-and-pay (take-if-offered) contracts, the purchaser is obliged to purchase the output and make necessary payments. In take-or-pay contracts, payment must be made whether or not purchaser takes the delivery.

Off-take agreements may not cover all the output to be produced. Minimum revenue can be guaranteed and the remaining part of risk may rest with the project firm.

Projects that are producing fluctuating amount of output seasonally, and having fixed costs forming a significant portion of operating expenses, are faced with a serious revenue risk. For those situations, capacity-plus-volume type of contracts may be arranged. With these contracts, fixed costs of operation are compensated and additional payment is made according to the amount produced (Wolfs, Woodroffe, 2002).

Governments may also provide "no-second-facility" guarantee that preclude both state owned utilities and others to construct a competing facility (Dias, Ioannou, 1995).

In addition, there may be cases where repayment of debt obligations is guaranteed by government. With above described type of guarantees, there is still a risk that project may fail in repaying debt. Lenders may insist on these types of guarantees depending on the reliability of the project. Moreover, government's repayment guarantee also results in a decrease in interest rates. In Turkey, two models are used for repayment guarantee as assumption model and buy-out model. Additional contracts are arranged between guarantor and lender, and in case of a financial failure of project firm for any reason, plant is taken over by a state owned utility. With assumption model, remaining debt repayment is made by government, as it is agreed by project firm and lender. On the other hand, in buy-out model, remaining portion of debt is repaid by government as soon as the plant is taken over.

Government guarantees are one of the most controversial subjects between government side and private investors' side in infrastructure development projects. The principle behind risk sharing is that each type of risk must rest with the party best able to control it and there are many forms of risk that project firm is unable to control. Due to that, some sort of risks should be left to government. However, governments often prefer to pass more risks to the promoter that promoter can properly handle (Tiong, 1996). This case is the same in Turkey as well; Turkish Government is usually reluctant on providing guarantees and insists in that the project company should retain risks. (Özdoğan, Birgönül, 2000).

Poorly designed government guarantees are criticized as they threaten the advantages of privatization. One major advantage of privatization is that private firms have stronger incentives in selecting good projects to invest. But with guarantees, investors' motivation in selecting feasible projects unavoidably decreases. With excessive government guarantees, private firms may invest in projects that are likely to fail also. Governments may run into trouble during recessions as their liabilities due to guarantees are realized[a].

[a] As mentioned by Irwin *et al.* (1997), a proposal is developed that awards BOT projects with a tender based on lowest present value of revenue with a discount rate determined by government. Concession ends when present value of revenue is equal to the amount in offer. Unless there is an extreme condition that revenue never exceeds the offer, there is no demand risk for project firm. Due to that, governments' exposure due to recession is eliminated without decreasing private firm's incentive in investing in BOT model infrastructure projects.

CHAPTER 5

FINANCIAL ENGINEERING IN POWER GENERATION SECTOR AND HYDROPOWER

5.1. General

Although power generation sector have similarities with other infrastructure sectors, some differences exist which may be analyzed independently.

Unless regulation exists, private power producers face risks from severe volatility in electricity prices. Volatility and covariance with other prices can be a model for estimating price but there are some sector specific properties in electricity generation that makes a precise estimation difficult. As Rose *et al.* (1997) stated, below are the major assumptions for a financial evaluation of an investment.

- Volatility in price is fairly stable over time.
- There are small differences in volatilities and correlations among regional markets. (Otherwise, arbitrage occurs by buying a commodity and selling it to different market.)
- A relationship can be formed to estimate long-term volatility with short-term volatility.
- Volatility is similar to other commodities or stocks.

As mentioned by Rose *et al.,* it is difficult to make the same assumptions in the power sector.

First, even if historical data is obtained for electricity prices, most probably, it may not reflect the condition today, as there is a trend in electricity power production towards deregulation, therefore historical price information is probably insufficient to be a model for today.

Since low-cost transmission systems are not available, arbitrage is not possible by buying and selling electricity in different regions. Therefore, electricity prices do not have to move in a similar manner.

Underlying occurrences that affect power price volatility differ according to the time interval under consideration. For that reason, establishing a relationship with short-term and long-term volatility is not possible. For short-term (up to 30 days), weather conditions are the primary factor in price variations. However, as duration increases electricity price variations are affected mainly by fuel prices, existence of new supply and economic conditions and population of the region.

In addition, take-or-pay type of agreements may be done on the supply side also. This type of agreement results in a serious loss in case of a late completion of construction phase.

Besides, different from other sectors, private firms may face with loss of income through illegal connection to the transmission system and power thefts especially in developing countries.

As tariff rate is the most sensitive factor for financial evaluation of BOT type power plants (Yeo, Tiong, 2000), and difficulties in estimation of future price are significant, related hedging instruments and special type of agreements for risk management purpose are unavoidable.

Long-term supply and purchase agreements are considered as a basis for risk management for energy projects (Jechoutek, Lamech, 1995). Future contracts, options are available for power sector in some markets. Besides, in case a positive correlation exists with electricity price and a commodity (e.g. fuel), a position in power can be hedged with an opposite position in the commodity (Rose *et al.*, 1997).

However, these instruments are limited and not available worldwide. According to Finnerty (1996), Public Utility Regulatory Policy Act (PURPA), which was accepted in 1978 in the United States, established a foundation for long-term contractual obligations to support nonrecourse project financing. According to PURPA, local utility companies are required to purchase all the electric output of qualified independent power producers (IPPs). Similar to PURPA, power purchase agreements (PPA) or energy sales agreements (ESA) are applied currently as long-term contracts.

According to PPA (or ESA), governments impose restrictions of IPPs by tariff agreements. Tariff structure may be formed either by capping the price or limiting the rate of return on investment. As Lam (1999) argued, with limiting rate of return, the problem in determining the actual cost of investment and operation exists. However, with determined price, IPP must handle the risk under consideration.

5.2. Hydropower Sector

Today, energy is provided mainly from thermal sources such as coal, gas and oil. However, this dependency is criticized for some important reasons. First of all, the sources have limits and obtaining adequate amount of them with required quality economically in the future will be a problem under current conditions. Besides, relying on foreign markets for these sources and air pollution due to thermal energy generation do not match with countries' long-term objectives.

Owing to that, countries are seeking ways to decrease their dependency on these sources by considering renewable energy sources. Solar energy, wind energy and geothermal energy can be examples for most used renewable energy methods, but they are not able to produce large amounts of energy for the future[a]. They are considered as intermittent sources for back-up energy production. However, hydropower is the largest source of energy among them as it represents more than 90% of all renewable energy generated.

5.2.1. Brief History of Hydropower

Hydropower has been used to turn water wheel for grinding wheat into flour for more than two thousand years. Water wheel was first used to produce electricity in the 1880s. With 20th century, water wheel was replaced by water turbine and dams were constructed to control the water flow.

[a] Ocean waves, tide, biomass, sewer system gases are also examples of renewable energy sources.

5.2.2. Main Characteristics of Hydropower

Hydropower produces nearly one fifth of the world's electricity. As the technology uses the power of naturally flowing water, without depleting it in energy production, it provides important advantages of renewable energy production.

