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National Taiwan University

Master Thesis

考量現金流量「均值估計風險」之投資計畫評估模型

Cash Flow "Mean Estimation Risk" Adjusted Project Evaluation Model

吳庭樂

Ting-Le Wu

指導教授：荷世平 博士

Advisor: S. Ping Ho, Ph.D.

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First of all,

I want to dedicate this thesis to my family.

Your love and support is the only reason that I was able to finish this paper.

To my friends and partners,

Our bond will continue as it supposed to be

Last but not least,

To my mentor, Professor Ho,

I cannot find a word to describe

how much I appreciate your guidance and willingness.

Thank you all for everything!

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摘要

因為專案融資其獨有的特性，價值評估一直是很有挑戰性和難度不論是在學術或業界中，其中以淨現值為價值評估的主流工具，淨現值是將預估的未來現金流量以一個穩定的折現率到今天，作為一個評估的準則，若大於零，該計畫被認定為值得投資。然而，我們認為建造期與營運期的折現率應以不同為計算，因為兩者本身存在不同的風險，特別是當營運的計畫為全新的案例，市場上少有借鏡的範本時，其營運之現金流量的預估值經常面臨不準確的情況，我們將其風險定義為「均值估計風險」。當專案在做營運現金流量評估時，往往是以第一年營運作為基準，並以一個穩定的成長率預估往後的每一年，而淨現值就將包含前期的投入以及營運期的現金流量折線到今天作為衡量的標準。所以若第一年實際的現金流入只有原先預估的 50%，同樣以淨現值，此計畫的價值就會減少 50%。而均值估計風險就是預估與實際的差距，然而這類型的風險並不是能被市場的股票以分散風險的方式對沖，另外當前評估價值的方法並未針對均值估計風險做近一步的研究，所以本研究，希望解決這項問題，並提出當計劃存在不確定性以及資訊不完整時，一個計劃評估模型。

關鍵字: 淨現值、計劃融資、均值估計風險

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Abstract

The estimation on the valuation of the Project Financing constantly remains a challenge in both academia and practice, due to its unique characteristics. The Net Present Value (NPV) estimates the future cash flow and present value with a constant discount rate as a measurement for investing the project. However, discounting the same rate in construction and operation creates biased on the NPV when the project involves with Mean Estimation Risks which is defined as, due to the information constraints, the lack of ability to estimate the exact amount of the operating cash flow streams. Since the projection on the operating cash flow is based on the first year operation allocating the constant growth rate, as a result, with the actual first operation cash inflow, the valuation of the project based on NPV is more precise in that year. If the actual cash flows are 50% off of the estimation, for example, according to NPV, the value on the project is 50% less. This difference of the estimation and the actual operation cash inflow is defined as the Mean Estimation Risk. The 50% difference reflects not only the impact of Mean Estimation Risk in project financing but the lack of ability in the NPV method where the uncertainty is involved. However, the market beta is unable to measure the Mean Estimation Risk in the project financing since this risk is challenging to hedge through diversification. As a result, in this study, we aim to solve this situation for project financing. In this research, we emphasize the importance of the mean estimated risk in the project financing while stating the relationship on the construction (C) and the operation (V) to simulate the expected return. Then, we proposed the adjusted project evaluation model for the project with Mean Estimation Risk.

Keyword: NPV, Project Financing, Mean Estimated Risk

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Chapter 1 Introduction

Project finance is a long-term collaboration in infrastructure, industrial projects, and public services using a limited recourse financial structure. With the unique characteristics: such as high operating margins, low to the average return on capital, limited life, significant free cash flows, and few diversification opportunities, project financing is the loan structure that relies primarily on the cash flow from the project for repayment. Therefore, the discounted cash flow (DCF) is available to facilitate the evaluation process and finds its net present value (NPV) as an illustration if the projects are worth more to the sponsors than they cost according to Finnerty. The exclusive purpose is carrying out the project by subcontracting most aspects through construction and operations. Because the revenue stream only occurs after the construction is done where the cash inflow begins at the operation; as a result, the project takes significant risks during the construction phase. However, the current literature has failed to discuss the importance of the estimation accuracy of the operating cash inflow. Due to the few diversification opportunities and lack of similar comparable projects, the market beta is unable to price the risk of the estimated cash inflows on the operation. Based on this concept, we proposed an evaluation model for project financing valuation.

1.1 Background

Typically, project financing uses the net present value (NPV) of the cash flows to measure the feasibility of the project, and the NPV is calculated by discounting the project cash flows with a required return. In finance, the discount rate is determined by the Capital Assets Pricing Model (CAPM), which measures the asset risk using the market beta. However, due to the unique characteristics of project financing, the concept of market

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beta for a project is often not applicable for project valuation. In the larger scale of projects, the estimation of project cash flows is usually very imprecise to its unique characteristics.

Moreover, it is difficult for the market to price such risk since similar types of projects often have not taken place before at the time of investment, such as highest speed rail BOT projects, the cash flows' mean estimation uncertainties remain large until the first year of the revenue is revealed. Since the following years' forecast is mostly based on the first year of revenue with specific growth rate, the first year's income can indicate the total value of the whole project — meanwhile, the incapability of valuing the uncertainty by the market risk. Therefore, if there is no similar project occurs priory, there is biased existed in the cash flows' mean estimation.

NPV is the most fundamental analysis tool to evaluate either public traded or private companies. NPV method estimates the present value of the future cash flows (CFs) of the investment/company by dividing a discounted rate. Since this is the simplest way to showcase to the owners the worth doing of the investment, NPV rule is often applied in the real world. The NPV method indicates how much value the project will create for the company. Managers can indicate how much a project will contribute to their value today to their shareholders. If the NPV, the difference of the present value of inflow and outflow, is equal to zero, the project can break even and means it is worth investing. However, the mean estimation risk is not considered in the traditional NPV method. We aim to implement the additional standard to the NPV rule by applying the mean risk in the valuation.

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Additionally, the discount rate is also known as the risk assessment of the cash flow. In finance, the discount rate has two essential definitions. First, the discount rate is the interest rate of the Federal Reserve charges on loans given to banks through the Fed's discount window loan process. Second, a discount rate is a part of the calculation of presenting value. The discounted rate is the expected return for certain projects. With a series of future CFs, we can estimate the present value of a project or potential investment with a lump sum value, as an estimator for the company's owners. If the discount rate is higher than it should be, the project is underestimated and vice versa. This impact represents the importance of accurate discount rate, which determines the project feasibility and applicability. Therefore, the inaccurate discount rate might cause significant managerial problems and net loss for the project.

1.2 Motivation

The calculation of the NPV method is quite straightforward; however, if the project itself is lack of the market information measurement or beta, this causes the difficulty of applying the NPV rule to value the project. Moreover, this could result in the inaccurate NPV for the potential investment, which might lead to the net loss for the project. Addition to the observation on Build-Operate-Transfer (BOT) projects, which are the most identical where project financing is used, the forecast of revenue is also challenging to the investors. Since some of the BOT projects are new to the market, the estimation of the revenue might differ significantly. On the other hand, we also observe the odd situation where applying a high discount rate in the NPV method of the investment cost, which results in a smaller present value. This leaves a wrong perspective on the high cost of the project, which leads to the biased on the value. We believe there is the undervalued

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of the importance of the mean risk and the consideration of different discount rate in the NPV method.

1.3 Objective

Finding the risk and return tradeoff is essential to the profitability of project financing. The purpose of this research is to approximate the appropriate evaluation model in projects. Because, the modern pricing model, or CAPM, is only applicable to the market beta which is not accessible in most of the projects with uncertainties. We also observe the mean risk of the cash flow in BOT projects where it is not measured in the market. Therefore, we propose an alternated computation for the projects with the mean risk valuation. Addition to providing a precise analysis of the non-identical discount rate in operating and investing cash flows.

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Chapter 2 Literature Review

In this chapter, the financial theory on asset pricing was introduced in Section 2-1. The valuation methods were reviewed in Section 2-2. Then, the approach on the level the market beta to the total beta was stated in Section 2-3. After reviewed the above financial theory, we proposed the CML function on estimating the risk for nontraded assets in Section 2-4 and the summary in the final section.

2.1 Cost of Capital

According to the finance theory and the survey by Bruner (1998), weighted average cost of capital (WACC) is the dominant discount rate used in the new project's valuation where WACC represents the opportunity cost that investors face for the company in one potential project instead of others with similar risk (Koller, Goedhart and Wessels, 2015). WACC, in other words, means the minimum required rate of return that a project must earn before generating value. WACC is the form of:

$$\text{WACC} = k_D \times (1 - T) \times \frac{D}{V} + k_D \times \frac{E}{V}$$

Where

k_D = cost of debt

k_E = cost of equity

E = firm's equity

D = firm's debt

V = E + D = total market value of the firm

E/V = equity ratio

D/V = debt ratio

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T = corporate tax rate

As the formula above showed, to determine the WACC is simply calculating three components: cost of equity, the after-tax cost of debt, and the company's target capital structure (Koller, et al. 2015).

To approximate the cost of equity, in the finance theory, we use the capital asset pricing model (CAPM) by Markowitz in 1952, which describes the relationship between systematic risk and expected return for assets. The CAPM, as shown in the equation, uses three variables: risk-free rate, the market risk premium, the difference between the market's expected return and risk-free bonds, and the stock's beta, which measures the stock's risks that are correlated with market returns.

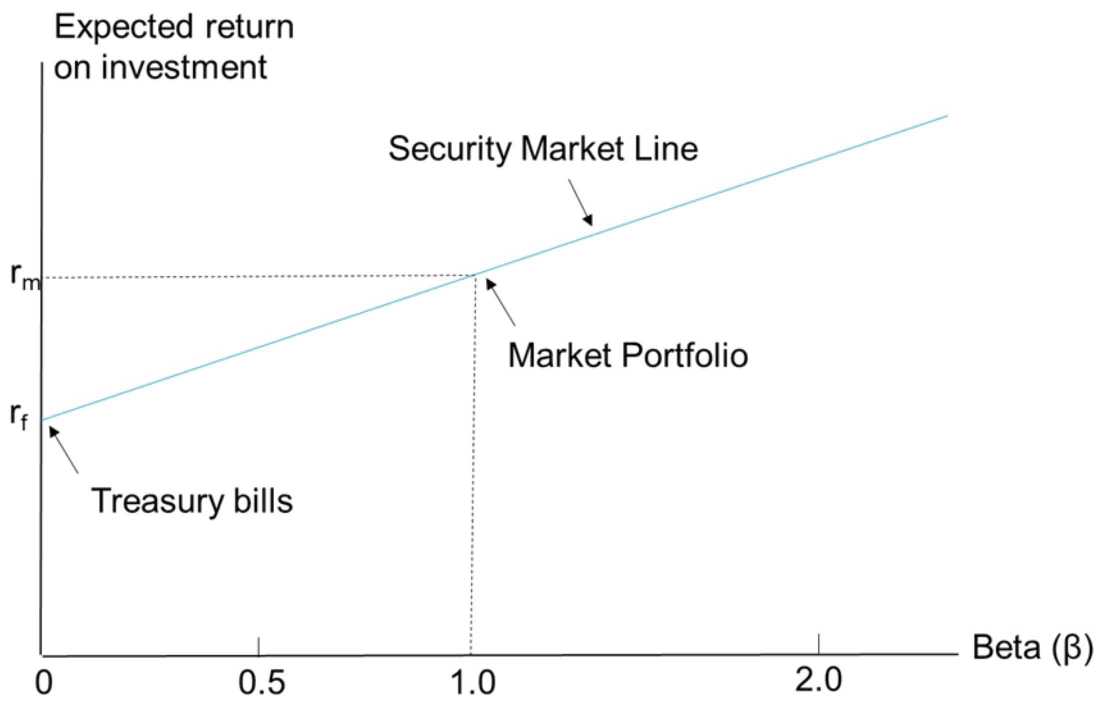

Figure 2-1 Security Market Line (SML)

The CAPM is based on security market line which represents the trade-off between the beta risks and expected return on the investment, as shown in Figure 2-1. The treasury

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bills are usually considered the risk-free asset, with a 0 beta since the government is rarely bankrupt; however, the return on the risk-free asset is lower than the risky asset. Investors, after all, require a higher return from the market portfolio than treasury bills' interest rate. ($r_m - r_f$) represents the difference between the return on the market and the interest rate, also known as, the market risk premium. Then, the relationship was established by William Sharpe in 1960 and can be written as,

$$k_e = r_f + (r_m - r_f) \times \beta$$

To estimate the cost of debt, use the company's yield to maturity on its long-term debt. The cost of debt is calculated by the total amount of the interest is paying on each of its debt divided by the total company's debt. Since the free CF is measured without tax rate, to calculate the cost of debt, it must go on the after-tax basis (Koller et al. 2015).

