

Revised capital assets pricing model: an improved model for forecasting risk and return

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ABSTRACT

This study's aim is to examine a new version of capital assets pricing model which is called Revised Capital Assets Pricing Model (R-CAPM) in Tehran Stock Exchange (TSE). According to Markowitz theory, systematic and unsystematic risk effect expected rate of return, in this paper by combining Capital Assets Pricing Model (CAPM) and leverages (financial, operational and economic), we found a new model which we will call it Revised CAPM (R-CAPM).

We compared the R-CAPM with 3 models as follows:

1. Traditional CAPM which was established by Markowitz with the introduction of portfolio theory.
2. Downside Capital Asset Pricing Model (D-CAPM), suggested by Estrada (2002).
3. Liquidity Adjusted-Capital Asset Pricing Model (Adj-CAPM), offered by Acharya and Pedersen (2004).

We investigated this new model and compared it with the 3 models (CAPM, D-CAPM and Adj-CAPM) through experimental testing, for 70 firms listed on the stock exchange of Tehran for the period 2000-2007.

Results from the tests of the hypothesis show that, there is a meaningful difference between measures of the R-CAPM expected return and the CAPM, D-CAPM and Adj-CAPM expected return. The best model which can be used for predicting expected return in Iran stock exchange is R-CAPM. Another hypothesis shows that there is not a meaningful relation between the three macro economic variables (interest, exchange rate and inflation rate) and a firm's sales.

Keywords: Revised Capital Assets Pricing Model, Risk, Return

INTRODUCTION

Capital asset pricing model (CAPM) is a significant accomplishment in finance. Through this model, risk and reward for bearing it are widely quantified. Its key idea is that the expected excess return of an asset is proportional to the expected covariance of the excess return of this asset with the excess return of the market portfolio. In other words, the difference in risk premium across assets largely depends on the difference between riskiness of the returns on the assets. This explains why investors trade off return and risk.

According to CAPM, there is a linear equilibrium relation between the expected return of a financial asset and the perceived market risk, β is calculated by the covariance of the asset's return and the return of the market portfolio.

The above mentioned risk component is irreducible, unchangeable and can not be omitted through portfolio aggregation and as a result a price needs to be set for it. The central testable implication of the CAPM is that assets must be priced so that the market portfolio is mean-variance efficient (Fama and French, 2004). Earlier empirical evidence supporting the CAPM includes Black, Jensen, and Scholes (1972), Blume and Friend (1973), and Fama and MacBeth (1973).

"In CAPM method, all of the assets are considered. But practically there are some problems for measurement of return of all the assets or finding general market index. In order to meet these goals, common stock is used for explaining of the model. First hypothesis of CAPM is that a kind of linear relationship exists between stock return of each activity and stock market return during some periods. In capital assets pricing model, if we suppose short term treasury papers of a company as an asset which are supposed to be risk less, according to this model, investors should gain a return more than return of treasury paper, because they accept more risk. According to CAPM supposition the equation is used for calculation of securities market line:

$$K_j = R_F + \beta(R_M - R_F) \quad (1)$$

Where:

R_F = risk free rate of return, β = beta coefficient, R_M = return rate based on market index, $R_M - R_F$ = premium or excessive return of market (risk premium) compared to risk free rate of return".

Beta of asset i (β_i) equals the covariance between asset i and the market portfolio divided by the variance of the market portfolio:

$$\beta_i = \frac{\delta_{iM}}{\delta_M^2} = \frac{E[(R_i - \mu_i) \times (R_m - \mu_m)]}{E[(R_m - \mu_m)^2]} \quad (2)$$

CAPM explains that expected rate of return of an asset is a function of two parts: risk free rate of return and risk premium.

There are only a few non-CAPM based models, of which the best known and most relevant is developed by Estrada (2002). "It overcomes one of the most serious weaknesses of the CAPM; specifically, that investors are assumed to be averse to variance or total risk. In fact, as already mentioned, investors are motivated by their aversion to downside risk, that is, downside and upside swings are not equally important for the investors, as his or her pivotal goal when selecting an investment target is a desire to avoid an economic loss".

