D-CAPM and RD-CAPM in Return Anticipation at Tehran Stock Exchange

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Abstract

From longtime ago, capital market has been engaged in decision-making about providing an optimum high-quality portfolio. Investors were always seeking a logical data base for correct dicision-making about shares. In recent years, Capital Assets Pricing Models (CAPM) have been broadly used to estimate securities return logically. In this research, anticipation power of Downside CAPM (D-CAPM) and Revised Downside CAPM (RD-CAPM) models to estimate destination year return (DYR) was examined. D-CAPM is a developed type of CAPM that anticipates DYR according to past data and systematic risks of company. In contrast, RD-CAPM additionally applies non-systematic risk in frame of financial and operational levers in its mathematical structure to anticipate DYR more precisely. Finally, we compare these two models in Tehran Stock Exchange for a period of eight years (2001-2009) to anticipate return of companies in destination year.

Keywords: Capital Assets Pricing Model (CAPM), Downside CAPM (D-CAPM), Revised D-CAPM (RD-CAPM), risk, return

1. Introduction

Capital markets as cheap finance sources play an important role in development of each country. Notice to this problem may organize financial and economical structure of a country. Therefore, leading unused funds toward major economical investment affect financial markets.

In financial market area, most concentration was on capital markets, and its performance was greatly investigated up to now. However, because of its complexity, this market requires more research to recognize its contributions and to prevent vacation of markets, so that it was recently happened in New York and London financial markets.

CAPM relates two main columns of each business namely risk and return. In recent years, this model has been noticed to anticipate future market behaviors and model real world performance. This may prevent transmission of financial crises.

CAPM models present expected return of each asset proportional to its risk by measurement of its systematic risk. By development of these models, we may form the optimum portfolio and source assignement.

Modern CAPM models can enter non-systematic risk in pricing equation rather than systematic one. Theoretically, they could near two concepts of risk and return. These models consider elements that create systematic and non-systematic risks by considering internal variables of a company and negative market risk. They describe more percentage of expected return theoretically and use financial, economical, and operational levers in their mathematical models.

This paper studies anticipation power of these two models for investors to assign sources better. Then investors can select the most compatible model with capital structure. Thus, they will expect an expected return proportional to the risk they incurred. In long term, this increases confidence and risk-taking of investors. Naturally, by increment of risk-taking, investors claim for less reward and eventually, capital cost will decrease.

1.1 Research History

First researches that related accounting components to systematic risk took place in 1970s and 1980s (Ray, 2009). Recent studies showed that profit vibration is an accounting variable which is related to stock systematic risk (Balbás et al., 2010; Low & Nayak, 2009; Chen, 2003).

There are many researches about capital assets that are different by market and time conditions. We refer to some cases here.

Spreitzer and Reznik (2007) sought to know investment fund portfolios by CAPM model and then to calculate role of return rate in this regard.

Levy (2007) introduced a new kind of capital asset pricing in his research called "positive-price CAPM".

Gonza´lez (2001) sought a replacement view for reduced beta and CAPM beta and suggested that selection of risk measurement criterion depends on current market.

Bartholdy and Peare (2003) showed that standard procedures to estimate beta independently in CAPM regression equation affects expected return.

Patton and Timmermann (2010) suggested that there were many theories indicating harmony of expected return and tried to anticipate expected return for securities in Hong Kong market. They also emphasized that CAPM with greater beta are more capable in anticipation of stock expected return.

Grauer and Janmaat (2010) applied cross-section tests on the two CAPM models and three Fama and French factors and provided a simple method to decrease data reclassification problems including weightless works.

Jerry Ho et al. (2011) offered DEMATEL (Note 1) combined technique with MCDM(Note 2) new model to discover selection by CAPM set.

1.2 Downside Capital Assets Pricing Model (D-CAPM)

Estrada (2002) propounded D-CAPM model. This model can suitably estimate expected return when market condition is asymmetric. In an asymmetric market, there are factors that affect either risk or expected return rate. Thus, it removes compromise of risk and return. In other words, investor would not obtain return as much as risk acceptance. In fact, it has a negative risk. Negative risk is the most important factor in D-CAPM. Strada introduced negative risk concept in capital assets pricing (CAP) in frame of D-CAPM pattern and found that CAPM up to 38% and D-CAPM up to 55% can estimate market in asymmetric conditions. He suggested that negative risk can offer a suitable estimation in and asymmetric market. These factors are changes of return rate without real economy risk, expected inflation rate, and probable risk reward rate.