First of all, water flow continues, as long as hydro cycle repeats. Thus, producing energy does not result in running out of sources. Analysts disagree about the time when fossil fuel sources will begin to decline. But, most of researchers claim that by the middle of this century, supplies of fossil fuels will begin to decline slowly (Janssen, 1999). Availability of sources locally is also important for energy production. Countries do not prefer to be dependent on international market for thermal sources. Turkey is heavily dependent on imported oil and gas and it is expected to be continued in near future (Oğulata, 2002). Besides, cost of production is not subject to fluctuations in market as compared with other energy production methods. Advantages of renewable energy production are remarkable as far as environmental benefits are concerned. Hydropower and the World's Energy Future Report (HWEF, 2000) argues that with recognition of these benefits, hydropower projects have also been developed in countries with sufficient reserves of fossil fuels.[a]

Different from thermal energy production systems; in hydropower, it is possible to reach maximum output quickly. This ability is important in meeting sudden demand fluctuations during the day, and power plants using thermal energy are not suitable for this purpose. Moreover, starting

[a] In 1997, it has been calculated that, hydropower saved GHG emissions (in terms of avoided fossil fuel generation) is equal to all the cars on the planet.

energy production without an outside source of power (black start capability) is possible in hydropower electricity generation.

Despite its various advantages, hydropower energy production has not drawn attention too much. One primary concern can be, its high initial investment cost. According to the U.S. Department of Energy (DOE), the average investment cost for hydroelectric construction is 2000$/kW for 21 hydroelectric power plants which started their operations in 1993. As Kulga (2001) analyzes, investment required for unit power production for different power plants in Turkey as of year 2000 is as follows:

Table 5.1 Investment for Different Types of Power Plants

Type of Power Plant	Investment Cost ($/kW)
Hydroelectric	1350
Natural Gas	500
Imported Coal	1200
Lignite	1600
Nuclear	2500

However, above values are just the averages of investment costs of power plants. Costs of building a hydroelectric project may vary significantly. Characteristics of the site where the project is constructed and environmental mitigation requirements are the primary factors affecting construction cost.

Construction duration is also another major factor in decreasing the motivation for developing hydroelectric power plants. Public financed HEPPs with all related construction facilities and electromechanical installation are constructed in 5 years on average, on the other hand, the duration may fall below 2 years if it is privately financed (Bakır, 2001).

However, economical life of hydroelectric power plant is considerably high. Power plants operating with thermal power have 25 years of economical life, whereas it is at least 50 years for hydro power plants. In addition, the initial investment is mainly composed of civil works. Electromechanical equipment constitutes about 200-400$/kW of the investment. With periodic replacement of electromechanical equipment by replacement of turbine runners, rewinding of generators or even the addition of new generating units, the plant life can further be extended beyond 50 years (HWEF, 2000).

As it does not rely on a fuel source, operation and maintenance costs constitute the cost of operation of hydropower. According to the Energy Information Administration (EIA), based on 1996 data, the operation and maintenance cost of hydropower was 0.7 cents/kWh. According to TEAŞ, based on 1998 data, it is 0.1 cent/kWh for power plants with dam and 0.7 cent/kWh for river type power plants. Electricity generation using thermal energy has operating costs about 3.0 cent/kWh for coal fired power plants and 3.9 cent/kWh for natural gas fired power plants (Bakır, 2001).

5.2.3. Hydroelectric Power Generation in Turkey

Turkey has an annual hydroelectric potential of 433000 GWh.[a] This amount has been calculated theoretically by using potential water head in rivers. But, depending on the technology applied, generating the theoretical amount is not possible. Due to that, technically exploitable portion is generally used as a function of gross potential. Technically exploitable portion of that capacity is 216000 GWh for Turkey, and 123000 GWh of the potential is economically feasible.[b] As of year 2001, total electricity generation is about 125000 GWh in Turkey.

As Turkey's Hydroelectric Energy Potential Report states, Turkey's first hydroelectric energy is generated in Tarsus in 1902 with a 60kW HEPP. In 1914, electricity generation is realized by private firms with special concession agreements. In 1923, when the Republic of Turkey is formed, 0.1MW of total 33.0 MW is generated by HEPPs.

As of year 2000, there were 120 HEPPs with a total installed capacity of 11600 MW and 42000 GWh annual generation capacity. This is about one third of total economically feasible potential. Thirteen of them with an installed capacity of 853 MW have been realized under BOT model. As of that year, 34 HEPPs with an installed capacity of 3300 MW and 11.000 GWh annual generation are under construction. And 329 more HEPPs with 20000 MW installed capacity will be constructed to complete the remaining potential, which needs an additional US$ 30 billion for investment. (Altınbilek, 2000)

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[a] As Altınbilek (2000) indicates, the gross annual hydroelectric potential is 1% of the world's total capacity and 14% of the potential of Europe.

[b] Economically feasible portion of the capacity may vary according to analysis applied. Bakır (2001) claims that the economically feasible potential in Turkey is higher than that amount if some side effects of hydroelectric power generation are taken into consider.

CHAPTER 6

CALCULATING OPTIMAL CAPITAL STRUCTURE IN BOT MODEL PROJECTS

6.1. Capital Structure in BOT Projects

There are constraints for borrowing in BOT model projects. Apart from debt limitations considering coverage ratios, there are also limitations imposed by the government. Financially sound consortium is essential for BOT project's success. Moreover, increase in equity participation increases the government's trust in project firm. Providing high equity is an indicator that the consortium has confidence in project's viability.

According to projects implemented by law no 3096, debt is limited by a percentage in total investment, specified in contract. With law no 3996, unless otherwise is stated, it is required to have equity participation at least 20% of total investment amount. In practice, equity contribution is found as just equal to that limit (Teba, 2002).

Optimization of debt ratio and analyzing whether maximum amount of debt is the best to prefer or not is done according to the theoretical framework which is based on the literature described in the previous chapters.

6.2. Theoretical Framework for Optimization of Capital Structure

According to the trade off theory, optimal capital structure exists considering the benefits of tax shield with leverage and losses due to decrease in financial strength with borrowing, providing that, there is no information asymmetry between investors.

APV method is selected as a financial tool for evaluating the value of debt ratio. Discount rate for the analysis is found by CAPM model. For energy sector, or more specifically electric sector, four firms, whose stocks are publicly traded are selected namely: Akenerji (Stock 1), Aksu Enerji (Stock 2), Ayen Enerji (Stock 3) and Zorlu Enerji (Stock 4). The respective market is taken as IMKB100 stock index for the analysis. As mentioned previously, the convention for beta in discount rate calculation is to use returns over the previous 60 months, however as these stocks have not been publicly traded for 60 months their returns from the beginning is taken into consideration.

As mentioned in Chapter 3, bankruptcy prediction is studied for normal businesses, not for special agreements like concessions. Besides, most of bankruptcy prediction methods are used to obtain a score for the risk. However, to complete the analysis for the case, a new approach is developed as explained below. More precise prediction models may be developed after some BOT experiences.

As stated before, a DSCR of 1.00 is called a breakeven cash flow and below this number indicates the financial distress. For this situation, having DSCR less than 1.00 means a severe risk of bankruptcy (almost 100%). In addition, DSCR above 1.50 is considered as very low level of financial distress (i.e. 1%). DSCR, which is between 1.25 and 1.50, is considered as suitable for investment grade projects. Besides, having too high level of DSCR does not guarantee that the project will not fail. There may occur a very low level of residual risk (i.e. 0.1%) with too high level of DSCR. Taking all into consideration, below formula is proposed, which would be one of the sound approaches that reflects all the situations above.