Lastly, with the cost of equity and the after-tax cost of debt, weighting on each of the equity to value and debt to value, then the WACC calculation is finally completed. WACC is the standard procedure to estimate the capital structure of a company. However, with the restriction of finding the beta, where it only considers the systematic risk, the application of WACC is yet appropriate for non-traded assets.

The valuation literature discusses two types of approaches in estimating the company's market value (Petitt & Ferris, 2013). Chapter 2 states one of the most identical valuation methods in literature; relative method, or Comparable Company Analysis (CCA), which examine the pricing of comparable assets to estimate the firm's value. The second is the direct method, or Discounted Cash Flow (DCF), in which firm value is estimated directly from its expected cash flows without appeal to the current price of other firms. In most literature, DCF is recognized as a better method than CCA. In the flowing

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chapter, further explanation is stated. In addition to the DCF method, since the valuation method in this research is established with the literature review, section 2.3 discusses the beta with non-diversification (Bhojraj and Lee, 2002).

2.2 Valuation methods

This section explains the relative and direct method in project's valuation. Section 2.1.1 explains the relative method, or CCA, and its implementation. As Chapter 1 covers the concept of NPV, the most identical direct method, section 2.1.2 explains the reason why most literature prefers using the NPV method rather than CCA.

2.2.1 Relative method (Comparable Company Analysis)

The relative method compares a company's value to its competitors in the industry to estimate a firm's financial valuation. Therefore, it also calls Comparable Company Analysis (CCA), which is the alternative model to the NPV which assess the company's intrinsic value based on the discounted value of the forecast cash flows. There are two assumptions that CCA must follow to have the same accuracy as the NPV method: "First, the comparable companies have proportional future cash flow expectations and risks as the firm being valued. Also, second, the performance measure (like EBITDA) is actually proportional to value" (Kaplan and Ruback, 1995).

To apply the CCA in valuation, the first step is to select the companies that are similar to the target firm. Since two identical companies do not exist in the real world, the importance of selecting judges is beyond any doubt. "The more similar the selected companies are to the subject company; the more weight the court is likely to place on a

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comparable companies' valuation" (Bowman & Bush, 2015).

Second, CCA is defined as the measurement to evaluate the value of a company using the metrics of other businesses of similar size in the same industry. After collecting the sample companies, gathering each financial information is the next step. Enterprise value to sales (EV/S), price to earnings (P/E), price to book (P/B), price to sales (P/S) and Earnings before interest, taxes, and amortization (EBITA) are the most common measurements in CCA.

After determined the multiples, the final step is to compare such multiple to the subject firm. Then, to calculate the market value of the target company, applying those multiples on average to the appropriate financial metrics. With the estimated market value, the comparison between the target company and the rest in the market can, therefore, be determined.

2.2.2 The problem of NPV and CCA

Indeed, as every valuation method, NPV has its weakness. This valuation is sensitive to the assumptions of forecast CFs. Even small adjustments can cause the valuation error of fair value. On the other hand, NPV valuation is a moving target: If any company expectations change, the fair value will change accordingly. This is where we provide the mean risk in the valuation to adjust the error of the NPV method. As the non-traded assets where lack of the market information, in the Project Finance valuation, NPV is a more appropriate method rather than the CCA method.

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2.2.3 First Chicago (Venture Capital) Valuation Method

The First Chicago method is the specific application of the Expected NPV technique which "considering several possible scenarios for the venture, assessing the probability of each scenario, then calculating the NPV of the expected cash flows using a somewhat lower (but still relatively high) discount rate" (Steffens and Douglas, 2007). This valuation method is common-used in the venture capital; thus, this is also known as Venture Capital method, which assumes three scenarios which are best, base, and worse cases. Then, the next step is to calculate the NPV of expected cash flows of these scenarios using an applicable discount rate. After defining different future scenarios for the company, the further step is to estimate the terminal value for each scenario using multiples. To do this, Multiples or Company Comparable Analysis, mentioned previously, is required. To compare within the same peer group, which is venture capital is characterized by enterprise industry, enterprise stage, and enterprise region. The final step is to assign the probability of each scenario. To estimate the probability is nearly impossible; however, the idea is to take extreme outputs into between the process. Then, the total value is the sum of each scenario's NPV allocating with a different probability.

The drawback of applying the VC method in project financing, firstly, is the same reason why the CCA method is not appropriate. Lack of the same peer group is the key essential why CCA is not feasible for project financing. Without the peer group, the terminal value is strenuous to estimate. On the other hand, the VC method, due to the characteristics in nature, is lack of discussion on the different discount rate applying in a different stage as we proposed within construction and operation. However, the concept of three scenarios of the cash flow is adapted and adjusted in our evaluation model, which is addressed later in the thesis.

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2.3 Total Beta

As the discussion above, the importance of accurate discount rate is the key to the success applying the DCF method. Discounted Cash Flow analysis aims to find out the value of a company today, based on projections of the money it will generate in the future. The idea is that the value of any company is equal to the sum of its future cash flows, discounted to a present value using an appropriate discount rate.

From section 2.1, we illustrated the role of WACC as the estimated discount rate in the DCF method. Then, to approximate the cost of equity in the WACC, CAPM is applied in the calculation where CAPM beta considers the risk exposure to the market. In other words, beta is an indicator of the degree of the investment's risks in the market.

According to Eugene Fama (2013), beta measures the systematic risk, which cannot be reduced through diversification through portfolio management. Therefore, by its definition, such measurement does not evaluate the risk of an investment held on a stand-alone basis, but the amount of risk the investment in a diversified portfolio. In other words, if the investors/owners do not own a diversified portfolio, the beta is not applicable. Such characteristic usually is the case for PHC' owners who put all the eggs in one bag. The scholars and literature have two steps for estimating the non-diversified beta. First, to measure the market beta and then, second, the total beta of the industry.

2.3.1 Estimating Market Beta

To measure the market beta for PHC, according to Damodaran (2002), there are three approaches for estimation:

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1. Accounting Beta

Since price information is not accessible for PHC, accounting earnings, on the other hand, is available. Accounting Beta regress changes in a private firm's accounting earnings against changes in earnings for an equity index (such as the S&P 500) to estimate the market beta.

$$\Delta \text{Earnings}_{\text{Private firm}} = \alpha + \beta \times \text{Earnings}_{\text{S\&P500}}$$

This approach has two limitations. First, is that PHC usually measures earnings only once a year, causing the regressions with fewer observations. The second is that earnings are often smoothed out and biased leading to mismeasurement of accounting betas.

2. Fundamental Betas

Researchers observe the publicly traded firms' variables of financial information to estimate the beta. Beaver, Kettler, and Scholes (1970) and Rosenberg and Guy (1976) examined the relationship between betas and seven variables - dividend payout, asset growth, leverage, liquidity, asset size, earnings variability, and the accounting beta. The following is a regression that Damodaran ran relating the betas of NYSE and AMEX stocks in 1996 to four variables: coefficient of variation in operating income (CVOI), book debt/equity (D/E), historical growth in earnings (g) and the book value of total assets (TA).

Beta = 0.6507 + 0.25 CVOI + 0.09 D/E + 0.54 g - 0.000009 TA $R2=18\%$

where CVOI = Coefficient of Variation in Operating Income= Standard Deviation in Operating Income/ Average Operating Income

While this approach is simple; nevertheless, it is only as good as the underlying regression. The low R2 suggests that the beta estimates that emerge from it are likely to

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have significant standard errors.

3. Bottom-up Betas

This approach is the alternative version of the CCA method using the publicly traded firms as the benchmark valuation. The bottom-up beta considered this as the unlevered betas of the businesses that the firms operated in to estimate bottom-up betas – the costs of equity were based upon these betas. This is applicable because of the low standard errors on these estimates (due to the averaging across large numbers of firms) and the forward-looking nature of the estimates (because the business mix used to weight betas can be changed). Thus, the beta for a private steel firm, for example, can be estimated by looking at the average betas for publicly traded steel companies.

While many analysts use the book value debt to equity ratio to substitute for the market ratio for private firms, Damodaran suggests an alternative. Assume that the private firm's market leverage will resemble the average for the industry. If this is the case, the levered beta for the private firm can be written as:

$$\beta_{\text{private firm}} = \beta_{\text{unlevered}} \times (1 + (1 - \text{tax rate})\ \ (\text{Industry Average Debt/Equity}))$$

The adjustment for operating leverage is more straightforward and is based upon the proportion of the private firm's costs that are fixed. If this proportion is higher than is typical in the industry, the beta used for the private firm should be higher than the average for the industry. However, this approach has the same error with the CCA method. Although the Bottom-up beta does not require only using the similar comparable companies and expand to the whole industry (a large amount of observations); nevertheless, the problem with the bottom-up beta is that the necessary to find publicly

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traded companies that operate dominantly or only in each business.

2.3.2 Estimating Total Beta

The sponsors or investors of the BOT projects are often unable to diversify since most of them are unable to run multiple similar BOT projects. Therefore, as we mentioned before, the betas can be questioned that would understate the exposure to market risk in these firms. Consequently, investors are exposed to all risk in the project, and it is not just the market risk (which is what the beta measures). The adjustment Damodaran (2002) suggests that can allow us to bring in this non-diversifiable risk into the beta computation.

Assume that the standard deviation in the private firm's equity value (which measures total risk) is σ_j and that the standard deviation in the market index is σ_m. If the correlation between the stock and the index is defined to be $\rho_{j,m}$, the market beta can be written as:

$$\beta_{market} = \rho_{j,m} \times \frac{\sigma_j}{\sigma_m}$$

To measure exposure to total risk (σ_j), we could divide the market beta by$\rho_{j,m}$. This would yield the following.

$$\frac{\beta_{market}}{\rho_{j,m}} = \frac{\sigma_j}{\sigma_m}$$

This is a relative standard deviation measure, where the standard deviation of the private firm's equity value is scaled against the market index's standard deviation to yield what we will call a total beta.

$$\beta_{Total} = \frac{\beta_{market}}{\rho_{j,m}} = \frac{\sigma_j}{\sigma_m}$$

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The total beta will be higher than the market beta and will depend upon the correlation between the firm and the market – the lower the correlation, the higher the total beta. The concept of Total Beta is significant by using the standard deviation in the private firm’s equity value divide by the standard deviation in the market index as the Total Beta.

2.4 CML & Non-traded Assets Risk and Return Tradeoff

As mentioned above, the CAPM lied on the security market line, which was based on the capital market line (CML). The similarity on both frameworks is the representation of risk and return trade-off, where CML represents the optimal combination of one portfolio on risk and return. Essentially, the CML represents the total risk (standard deviation) where the SML measures the systematic risk. Securities that are reasonably priced will lie on the CML and the SML. Securities that exist above the CML or the SML are generating higher returns for the given risk, which also means those are underpriced vice versa. Since we assume the investors are smart and rational, such assets or stocks will eventually become to its equilibrium of risk and return tradeoff. As a result, if all the investors hold the same risky portfolio, it must be the market portfolio. All investors choose along the CML, and efficient portfolios will be on this line. Those who are not efficient will, however, be below the line.

Using the approach from CML, we then can establish our model of nontraded assets’ valuation. If we assume that a well functional company is on the CML which manages its assets by allocating the risk-free and risky assets efficiently and consider the company as a portfolio, the relationship between the market and the expected return of the company

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can be shown on the CML. As Figure 2-2 illustrates, point M represents the market risk (σ_m) and the market expected return (E(R_m)) tradeoff. Then the CML function can be written as,

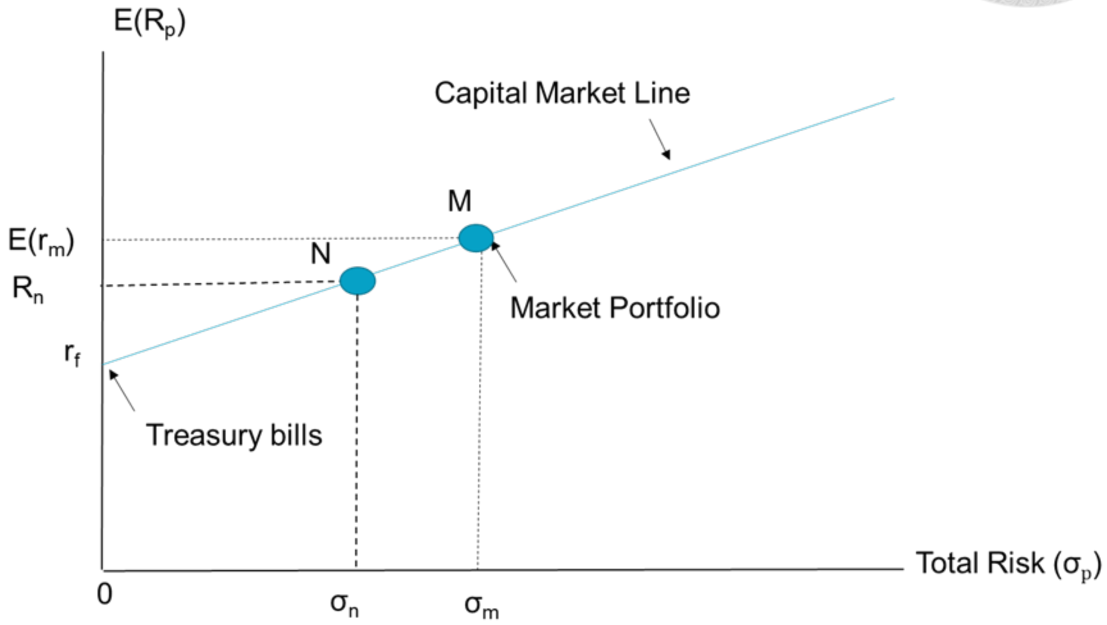

Figure 2-2 Capital Market Line (CML)

$$R_n = r_f + \frac{E(r_m)\text{-}r_f}{\sigma_m} * (\sigma_n) \qquad \text{Equation 1}$$

$\frac{E(r_m)\text{-}r_f}{\sigma_m}$ represents the market premium, or slope of risk-return ratio and σ_n is the standard deviation of a portfolio, which is the nontraded assets in this case. We assume that the operation of the company plot on the CML and able to reflect the estimated expected return of the company. In our model, the project's equity cash flow is used to represent the volatility of the BOT project comparing to the market. Then, the CML function can measure the cost of equity of the nontraded assets.