Estrada (2002) introduced the Downside Capital Asset Pricing Model (D-CAPM) to deal with the above mentioned problem. In general, the cost of equity calculated under the D-CAPM is higher than that of the CAPM and lower than that of the models double-counting the risk; therefore the D-CAPM should not only explain returns in developed countries, but in emerging market as well.

The usage of semi-variance and downside beta is the only difference between the D-CAPM and the CAPM. "The formula of the cost of equity under the D-CAPM therefore is as follows:

$$K_j = R_F + \beta^D \times (R_M - R_F) \quad (3)$$

Where β^D is the downside beta and like to the CAPM beta, is equal to cosemivariance divided by the market's semi variance of returns":

$$\beta_i^D = \frac{\delta_{im}}{\delta_m^2} = \frac{E\{Min[(R_i - \mu_i), 0] \times Min[(R_m - \mu_m), 0]\}}{E\{Min[(R_m - \mu_m), 0]^2\}} \quad (4)$$

Acharya and Pedersen (2004) in a paper called "Asset Pricing with Liquidity Risk" studied the effect of liquidity risk on CAPM. Liquidity risk is the risk coming from unpredictable changes in liquidity. "In their Liquidity –Adjusted capital asset pricing model (Adj-CAPM), a security's required return depends on its expected liquidity as well as on the covariance of its own return and liquidity with market return and market liquidity, if it is persistent, results in low contemporaneous returns and high predicted future returns. The model provides a simple, unified framework for understanding the various channels through which liquidity risk may affect asset prices".

"In Acharya and Pedersen model, the expected return of a security is increasing in its expected illiquidity and its "net beta". Their model defines the proportional to the covariance of its return, r_i net of illiquidity costs, C_i , with the market portfolio's net return, $R_M - C_M$.

The conditional expected net return of security i in this unique linear equilibrium is:

$$E(r_{t+1}^i - C_{t+1}^i) = r^f + \lambda_t \frac{\text{cov}_t(r_{t+1}^i - C_{t+1}^i, r_{t+1}^m - C_{t+1}^m)}{\text{var}_t(r_{t+1}^m - C_{t+1}^m)} \quad (5)$$

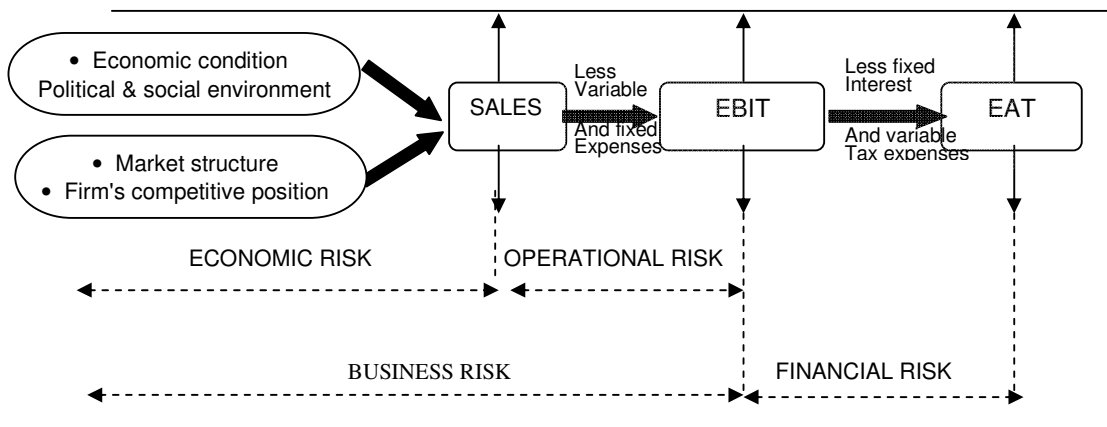
Where $\lambda = E_t(r_{t+1}^m - C_{t+1}^m - r^f)$ the risk premium and beta is equal to":

$$\beta = \frac{\text{cov}_t(r_{t+1}^i - C_{t+1}^i, r_{t+1}^m - C_{t+1}^m)}{\text{var}_t(r_{t+1}^m - C_{t+1}^m)} \quad (6)$$

However, past and recent tests criticized CAPM's assumptions, but it can be a foundation of developed approach with some adjustments and revision as we did it in this paper.