Probability of Bankruptcy (λ) $= 0.999 \times DSCR^{-12} + 0.001$

But not greater than 1.000 (6.01)

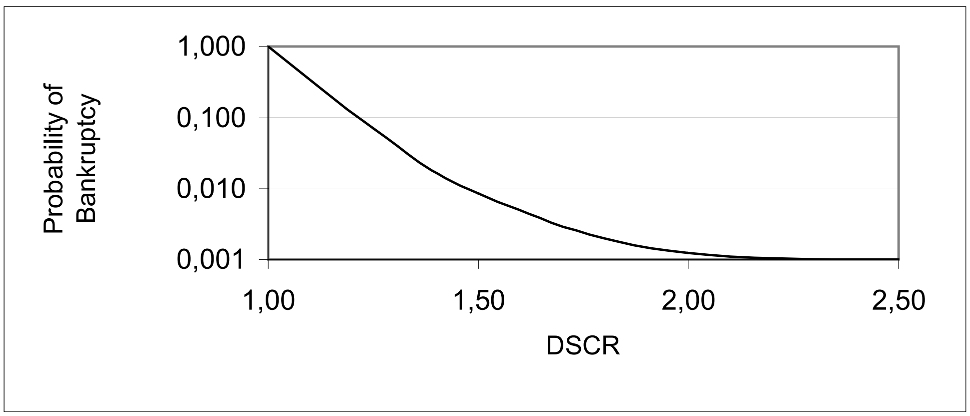

Fig. 6.1 Probability of Bankruptcy vs. DSCR

With above formula, bankruptcy probability is independent of bankruptcy probability of previous years. True bankruptcy probability is the product of not becoming bankrupt during previous years and probability of bankruptcy for the current year.

Bankruptcy Probability ($P_b(n)$) $= (1 - \lambda_1)(1 - \lambda_2) \ldots (1 - \lambda_{n-1}) . \lambda_n$ (6.02)

6.3. Case Study

The case is taken from a real analysis for a hydroelectric project, which has 37.7 GWh energy production capacity per year. The numerical part of the analysis reflects a real proposal. However, for confidentiality reasons, details about the project are not mentioned throughout the study.

6.3.1. Investment Required

Two years are required for the investment period. Below is the list of items constituting the investment.

- Civil works,
- Electromechanical (E-M) equipment and installation,
- Energy transmission line,
- Design and consultancy,
- Insurance,
- Expropriation,
- Independent audit,
- Working capital,
- V.A.T.,
- Interest during construction,
- Commitment fee

Civil works and electromechanical works are found to be USD 5.18 and 4.00 million respectively. For this type of projects, their corresponding contingencies are suggested to be 7.5% and 5.0%. The amount required for energy transmission lines is calculated as USD 0.8 million.

Some portion of civil works is planned to include expenses, which are subjected to V.A.T. The rest of the investment is not subjected to V.A.T. Thus, V.A.T is calculated as USD 0.84 million.

The amount required for design and consultancy includes 10.0% of civil works and 5.0% of E-M works.

The plant was planned to be constructed on an area partly including both private and public land. As a result, an expropriation expense exists and it is found to be USD 0.2 million.

USD 0.04 million is required for insurance, and USD 0.01 million is required for independent audit. Calculation of interest during construction and commitment fee ‘f’ will be mentioned below.

When all items are added together, total amount of investment for this HEPP is found to be USD 12.477 million plus f.

In addition, investment in working capital was assumed to be USD 100000. This amount is returned back at the end of the concession period.

Table 6.1 Investment Required

Investment Item	Amount (USD Mill.)
Civil Works	5.180
Electromechanical Works	4.000
Contingency for Civil and E-M Works	0.589
Energy Transmission Lines	0.800
Design and Technical Consultancy	0.718
Insurance	0.040
Expropriation	0.200
Independent Consultant	0.010
Working Capital	0.100
VAT	0.840
Investment Period Interest + Loan Expenses	f

6.3.2. Annual Costs

All items about costs of the HEPP can be summarized in 5 major items such as; personnel, operation and maintenance (O&M), depreciation, indirect-administrative and insurance.

USD 250000 per year is calculated for personnel cost (including all related insurances, taxes, etc.). USD 50000 for O&M, USD 25000 for indirect-administrative costs, and USD 15000 for insurance are required.

There is a special type of application for depreciation in BOT type projects. Without special type of agreements, depreciation rate for buildings is 4% (The rate is higher in E-M installations). In other words, whole depreciation is completed in 25 years. However in BOT type projects, depreciation is allowed to be completed within concession period. (Şenyüz 1996)

According to related Turkish accounting rules, four items, which are V.A.T., working capital, insurance and expropriation, are not subjected to depreciation. Due to that, total amount to be allowed for depreciation is calculated as the USD 11.297 million plus ‘f’.

Concession period is 20 years, thus, depreciation is found to be ’USD 11.297 million plus f’ divided by 20.

To sum up, total annual cost is found to be USD 340000 excluding depreciation.

6.3.3. Debt Financing

‘Equal annual loan drawdown for two years’ was planned for the project. Interest rate for the credit was 10% and it was assumed that, it did not change with leverage. Commitment fee for the loan was 2%. Grace period was suitable for the investment duration and it was 2 years. Interest payment was not going to be made during the grace period and it was going to be capitalized. Equal annual principal installment is selected for debt repayment. Debt repayment continues for 8 years after the grace period. Interest payment for a year is calculated as multiplying the interest rate and the remaining amount of debt. Below formulas show how installments, both principal ‘P’ and interest ‘Int’ are calculated.

P = (Total capitalized amount of debt) / 8 (6.03)

Int = Remaining Debt Amount * 0.10 (6.04)

Below is an illustration for debt repayment. Total capitalized amount of debt (including interest amount, commitment fee) is taken as CA.

Table 6.2 Calculations for Debt Repayment Schedule

Year	Remaining Debt at the end of the year	Principal Installment	Interest Payment
0	CA		
1	CA – CA/8	CA / 8	CA × 0.10
2	CA – CA/8 – CA/8	CA / 8	(CA - CA/8) × 0.10
3	…	CA / 8	…
4	…	CA / 8	…
5	…	CA / 8	…
6	…	CA / 8	…
7	CA/8	CA / 8	…
8	0	CA / 8	CA/8 × 0.10

There are three implicit functions. The amounts of interest during investment period and loan expenses are factors in calculating investment amount. Besides, loan amount is a function of the investment. In addition, amount of interest during investment period plus loan expenses ‘f’ are calculated by using the amount of loan. As a result, these implicit functions have to be solved before going further.

By taking θ as debt ratio, below formulas are obtained (Values are in USD millions);

Total amount of investment, inv	$= 12.477 + f$	(6.04)
Loan amount, L	$= inv \times \theta$	(6.05)

Half of the loan amount is borrowed in the beginning of the first year. With interest rate 10%, the amount of capitalization together with loan amount (the sum is taken as f_1) is

$$f_1 = \frac{L}{2} \times 1.10^2 \qquad (6.06)$$

Rest of the loan amount is borrowed in the beginning of the second year. With interest rate 10%, the amount of the capitalization together with loan amount (the sum is taken as f_2) is;

$$f_2 = \frac{L}{2} \times 1.10 \qquad (6.07)$$

Commitment fee including all other expenses for credit (f_3) is 2%;

$$f_3 = 0.02 \times L \qquad (6.08)$$

Taking all three equations into consideration, f is found as;

$$f = f_1 + f_2 + f_3 - L \qquad (6.09a)$$

$$= 0.175 \times L \qquad (6.09b)$$

Solving three equations (6.04), (6.05) and (6.09b) together, f is found as below;

$$f = (12.477 + f) \times \theta \times 0.175 \qquad (6.10a)$$

$$= \frac{2.1835 \times \theta}{1 - 0.175 \times \theta} \qquad (6.10b)$$

6.3.4. Calculating Discount Rate by Using CAPM

As mentioned before, four shares are analyzed. Firms are selected from energy production sector. All of them have been publicly available since August of the year 2000, and their prices with the change in market (İMKB100) is analyzed from August 2000. Share prices are taken from the first working day of each month. Share prices are adjusted to eliminate the effect of stock splits (if any). Below is the table, showing the share prices of four firms and corresponding market index according to date.