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2.5 Summary

Many would argue that WACC is a better measurement to value a company's opportunity cost in their investments. However, in this research, the cost of equity is used instead. Cost of equity represents two different perspectives. One, as a company, the cost of equity is the required rate of return of a particular project. Second, as an investor, cost of equity; on the other hand, is the rate of return required of a project, he or she invested.

Furthermore, the feature of the BOT project is not identical to other projects. This is business will be transferred to the government. In other words, this investment has an end date. On the contrary, all companies are assumed to be continuity in their business.
As Koller stated that WACC is the simple, robust method when valuing cooperate business; nevertheless, a constant WACC can overstate or understate the impact of interest tax shields when the capital structure of the target company, such as BOT project, is adjusted significantly over the years.

In this chapter, the literature on the cost of capital, valuation methods for nontraded assets, and the total beta estimation are reviewed. The one thing in common of these is the requirement for the public-traded information. Therefore, we propose the CML function when the valued asset is nontraded to identify as the total risk of a project. In the following research, this technique is applied for the evaluation. Additionally, the existing literature does not provide an analysis methodology on the project evaluation with uncertainty. The impact on the inaccurate estimation of the operating cash inflows is undervalued in the current valuation method.

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Moreover, because the market beta is failed to measure such risks or Mean Estimation Risk (MER), using the same discount rate creates bias, which involves uncertainty. This caused a significant issue where due to the higher required rate of return in the operation period, this higher discount rate would result in a lower construction cost. Then, a higher/positive NPV is concluded. In this research, we implemented two different discount rates in construction and operation period as an adjusted evaluation model for projects with uncertainty.

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Chapter 3 Mean Estimation Risks

In chapter 1, we identified the issue of applying the same discount rate in the project financing in the construction and operation period. If the project with the uncertainty, using the same discount rate would cause the overrated NPV. Meanwhile, in chapter 2, the literature is reviewed on the current method valuing the nontraded assets. Then, we proposed an alternated function to estimate the required rate of return of the total risk, which is represented by the CML function. In this chapter, we will further explain the Mean Estimation Risks (MER) and its implementation in the project evaluation.

3.1 Discount Rates with uncertainty

The problem with applying the same discount rate with on both operating and construction is the different risks each facing. In construction management, the risk is usually the construction itself but not relate to the market. In other words, the market beta fails to measure the risk of construction. The idea of expecting the same required rate of return every year in the project lifetime is the assumption made by NPV. However, applying the construction with the same discount rate causes a smaller value of the cost or cash outflow. This results in a higher project value, which would impact the investors to make the judgment of the business. Since there is no reliable evidence on the relationship between construction cost and the market risk, we assume the construction cost is an idiosyncratic risk. Therefore, the required rate of return on the construction is only slightly higher than the risk-free rate. If other things remain the same, the construction cost discounted by risk-free rate means a higher present value of the initial cost, which is a smaller NPV value than the traditional method. After adjusting to the risk-free rate, if the NPV is still higher than or equal to zero, the project is even worth more to

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invest.

3.2 True Mean Revealed

As the previous section mentioned, two discount rate is suggested to apply in NPV valuation since the construction risk is unable to be measured by the market. To discount construction cost by market beta is inappropriate and disvalue the project, which is more applicable to the more complicated construction such as BOT projects. Considering BOT projects contains a higher value of initial investments, the underestimation on construction cost is much more significant.

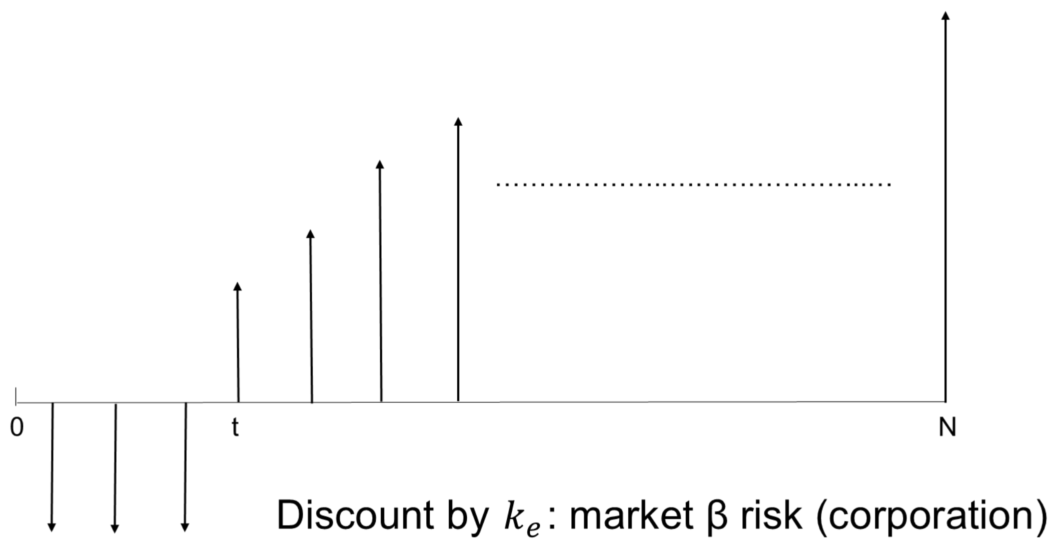

Figure 3-1 Cash Flow Forecast

Additionally, most companies do not have the resources to run multiple BOT projects. Thus, the diversification on such investment is unavailable in reality. This further explains that the market beta cannot quantify the risk of construction. In figure 3-1, the identical cash flow forecast is stated where year t is when the operation started. With the cash flow in each year, the NPV is calculated by discounting CFs with the cost of equity or the required rate of return. However, in the BOT projects with uncertainty, as we

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suggested, since the MER has taken place, the uncertainty should be considered.

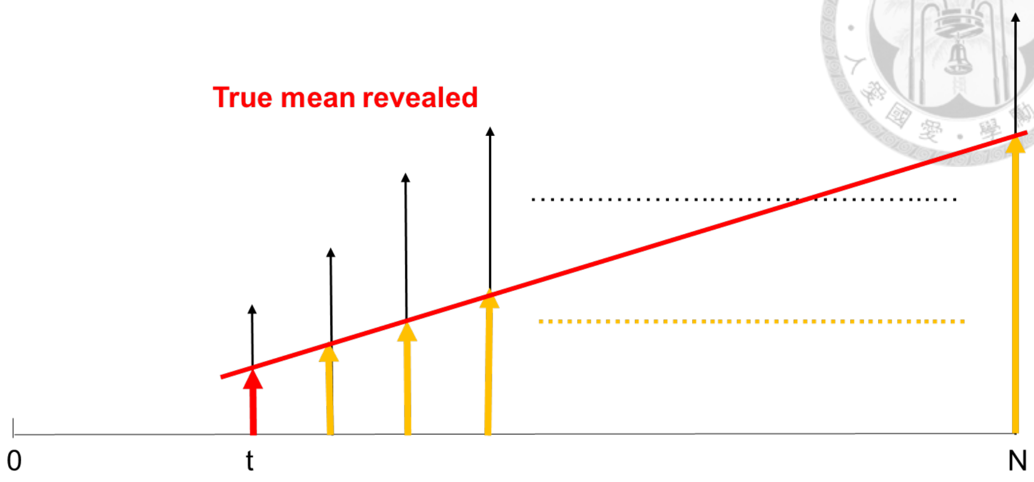

Figure 3-2 True mean revealed in year t (when the operation started)

In Figure 3-2, with the same forecast as in Figure 3-1, the red arrow on the year t indicates the true mean revealed or the actual operating cash inflow in year t. This can only be known at the end of year t, and it is identified as the reveal year in this research. After the reveal year, the projection of the future cash flows is re-estimated as yellow arrow shown in Figure 3-2. The constant growth rate is still applied; however, with the new operation cash inflow in the year t, is the 50% of the original assumption, for example, the total cash inflows of the project is 50% off. This difference is called Mean Estimation Risk. Due to the lack of information and knowledge to project the accurate cash inflow in the reveal year, the impact on MER occurs in the project with uncertainty. Since the NPV technique is used in the project financing valuation, after the reveal year of the operation, the actual valuation of the project can be known. Thus, at the end of the revenue reveal year, the investors can have a better assumption on their profitability on their projects.

When the construction management considering the cost of building, the collective knowledge is that it is unlikely the actual cost will be reduced to less than 90% which in

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some severe projects, the cost was even doubled. This fact represents a log-normal distribution on the cost of construction. On the other hand, the operation, due to the Mean Estimation Risk, without the essential knowledge or information, the actual sale might less considerably than the original assumption. Therefore, we assumed that the operating cash inflow is also in the log-normal distribution; however, unlike the construction cost is skewed to the right, the operating cash inflow is skewed to the left. In the MER evaluation, the experts are consulted to have the educational guesses on the distribution of both construction and operation cash outflow/inflow.

3.3 Value, Cost and Required Rate of Return

According to our theory on MER, if we assume that at the end of the reveal year, the valuation on the project is convinced since the forecast of the operating cash flow is adjusted based on the actual performance of the past year as demonstrated in Figure 3-2. Then, according to the actual performance in the year t, V_t, the total value of the project at the end of the reveal year, is obtained, as shown in Figure 3-3. V_t is discounted by the cost of equity to the year t since we assumed that market β for the operation could be founded.

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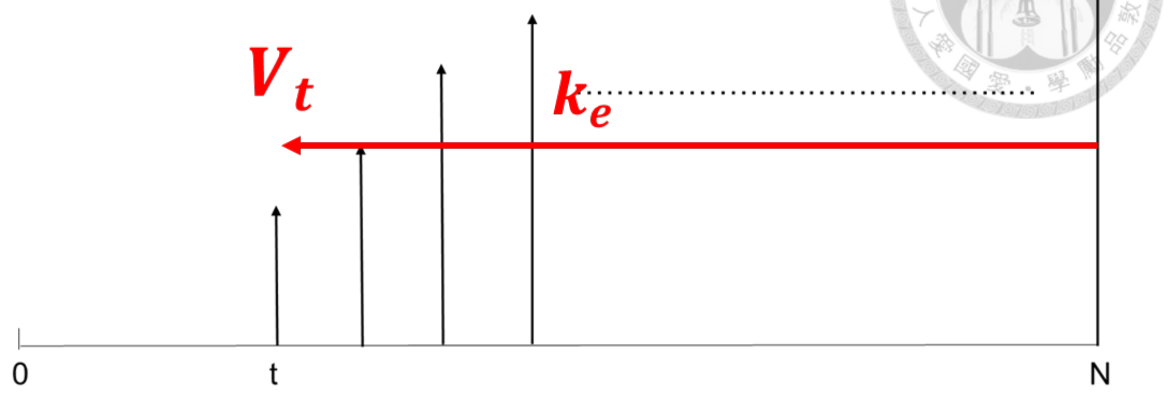

Figure 3-3 V_t or the total value of the project at the end of the reveal year

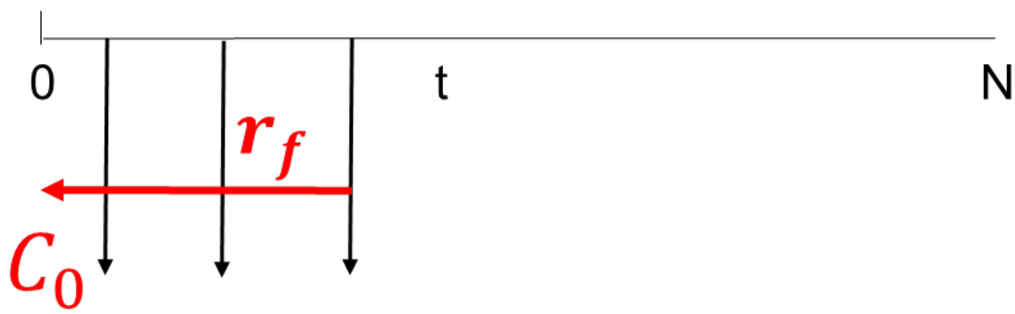

Figure 3-4 C_0 or the total actual construction cost

Secondly, as Figure 3-4 shown because we assumed that market β for construction is not available and cannot be replicated in the market, the actual construction cost is discounted by the risk-free rate. Then at the end of the reveal year, the V_t and C_0 are defined as Figure 3-5 illustrated.

