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Estimating Capital Cost of Project in the Inefficient Market

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ABSTRACT

The method for estimating capital cost of project based on CAPM does not work in the inefficient market. According to frameworks that using BAPM to estimate capital cost of project, this paper detailed how to eliminate noise trader risk and un-lever financial leverage to obtain the project beta, provided the theoretical basis of choosing the yield-to-maturity on one-year book-entry treasury bonds as risk-free rate and substituting Shanghai Composite Index for market portfolio. This paper not only proposed logical steps to estimating market risk premium, but also have estimated and provided the value of risk-free rate and market risk premium, which is respectively 3.52% and 10.01%. In this paper, we provided more realistic and practical method for estimating capital cost of project in the inefficiency market, which would be helpful to improve the quality and efficiency of project investment decision

Keywords: *Inefficient market; BAPM; capital cost of project; project investment decision*

1. INTRODUCTION

Capital Cost of Project play an important role in corporate finance practices. Therefore, how to estimate capital cost of project is an important problem studied continuously by many scholars in Finance. Under the condition that capital market is efficient and perfect, people usually adopt the following steps to estimate capital cost of project (Graham, 2001; Baker, 2011). Firstly, substitute stock beta (β_{stock}) for equity beta (β_{equity}) into Capital Asset Pricing Model (CAPM) to obtain the cost of equity capital. Secondly, calculate the weighted average of cost of equity capital and cost of debt capital, namely weighted average cost of capital (WACC). However, the study of Behavioral Corporate Finance shows that, securities market is not efficient in reality, the price of some stocks do not reflect their intrinsic value (Shleifer, 2000; Haugen, 2001; Baker, 2011). On that basis, Shao (2008) suggests that stock beta obtained from CAPM contains noise trader risk (NTR) and it is no longer equal to equity beta by formula deduction. In addition, the author clearly indicated that Behavioral Asset Pricing Model (BAPM) issued by Shefrin in 1994, can be used to estimate the capital cost of project and provide its frame idea as well. Based on the theory frame of BAPM, this paper will make an intensive study to refine its logical steps and concrete technique of how to estimate the capital cost project in the inefficient market.

In order to apply BAPM to estimate the capital cost of project, we need to know the value of several key parameters in the model, such as risk-free rate, market risk premium and project beta. Therefore, the major issues of this paper focus on the following questions: (1) How to select comparable companies, eliminate noise trader risk to obtain equity beta and un-lever financial leverage in the process of estimating project beta? (2) In the estimation of risk-free rate, which kind of monetary instrument could substitute for risk-free asset, which yield to maturity on risk-free asset should be select and what is the estimated value of risk-free rate in China? (3) When calculating the market risk premium, which market index could substitute for market portfolio, how to decide the length of data period and calculate the average return rate of market index?

2. USING STOCK MARKET INFORMATION FOR PROJECT BETA ESTIMATION

Systematic Risk of a project, measured by **project beta** or $\boldsymbol{\beta_{project}}$, is the most important parameter in applying BAPM to estimating the capital cost of project. Those investment projects are ahead events whose risk isn't observable, so it is necessary to use public and adequate information in stock markets to estimate capital cost of project. That is to say, we can use the information of some listed comparable companies to estimate the betas. Above all, we need to figure out the relations among all kinds of beta.

2.1 Relation Analysis of Different Betas

Shao (2012) suggest that, a certain system risk factor which affects return of all assets in the market can first cause the volatility of sales revenue, denoted by **sales beta** ($\boldsymbol{\beta_{sales}}$). With operating leverage measured by Degree of Operating Leverage (DOL), earnings before interest and taxes (EBIT) or return on assets (ROA) will experience larger volatility than sales revenue, denoted by **asset beta** ($\boldsymbol{\beta_{asset}}$). With financial leverage measured by Degree of Financial Leverage (DFL), earning after taxes (EAT) or return on equity (ROE) will experience larger volatility than ROA, denoted by **equity beta** ($\boldsymbol{\beta_{equity}}$). Besides, noise trader risk (NTR) in stock market make the stock price more volatile, denoted by **stock beta** ($\boldsymbol{\beta_{stock}}$), as shown in Figure 1.