In the second table, rate of change for each four stock prices and market index are tabulated.

Table 6.3 Adjusted Share Prices and Market Index

Month	Year	stock 1	stock 2	stock 3	stock 4	market
8	2000	7875	12815	11555	2469	14100
9	2000	7125	11916	11676	2500	13070
10	2000	5938	10454	10460	2281	11350
11	2000	7250	15063	13136	2813	14079
12	2000	4063	8431	6811	1563	7978
1	2001	6750	11016	8636	1969	9437
2	2001	6375	9892	7906	1969	10638
3	2001	6000	8453	6811	1500	9407
4	2001	6000	8608	7298	1325	8023
5	2001	10125	12533	13622	2156	12093
6	2001	8750	9364	11926	1719	11271
7	2001	8750	9459	13630	1781	11204
8	2001	9250	9081	12188	1594	10211
9	2001	9125	8513	12188	1625	9879
10	2001	6750	6716	8257	1313	7729
11	2001	9250	8135	11009	2000	9635
12	2001	10000	8797	11992	2938	11634
1	2002	10750	11587	13171	3750	13783
2	2002	13750	11587	13171	3313	13375
3	2002	11750	9648	10812	2906	11471
4	2002	10250	8891	10812	3063	11622
5	2002	9000	8600	10812	2938	11480
6	2002	8500	8200	10250	2813	10414
7	2002	8000	7900	8200	3250	9565
8	2002	9000	8800	8700	3250	10582
9	2002	8400	8100	9500	3625	9547
10	2002	7800	7700	8500	3500	9057
11	2002	8600	7900	9200	3313	10217
12	2002	10500	9200	11500	4250	13300
1	2003	7200	6900	8700	4400	10370

Table 6.4 Rate of Change of Stock Prices and Market Index

Month	Year	stock 1	stock 2	stock 3	stock 4	market
8						
9	2000	-0.10	-0.07	0.01	0.01	-0.07
10	2000	-0.17	-0.12	-0.10	-0.09	-0.13
11	2000	0.22	0.44	0.26	0.23	0.24
12	2000	-0.44	-0.44	-0.48	-0.44	-0.43
1	2001	0.66	0.31	0.27	0.26	0.18
2	2001	-0.06	-0.10	-0.08	0.00	0.13
3	2001	-0.06	-0.15	-0.14	-0.24	-0.12
4	2001	0.00	0.02	0.07	-0.12	-0.15
5	2001	0.69	0.46	0.87	0.63	0.51
6	2001	-0.14	-0.25	-0.12	-0.20	-0.07
7	2001	0.00	0.01	0.14	0.04	-0.01
8	2001	0.06	-0.04	-0.11	-0.11	-0.09
9	2001	-0.01	-0.06	0.00	0.02	-0.03
10	2001	-0.26	-0.21	-0.32	-0.19	-0.22
11	2001	0.37	0.21	0.33	0.52	0.25
12	2001	0.08	0.08	0.09	0.47	0.21
1	2002	0.08	0.32	0.10	0.28	0.18
2	2002	0.28	0.00	0.00	-0.12	-0.03
3	2002	-0.15	-0.17	-0.18	-0.12	-0.14
4	2002	-0.13	-0.08	0.00	0.05	0.01
5	2002	-0.12	-0.03	0.00	-0.04	-0.01
6	2002	-0.06	-0.05	-0.05	-0.04	-0.09
7	2002	-0.06	-0.04	-0.20	0.16	-0.08
8	2002	0.13	0.11	0.06	0.00	0.11
9	2002	-0.07	-0.08	0.09	0.12	-0.10
10	2002	-0.07	-0.05	-0.11	-0.03	-0.05
11	2002	0.10	0.03	0.08	-0.05	0.13
12	2002	0.22	0.16	0.25	0.28	0.30
1	2003	-0.31	-0.25	-0.24	0.04	-0.22

Debt ratios for each firm are obtained from their publicly available balance sheets as shown in Table 6.6. Balance sheets as of year 2000 are used. Debt ratios for the duration under consideration are assumed to be constant.

Covariance and beta values for each stock are calculated as described in Chapter 3. Below is the table for both covariance and beta values for each four stocks.

Table 6.5 Covariance and Beta Values for Each Four Stocks

Stock #	Covariance	Beta
1	0.0385	1.089
2	0.0332	0.942
3	0.0399	1.131
4	0.0371	1.052

Beta values in the above table are the ones of stocks with different levels of leverages. To find the beta for the business, the values must be adjusted. In other words, beta of each stock is calculated through eliminating the effect of leverage on stock fluctuations. The computation is carried out by using the following formula given as (3.06) before.

$$\beta_A = \beta_U = \beta_D \times \frac{D}{V} + \beta_E \times \frac{E}{V} \qquad (6.11)$$

$\frac{D}{V}$ is denoted by θ, and $\frac{E}{V}$ is taken (1-θ) herein after. Normally, β_D is taken as zero and debt is assumed to be almost risk-free. So beta (unlevered) is computed as below;

$$\beta_U = \beta_E \times (1-\theta) \tag{6.12}$$

Debt ratios for stocks and their adjusted beta values are shown in Table 6.6.

Table 6.6 Debt Ratios and Unlevered Beta for Each Stock

Stock #	θ	β (equity)	β (unlevered)
1	0.13	1.089	0.95
2	0.01	0.942	0.93
3	0.55	1.131	0.51
4	0.32	1.052	0.71

To find a beta that represents the business (electricity generation sector), arithmetic average of above four beta (unlevered) values are taken, which is

$$\beta_u = \frac{1}{n} \times \sum_{i=1}^{n} \beta_{u_i} \text{ (for n stocks)} \tag{6.13}$$

$\beta_u = 0.775$

Risk free rate is selected as interest rate for the debt, 10%. Market rate is chosen as 15%[a]. By using CAPM formula;

$$r = r_f + \beta\,(r_m - r_f) \qquad (6.14)$$

$$r = 0.10 + 0.775 \times (0.15 - 0.10)$$

$$r = 0.13875 \approx 0.139$$

Where, r denotes the discount rate.

6.3.5. Cash Flow Table

All above calculations are done to constitute the cash flow diagram (Appendix A). It summarizes all transactions during the life time of the project. Explaining all items in the table one by one, would be a better approach to clarify the work done.

Debt ratio is the independent variable and optimal capital structure is determined by changing the value of this ratio.

Escalation rates for revenue and cost are estimated by the project firm. They are determined according to the contract. They may be either the rates on the date of signing the contract or they may be rearranged according to the future occurrences. For this case, firm's estimate about the future is used. They are 1.01 for expense and 1.045 for revenue. Expenses are local and they are not escalating like revenues on U.S. Dollars basis. Due to that, two different escalation rates are used.

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[a] Actually, there is not a strict rule to define market rate and risk free rate. In this case study, debt characteristics is similar to risk-free debt. So, 10% is taken as r_f. For market rate, most financial consultant companies use 15-18%. For calculating optimal capital structure, changes in these values do not affect the result so much. However, an analysis for optimum debt ratio is carried out by changing risk-free rate and expected market premium in Appendix B.

Tax rate for the project is 15.0% and ten percent of this tax is added to the rate for Defense Fund. Totally, 16.5% is taken as tax rate.

First two rows are for item title. Next two rows are for two years of investment (I1 and I2). Loan and equity amounts for each year are allocated for the project in the beginning of the years. However, calculations for years of operation are done according to the end of year. Due to this difference, a blank row exists. The rest 20 rows are for the years of operation.