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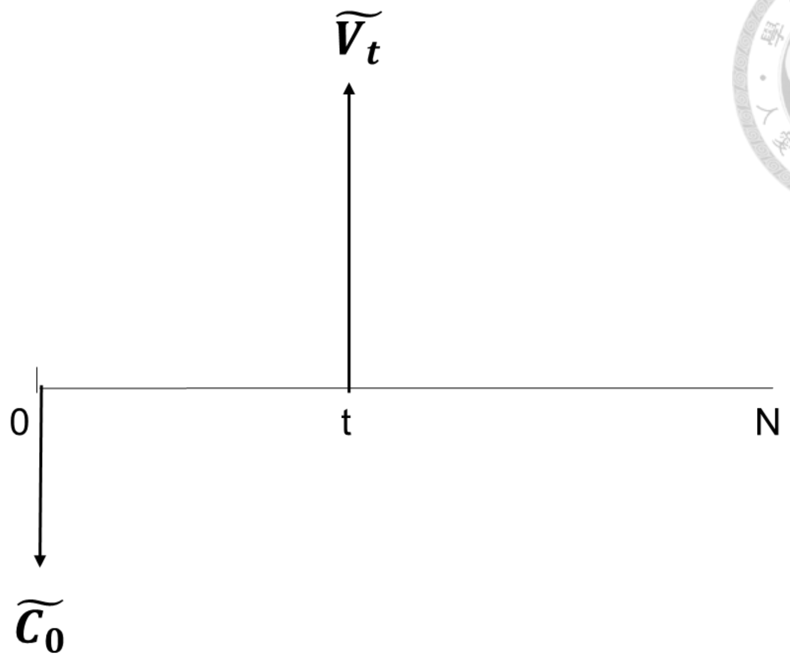

Figure 3-5 $\widetilde{V_t}$ & $\widetilde{C_0}$

Then, the NPV of initial construction cost, C_0, with a required rate of return, r_c, should be less or equal to V_t, the value of the project at the end of the reveal year, as following equation stated.

$$C_0 \times (1 + r_c)^t = V_t \qquad \text{Equation 2}$$

Where t is the reveal year. With the simulation on the MER, each realization of r_c, the random variable, is considered as the return on C_0. However, this is not represented as the project normal return, which is the cost of equity, or the minimum return of any cost.

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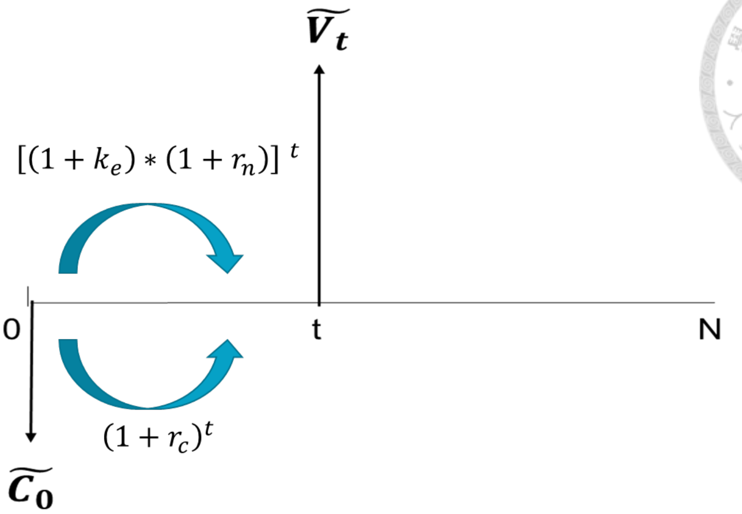

Figure 3-6 $\widetilde{r_c}$ & $\widetilde{r_n}$ due to MER

As a result, to compare r_c with k_e, the calculation on the return difference, which is the nontraded assets rate of return, r_n, due to MER is assumed. If the return on construction is r_n, the future value to year 4 is $C_0 \times (1 + r_c)^4$. In the meantime, because V_t requires k_e as the return, the additional r_n is required where the NPV of V_t is equal to V_t/((1+k_e)(1+r_n))^4. This means that ((1+ke)*(1+r_n))^4 = (1+r_c)^4 which is reorganized as $[(1 + k_e) * (1 + r_n)] = (1 + r_c)$. As Figure 3-6 illustrated the relationship. Accordingly, with the known k_e and the calculated r_c from MER simulation, r_n is presented as in Equation 3.

$$r_n = \frac{1 + \ r_c}{1 + k_e} - 1 = \frac{r_c - k_e}{1 + k_e} \qquad \text{Equation 3}$$

After the simulation, the expected return on the nontraded assets of this project, $\mathrm{E}(r_n)$, is the mean of r_n. In the meanwhile, the required rate of return of nontraded risk, or R_n, is measured based on the volatility of expected return, or σ_n. According to Equation 1, R_n = r_f + $\frac{\mathrm{E}(r_m)\text{-}r_f}{\sigma_m} \times (\sigma_n)$. If $\mathrm{E}(r_n) > R_n$, the project is worth to invest. On the contrary, the project is expected to have a net loss if $\mathrm{E}(r_n) < R_n$. Besides, with the R_n, the second simulation is needed to result in the expected $NPV_{MER,}$ which is calculated as followed in

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Equation 4. V_t is the MER value at the end of the reveal year with the following cash flow. To NPV V_t, the value is discounted to the return of [(1+k_e)* (1+R_n)]

$$NPV_{MER} = \mathrm{E}\left[\frac{\widetilde{V_t}}{[(1+k_e)*(1+R_n)]^4} - \widetilde{C_0}\right] \quad \text{Equation 4}$$

As a result, our evaluation model on MER is completed with the six steps mentioned above and organized in Table 3-1.

Table 3-1 Steps for MER Evaluation Model

Step 1	**Define $\widetilde{V_t}$**
Step 2	**Define $\widetilde{C_0}$**
Step 3	**Define $\widetilde{r_c}$ & $\widetilde{r_n}$ due to MER**
Step 4	**Obtain R_n**
Step 5	**Compare E [$\widetilde{r_n}$] & R_n**
Step 6	**Obtain NPV_{MER} by simulation**

On the next chapter, research methodology is stated. The MER evaluation mentioned in this chapter was illustrated in six steps demonstrating in Section 4-3. Also, the Monte Carol simulation is used in this research to replicate the parameters in the MER evaluation.

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Chapter 4 Research Methodology

In this chapter, the research process was first introduced and divided into three stages. More explicitly, three stages involved the preparation, evaluation model development, and the illustration in this research with more detail explained in the following chapter.

4.1 Research Process

The research process is exhibited in the following page. Three stages are demonstrated in Figure 3-1 involving processes of preparation, evaluation model development, and illustration on the real case. Besides the preparation and the MER mentioned previously, to complete this research, the evaluation model and the case study was introduced in the latter chapter.

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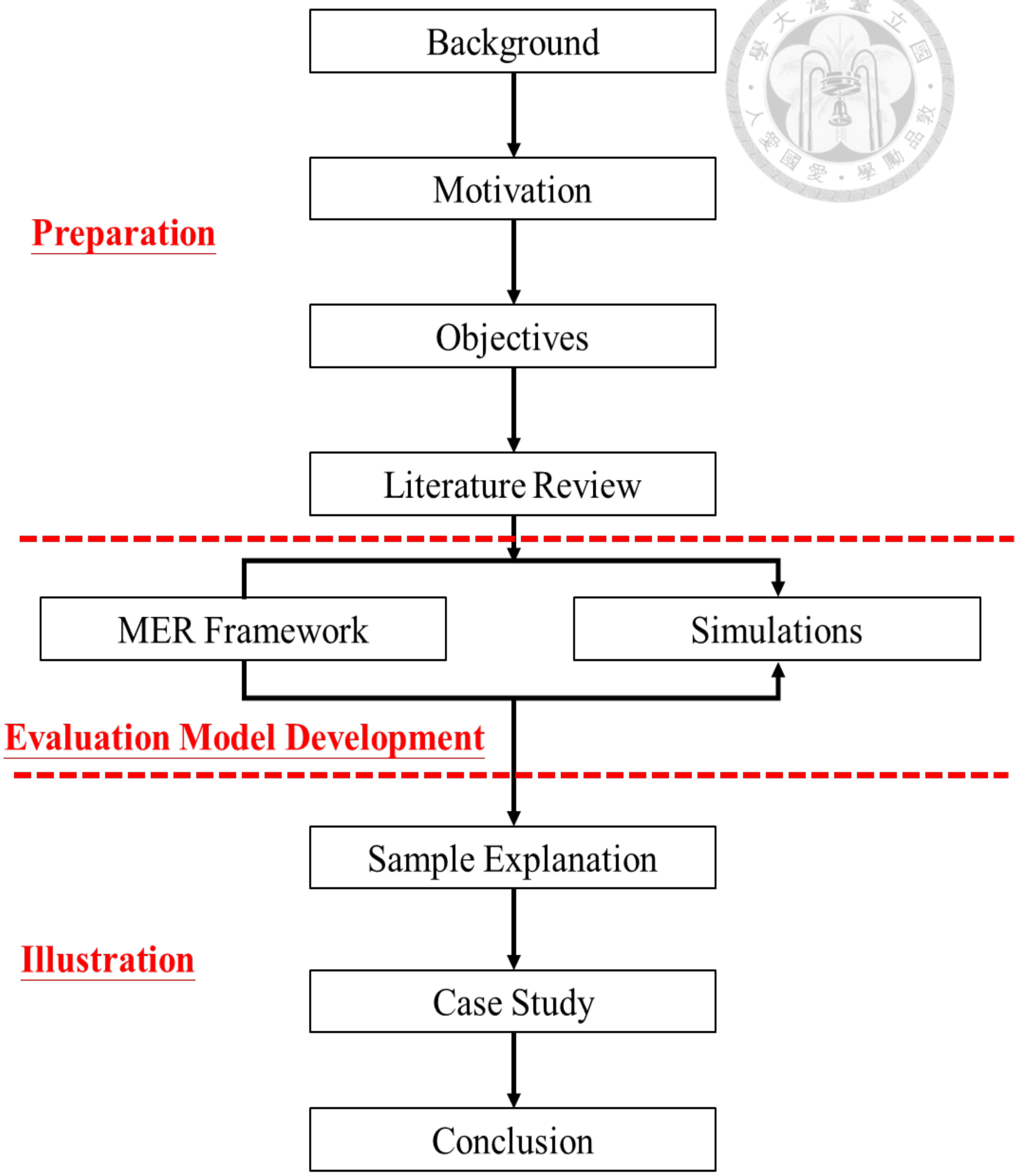

Figure 4-1 Research Process

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4.2 Preparation

This study was conducted as an iterative approach to research on the project financing valuation. The initial step was to study the current practice and problem of project pricing theory and review the conventional valuation methods for nontraded firms in literature, focusing on the assumptions/concepts and drawbacks of these methods. Secondly, built upon existing asset pricing theories, we developed the adjusted cost of equity for nontraded assets, CML function, which may account for the particular risk characteristics often presented in BOT projects.

4.3 Evaluation Model Development

In chapter 3, the theory of Mean Estimation Risk is demonstrated, and the parameters were stated to execute the theoretical framework on MER. The evaluation framework is followed the six steps of the MER model, which mentioned earlier. To replicate the required rate of return of the nontraded assets, Monte Carol simulation, run by Crystal Ball, is applied in this research. With 3000 times of simulation for r_n, we can obtain $E[\widetilde{r_n}]$ and σ_n to finalize the following steps.

4.4 Illustration

With the preparation and the MER evaluation model, the final stage for this research can carry out. Before we showcase our adjusted evaluation model in the real case, the sample explanation is demonstrated, to clarify the implementation in a simple instance. Then, we can finally conduct the MER evaluation model in a case study in this research, which is a BOT project of a sewage treatment plant in Taiwan. Finally, the conclusion was described in Chapter 7.

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Chapter 5 Mean Estimation Risk Evaluation Model

This chapter is designed to showcase the implementation in a standard cash flows NPV example. To demonstrate the evaluation model, before the real case scenario stated in Chapter 6, Chapter 5 aims to illustrate the concept of MER followed by the six steps mentioned previously.