"Hamada (1969, 1972) demonstrated systematic risk can be decomposed into operating risk and financial risk and enter accounting variables into risk measuring discussion. Hawawini and Viallet (1999) showed multiple dimensions of systematic risk as Figure 1. They illustrated financial risk as the relation between earning after taxes and earning before interest and taxes, and operational risk as the relation between EBIT and sales".

Figure 1: Analysis of Multiple Dimensions of Systematic Risk.



This figure shows the economic, operational and financial risk
 From: Finance for Executives (1st ed.), by G.Hawawini and C.Viallet 1999.

Indeed, relating accounting numbers to market measures of systematic equity risk was mainly accomplished in the 1970s and early 1980s (Ryan, 1997). Such research can be divided as theoretical and practical studies. The theoretical studies have failed to guide the practical field (Foster, 1986). The outcome is regressions of market measures of market beta on different accounting measures of risk (Beaver, Kettler and Scholes, 1970; Pettit and Westerfield, 1972; Breen and Lerner, 1973; Rosenberg and McKibben, 1973; Thompson, 1974; Lev, 1974; Lev and Kunitzky, 1974; Bildersee, 1975; Beaver and Manegold, 1975) or the use of accounting number analogues to market derived measures of risk (Hill and Stone, 1980).

Hamada (1972) and Rubinstein (1973) began the theoretical work. They defined the multiplicative impact of financial leverage on the beta of the levered firm. There at the moment a famous result is:

$$\beta = \beta^* + \beta^* (1 - \tau) \frac{D}{E} \quad (7)$$

Where;

- β = the levered firm's common stock beta,
- β^* = the unlevered firm's common stock beta,
- τ = the corporate income tax rate,
- D = the market value of debt, and
- E = the market value of common equity.

While β^* was named as operating risk, Rubinstein found out that β^* reflected the combined effects of operating leverage, the utter systematic influence of economy wide events and the existing uncertainty which surrounds the operating efficiency of the firm. Lev (1974) separated operating leverage from the other two variables and realized that it is important on its own and reported that operating leverage has a positive effect on systematic risk. Financial leverage also has a positive effect on systematic risk (Myers, 1977) and explains about 25 percent of systematic risk (Hamada, 1972).

Gahlon and Gentry (1982) developed a model for calculating beta that included the degree of operating leverage (DOL) and the degree of financial leverage (DFL) as explicit variables. "Specifically, the study examined how operating and financial decisions will affect systematic risk and value. They identified the DOL and DFL as real-asset risk measures. Furthermore, they analytically demonstrated that beta is a function of the degrees of operating

and financial leverage, the coefficient of variation of the revenues, and the correlation coefficient between the cash flows to the owners and the aggregate dollars return to all capital assets".

"Huffman (1989) found that systematic risk is positively related to DFL but negatively related to DOL. Mensah (1992) pointed out that the operating, financing and strategic decisions of a firm are related to its systematic risk".

"Li and Henderson (1991) examined the relation between combined leverage and common stock risk, and report that high growth firms have high operating and financial leverages at the same time".

"Mandelker and Rhee (1984) explicitly incorporate measures of the degree of operating and financial risk into their theoretical model and arrive at the following relationship":

$$\beta_j = (DOL)(DFL)\beta_j^0 \quad (8)$$

Where,

$$DOL = \frac{(\tilde{X}_{jt}/X_{jt-1})-1}{(\tilde{S}_{jt}/S_{jt-1})-1}, \quad (9)$$

$$DFL = \frac{(\tilde{\Pi}_{jt}/\Pi_{jt-1})-1}{(\tilde{X}_{jt}/X_{jt-1})-1} \quad (10)$$

And

$$\beta_j^0 = Cov[(\Pi_{jt-1}/S_{jt-1})(S_{jt}/E_{jt-1}), R_{mt}] / \sigma^2(R_{mt}) \quad (11)$$

Where,

\tilde{X}_{jt} = earnings before interest and taxes for company j in period t

\tilde{S}_{jt} = sales for company j in period t

$\tilde{\Pi}_{jt}$ = earnings after interest and taxes for company j in period t

β_j^0 = the intrinsic business risk of common equity of company j

E_{jt} = the market value of common equity of company j in period t

R_{mt} = the rate of return on the market portfolio for period t-1 to t.