Sale price is the price of electricity (cent/kWh), which was given in proposal. Two different columns represent the price without and with escalation.

According to the contract, government was going to pay the electricity price, whether or not the plant was going to be capable of generating the output. This type of agreement covered the lack of capability due to weather conditions. Lack of capability due to insufficient management was not covered by contract.

Revenue is obtained for each year by multiplying the energy production with the electricity unit price (including escalation).

With 'y' denoting the year of operation period and 'e_r', denoting the escalation rate for revenue, revenue 'R' for each year is obtained as below:

$$R = 0.377 \times \text{SALE PR. (w/o esc.) (cent/kWh)} \times e_r^{y+1} \quad (6.15)$$

Cost of operation ‘C’ includes both operating expenses and depreciation ‘dep’. It is calculated as below;

$$C = Dep + \text{Operating Expenses} \quad (6.16a)$$

$$= Dep + 0.340 \times e_c^{y+1} \quad (6.16b)$$

Profit (or Earning) Before Interest and Tax ‘PBIT’ or ‘EBIT’ is the difference between Revenue ‘R’ and Cost ‘C’.

$$PBIT = R - C \quad (6.17)$$

Interest Payment, ‘Int’ is deducted from PBIT to calculate Profit Before Tax ‘PBT’. Withholding Tax ‘WT’ is calculated by using PBT

$$PBT = PBIT - Int \quad (6.18)$$

$$WT = PBT \times 0.165 \quad (6.19)$$

Profit After Tax ‘PAT’ or net profit is obtained by subtracting withholding tax from PBT;

$$PAT = PBT - WT \quad (6.20)$$

Depreciation is a cost but not a cash outflow, it is added to net profit. Invested V.A.T. is repaid to equity holders. It is 15% of the revenue from operation and it continues until total V.A.T. reaches to V.A.T. in the investment phase. In addition, invested working capital ‘WC’ is returned when concession period ends. So total fund to investors including principal for each period is obtained as below;

$$\text{Tot. Fund} = PAT + dep + VAT + WC \quad (6.21)$$

Principal repayment is made according to predetermined schedule, which was described above. Return of equity is payment to equity holders, which is equal to their initial investment in total. The difference of initial investment and total V.A.T is repaid to equity holders in equal amount during the years after the debt is repaid. Return on equity is the remaining portion of operating cash inflow that is distributed to equity holders as well.

$$\text{Ret. on Equity} = \text{Tot. Fund} - P - \text{Ret. of Equity} \quad (6.22)$$

In the 'Cash Flow to Equity' column, first two rows show the equity drawdown in the beginning of two years. Cash inflow for 20 years is calculated by adding return of and return on equity together.

'Cash Flow for Debtholders' shows the loan drawdown for two years and cash inflow to debtholders, which is the summation of principal and interest.

'Overall Cash Flow' shows the summation of cash flows for both debtholders and equity holders.

Up to here, deterministic approach for cash flow analysis is covered. Below, probabilistic approach through introducing probability of bankruptcy is explained.

Debt Service Coverage Ratio is calculated by taking the ratio of the difference between revenue and operating cost to total debt service amount. That is formulated as below;

$$\text{DSCR} = \frac{R - C + dep}{P + Int} \quad (6.23)$$

The procedure in the event of bankruptcy is discussed in Section 4.7. And bankruptcy probability calculation is covered in Section 6.2. With bankruptcy, government makes remaining debt repayment. Only the cash inflow to equity holders ends. In the table, the column for '(-) Expected Cash Flow to Equity' shows the deprived amount in the case of bankruptcy. The amount is obtained by multiplying cash flow to equity with bankruptcy probability for the year.

'Final Overall Cash Flow' is obtained. The column shows the cash flow for both equity holders and debtholders. And according to the model, the aim is to maximize adjusted present value (APV), for this column.

6.3.6. Optimization of Capital Structure

This optimization can be performed by using special software programs. But optimization through obtaining APV for different levels of debt ratio is preferred. Below graph shows, how APV changes with leverage

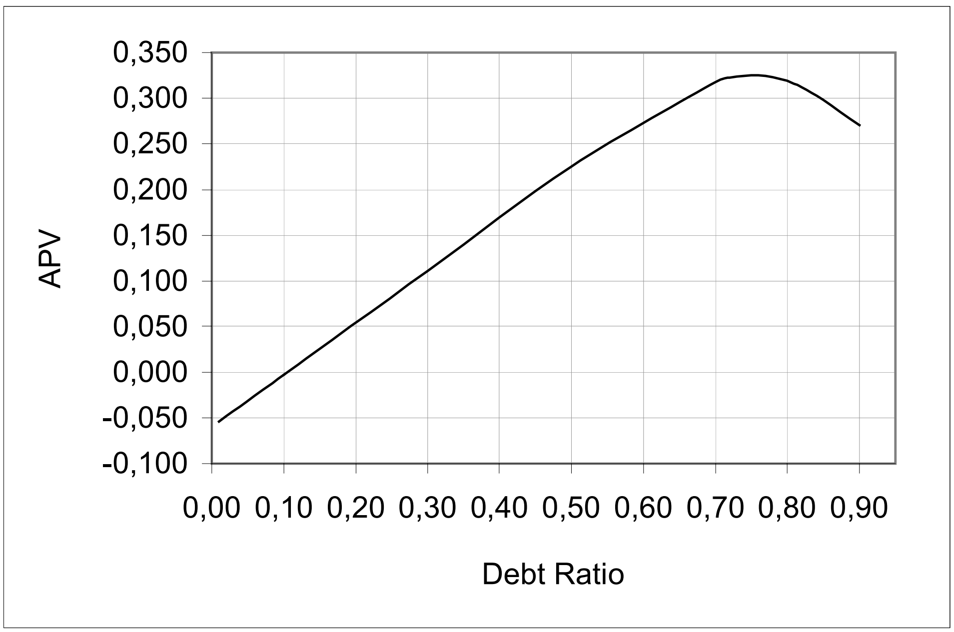

Fig. 6.2 APV vs Debt Ratio Graph

For the case maximum APV exists with 0.75 debt ratio.

To be more precise, APV is analyzed with debt ratio with 0.01 precision as below;

Table 6.7 APV vs Debt Ratio

Debt Ratio	APV
0.70	0.318
0.71	0.320
0.72	0.322
0.73	0.324
0.74	0.325
0.75	0.325
0.76	0.325
0.77	0.324
0.78	0.323
0.79	0.321
0.80	0.319
0.81	0.316
0.82	0.312

Below graph shows, how optimal capital ratio changes with tax rate. As expected, optimum capital ratio, which makes APV maximum, increases with tax rate.