5.1 Simulation Setting

5.1.1 Market risk premium

The information of the market risk premium was captured from the database of Taiwan Economic Journal (TEJ), which was founded in 1990. The flowing section contains both the risk-free rate and market risk premium used in Taiwan.

Risk-free rate

In the finance theory, the definition of risk-free rate is the return of a portfolio which has zero covariance. Indeed, every investment or asset comes with its own risk by natural; however, in modern portfolio theory, the government's bond was identified as the risk-free assets, since the government is considered as stability. Thus, the long-term government default-free bonds are the measurement for the risk-free rate. For example, for the U.S. company, the most common proxy is the 10-year government bond. Additionally, when the valuation of long-term project/company, the short-term bonds is not suited for determining the risk-free rate. Short-term bonds are applicable, only when the valuation is for next month. As a result, in Taiwan, the 10-year bond dividend yield is considered as the risk-free rate, which is 1.983% on average from 1999 to 2018 (TEJ).

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Market Risk Premium

The difference between the market expected return, and the risk-free rate is identified as the market risk premium in the market theory. Although this concept is debated in finance theory; however, the ability to observe the expected return is unobservable, similar to the stock's expected return. The TAIEX (Taiwan Stock Exchange Capitalization Weighted Stock Index) covers all of the listed stocks on the Taiwan exchange. When measuring the performance, analysts use total return, which includes the cash dividends to the index. This provides a better valuation measurement for investors. The TAIEX Total Return Index started from January 2, 2003, as Table 4-1 showed. In historical approach, first, the yearly return was calculated by the difference of end of the year and the beginning of the year and, then divide by the beginning of the year. Then, yearly-returns were average to the arithmetic mean, which is 11.2%. This is the market expected return. Therefore, the market risk premium is the difference between the two, which is 9.22%, and the market standard deviation is 0.20.

5.1.2 NPV_{ke}, $NPV_{(ke,\ \beta c)}$ & $NPV_{(ke,\ rf)}$

Table 5-1 illustrates the equity cash flow example with the cost of equity, or k_e equals to 8% and the risk-free rate, 1.98%, and the growth rate of the operating cash flow, 10%. The initial cost is 4 thousand each year in the first three years. According to the NPV method, if we discount the cost of equity on both construction and operation, the NPV_{ke} is $589 which means the project is worth to invest; however, if we assume, there is β_c which can diversify the construction cost. Since prosperity is booming, the cost is increasing in the meantime, if all others remain the same, the rate of return is smaller. Thus, we assume the β_c with a negative value of -0.2. Then, according to CAPM, the

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cost of equity on construction cost is equal to 0.136% which is the sum of the risk-free rate, 1.98% and -0.2 times to the market premium (11.2% - 1.98%). Then the $NPV_{(ke, rc)}$ -$1070 with an increased cost. However, because β_c is only an assumption, the following implementation on the nontraded risk measurement is needed.

With the MER on the simulation, construction cost is discounted by the risk-free rate. As Table 2 shown, the $NPV_{(ke, rf)}$ is -$643.

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Table 5-1 Equity Cash Flow Sample Explanation on NPV with k_e, β_c and r_f

Equity Cash Flow												
year	1	2	3	4	5	6	7	8	9	10	15	20
Cash Flow	($4,000)	($4,000)	($4,000)	$750	$825	$908	998	1098	1208	1329	2140	3446
Operation discounted by k_e				$551	$561	$572	$582	$593	$604	$615	$675	$739.4
Conctruction discounted by												
k_e	($3,704)	($3,429)	($3,175)									
CAPM(βc)	($3,922)	($3,846)	($3,772)									
r_f	($3,995)	($3,989)	($3,984)									

	Operation	Construction	Total
NPV_{ke}	$10,897	-$10,308	$589
$NPV_{(ke,\ \beta c)}$	$10,897	-$11,967	-$1,070
$NPV_{(ke,\ rf)}$	$10,897	-$11,540	-$643

ke	8.00%
rf	1.98%
growth rate	10%
CAPM(βc)	0.136%

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5.2 Standard MER Simulation

With the same cash flow, if it is a BOT project with the MER on both construction and operation. In reality, since the MER is due to the fact of incomplete information, we can only make the educated guess on the minimum, most likely, and maximum value on how the construction cost and revenue would differ. In table 5-2, the possibility comparing to the original forecast is placed. The simulation is run by the Crystal Ball, which can set any distribution on the assumption, in this case, triangle distribution, as Figure 5-2 shown. The cell C30 in green is the assumption of construction cost made by the triangle distribution, which is between 90% to 150% with the most likely of 100%.

Table 5-2 Standard MER Triangle Distribution

MER on each year cash flow			
Item	min.	Most likely	max.
Construction	90%	100%	150%
Operation	65%	100%	130%

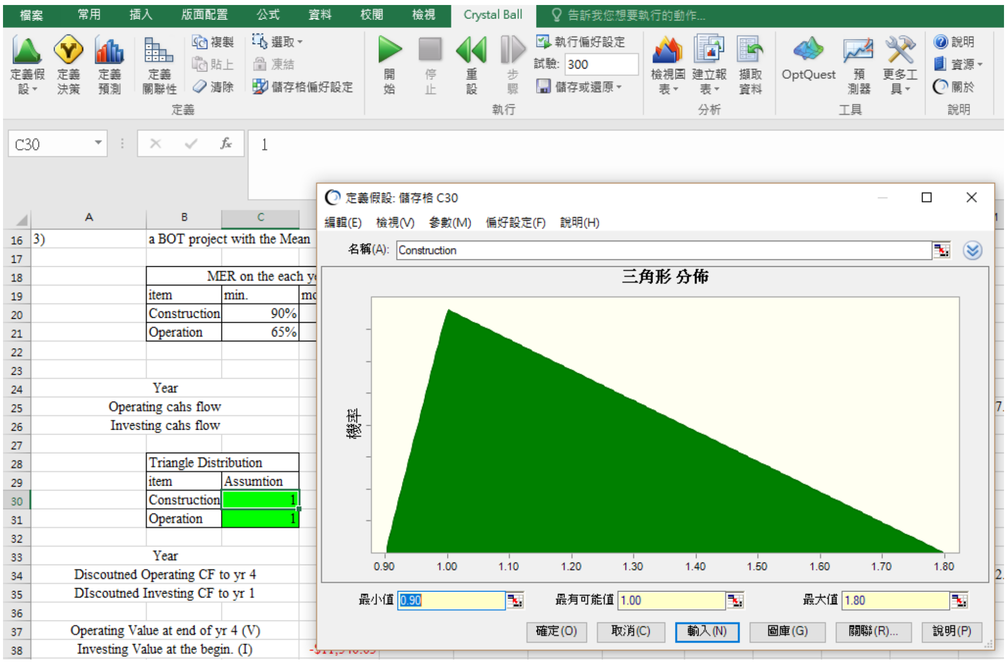

Figure 5-1 Crystal Ball Triangle Distribution

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Table 5-3 MER Simulation w/ r_c and r_n

A BOT project with the Mean Estimated Risk

MER on the each year cash flow			
item	min.	most	max.
Construction	90%	100%	150%
Operation	65%	100%	130%

Equity Cash Flow													
Year	0	1	2	3	4	5	6	7	12	17	18	19	20
Cash Inflow					$750	$825	$908	$998	#####	$2,589	$2,848	$3,133	$3,446
Cash Outflow		($4,000)	($4,000)	($4,000)									

Triangle Distribution	
item	Assumtion
Construction	1
Operation	1

Year	0	$1	$2	$3	$4	$5	$6	$7	$12	$17	$18	$19	$20
Discoutned Operating CF to yr 4					$750	$764	$778	$792	$869	$952	$970	$988	$1,006
Discoutned Construction CF to yr 0		($3,922)	($3,846)	($3,772)			$2						
Operating Value at end of yr 4 (V)					$14,826								
Construction cost at the begin. (C)	-$11,540												

r_c	0.065
r_n	-0.01422

Step 1: Define $\widetilde{V_t}$

Step 2: Define $\widetilde{C_0}$

Step 3: Define $\widetilde{r_c}$ & $\widetilde{r_n}$ due to MER

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In Table 5-3, Step 1, defining $\widetilde{V_t}$ are the initial step, which is the discounted (cost of equity) cash flow to the end of year 4 and Step 2, $\widetilde{C_0}$ Is also defined, which is the discounted (risk-free) cash flow to the beginning. Then, the 3rd step, r_c and r_n are the defining forecast of the simulation. Then the simulation is started by clicking the run button on Figure 5-1 with 3000 times. In the next section, the illustration of the process of MER simulation is stated.

5.3 Illustration of MER Simulation

In this section, the rest of the evaluation steps from the previous section was completed. Not only then that, but we will also increase the cash inflow in the 4th year, to observe by increasing the $\widetilde{V_t}$, the impact resulted in the NPV_{MER}.

(A) 1st Cash Inflow of $750

In Table 5-4, the six steps of the evaluation were organized. With the cash inflow $750 in 4th year or the reveal year, the NPV_{ke} is $589 and $NPV_{(ke, rf)}$ is negative as Table 5-1 shown. Based on this setting, the simulation was run with the result of $E(r_n)$ with -4.789% and standard deviation 0.0428, as shown in Figure 5-2. With the variance of the r_n, R_n is calculated with 3.95% according to Equation 2. Since $E(r_n) < R_n$, the 2nd simulation results the expected NPV_{MER} of -$3867 as Figure 5-3 shown. The NPV_{MER} further identified that the net loss is expected if the investment of the project is made.

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Table 5-4 Evaluation Steps-1st Cash Inflow of $750

Step 1	**Define** $\widetilde{V_t}$	$14826
Step 2	**Define** $\widetilde{C_0}$	-$11540
Step 3	**Define** $\widetilde{r_c}$ & $\widetilde{r_n}$ **due to MER**	$E[r_n] = -4.78\%$
Step 4	**Obtain** R_n	$R_n = 3.95\%$
Step 5	**Compare E** $[\widetilde{r_n}]$ **&** R_n	$E[r_n] < R_n$
Step 6	**Obtain** NPV_{MER} **by simulation**	$NPV_{MER} = -\$3867$

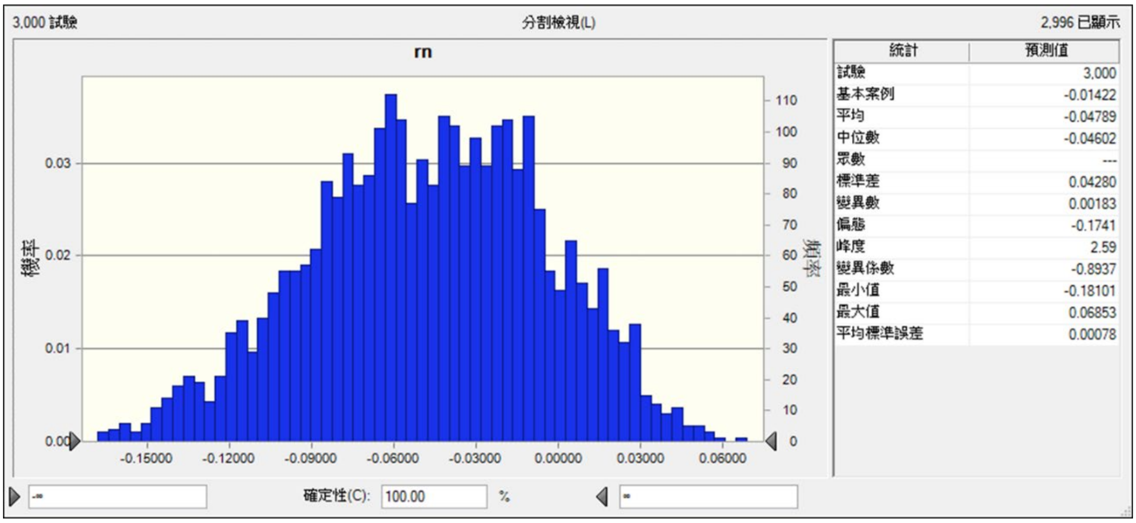

Figure 5-2 r_n distribution and stat. w/ 1st Cash Inflow of $750

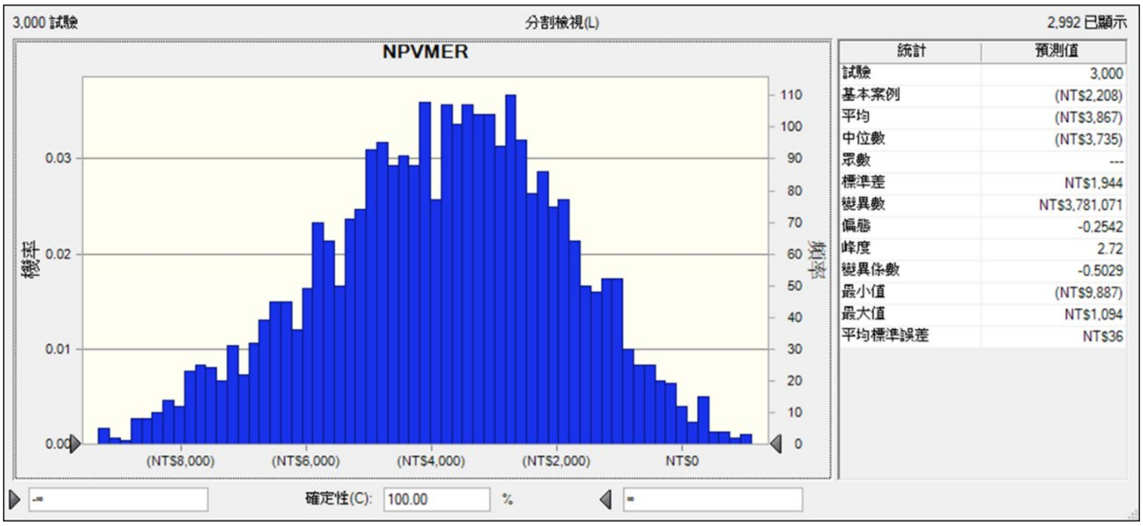

Figure 5-3 NPV_{MER} w/ 1st Cash Inflow of $750

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(B) 1st Cash Inflow of $1075

Table 5-5 NPV w/ 1st Cash Inflow of $1075

	Operation	Construction	Total
NPV_{ke}	$15,619	-$10,308	$5,311
$NPV_{(ke,\ \beta c)}$	$15,619	-$11,967	$3,652
$NPV_{(ke,\ rf)}$	$15,619	-$11,540	$4,079

If the 1st year of the operating cash inflow increases to $1075 with the same growth rate in the following rest of the years. The three standards of NPV are all greater than zero significantly, as illustrated in Table 5-5. By increasing $\widetilde{V_t}$, we observed an incremental NPV_{MER} as displayed in the following Table 5-6. In the first simulation, $E[r_n]$ and R_n were obtained. Then after increasing $\widetilde{V_t}$, the expected return is greater than the required rate of return.