By lapse of time, investors need more precise and realistic anticipation, which created a new generation of CAPM. Some of assumptions of developed CAPM models, such as R-CAPM are:

1) Regarding intrinsic and total (systematic/ non-systematic) risk to anticipate expected return rate

2) Using past and future data

Historical path of this innovation is:

1) Study of history of Markovitz theory

2) Capital market theories (CMT) including stock market curve and capital market curve

3) CAPM and its changes

4) Levers as risk measurement tools

5) Study of realities in capital market

6) Effect of past and future information in anticipation of expected return rate

1.3 RD-CAPM Model

Regarding to theoretical fundamentals of CAPM and assumptions of D-CAPM and R-CAPM, a new model titled "Downside Revised CAPM" (RD-CAPM) can be suggested in asymmetric market. Parts of a firm's risk for operational sale and decisions are concluded from these determinative decisions before interest and ta*x*. *(Rahnamy Rudposhti et al, 2009)*

These items are included in operational lever of RA-CAPM equation. Also, if profit is different before interest and tax with anticipated amounts, the firm encounters a financial risk, which these are also included in RA-CAPM. Also, sale sensitivity of a firm to economical disorders is considered in this model as economical

lever.

1.4 Intrinsic Risk in Lack of Operational, Financial, and Economical Risks

RD-CAPM calculates intrinsic risk of each company after exclusion of operational, financial, and economical risks under title $\beta 0$ of each stock. Then it provides a comprehensive criterion for risk of each company by combining operational, financial, and economical risks by accounting data not stock market data.

2. Research Method and Data Analysis

This is a descriptive research indicating that the researcher has no role in data control. Also, this is an application research by goal, namely the researcher tries to find application of a scientific principle in real world.

This is a correlation research, which the researcher seeks a correlation relationship between variables and then studies severity of this relationship. The goal of a correlation is an investigation about existence of a relationship and using it for future anticipation. In this research, βD and βRD as risk criteria are independent variables, and expected return is dependent variable. Anticipation power of independent variable for anticipation of expected return has been compared.

2.1 Research Territory

2.1.1 Time Territory

The research period is from 2001 to 2009. This period was selected because there was complete information about it in the selected companies.

2.1.2 Location Terrirory

The research location includes publicly traded companies in Tehran Stock Exchange.

2.1.3 Statistical Society

All companies accepted in Tehran Stock Exchange.

2.1.4 Statistical Sample

Statistical sample of this research includes all companies with at least one transaction day, except investment companies. Totally, 149 companies out of 337 were selected.

2.2 Research Assumption

RD-CAPM model is more powerful than D-CAPM in anticipation of expected return of capital assets in security market.

2.2.1 Approaches

The assumption is considered with three approaches. Thus, the assumption was tested by three different methods. These approaches are:

Approach 1: Expected value is equal to arithmetic average of return of previous periods.

Approach 2: Expected value is equal to geometrical average of return of previous periods.

Approach 3: Expected value is equal to real return.

2.3 Calculation Methods of Variables

Annual return of each stock is:

$$= \frac{(P_1 - P_0) + D + \frac{(P_1 - F) \times n_c}{n_0} + \frac{P_1 \times n_r}{n_0}}{P_0}$$

Annual return of each stock

where,

P_1 = stock price at end of year

P_0 = stock price at start of year

D = gross profit of each stock (according to the number of stock at start of year)

F = nominal value of each stock

n_c = number of added stocks by claims and cash

n_r = number of added stocks by savings and mass profit

n_0 = number of stocks at start of year

Non-risk return rate

Rate of securities in Iran can be considered as "non-risk return rate" (NRR). Since, this rate was 17% for 2001-2004 and 15.5% for 2005 and 2009 by report of The Central Bank of Iran, and since this was paid quarterly, then NRR is calculated by:

$$R F = [(1 + \frac{1}{4})^4 - 1]$$

According to this equation, NRR for 2001-2004 is 18.11 and it is 16.42 for 2005-2009.

Market return rate (MRR) and expected market return (EMR)

To calculate MRR, weighted average of return of 149 companies were investigated so that at first market value of each stock to sum of market value of all stocks is calculated for each stock. Then harmonic average of portfolio of 149 stocks was calculated.

$$R_m = \sum W_i R_i$$

where, W_i is ration of market value of each stock to sum of market value of all stocks at end of year. Market expected return, $E(R_m)$, is average of market portfolio return in the previous periods, similar to expected return.