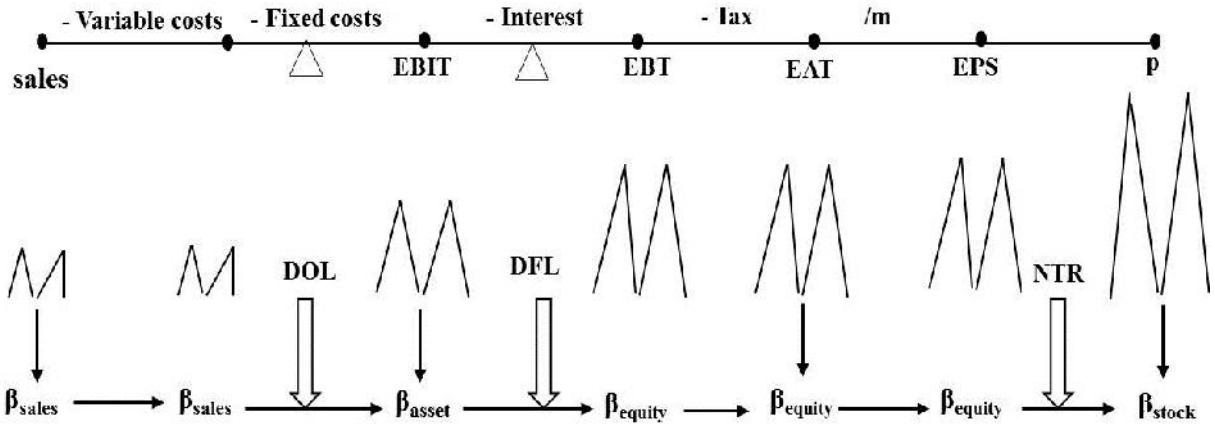

Fig 1: Transmission Mechanism of Systematic Risk Inside the Company

AS you can see From Figure 1, the gap exists between sales beta and asset beta because of operating leverage, we can re-lever sales beta with the operating leverage to obtain asset beta. Similarly, the gap exists between asset beta and equity beta out of financial leverage, we can un-lever equity beta with the financial leverage to obtain asset beta. Furthermore, the gap exists between equity beta and stock beta because of noise trader risk, and it shows that equity beta is not equal to stock beta any more in the inefficiency market.

2.2 Estimation Approaches For Project Beta

According to relation analysis of different betas in section 1.1, the key steps to obtain asset beta from stock beta include: (1)equity beta is no longer equal to stock beta, so noise trader risk incorporated in stock beta need eliminating to obtain equity beta based on BAPM. (2) Un-lever the equity beta with the financial leverage to obtain the asset beta.

There are some specific steps in using stock market information to estimate project beta, including choosing some comparable companies from listed companies, eliminating noise trader risk incorporated in stock beta to obtain equity beta, un-levering financial leverage of comparable companies to obtain their own asset betas, calculating average value of those asset betas and use it as project beta, as shown in Figure 2.