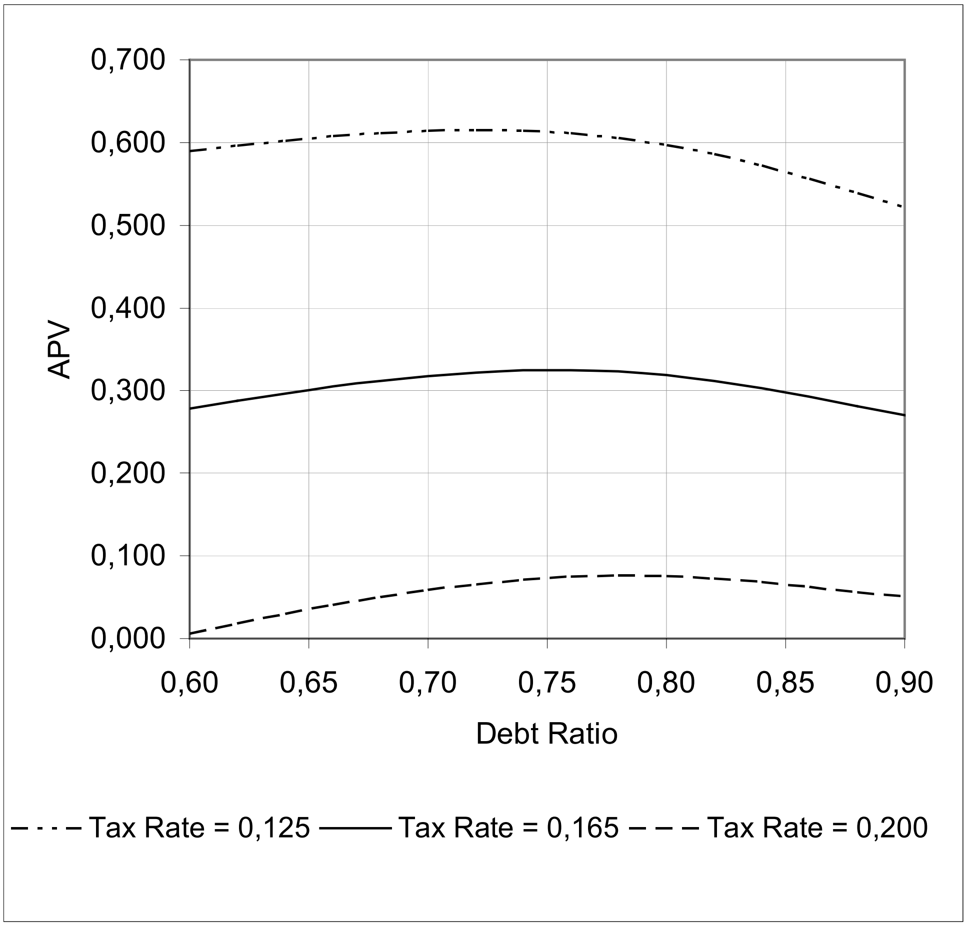

Fig. 6.3 APV vs Debt Ratio with Different Tax Rates

The exponent '-12' in the formula 6.01 may be changed according to the risk attitude towards DSCR. If actual bankruptcy probabilities are higher than those were assumed, this number 'k' must be above -12. So, the probability of bankruptcy increases with same levels of DSCR. On the other hand, with another analysis, that expects actual probability of bankruptcy occurs to be less, may take the exponent 'k' lower than -12.

So, the probability of bankruptcy decreases as compared to the first one, with same levels of DSCR.

Below is another graph, showing how optimal capital structure changes with different k values.

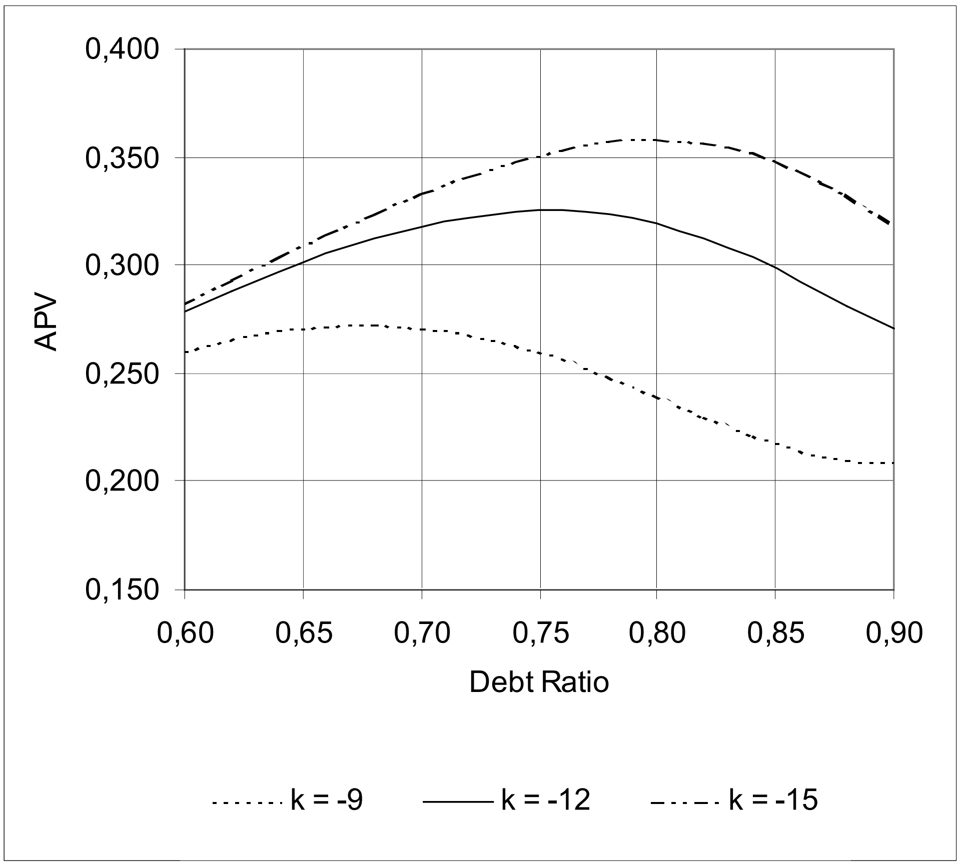

Fig. 6.4 APV vs Debt Ratio with Different Bankruptcy Probabilities

As it was expected, increase in bankruptcy probability (via increasing k value), maximizes APV with low levels of debt ratio. On the other hand, decrease in bankruptcy probability (via decreasing k value), maximizes APV with high levels of debt ratio.

6.4. Is It a Coincidence to have 80/20 Debt to Equity Ratio in Almost All BOT Projects?

With theoretical framework, one of the major assumptions is that, the plant is taken over by government in case financial failure occurs. However, in practice, the project firm may be given a duration to overcome the problem. The terms and conditions of this occurrence are not well defined and project firms may think that, the problem may be solved.

Besides, since many BOT agreements are not arranged in severe competitive agreement, high profitable tariff agreements may be arranged. In addition, probably, the total budget is a little bit overestimated for some reasons. Together with these two conditions, exact equity ratio may fall below 20%, or even close to zero sometimes. This seems to be more attractive since total financing by project firm is too low as compared to the investment. So, the intensity of risk of financial failure is not as much as expected.

CHAPTER 7

SUMMARY AND CONCLUSION

7.1. Summary

Efficiency in infrastructure development is one of the most important areas under discussion for a country's wealth. Due the different characteristics of the infrastructure sector, BOT model projects, or more generally concession agreements are seem to be the best alternative for the sector's further development. Main reasons for that can be summarized as budget limitations of developing countries' governments and benefits through privatization.

BOT projects are one of the most discussed topics in Turkey, through new developments in economy, especially after 1980's. BOT model projects introduce a new financial method, called as project finance, which is so different in terms of financial rules as compared to traditional method of financing.

The aim of this study has been to analyze the effects of capital structure in BOT model projects. This is carried out by adapting financial rules to BOT model projects, while combining the rules of concession agreements with financial methods.

The method for analyzing and optimization of capital structure is achieved by net present value. Other frequently used methods are mentioned in the study, but theory and researches show that, net present value must be selected as a financial tool for a well-developed analysis.

The critical factor in NPV analysis is found to be the discount rate. For the sake of simplicity, discount rates may be selected according to the type of investment. However, setting a precise discount rate is essential. Wrong decisions may be taken, if the analysis is carried out without a precise discount rate.