Adjusted beta based on negative risk (β^D)

Adjusted beta factor (β^D) is a criterion to measure systematic risk of an asymmetric market. It compares risk of a financial asset with risk of all securities. Here we use semi-variance to calculate it:

$$\beta^D = \frac{\text{semi cov}(R_i, R_m)}{\text{semi Var}(R_m)}$$

$$\beta^D = \frac{E\{(\min[(R_i - \mu_i), 0], \min[(R_m - \mu_m), 0]\}}{E\{\min[R_m - \mu_m), 0]^2\}}$$

Non-systematic and justified risk criteria based on negative risk (β_j^0)

RD-CAPM principles are used to calculate (β_j^0). This model uses assumptions of R-CAPM and D-CAPM models. Thus, we have

$$\beta_j^0 = \frac{\text{semi cov}[((\frac{\pi_{j,t-1}}{Z_{j,t-1}})(\frac{\tilde{Z}_{j,t}}{E_{j,t-1}})), \tilde{R}_{m,t}]}{\text{semi var}_{m,t}}$$

where,

semi Cov = semi-variance

β_j^0 = intrinsic risk

$\pi_{j,t-1}$ = profit after interest and tax

$Z_{j,t-1}$ = economical disorder in period t-1

$Z_{j,t}$ = economical disorder in period t

$E_{j,t-1}$ = market value of company

$R_{m,t}$ = market portfolio return in period t

Adjusted beta is calculated by three lever degrees and intrinsic beta:

$$\beta_j^{RD} = (DEL)(DOL)(DFL)\beta_j^0$$

Calculation of return by D-CAPM

Return of each stock is calculated by assumptions of D-CAPM model and β_j^D:

$$K_j = R_i + \beta^D \ (R_m - R_i)$$

Calculation of return by RD-CAPM

Expected return is calculated by adjusted beta and modified beta, similar to D-CAPM model. Thus we have:

$$K_j = R_i + \beta^{RD} \ (R_m - R_i)$$

Assumption Test Methods

The first method is Pearson correlation coefficient. This method is mostly used in correlation researches. This method expresses correlation between independent and dependent variables with their significance. Regarding to the four independent variables (β^D, β^{RD}) and three dependent variables (returns obtained from the three approaches), we totally have 12 correlation coefficients that indicate confirmation or rejection of approaches.

In the second method, evaluation criteria of previous models were used to test conformity of calculated return with real values. These criteria, which are common to study anticipation power of a model in economy, are: Root Mean Squared Error (RMSE), Mean Absolute Error (MAE), Mean Absolute Percentage Error (MAPE), and Theil Inequity Coefficient (TIC), which this includes three components: bias proportion (BP), variance proportion (VP), and covariance proportion (CP). It should be mentioned that asymmetric coefficient is the most powerful evaluation criterion. If there is any inconsistency between these criteria, Theil criterion is used as decision criterion.

RMSE shows confidence of a model. If the value is less than RMSE, it indicated more conformity between data of model and reality. RMSE is calculated by:

$$\text{RMSE} = \sqrt{\sum_{j=1}^{h} \frac{(\hat{y}_j - y_j)^2}{h}}$$

where, $\hat{y}_j$ are value from the model and y_j are real values. h is number of observations.

MAE is precision criterion of the model and its lower values are more desirable. MAE is calculated as:

$$\text{MAE} = \sum_{j=1}^{h} \frac{\left|\hat{y}_j - y\right|}{h}$$

MAPE is error value of estimation or return by each model, which is written as a percentage and its lower values are more desirable. MAPE is calculated as:

$$\text{MAPE} = 100 \sum_{t=1}^{h} \frac{\left|(\hat{y}_t - y_t)/y_t\right|}{h}$$

TIC, which sometimes is used to test anticipation power in turning points, is the most powerful criterion in this set and is used if there is any inconsistency between values.

$$\text{TIC} = \frac{\sqrt{\sum_{t=1}^{h} \frac{(\hat{y}_t - y_t)^2}{h}}}{\sqrt{\sum_{t=1}^{h} \frac{\hat{y}_t^2}{h}} + \sqrt{\sum_{t=1}^{h} \frac{y_t^2}{h}}}$$

To describe three components in TIC, RMSE is considered and is divided into the following three components:

$$\sum(\hat{y}_t - y_t)^2 / h = ((\sum y_t / h) - \overline{y})^2 + (s_{\hat{y}_t} - s_y)^2 + 2(1 - r)s_y s_y$$

in which, $\Sigma\hat{y}_t / h$, $\overline{y}$, $s_{\hat{y}}$, and s_y are average and standard deviation of $\hat{y}_t$ and y_t, respectively, and r is correlation between $\hat{y}_t$ and y_t. Thus, three components of error are defined as

   1) BP indicating difference between average of anticipated values and average of real values,

2) VP indicating difference between variance of anticipated values and variance of real values,

3) CP indicating non-systematic errors.