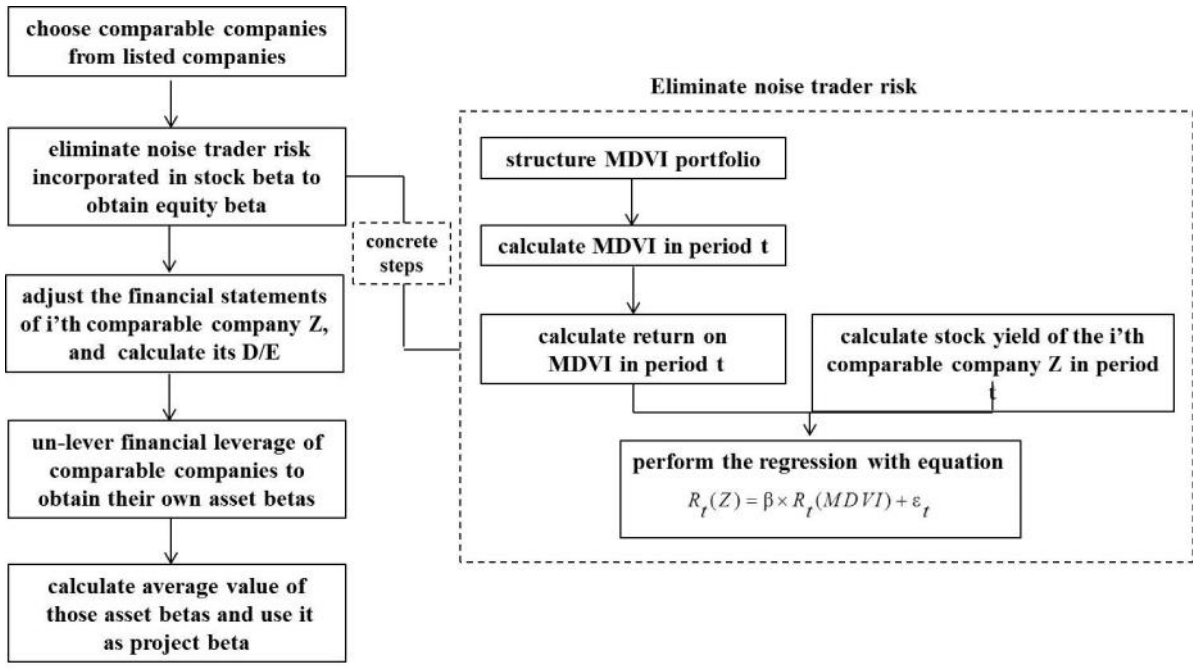

Fig 2: The logical steps in using stock market information to estimate project beta

Step One: **Choose Some Comparable Companies from Listed Companies**

Comparable companies should have similar business with the project. On one hand, if they have similar business, their asset structure and cost structure will be similar to each other. In this way, their operating leverage is similar, too. On the other hand, they share the common market, so the systematic risk factor has the similar effect on their sales revenue. In this case, the asset betas of comparable companies could be used as estimated value of project beta.

If comparable companies could not be found for some reasons like new technology project, we can look for comparable companies from potential customers of the project in the industry chain downstream. The main reason why we can adopt this approach is that risk source of comparable companies is the volatility of sales revenue. Cost structure could be inferred from asset structure of a company, so that we can infer the proximity of their operating leverage from the cost structure. If the project and its potential customers have the similar operating leverages, then we can use asset beta of potential customers as the project beta. If the difference of their operating leverages is great, then re-lever sales beta with project's operating leverage to obtain project beta.

Step Two: Eliminate Noise Trader Risk Incorporated In Stock Beta to Obtain Equity Beta

When using the CAPM, people usually substitute market index for market portfolio in regression of stock beta. However, stock beta obtained in this way may contain noise trader risk and is not the equivalent of equity beta any more. In order to get rid of noise trader risk, we have to find out the portfolio that can reflect the sentiment of market traders or noise trading. Ramiah (2002) summarized the previous studies and indicated that "there is enough evidence to believe that trading volume will be affected when there are noise traders in the market" and constructed the Dynamic Volume Index (DVI) based on the trading volume. In the application of Dynamic Volume Index, some scholars find that the calculation of DVI is very large and they usually substitute the stock price index for Dynamic Volume Index. According to experience of DVI application in China, Shao (2008) put forward two modifications of Dynamic Volume Index and constructed the Modified Dynamic Volume Index (MDVI). The first modification is to use turnover rate of stock exchange instead of the trading volume as the criterion to choose stocks joining the portfolio and the second modification is that stocks in the dynamic portfolio should be relative stable in a period rather than changing in every day. In this way, we can obtain equity beta without noise trader risk when substituting MDVI for market portfolio in the regression. The operational details are shown as follows:

a. Access to information from the financial services websites, including daily turnover rate of each stock and the average daily turnover rate of stock exchange.
b. Structure MDVI (modified dynamic volume index) portfolio: we first select all the active stocks whose daily turnover rate is higher than the average daily turnover rate of stock exchange. If its number of active days is more than half actual trading days of the stock exchange, then the stock gets picked to MDVI portfolio.
c. Calculate modified dynamic volume index MDVI . The calculating formula for MDVI in period t is shown as the following:

$$MDVI_t = \frac{\sum (S_{it} \times P_{it})}{\sum (S_{i0} \times P_{i0})} \times I_0 \qquad (1)$$

where, S_{it} is shares outstanding of the i^{th} stock selected to MDVI portfolio in period t; S_{0t} is shares outstanding of the i^{th} stock selected Ito MDVI portfolio in period 0; P_{it} is the stock price i of the i^{th} stock selected to MDVI portfolio n period t; P_{i0} is the stock price i of the ith stock selected to MDVI portfolio n period 0; I_0 is an adjustable factor.

d. Calculate return on MDVI. The calculating formula for return on MDVI in period t is shown as the following:

$$R_t(MDVI) = \frac{MDVI_t - MDVI_{t-1}}{MDVI_{t-1}} \qquad (2)$$

e. Calculate stock yield of the i^{th} comparable company Z. The calculating formula for $R(Z)$ in period t is shown as the following:

$$R_t(Z) = \frac{P_t - P_{t-1}}{P_{t-1}} \qquad (3)$$

f. Perform regression to obtain equity beta with the equation as the following:

$$R_t(Z) = \beta \times R_t(MDVI) + \varepsilon_t \qquad (5)$$

where ε_t is residual term.

In the light of the step above, most of the noise trader risk could be eliminated so that we could obtain equity beta exclusive of noise trader risk of comparable company Z

Step Three: Un-Lever Financial Leverage of Comparable Companies to Obtain Their Own Asset Betas

Operational details are shown as follows:

a. Adjust the financial statements of i^{th} comparable company Z, and separate their own operating liabilities and financial liability.
b. Calculate the debt-equity ratio (D/E) of i^{th} comparable company Z. Because financial liability can produce financial leverage effect, D in the debt-equity ratio refers to financial liability only.
c. Un-lever financial leverage to calculate the asset betas of each comparable company. Most corporate finance textbooks follow Hamada (1972) and Rubinstein (1973) to un-lever an equity beta. The model with taxes is shown as the following:
d.

$$\beta_{asset} = \frac{\beta_{equity}}{\left[1 + 1 - T \quad D/E\right]} \qquad (4)$$

Step Four: Calculate Average Value Of Those Asset Betas And Use It As Project Beta.

The calculating formula of project beta is shown as the following:

$$\beta_{project} = \frac{\beta_{asset(1)} + \cdots + \beta_{asset(n)}}{n} \qquad (5)$$

3. ESTIMATION OF RISK-FREE RATE

With regard to risk-free rate, foreign scholars consider the use of T-bills yields in the study as they have virtually no default risk or interest rate risk (Geltner, 2007; Hutchison, 2011). While some Chinese scholars use the banks' deposit rates like 3-month banks' deposit rates or one-year banks' deposit rates for the risk-free rate in the current research. It is because that banking system in China mainly consists of state-owned commercial banks, the probability of default risk is low. However, bank deposits are less safe than national debt. Besides, there is no secondary market for bank deposits, so that it cannot be freely transferred and cannot efficiently reflect the market traders' inflationary expectations. It is thus clear that using the banks' deposit rates for risk-free rate is unreasonable. And then the question is, how should we obtain estimated value of risk-free rate?

Practically, we usually adopt the following approach to obtain estimated value of risk-free rate. That is to select a monetary instrument that meets the standards of risk-free asset, and substitute its rate for return for risk-free rate.