"Griffin and Dugan (2003) considered multiple dimensions of systematic risk defined by Hawawini and Viallet and empirically represented the economic risk construct through the use of the term, degree of economic leverage (DEL). They define DEL as a percentage change in firm's sales resulting from a unit percentage change attributable to an exogenous disturbance, so"

$$DEL = \frac{(\tilde{S}_{jt}/S_{jt-1})-1}{(\tilde{Z}_{jt}/Z_{jt-1})-1} \quad (12)$$

Z_{jt} = exogenous disturbance in period t.

They developed Mandelker and Rhee's model by using DEL in Mandelker and Rhee's β_j^0 and offered their risk measure as:

$$\beta_j = (DEL)(DOL)(DFL)\beta_j^0 \quad (13)$$

Where

$$\beta_j^0 = Cov[(\Pi_{jt-1}/Z_{jt-1})(Z_{jt}/E_{jt-1}), R_{mt}] / \sigma^2(R_{mt}) \quad (14)$$

All mentioned researches have resulted in definition of some leverage as well determinants of systematic risk and have not discussed expected return. In this paper we

extended Griffin and Dugan's model to estimate expected return as we believe this computation of beta have a rigorous explanatory power considering firm's intrinsic variables. So we utilize systematic and unsystematic risk through combining leverage and the traditional CAPM as well as historical and estimated data completely and we will call it Revised Capital Asset Pricing Model (R-CAPM).

According to R-CAPM supposition the equation is used for linear calculation of securities market:

$$K_j = R_F + \beta^R (R_M - R_F) \quad (15)$$

Where:

$$\beta^R = (DEL)(DFL)(DOL)\beta^o_j \quad (16)$$

The CAPM, D-CAPM and Adj-CAPM focus only on systematic risk and historical data, but in R-CAPM to achieve more accurate prospecting predicted return, we use systematic and unsystematic risk as well as historical and estimated data completely.

Methodology

The objective of the present research is to demonstrate the degree of economic leverage as a determinant of systematic risk, and the assessment of the incremental explanatory power of the DEL through empirical testing.

Research method is according to survey method and is of a correlation type and regression which its main goal is definite the relationship among some quantitative variables.

Population of this research is 70 companies in Tehran Stock Exchange which have operated for 8 years, since 21 March 2000 to 21 March 2007.

We use Mandelker and Rhee model to provide the theoretical framework for the DEL. In this research the unit percentage change attributable to an exogenous economic disturbance is changes in three macroeconomic variables:

- Interest rate,
- Exchange rate,
- Inflation rate

Based on the above literature, this study seeks to test the following hypotheses:

H_1 : There is a meaningful relation between interest rate and company's sale.

H_2 : There is a meaningful relation between exchange rate and company's sale.

H_3 : There is a meaningful relation between inflation rate and company's sale.

H_4 : There is a meaningful difference between accumulated beta by DEL and accumulated beta by CAPM, D-CAPM and Adj-CAPM.

Hypothesis Testing

Correlation and regression analysis were conducted on the data to test the hypothesis one to four. Results of correlation in table 1 provide a support to hypothesis 1 to 3 which states the existence a conceptual relation between sales and the 3 exogenous economic disturbances, (interest rate, exchange rate and inflation rate) with confidence level of 95% is not accepted.