Calculating a discount rate requires several factors to be determined. CAPM theory is selected for calculating a discount rate. The theory considers both the situation of the economy, expectations in the market, and also the behavior of the market with the sector under consideration. One of the most useful information for calculating the discount rate is the risk of the business. This is performed by analyzing the movements of the stocks within the sector and the corresponding market index.

MM's well-known theory forms the basis for capital structure analysis. According to the theory, in perfect markets, financing decision is irrelevant; an increase in value cannot be achieved by changing capital structure. Increasing leverage increases the return on equity invested, and the risk of return increases so as to compensate the return. However, this theory does not reflect the actual case in practice. Mainly, there are taxes, financial distress costs and also there exists information asymmetry between investors (equity holders, debt holders, guarantors, etc.).

By changing capital structure via increasing leverage, interest payments increases. As interest payment is considered as an item in expenses, it produces a tax shield, which increases the value for investors. On the other hand, risk of financial distress increases with leverage. With bankruptcy probability, the value decreases significantly.

According to the Trade-off Theory, there exists an optimum capital structure, where tax savings due to interest payments is equal to the value loss due to financial distress.

Since, BOT model projects are implemented by special type of agreements, which is generally with project finance concept; the topic is discussed in a detailed manner. To be more specific; projects are financed by limited or non-recourse financing, major concern is the credibility of the project, not the firm, and free cash flow is distributed to the investors without holding it for financing purposes, etc.

Risks may differ in project finance, as compared to traditional finance. In addition to that the project is developed by project finance; an investment is made in infrastructure sector. That brings additional risks to be managed or hedged. For some risks, government support through different types of guarantees is essential. These risks and guarantees are also taken into consideration in financial evaluation.

Besides general characteristics of infrastructure sector; specifically, power generation sector is discussed in detail. Power generation sector has some differences, which makes the analysis more difficult. First of all, the sector is in developing phase, so historical data may not be sufficient to represent today. Moreover, prices do not have to move in similar direction and intensity in different regions. Besides, it is hard to establish a relationship between long-term and short-term price fluctuations, since they are affected by different type of factors. However, it is possible to overcome these difficulties by means of special hedging instruments, government support through guarantees and special type of contracts.

According to briefly discussed topics above, a theoretical framework is established to calculate an optimal capital structure. An actual proposal for a BOT model hydropower project is analyzed for the case study. The objective is to maximize APV by changing the independent variable, which is the debt ratio. CAPM model is used for setting the discount rate, and stocks are selected from firms, which are publicly traded, in the power sector.

One of the most critical point for analysis is setting a formula for financial distress and bankruptcy. Most researches for bankruptcy prediction do not give an exact probability for financial distress. Moreover, they are designed for corporate finance, not for project finance. In addition, obtaining a real data to set a model for bankruptcy probability is impractical. Due to these reasons, a theoretical model is established. The model considers some benchmarks for the level of DSCR. A more precise model may be developed after some BOT experiences.

7.2. Conclusion

By carrying out accounting and financial procedures with the theoretical framework developed for the case study, APV is obtained for a level of debt ratio. With different capital structures, APV graph is plotted. According to the model, for the case under consideration, optimum debt ratio exists somewhere below 80%, which is the constraint in Turkey according to law no. 3996.

According to the MM's theory, the two major critical factors in capital structure are the tax shield and the value of financial distress. First, optimization of capital structure is analyzed with different tax rates. According to the model, the result is as it is expected. APV decreases with the increase of tax rate. However, the peak takes place with higher level of debt ratio. Optimum level of debt ratio increases significantly with tax rate. Increase in tax rate makes interest tax shield more valuable while encouraging borrowing more.

Second, the behavior of the graph is analyzed with different level of intensity of bankruptcy probability. The theoretical hypothesis is verified with the model. The value of APV decreases with the intensity of bankruptcy, but the important point is that the peak takes place with lower level of debt ratio. Increasing the rate of change of bankruptcy probability with DSCR, decreases the optimum debt ratio considerably.

As it is discussed, following the analysis, the optimum debt ratio, which is calculated according to the model, does not take place with debt ratio higher than maximum debt ratio (80%). However, in almost all BOT projects, capital structure is arranged with maximum debt ratio according to the law.

The main reason for the inconsistency may be the information asymmetry between investors. All information related with the calculations of investment, costs, and etc. may not be known accurately by all the parties involved in a BOT project. The total budget can be overestimated for some reasons and other parties may be uninformed. Also, expectations about financial distress may be more optimistic than it is assumed in the analysis. Increasing the debt ratio increases the tax shield and the rate of change in the value of financial distress may be too low as compared to the value of tax shield. As a result, the APV graph inclines every time with an increase in debt ratio.

Further research for this study can be made by setting a more precise financial failure prediction modeling that reflects the actual case in practice. To perform this, however, requires some financial distress experiences in BOT projects.

Also, with the new period in power generation sector, the characteristics of the concession model are changed. There will be no revenue or debt repayment guarantee for power generation sector. A detailed analysis will be based on a precise demand and price study in power usage.

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APPENDIX A

CASH FLOW TABLE FOR THE CASE STUDY

Some column titles are listed below:

Sale Price (w/o esc.)	:	Sale Price (without escalation)
Sale Price (with esc.)	:	Sale Price (with escalation)
Energy Prdc.	:	Energy Production
Cost (w/o esc., incld. depr.)	:	Cost (without escalation, including depreciation)
Tot. Fund (Princ. + Ret. to Equity)	:	Total Fund (Principal + Return to Equity)
Prob. of Bankrp. (indep.)	:	Probability of Bankruptcy (independent)
Prob. of Bankp. (depndt.)	:	Probability of Bankruptcy (dependent)
Exp. C. Flow to Equity	:	Expected Cash Flow to Equity

In Table A.1, cash flow table for the case study is constructed with 0.80 debt ratio.

Table A.1 Cash Flow Table

YEARS	SALE PRICE (w/o esc.) (cent/kWh)	SALE PRICE (with esc.) (cent/kWh)	ENERGY PRDC. (GWh)	REVENUE	COST (with esc., incld. depr.)
y				**R**	**C**
I1					
I2					
1	8.739	9.543	37.7	3.598	0.912
2	8.365	9.546	37.7	3.599	0.915
3	7.991	9.529	37.7	3.593	0.919
4	7.617	9.492	37.7	3.579	0.922
5	7.243	9.432	37.7	3.556	0.926
6	6.869	9.348	37.7	3.524	0.929
7	6.495	9.237	37.7	3.482	0.933
8	6.121	9.096	37.7	3.429	0.937
9	1.927	2.993	37.7	1.128	0.940
10	1.872	3.038	37.7	1.145	0.944
11	1.818	3.083	37.7	1.162	0.948
12	1.763	3.124	37.7	1.178	0.952
13	1.708	3.163	37.7	1.192	0.956
14	1.653	3.199	37.7	1.206	0.960
15	1.598	3.232	37.7	1.218	0.964
16	1.543	3.261	37.7	1.229	0.967
17	1.488	3.286	37.7	1.239	0.972
18	1.433	3.307	37.7	1.247	0.976
19	1.378	3.323	37.7	1.253	0.980
20	1.323	3.334	37.7	1.257	0.984