3.1 The Substitute of Risk-Free Asset

Risk-free asset shall have corresponding characteristics, including security, liquidity, good profitability, marketability and rationality of term structure. So the substitute of risk-free asset should match all its standards. **This paper argues that book-entry T-bonds is the best substitutes for risk-free asset based on concrete causes presented below:**

a. T-bonds are at the highest security level among the alternative options, so that it has the security to meets the standards of risk-free asset.
b. Certificate T-bonds and savings bonds could be issued over the counter in bank, but they cannot be listed. However, book-entry T-bonds could circulate or transfer in the share market. In addition, T-bonds repo market in China greatly increased the liquidity of T-bonds. Therefore, it is reasonable to substitute T-bond for risk-free asset.
c. Profitability of T-bonds is relatively good.
d. The divisibility of Chinese bond market is getting weaker and weaker, and the two markets are appearing to the gradual integration. So T-bonds have marketability.
e. T-bonds with different maturities could meet the reasonable standard of term structure.

3.2 Risk-free Rate Estimation for China Stock Market

According to section 2.1, book-entry T-bonds is selected as the best substitutes for risk-free asset, the question is what kind of yield-to-maturities (YTM) on the T-bonds should be chosen as risk-free rate?

Up till now, there are different types of short-term book-entry T-bonds in Chinese bond market, including 3-month, 6-month, 9-month and one-year book-entry T-bonds is selected. However, limited circulation of 3-month, 6-month, 9-month book-entry T-bonds would lead to lack of data. For this reason, we should substitutes YTM of one-year book-entry T-bonds for risk-free rate.

One-year book-entry T-bonds has been issued since 1994, listed in Table 1. All data in Table 1 came from http://bond.hexun.com and http://www.gildata.com. We apply arithmetical method to calculating average yield-to-maturity of one-year book-entry T-bonds issued from 1994 to 2012 and it comes out 3.52%. That is to say, the estimated value of risk-free rate in China is 3.52%.

Table 1: Chinese one-year book-entry treasure bonds issued in 1994-2012 and their YTM

T-bonds	Issuing date	Period	INT payment	YTM(%)
000294	31/01/1994	1	Yearly-pay	11.98%
101951	26/08/1995	1	Yearly-pay	11.98%
000295	26/08/1995	1	Yearly-pay	11.98%
000196	08/01/1996	1	Discounting	12.07%
000596	02/04/1996	1	Discounting	12.04%
000011	24/11/2000	1	Yearly-pay	2.35%

020008	12/07/2002	1	Discounting	1.91%
030012	11/12/2003	1	Discounting	2.54%
010401	15/03/2004	1	Discounting	2.35%
010502	15/03/2005	1	Discounting	2.11%
050006	15/06/2005	1	Discounting	1.14%
050010	15/09/2005	1	Discounting	1.40%
060008	15/06/2006	1	Yearly-pay	1.96%
060015	15/09/2006	1	Yearly-pay	1.93%
070002	15/03/2007	1	Yearly-pay	2.10%
070009	14/06/2007	1	Yearly-pay	3.66%
070016	13/09/2007	1	Yearly-pay	2.95%
070020	13/12/2007	1	Yearly-pay	2.61%
080009	06/10/2008	1	Yearly-pay	3.42%
080016	08/09/2008	1	Yearly-pay	3.34%
080024	08/12/2008	1	Yearly-pay	1.28%
019908	14/05/2009	1	Yearly-pay	0.89%
019914	09/07/2009	1	Yearly-pay	1.06%
019921	03/09/2009	1	Yearly-pay	1.46%
019928	11/11/2009	1	Yearly-pay	1.44%
019004	04/03/2010	1	Yearly-pay	1.44%
019011	29/04/2010	1	Yearly-pay	1.49%
019021	15/07/2010	1	Yearly-pay	1.87%
019030	09/09/2010	1	Yearly-pay	1.87%
019036	11/11/2010	1	Yearly-pay	2.15%
019101	13/01/2011	1	Yearly-pay	2.81%
019109	24/03/2011	1	Yearly-pay	2.8%
019111	05/05/2011	1	Yearly-pay	2.77%
019118	14/07/2011	1	Yearly-pay	3.48%
019120	15/09/2011	1	Yearly-pay	3.9%
019201	12/01/2012	1	Yearly-pay	2.78%
019202	08/02/2012	1	Yearly-pay	2.87%
019211	14/06/2012	1	Yearly-pay	2.15%
019219	18/10/2012	1	Yearly-pay	2.94%