Table 5-6 Evaluation Steps-1st Cash Inflow of $1075

Step 1	**Define $\widetilde{V_t}$**	$21250
Step 2	**Define $\widetilde{C_0}$**	-$11540
Step 3	**Define $\widetilde{r_c}$ & $\widetilde{r_n}$ due to MER**	$E[r_n] = 4.18\%$
Step 4	**Obtain R_n**	$R_n = 4.11\%$
Step 5	**Compare E $[\widetilde{r_n}]$ & R_n**	$E[r_n] > R_n$
Step 6	**Obtain NPV_{MER} by simulation**	$\boldsymbol{NPV_{MER}} = \$22$

Furthermore, with R_n, the second simulation on NPV_{MER} is made with a value of $22 which is slightly higher than zero, as shown in Table 5-6 and Figure 5-5. The increase in total V_4 represents a higher NPV_{MER}, which is nearly over than zero. This indicated that because of the MER involved, the simulation shows us only a higher V_4 can excel a NPV_{MER} which is greater than zero. From the last example, NPV_{ke} of a smaller V_4 is

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already satisfied with the NPV rule where if the value is over zero, investors should agree on the project; however, with the MER simulation tells us, on the other hand, with uncertainty, V_4 has to be much higher in order to result the positive NPV.

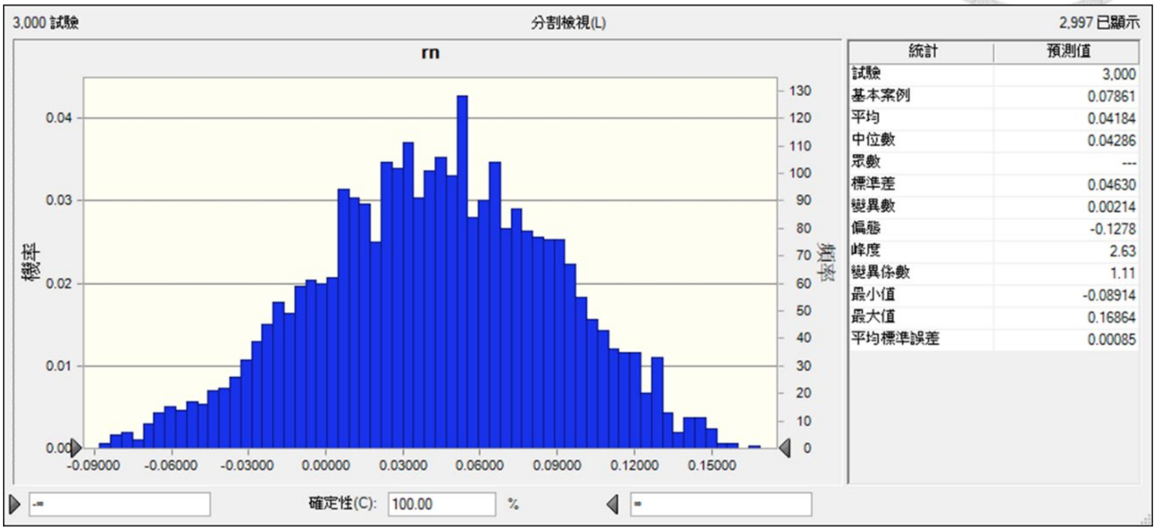

Figure 5-4 r_n distribution and stat. w/ 1st Cash Inflow of $1075

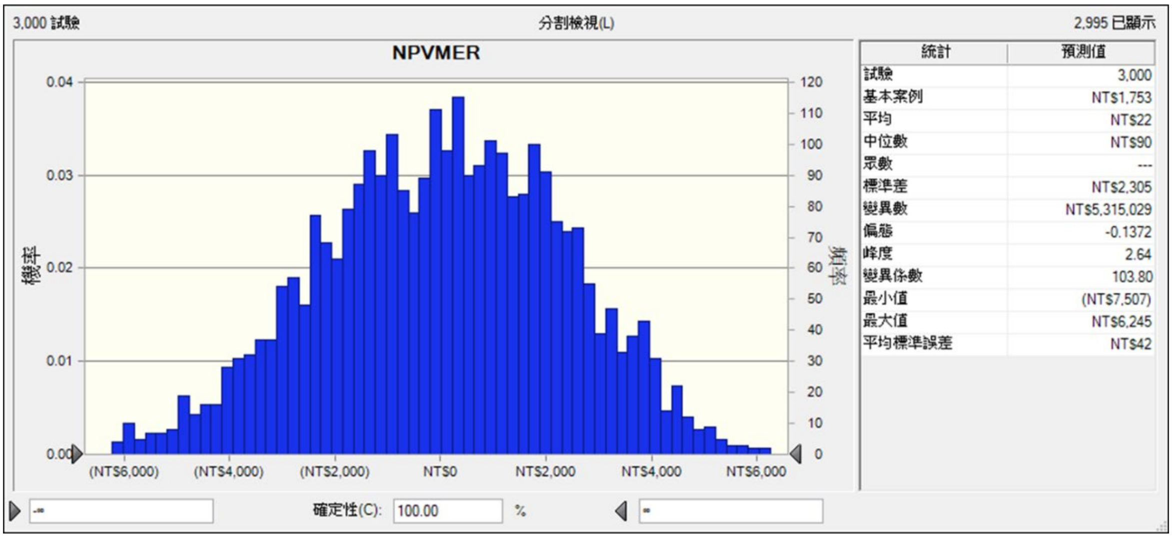

Figure 5-5 NPV_{MER} w/ 1st Cash Inflow of $1075

5.4 Project with low MER

The following two examples are illustrated in the extreme distribution, as shown in Table 5-7. If all things considered equal, the results of the low MER were shown in the

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following.

Table 5-7 Low MER Distribution

MER on the each year cash flow			
item	min.	most	max.
Construction	90%	100%	110%
Operation	90%	100%	110%

(C) 1st Cash Inflow of $750

We began with the same amount of the 1st Cash Inflow of $750, where the NPV_{ke} is slightly higher than zero and negative $NPV_{(ke\&rf)}$. The following Figure 5-6 & 5-7 were the simulation results, and Table 5-8 was the evaluation result. A -1.387% of $E(r_n)$ and 2.63% of R_n were calculated due to the standard deviation of 0.01411 is shown in Figure 5-6. Then the expected NPV_{MER} is -$1725 was simulated in the second time.

Table 5-8 Evaluation Steps-1st Cash Inflow of $750 with Low MER

Step 1	**Define** $\widetilde{V_t}$	$14826
Step 2	**Define** $\widetilde{C_0}$	-$11540
Step 3	**Define** $\widetilde{r_c}$ & $\widetilde{r_n}$ **due to MER**	$E[r_n] = -1.387\%$
Step 4	**Obtain** R_n	$R_n = 2.63\%$
Step 5	**Compare E** $[\widetilde{r_n}]$ **&** R_n	$E[r_n] < R_n$
Step 6	**Obtain** NPV_{MER} **by simulation**	$NPV_{MER} = -\$1725$

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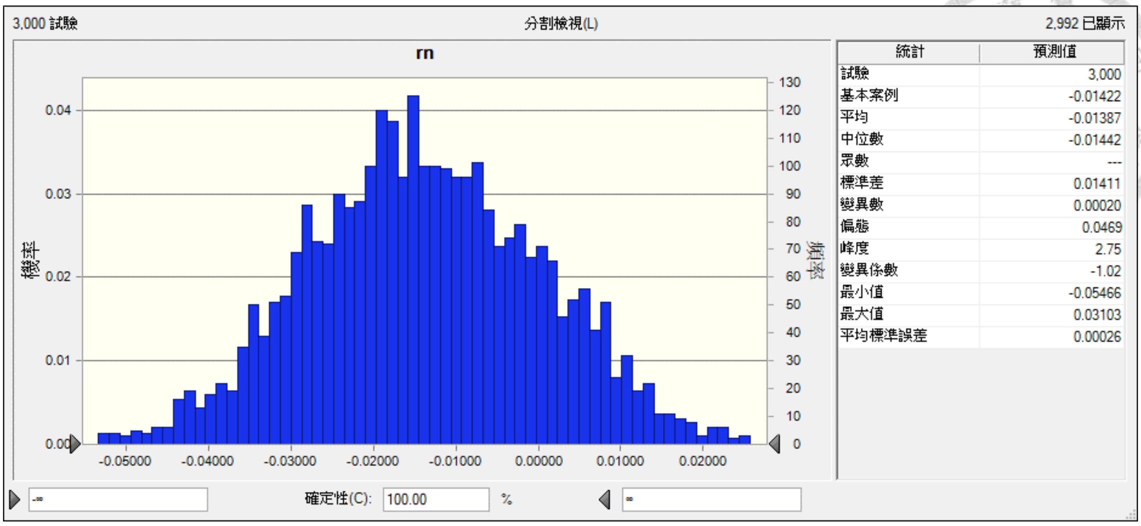

Figure 5-6 r_n distribution and stat. w/ 1st Cash Inflow of $750 in Low MER

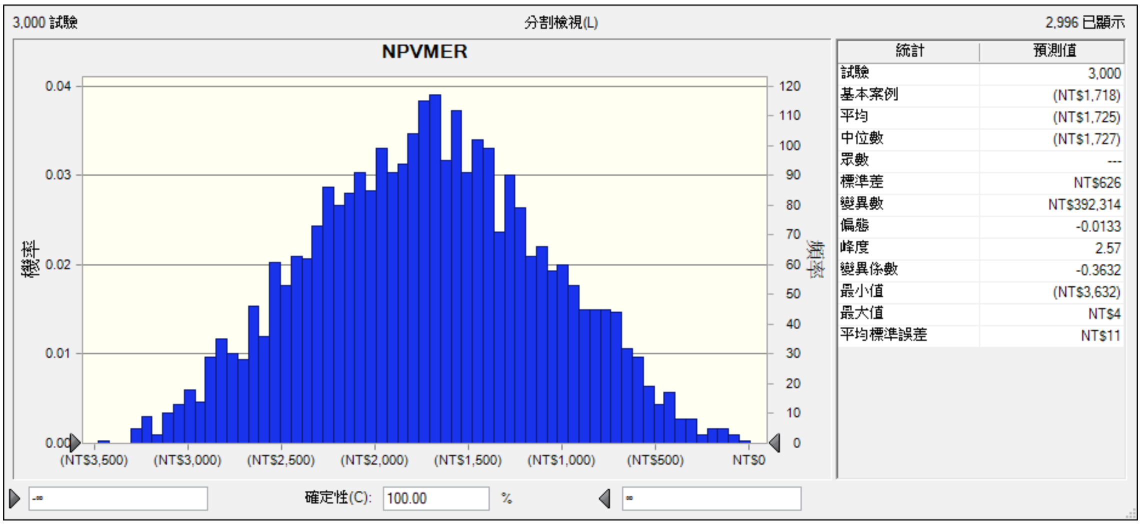

Figure 5-7 NPV_{MER} w/ 1st Cash Inflow of $750 in Low MER

(D) 1st Cash Inflow of $885

Table 5-9 NPV w/ 1st Cash Inflow of $885

	Operation	Construction	Total
NPV_{ke}	$12,859	-$10,308	$2,550
$NPV_{(ke,\ \beta c)}$	$12,859	-$11,967	$891
$NPV_{(ke,\ rf)}$	$12,859	-$11,540	$1,319

Same with the previous section with the standard MER distribution, we readjusted the 1st

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year cash inflow of \$890 to observe the $E[r_n], R_n$ and NPV_{MER}. If the 1st Cash Inflow is increased to \$885, the $NPV_{(ke,\ rf)}$ is slightly higher than zero, and as Table 5-9 shown. In Table 5-10, the evaluation was organized with the simulation results in Figure 5-8 and Figure 5-9. The $E(r_n)$ is 2.76%, and the R_n is calculated as 2.66% with the standard deviation of 0.01473. With the second simulation, the expected NPV_{MER} is \$45, which is nearly higher than zero.