Values are in USD millions

Table A.1 (continued) Cash Flow Table

YEARS	PROFIT BEFORE INTR. & TAX	INTEREST PAYMENT	PROFIT BEFORE TAX	TAX	PROFIT AFTER TAX
y	**PBIT**	**Int**	**PBT**	**WT**	**PAT**
I1					
I2					
1	2.686	1.173	1.513	0.250	1.264
2	2.684	1.026	1.657	0.273	1.384
3	2.674	0.880	1.794	0.296	1.498
4	2.656	0.733	1.923	0.317	1.606
5	2.630	0.586	2.044	0.337	1.707
6	2.595	0.440	2.155	0.356	1.799
7	2.549	0.293	2.256	0.372	1.884
8	2.493	0.147	2.346	0.387	1.959
9	0.188		0.188	0.031	0.157
10	0.201		0.201	0.033	0.168
11	0.214		0.214	0.035	0.179
12	0.226		0.226	0.037	0.189
13	0.237		0.237	0.039	0.198
14	0.246		0.246	0.041	0.206
15	0.255		0.255	0.042	0.213
16	0.262		0.262	0.043	0.219
17	0.267		0.267	0.044	0.223
18	0.271		0.271	0.045	0.226
19	0.273		0.273	0.045	0.228
20	0.273		0.273	0.045	0.228

Values are in USD millions

Table A.1 (continued) Cash Flow Table

YEARS	DEPRE-CIATION	RETURN OF VAT & WC	TOT. FUND (PRINC. + RET. TO EQUITY)	PRINCP. INSTALL.	RETURN OF EQUITY
y	**dep**			**P**	
I1					
I2					
1	0.565	0.540	2.368	1.466	
2	0.565	0.300	2.249	1.466	
3	0.565		2.063	1.466	
4	0.565		2.171	1.466	
5	0.565		2.271	1.466	
6	0.565		2.364	1.466	
7	0.565		2.449	1.466	
8	0.565		2.524	1.466	
9	0.565		0.722		0.138
10	0.565		0.733		0.138
11	0.565		0.744		0.138
12	0.565		0.754		0.138
13	0.565		0.763		0.138
14	0.565		0.771		0.138
15	0.565		0.778		0.138
16	0.565		0.783		0.138
17	0.565		0.788		0.138
18	0.565		0.791		0.138
19	0.565		0.793		0.138
20	0.565	0.100	0.893		0.138

Values are in USD millions

Table A.1 (continued) Cash Flow Table

YEARS	RETURN ON EQUITY	C. FLOW TO EQUITY	C. FLOW FOR DEBT HOLDERS	OVERALL CASH FLOW	DSCR
y					
I1		-1.248	-4.991	-6.238	
I2		-1.248	-4.991	-6.238	
1	0.902	0.902	2.639	3.541	1.23
2	0.783	0.783	2.492	3.275	1.30
3	0.597	0.597	2.346	2.943	1.38
4	0.705	0.705	2.199	2.904	1.46
5	0.805	0.805	2.052	2.858	1.56
6	0.898	0.898	1.906	2.804	1.66
7	0.983	0.983	1.759	2.742	1.77
8	1.058	1.058	1.613	2.670	1.90
9	0.584	0.722		0.722	
10	0.595	0.733		0.733	
11	0.606	0.744		0.744	
12	0.616	0.754		0.754	
13	0.625	0.763		0.763	
14	0.633	0.771		0.771	
15	0.640	0.778		0.778	
16	0.646	0.783		0.783	
17	0.650	0.788		0.788	
18	0.653	0.791		0.791	
19	0.655	0.793		0.793	
20	0.755	0.893		0.893	

Values are in USD millions

Table A.1 (continued) Cash Flow Table

YEARS	PROB. of BANKRP. (indep.)	PROB. of NON-BANKRP.	PROB. of BANKRP. (depndt.)	(-) C. FLOW TO EQUITY	(-) EXP. C. FLOW TO EQUITY
y	λ_n	$1-\lambda_n$	$P_b(n)$		
I1					
I2					
1	0.083	0.917	0.083	-0.902	-0.075
2	0.043	0.957	0.039	-0.783	-0.031
3	0.022	0.978	0.019	-0.597	-0.011
4	0.011	0.989	0.010	-0.705	-0.007
5	0.006	0.994	0.005	-0.805	-0.004
6	0.003	0.997	0.003	-0.898	-0.003
7	0.002	0.998	0.002	-0.983	-0.002
8	0.001	0.999	0.001	-1.058	-0.001
9	0.001	0.999	0.001	-0.722	-0.001
10	0.001	0.999	0.001	-0.733	-0.001
11	0.001	0.999	0.001	-0.744	-0.001
12	0.001	0.999	0.001	-0.754	-0.001
13	0.001	0.999	0.001	-0.763	-0.001
14	0.001	0.999	0.001	-0.771	-0.001
15	0.001	0.999	0.001	-0.778	-0.001
16	0.001	0.999	0.001	-0.783	-0.001
17	0.001	0.999	0.001	-0.788	-0.001
18	0.001	0.999	0.001	-0.791	-0.001
19	0.001	0.999	0.001	-0.793	-0.001
20	0.001	0.999	0.001	-0.893	-0.001

Values are in USD millions

Table A.1 (continued) Cash Flow Table

YEARS	FINAL OVERALL C. FLOW	ADJ. PRESENT VALUE
y		APV
I1	-6.238	0.319
I2	-6.238	
1	3.466	
2	3.245	
3	2.931	
4	2.897	
5	2.854	
6	2.801	
7	2.740	
8	2.669	
9	0.721	
10	0.732	
11	0.743	
12	0.753	
13	0.762	
14	0.770	
15	0.777	
16	0.783	
17	0.787	
18	0.791	
19	0.792	
20	0.892	

Values are in USD millions

APPENDIX B

SENSITIVITY ANALYSIS FOR THE CAPM FORMULA

As mentioned in the Case Study, risk-free rate, 'r_f' and expected market premium, 'r_m-r_f' rate are selected as 10% and 5% respectively. Table B.1 shows how APV changes with different levels of risk free rate and expected market premium.

Table B.1 APV vs Debt Ratio with Different Levels of Risk-Free Rate

Debt Ratio \ **r_f**	**0.02**	**0.04**	**0.07**	**0.10**
	APV (USD millions)			
0.70	8.124	5.540	2.551	0.318
0.71	8.127	5.543	2.554	0.320
0.72	8.131	5.546	2.556	0.322
0.73	8.133	5.548	2.558	0.324
0.74	8.136	5.550	2.559	0.325
0.75	8.137	5.551	2.560	**0.325**
0.76	**8.138**	**5.552**	**2.560**	0.325
0.77	8.138	5.552	2.560	0.324
0.78	8.137	5.551	2.559	0.323
0.79	8.135	5.549	2.557	0.321
0.80	8.133	5.547	2.554	0.319

Table B.2 shows how APV changes with different levels of expected market premium.

Table B.2 APV vs Debt Ratio with Different Levels of Market Premium

$r_m - r_f$ / **Debt Ratio**	**0.02**	**0.05**	**0.10**	**0.15**
	APV (USD millions)			
0.70	1.992	0.318	-1.809	-3.356
0.71	1.995	0.320	-1.807	-3.355
0.72	1.997	0.322	-1.806	-3.354
0.73	1.999	0.324	-1.804	-3.353
0.74	2.000	0.325	-1.804	-3.352
0.75	2.001	**0.325**	**-1.804**	**-3.352**
0.76	**2.001**	0.325	-1.804	-3.353
0.77	2.001	0.324	-1.805	-3.353
0.78	2.000	0.323	-1.806	-3.355
0.79	1.998	0.321	-1.808	-3.357
0.80	1.995	0.319	-1.810	-3.359

In both Table B.1 and B.2, bold values indicate maximum APV where optimum debt ratios are obtained. As it can be verified from the two tables, in the CAPM formula, contributions of risk-free rate and expected market premium are very low for calculating optimal capital structure.