4. ESIMATION OF MRP FOR CHINA STOCK MARKET

Market risk premium (MRP) suggests the risk premium that investors can gain by bearing every unit of systematic risks, is a key input into estimating costs of capital in both corporate finance and valuation. The estimated value of MRP is the differentials between the expected return on a market portfolio and the risk-free rate, formulated by (R_M-R_f). Common estimation methods of MRP in the current study include the historical method, the prospective method and the questionnaire method. In this paper, we sum up the characteristics of these methods, as shown in Table 2.

Table 2: Characteristic analysis on estimation methods of MRP

Type	Characteristic
Prospective method	(1) Essential data needed for prospective method is predicted data, which is affected by many factors and it is hard to obtain predicted data. (2) The prospective method is only suitable for mature stock market.
Questionnaire method	(1) The questionnaire method is quite subjective and lack of theoretical basis. (2) We can obtain value ranges not an accurate numerical result of MRP through this method.
Historical method	(1) The historical method assumes that market risk premium in the future is similar to those in the past. (2) History data is available and objective.

The stock market in China is a new developing market with only 20-year history, so the prospective method is not suitable. Furthermore, the questionnaire method is not suitable due to its strong subjectivity and lack of theoretical basis. History data is available and objective, and historical method is frequently used to estimate MRP (Cornell, 1999; Brailsford, 2008; Ross, 2011; Brailsford, 2012). Therefore, historical method is adopted for MRP estimation.

There are some specific steps in historical method for estimating MRP as shown in Figure 3, including selecting stock market index, selecting time period, calculating average rate of return on stock market index, estimating risk-free rate and MRP.

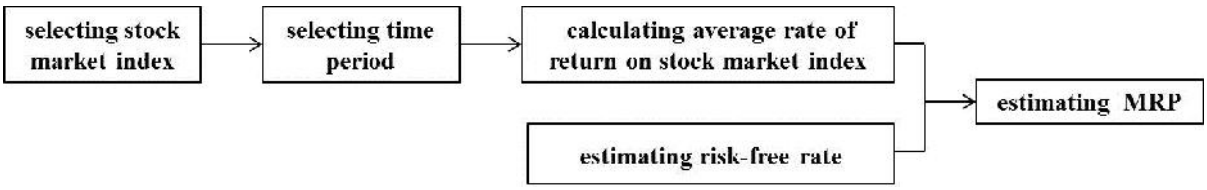

Fig 2: logical steps in using historical method to estimate MRP

4.1 Selection of Stock Market Index

Theoretically, all stocks should be taken into account when we estimate the market risk premium, which is thought to be not suitable. Therefore, we should substitute the stock market index with highest representativeness for market portfolio according to actual conditions of a country. This stock market index should possess the following characteristics:

a. Comprehensive-Stock market index must contain enough stocks and occupy a large proportion of market value.
b. Substantial: Stock market index must contain a longer period and more amount of data in order to reflect situation of MRP.
c. Representative and typical.

There are many stock market indexes in our country, so we analyze their characteristic and decide whether they can substitute for market portfolio based on the characteristics above. Concrete analysis is as follows:

a. All the industry stock index, the style index, index of scale and sartorial index are not suitable, because they just show characteristics of some stock and lack of representativeness.
b. The Shanghai and Shenzhen 300 Index reflects the performance of all stock in Shanghai and Shenzhen Stock Exchange. However, the preparation of this index started in 2002 and only 300 stocks were selected into preparation. In general, Shanghai and Shenzhen 300 Index does not contain a longer period and cover a wide range of stock samples.
c. Both Shanghai Composite Index and Shenzhen Composite Index belong to composite index, which contain a larger range of stock samples. They both meet the characteristics of market portfolio.