These proportions are calculated as:

$$BP = \frac{((\Sigma \hat{y}_t / h) - \bar{y})^2}{\Sigma(\hat{y}_t - y_t)^2 / h}$$

$$VP = \frac{(s_{\hat{y}} - s_y)^2}{\Sigma(\hat{y}_t - y_t)^2 / h}$$

$$CP = \frac{2(1-r)s_{\hat{y}}s_y}{\Sigma(\hat{y}_t - y_t)^2 / h}$$

It should be noticed that maximum value of these proportions is 1.

3. Results

• Pearson correlation coefficient test

In this stage, correlation of main variables (betas of two models) and sub-main variables (return with different approaches) are shown.

• Relationship between betas of models and simple, geometrical, and real average of return

Table 1. Correlation of variables and relationships between betas

Approaches and models		Approach 1 RM	Approach 2 RG	Approach 3 R89
D-CAPM	Pearson Correlation	-0.133	0.156	0.124
	Sig.	0.483	0.412	0.515
RD-CAPM	Pearson Correlation	0.146*	-0.362*	-0.362*
	Sig.	0.041	0.049	0.035

• By study of output of SPSS for RM (return with approach 1), it is indicated that expected return obtained from simple average is positively correlated with β^{RD} in significance level 5 or even 1%, but not with β^D. Therefore, approach 1 is confirmed by significance level of 95%.

• By study of output of SPSS for RG (return with approach 2), it is indicated that expected return obtained from geometrical average is negatively correlated with β^{RD} in significance level 5%, but not with β^D. Therefore, approach 2 is confirmed by significance level of 95%.

• By study of output of SPSS for R89 (return with approach 3), it is indicated that real return is negatively correlated with β^{RD} in significance level 5%, but not with β^D. Therefore, approach 3 is confirmed by significance level of 95%.

Table 2. Evaluation criteria for anticipation power in D-CAPM model

D-CAPM	RMSE	MAPE	MAE	TIC
Approach 1	15.25999492*	0.360738688*	11.67283542*	0.153927438**
Approach 2	46.10341029	0.70594881	35.9694816	0.711118773
Approach 3	145.8450334	1.339933107*	90.53381608	0.903017956

Table 3. Evaluation criteria for anticipation power in RA-CAPM model

RA-CAPM	RMSE	MAPE	MAE	TIC
Approach 1	42.0865229	0.672928748	30.01090924	0.704390376
Approach 2	23.729174[*]	0.314288416[*]	16.38712247[*]	0.227681424[**]
Approach 3	138.8976403[*]	2.570267296	90.38430372[*]	0.69138671[**]

4. Discussion

In recent years, CAPM models have moved toward considering fundamentals of non-systematic risk in their structure. Many researchers have tried to conform these mathematical models with reality of capital market by removing their faults. Sometimes a model had inconsistent results in different markets. Therefore, finding a suitable pricing model for capital market structure is important. By finding this model, a step is done toward relationship between risk and return. By application of non-systematic risk in its structure, RD-CAPM tries to increase precision of return anticipation than D-CAPM, which only considers systematic risks.

In this research, by considering an 8-year return period to recognize return of year 9, it was found that RD-CAPM shows better results by Pearson method than D-CAPM. Here, D-CAPM had better results for return anticipation in approach 1, but the results is similar to Pearson method in approaches 2 and 3, and so, RD-CAPM is better.

As mentioned before, different approaches were used to recognize anticipation power of models. For approach 1, simple average of returns for 2001-2009 was used to calculate return of 2010. For approach 2, geometrical average of returns was used. Finally, for approach 3, real return of 200 was used.

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Notes

Note 1. Decision-making Trial and Evaluation Laboratory (DEMATEL)

Note 2. Multiple Criteria Decision-making