Table 1: Testing correlation between sale & the 3 exogenous economic disturbances

<p>Regression Analysis: % SALE versus % INTEREST RATE The regression equation is: $\% \text{ SALE} = 98.6 + 0.092 \% \text{ INTEREST RATE}$ Pearson correlation of % SALE and % INTEREST RATE = 0.020 P-Value = 0.644</p>
<p>Regression Analysis: % SALE versus % EXCHANGE RATE The regression equation is: $\% \text{ SALE} = 111 - 0.76 \% \text{ EXCHANGE RATE}$ Pearson correlation of % SALE and % EXCHANGE RATE = -0.005 P-Value = 0.914</p>
<p>Regression Analysis: % SALE versus % INFLATION RATE The regression equation is: $\% \text{ SALE} = 103 - 3.31 \% \text{ INFLATION RATE}$ Pearson correlation of % SALE and % INFLATION RATE = -0.038 P-Value = 0.379</p>

Results of comparing beta and expected return in real and predictable manner through CAPM, D-CAPM, Adj-CAPM and R-CAPM models have been summarized in table 2; respond to the main question of research which is the purpose of research. The claim is the existence a conceptual difference between the calculated Beta by R-CAPM and the calculated Beta by the three other methods. For this purpose, first by using the annual real data, we have calculated the amount of Beta from for methods of CAPM, D-CAPM, Adj-CAPM and R-CAPM for years 2000 to 2007 and then by using the growth rate of each year, we have predicted each of the variables for the years and the amount of Beta has been predicted from each four mentioned methods for this period of time. Finally, by using the real and predicted Beta and expected return (K_j) for these eight years has been actually computed and then predicted and then compared. Through comparing the real and predicted amounts in each three methods, we will attain this result that total predicted amounts of all variables (Beta and expected return) are closer to the reality in compare with other three methods through helping of R-CAPM method for all existent companies and our claim will be accepted in this hypothesis, that is the calculated Beta by Revised CAPM has a conceptual difference with the calculated Beta by CAPM, D-CAPM and Adj-CAPM method. Furthermore, it is considerable that not only the calculated predicted return by the improved model is closer to the reality when compared with the other methods, but also we can say that the reason of this difference is the interference of the number of very important variables such as interest, exchange and inflation rate.

Table 2: Comparing Beta and Expected Return in Real and Predictable Manner through CAPM, D-CAPM, Adj-CAPM and R-CAPM Models (average of 70 companies)

Variable	CAPM			D-CAPM			Adj-CAPM		
	Actual	Forecast	Difference	Actual	Forecast	Difference	Actual	Forecast	Difference
β	0.35	0.005	0.355	1.52	1.876	0.351	0.03	0.040	0.014
(%) K_j	22.08	7.09	14.17	39.2	46.80	7.6	16.1	16.88	0.81

Variable	R-CAPM (interest rate)			R-CAPM (exchange rate)			R-CAPM(inflation rate)		
	Actual	Forecast	Difference	Actual	Forecast	Difference	Actual	Forecast	Difference
β	0.0001	0.017	0.017	0.0002	0.0031	0.003	0.0004	0.008	0.008
(%) K_j	16.62	16.17	0.45	16.63	16.77	0.14	16.62	16.67	0.05

Conclusion and Recommendation

After theoretical conceptual studies by using Regression analysis and Pearson correlation testing, the first hypothesis, which is the inverse and meaningful relation between interest rate and a company's sales, was not accepted. The other two hypotheses also were not accepted. But the hypothesis that is a meaningful difference between measure of the Beta calculating by DEL and the Beta computing by CAPM, D-CAPM and Adj-CAPM were accepted.

By combining CAPM with leverages (financial, operational and economic leverages), we found a new model which we will call it Revised CAPM (R-CAPM). In this model to achieve more accurate prospecting predicted return, we focus on systematic and unsystematic risk as well as historical and estimating data completely.

Regarding the results of research, it is suggested that, the beta Coefficient of degree of economic leverage is used for determining the systematic risk and predicting the expected return rate and also the economic leverage is used beside other leverages for making decision about sale changes and profitableness of companies. We suggest that investigate other macro economic variable as other exogenous economic disturbances.

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