Table 5-10 Evaluation Steps-1st Cash Inflow of \$890 with Low MER

Step 1	**Define** $\widetilde{V_t}$	\$17494
Step 2	**Define** $\widetilde{C_0}$	-\$11540
Step 3	**Define** $\widetilde{r_c}$ & $\widetilde{r_n}$ **due to MER**	$E[r_n] = 2.76\%$
Step 4	**Obtain** R_n	$R_n = 2.66\%$
Step 5	**Compare E** $[\widetilde{r_n}]$ **&** R_n	$E[r_n] > R_n$
Step 6	**Obtain** NPV_{MER} **by simulation**	$NPV_{MER} = \$45$

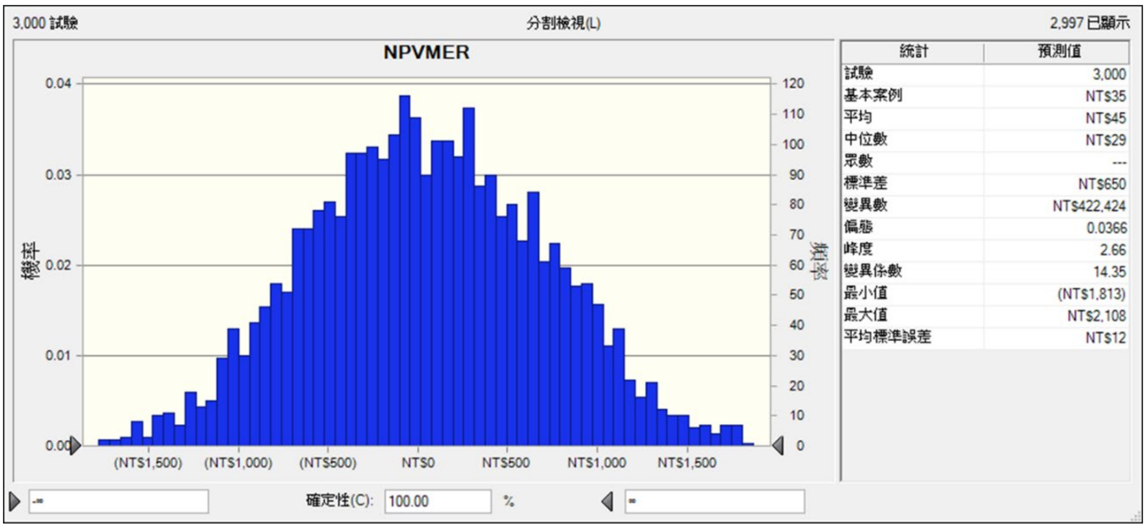

Figure 5-8 NPV_{MER} w/ 1st Cash Inflow of \$885 in Low MER

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Table 5-11 Summary

	Standard MER		Low MER	
1st cash inflow	\$750	\$1,075	\$750	\$885
NPV_{ke}	\$589	\$5,311	\$589	\$2,550
NPV_{MER}	(\$3,876)	\$22	(\$1,725)	\$45

Table 5-11 states the summary of the NPV result in this chapter. The purpose of illustrating extreme distribution is to showcase the feasibility of our method. In the standard MER, the requirement of higher V_4 is observed where NPV_{MER} is nearly positive only when the 1st cash inflow is \$1075, which is significantly higher than the other distribution with less randomness. The illustration in this chapter indicated the impact and the importance of Mean Estimation Risk involving in the project financing. In the standard MER example, to output a positive NPV_{MER}, the 1st year cash flow of \$750, which has a positive NPV_{ke} already, has to increase by 43% to \$1075. The result illustrated that even with the positive NPV, as long as the uncertainty of MER involved in the project, a slightly positive NPV is not adequate. Considering the Mean Estimation Risk, a higher V_t is necessary to excel a positive NPV_{MER}. In the next chapter, a case study was implemented with the MER evaluation model.

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Chapter 6 Case Study

The case study used in this research is by an environmental engineering company which operates a Build-Operate-Transfer (BOT) project of a sewage treatment plant in Taiwan. Since it is confidential, certain data/information of the project and the company cannot be disclosed. The following chapter contains the background of the case, the simulation with MER, and the implementation of the additional NPV rule.

6.1 Background

This BOT project was based on Promotion of Private Participation in infrastructure projects which aim to improve the quality of life, standard protection of water quality, and the rate of sewerage popularity. The project involves four phases of building the sewage main, sub, branch, and household-connection pipes, where the total area is approximately 7000 ha. The treatment plant area contains 16 ha, and the estimated amount of sewage treating in design is 200,000 cubic meter per day (CMD) divided into four phases, which is 50,000 CMD per phase.

6.2 MER Simulation on Sewage Treatment BOT

We use Crystal Ball to implement the randomness into excel function as the MER of both construction cost and the revenue, which in this case is the sewage inflow every day. The dollar unit is NT$ 1 thousand dollars displaying in the table. For all the mean risk assumption we made is based on the educational with guess from multiple sewage treatment experts with multiple years of experience. We apply triangle distribution as the assumption of the random variables on construction cost and sewage inflow cubic meter per day (CMD). In Figure 6.1, the minimum, most likely, and the maximum is set as the

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triangle distribution on the Crystal Ball, which takes place on cell E26. This means that the random variable is between 0.9 to 1.5, with the most likely on 1.05. The triangle distribution is applied when incomplete information happened. Because of the original estimation on cost and sewage CMD is set by the government, the investors should apply the simulation of this uncertainty which might alter during the project.

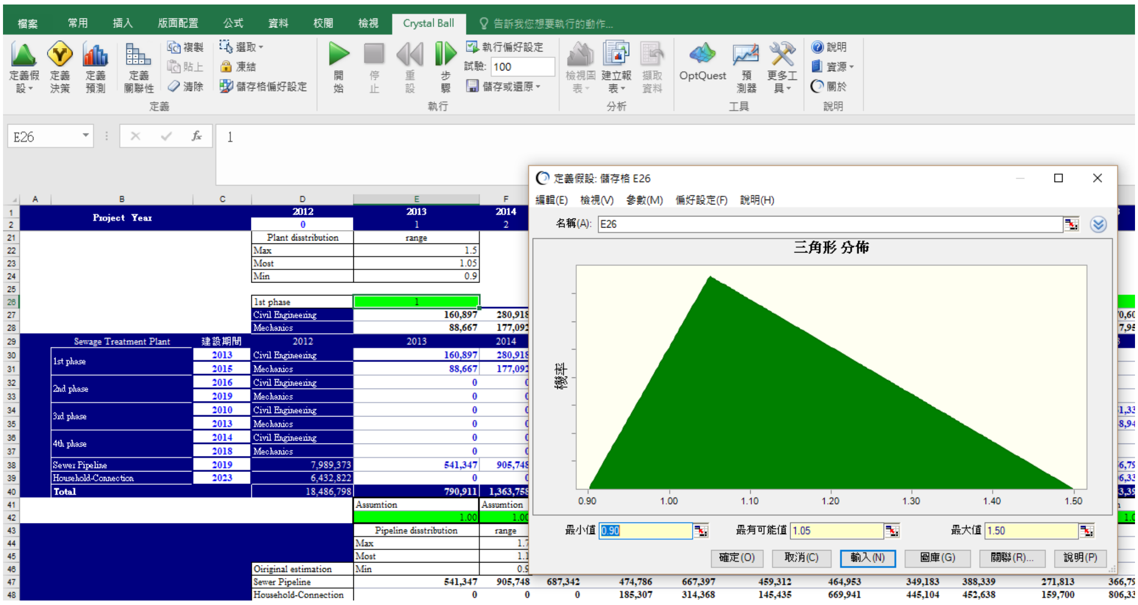

Figure 6-1 Crystal Ball with Triangle Distribution

Construction Cost Assumption

The construction cost can be divided into two categories: the sewage treatment plant & the pipeline. We apply one random variable to each phase of the construction. Since the risk of the plant construction is not influenced year by year, we set the triangle distribution on each phase differently. The construction of sewer pipeline, on the other hand, faces more significant risk, so we set on higher value with the triangle distribution.

In table 6-1, on row 42, the assumption on the distribution of pipe cost is simulated every year. As mention previously, pipe construction has a higher risk due to the construction difficulty. As a result, our experts estimate a higher maximum and most likely value on the pipe construction

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Table 6-1 Construction cost w/ MER

	A	B	C	D	E	F	G	H	I	R	S	T	U	V	W	X	Y	Z
1		**Project Year**		**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**
2				0	1	2	3	4	5	14	15	16	17	18	19	20	21	22
21				Plant disstribution	range													
22				Max	1.5													
23				Most	1.05													
24				Min	0.9													
25																		
26				1st phase	1						4th phase	1						
27				Civil Engineering	160,897	280,918	411,501				Civil Engineering	170,601	361,331					
28				Mechanics	88,667	177,092	249,044				Mechanics	117,956	248,940					
29		Sewage Treatment Plant	建設期間	2012	2013	2014	2015	2016	2017	2026	2027	2028	2029	2030	2031	2032	2033	2034
30		1st phase	2013	Civil Engineering	160,897	280,918	411,501	0	0	0	0	0	0	0	0	0	0	0
31			2015	Mechanics	88,667	177,092	249,044	0	0	0	0	0	0	0	0	0	0	0
32		2nd phase	2016	Civil Engineering	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33			2019	Mechanics	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34		3rd phase	2010	Civil Engineering	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35			2013	Mechanics	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36		4th phase	2014	Civil Engineering	0	0	0	0	0	0	170,601	361,331	0	0	0	0	0	0
37			2018	Mechanics	0	0	0	0	0	0	117,956	248,940	0	0	0	0	0	0
38		Sewer Pipeline	2019	7,989,373	541,347	905,748	687,342	474,786	667,397	334,900	331,507	596,791	290,890	214,891	0	0	0	0
39		Household-Connection	2023	6,432,822	0	0	0	185,307	314,368	413,194	132,283	730,319	426,616	381,066	263,524	0	0	0
40		**Total**		18,486,798	790,911	1,363,758	1,347,886	660,093	981,765	748,094	752,346	1,937,381	717,506	595,957	263,524	0	0	0
41					Assumtion	Assumtion	Assumtion	Assumtion	Assumtion	Assumtion	Assumtion	Assumtion	Assumtion	Assumtion	Assumtion			
42					1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00			
43					Pipeline disstribution	range												
44					Max	1.7												
45					Most	1.1												
46				Oiriginal estimation	Min	0.9												
47				Sewer Pipeline	541,347	905,748	687,342	474,786	667,397	334,900	331,507	596,791	290,890	214,891	0	0	0	0
48				Household-Connection	0	0	0	185,307	314,368	413,194	132,283	730,319	426,616	381,066	263,524	0	0	0

Table 6-2 Sewage inflow e/ MER

	A	B	C	D	E	F	G	H	I	J	AG	AH	AI	AJ	AK	AL	AM
1		**Project Year**		**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2041**	**2042**	**2043**	**2044**	**2045**	**2046**	**2047**
2				0	1	2	3	4	5	6	29	30	31	32	33	34	35
60					Sewage distribution	range		Oiriginal estimation									
61					Max	0.8		3,649	13,110	22,706	141,787	141,787	141,787	141,787	141,787	141,787	141,787
62					Most	0.6	Assumtion	5,526	20,059	33,576	189,740	191,442	193,144	194,846	196,548	198,250	199,952
63					Min	0.3	1.00	5,527	20,060	33,577	189,741	191,443	193,145	194,847	196,549	198,251	199,953
64																	
65		Est. Household conncetion Sewage CMD each Yr			0	0	0	3,649	13,110	22,706	141,787	141,787	141,787	141,787	141,787	141,787	141,787
66		Est. Total Sewage CMD each Yr			0	0	0	5,526	20,059	33,576	189,740	191,442	193,144	194,846	196,548	198,250	199,952

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Sewage CMD

The sewage is virtually the sole revenue of this project. If the estimation of the sewage per day is inaccurate, the project probably faces a net loss. We assume that in the end, the first year of the sewage inflow can demonstrate the net worth of the whole project. Since the sewage CMD is based on the first year in each year, the mean risk is set with the assumption that with the simulation, the following sewage amount is changed due to the first year variation. In Table 6-2, the cell G63 is the triangle distribution with the min. 0.3, most likely 0.6, and max. 0.8. Our experts believe the estimation by the government of the sewage amount is usually overrated. As a result, even the maximum amount is only 0.8 of the original data.