When comparing with Shenzhen Composite Index, Shanghai Composite Index has a longer history and larger data-volume. Besides, Shanghai stock market is more typical than Shenzhen stock market and reflects more characteristics of the China stock market. Therefore, it is suitable to substitute Shanghai Composite Index for market portfolio in our country.

4.2 Selection of Time Period

Historical method has a premise that market risk premium in the future is similar to those in the past. It also assumes that data should be stable when using history data for estimation of MRP.

AS we known, stock returns are volatile in the short term. Therefore, we should select time period as long as possible, in order to eliminate the effect of abnormal factors and obtain a relatively accurate estimated value of MRP. Given this, time period in the article is 21 years, from January 1, 1991 to December 31, 2012 based on the specific situation of Chinese stock market.

4.3 Calculating Average Rate of Return on Stock Market Index

Before calculating average rate of return on stock market index, we need to find out which method is suitable, arithmetical average method or geometric method? The biggest difference between geometric method and arithmetical average method is that arithmetical average method is suitable for independent event, but geometric method is suitable for dependent events. According to historical method, history data is used for predicting expected MRP, so each history data is regarded as independent sample. Besides, MRP calculated by arithmetical average method is the better one to reflect opportunity cost of investment capital with similar systematic risk. Therefore, we should use arithmetical average method when calculating MRP for estimation of capital cost.

History data of Shanghai Composite Index that obtained from financial databases is daily return rate, so we need to turn it into annual rate, as shown in Table 3.

After elimination of the abnormal data, average annual rate of return on Shanghai Composite Index from 1991 to 2012 comes to 13.53% by arithmetical average method.

Table 3: Average annual rate of return on Shanghai Composite Index from 1991 to 2012

Year	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**
annual rate	84.31%	152.34%	24.80%	1.03%	-4.10%	62.36%
Year	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
annual rate	32.31%	-1.90%	21.27%	43.97%	-20.79%	-16.43%
Year	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
annual rate	11.33%	-14.63%	-6.43%	85.81%	73.71%	-95.92%
Year	**2009**	**2010**	**2011**	**2012**	-	-
annual rate	63.25%	-13.10%	-22.79%	9.69%	-	-

Comment: The figures in parentheses are abnormal data, which have been eliminated.

4.4 MRP of China

From section 3.2 and 3.3, we have known that risk-free rate is 3.52% and average rate of return on stock market index is 13.53%. So MRP of China is 10.01%, whose calculation is as following:

$$MRP = \overline{R}_M - R_f$$
$$= 13.53\% - 3.52\% = 10.01\% \quad (6)$$

5. CONCLUSION

Irrational behavior of securities investors and limited arbitrage causes the deviation between market prices and intrinsic values of some stocks. This is to say, security market is not efficient in reality. In that case, application conditions of CAPM cannot be met, equity beta is no longer equal to stock beta, and the method for estimating capital cost of project based on CAPM doesn't work in the inefficiency market. According to frameworks that using BAPM to estimate capital cost of project, the article provides operating steps for the project beta, including how to choose comparable companies from listed companies, structure MDVI portfolio to eliminate noise trader risk and un-lever equity beta to obtain asset beta. Besides, the article makes a sound analysis and exposition of how to estimate risk-free rate and market risk premium. On one hand, we choose the yield-to-maturity on one-year book-entry treasury bonds as risk-free rate, and provide its estimated value of 3.52%. On the other hand, taking securities market in China as an example, we substitute Shanghai Composite Index for market portfolio to obtain MRP, and provide its estimated value of 10.01%. In general, the article provides more realistic and practical method for estimating capital cost of project in the inefficiency market.

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