6.3 Simulation Result

Since the first revenue is started on year 4, in the previous section, the MER is defined on the sewage inflow CMD. In other words, the reveal of the sewage amount at the end of the 4th year is the timing to observe the valuation of the project based on the real data. Addition to the construction risk on plant and pipe, the MSR is also defined as mentioned above. Because of the unique characteristics of this project, the construction is continued to build while the operation begins. To implement Equation 1, (C_0) is only equal to the present value of the initial three years of construction cost but not the whole duration. Since after year 4, the construction continues until year 19. However, the

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Table 6-3 Equity Cash Flow

Project Year		2012 0	2013 1	2014 2	2015 3	2016 4	2017 5	2022 10	2032 20	2042 30	2047 35
Equity Analysis	Ke=										
Operating Cash Flow	6.95%										
EBIT after Tax			(9,000)	(24,676)	(50,915)	184,220	188,591	469,001	988,641	1,160,429	1,416,876
Interest fee			0	(14,638)	(39,850)	(93,441)	(96,016)	(147,595)	(33,495)	0	0
Depreciation			6,000	21,676	47,915	126,520	145,642	305,261	565,997	557,389	546,381
Operating net cash flow			(3,000)	(17,638)	(42,850)	217,299	238,217	626,667	1,521,143	1,717,818	1,963,257
Financing cash low			338,607	783,268	828,173	147,201	301,880	(234,968)	(20,093)	(1,294)	(914,902)
Investing (4th~35th)						(669276)	(993471)	(728655)	(201108)	0	0
Operating + Financing + Investing (4th ~ 35th)			335,607	765,630	785,323	(304,776)	(453,374)	(336,957)	1,299,942	1,716,523	1,048,355
Last year cash discounted						601,373					
Discount at end of 4th yr						296,597	(423,908)	(225,147)	443,580	299,125	130,554
Discount at end of 4th yr Total						1,962,411					
FV at the end of 4th yr			495,933	875,766	839,910						
(V)_Total Value at end of 4th yr						4,174,020	Step 1: Define $\widetilde{V_t}$				
Investment(construction) cash flow (1st ~ 3rd)	rf=		(831,604)	(1,389,486)	(1,385,628)						
	1.98%	(I)_Total Cost at the beg_in rf	-$3,457,989								
				Step 2: Define $\widetilde{C_0}$							
	r_c	0.0482									
	r_n	-0.0264	Step 3: Define $\widetilde{r_c}$ & $\widetilde{r_n}$ due to MER								

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Operation begins at year 4. Thus, the risk of the following years should consider the same as operation. As a result, the construction cost, or investing cash flow is considered as part of the operation. (V) in this project is equal to the sum of operating cash flow, financing cash flow, investing cash flow ($4^{th} \sim 35^{th}$) and the last year cash, as illustrated in Table 6-3.

Evaluation Steps:

In Table 6-3, we first defined the present value of the operation in year 4, which is \$4,174,020,000. Then, the present value of the construction cost is -\$3,457,989,000, also shown in the table. In the third step, due to the Mean Estimation Risk with $\widetilde{r_c}$ & $\widetilde{r_n}$, the simulation was run with the result of $E[r_n] = -13.53\%$ and 0.0371 in the standard deviation. In the next step, according to the CML function, R_n was obtained which is the result of $R_n = 1.98\% + \frac{(11.2\% - 1.98\%}{0.2} \times 0.0371 = 3.69\%$. Thus, to compare $E[r_n]$ and R_n, the MER simulation indicated that the expected return is less than the required rate of return. As a result, the project is not worth to invest, in other words, the NPV_{MER} is negative. By acquiring the R_n, with Equation 4, $NPV_{MER} = \mathrm{E}\left[\frac{\widetilde{V_t}}{[(1+ke)*(1+Rn)]^4} - \widetilde{C_0}\right] = -\$1{,}929{,}509{,}000$ is simulated, as shown in Figure 6-3.

Table 6-4 Evaluation Steps

Step 1	**Define $\widetilde{V_t}$**	\$4,174,020,000
Step 2	**Define $\widetilde{C_0}$**	-\$3,457,989,000
Step 3	**Define $\widetilde{r_c}$ & $\widetilde{r_n}$ due to MER**	$E[r_n] = -13.53\%$
Step 4	**Obtain R_n**	$R_n = 3.69\%$
Step 5	**Compare E [$\widetilde{r_n}$] & R_n**	$E[r_n] < R_n$
Step 6	**Obtain NPV_{MER} by simulation**	$\boldsymbol{NPV_{MER}} = -\$1{,}929{,}509{,}000$

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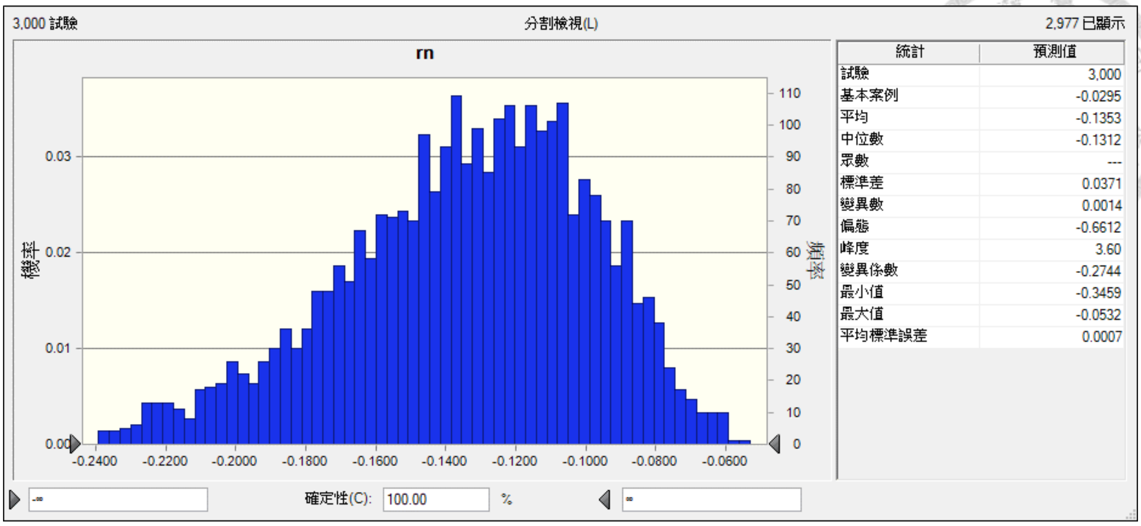

Figure 6-2 rn Distribution & Stat.

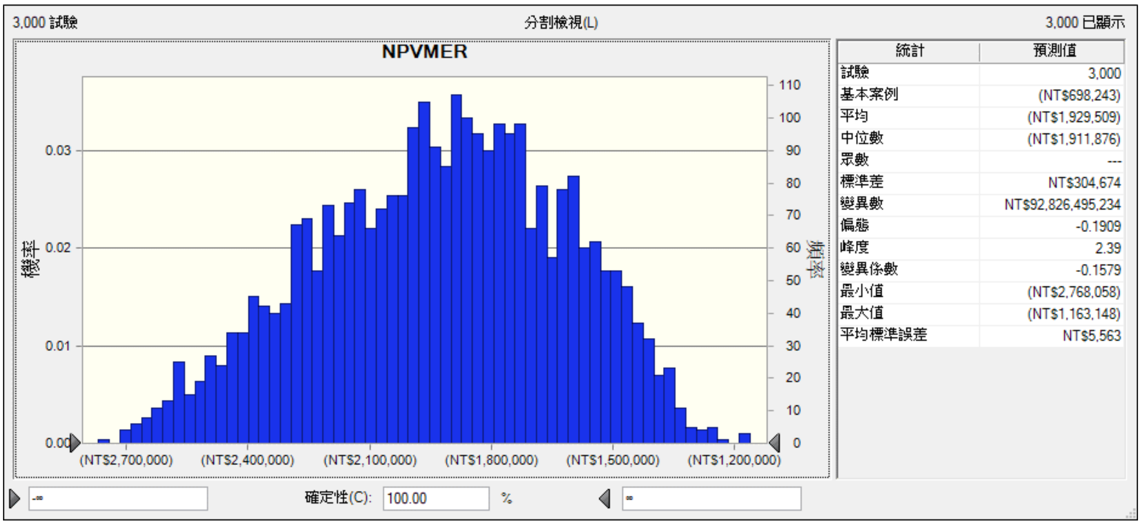

Figure 6-3 NPV_{MER}

6.4 Summary

Table 6-5 NPV_{ke} vs. NPV_{MER}

NPV_{ke}	$0
NPV_{MER}	−$1,929,509,000

This result indicates that with a cost of equity 6.95% where NPV_{ke} is equal to zero, the

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NPV_{MER} is near -$2 billion as displayed in Table 6-5. Unlike the illustration from the previous chapter, the real case represents the real money. Only considering the $NPV_{ke} > 0$ is not adequate to invest a BOT project with MER or uncertainty. As at the end of the previous chapter, V_4 was increased by adding up the 1st year of the cash inflow. In other words, to enable a positive NPV_{MER}, adequate cash inflow is necessary.

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Chapter 7 Conclusion and Recommendations

In the last chapter, the conclusion and recommendations were proposed to outline this paper and offer the future works with the suggestions. The purpose is to summarize the contributions of this thesis for the readers and researchers.

7.1 Conclusion

NPV is the most popular method to value the project finance. With the discount rate, the investors can present value both inflow and outflow. However, estimating the required return is still a mystery in the finance world, especially in project financing. CAPM lies on the SML, brings the relationship of a company's return volatility and the market as a measurement for systematic risk. However, when a PPP project, which is a nontraded asset, lacks such information, the valuation cannot be estimated. Therefore, this research proposes an alternative model, the CML function, which estimates the volatility of a company to the total risk of the market assuming that such functional company is well organized and their company portfolio is on the CML.

Additionally, PPP projects like BOT projects have often faced the risk of the estimation on the revenue of the operation and investment on assets, which is defined as Mean Estimated Risk (MER). Without the complete historical data and information, the simulation on MER is assumed in a triangle distribution where the education guesses on minimum, most likely and the maximum value of the forecast. Take the case study as an example; the sewage treatment BOT project is built in a developing city. Even though the government estimated the sewer based on a similar situation in a different city; but the domestic household connection rate which has a direct impact on the sewage CMD. This

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estimation of the CMD is revealed in the first year of the operation. Since the forecast sewage CMD is based on the very first year, if the estimated is incorrect with an enormous difference, the project has faced the risk of net loss. This is the definition of the MER when the uncertainty involved. Meanwhile, the construction cost, which is not related to the market performance but the technique, engineering management, and scheduling, has its MER to build on a budget.

Assuming that at the reveal year, the actual valuation is projected with the value V discounting by the cost of equity. Then the construction cost (C) prior to the operation is discounted by the risk-free rate, which is assumed that the market is not able to measure the construction cost. Then the relationship between V and C is displayed as:

$C_0 * (1+ r_c)^t = V_t$ where t is the reveal year, and r_c is the required return for the initial construction cost. With the uncertainty, the Monte Caro Simulation is made to calculate the r_n, which is the nontraded rate of return. After the simulation, the $E(r_n)$ or expected return is calculated, and the required return R_n is calculated from the CML function with the standard deviation or σ_n. If the expected return of the construction investment is higher than the required rate of return, the project is worth to invest.

The significant contribution of this research is the illustration of finding the project risk when there is no market beta. Since there is no firm evidence of the relationship with market performance and the construction and the revenue of the BOT project, the MER is applied for the risk measurement. After simulation on the uncertainty, with the volatility of the expected return, the CML function concludes the required return of the nontraded assets. With the R_n, the NPV_{MER} can be calculated as an extended version of the NPV on nontraded assets with the uncertainty. This provides a better standard for the investors

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rather than traditional NPV.

7.2 Recommendations

The contribution of these results is to showcase the problem of using the traditional NPV method when the investors underestimate the Mean Estimation Risk of construction and operation. Before applying the MER, the investors were willing to take this project with the required return 6.95%. However, the results show that the decision based on MER should not be the same when the expected return is significantly smaller than the required return. Indeed, the unique characteristics of this sewage treatment plant BOT project would result biased of the research. With continuing construction built after the operation started, this brings a vast amount of cash outflow for the project as a minus of the (V). This is not a typical scenario for BOT projects. For future research, another case study should be illustrated. With more case study implemented in the MER evaluation model, the impact and the importance of Mean Estimation Risk can be, as a result, demonstrated to the audience.

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