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Full Length Research Paper

Comparative analysis of sensitivity coefficient using traditional beta of CAPM and downside beta of D-CAPM in automobile manufacturing companies

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The main purpose of this research was to compare the two widely-used pricing models, capital asset pricing model (CAPM) and downside capital asset pricing model (D-CAPM), in the automobile manufacturing industry so as to suggest more suitable model that can be used to estimate the expected return rate in such industries. The comparison was made through defining four hypotheses each focusing on the risk premium correlation rate as an independent variable with the expected return in the two models, CAPM traditional beta and D-CAPM downside beta, the expected return rate of the two models, and finally the deviation rate of the expected return from the realized return in both models. The statistical results of testing the hypotheses proved the superiority of D-CAPM over CAPM to determine the expected return rate in automobile manufacturing companies.

Key words: capital asset, pricing model, traditional beta, downside beta, return rat.

INTRODUCTION

Ever since Sharpe and Lintner presented the capital asset pricing model (CAPM), the model has extensively been investigated both theoretically and empirically. However, no irrefutable conclusions have so far been reached. Although the evidential anomalies that refute the CAPM cannot be denied, they are themselves a puzzle that has partially been solved. For over 30 years, academics and practitioners have been debating the merits of CAPM, focusing on whether beta is an appropriate measure of risk. Most of these discussions focus on comparing the ability of beta to explain the cross-section of returns relative to that of alternative risk variables. They, however, overlook where beta as a measure of risk comes from, namely, from the equilibrium in which investors display mean variance behavior (MVB). In other words, the CAPM stems from the equilibrium in which investors maximize a utility function that depends on the mean and variance of returns of their portfolio.

The variance of returns, however, is a questionable measure of risk for at least two reasons: First, it is an appropriate measure of risk only when the underlying distribution of returns is symmetric, and second, it can be applied straightforwardly as a risk measure only when the underlying distribution of returns is normal. However, both the symmetry and normality of stock returns are seriously questioned by the empirical evidence on the subject. The semi variance of returns, on the other hand, is a more credible measure of risk for several reasons: First, investors obviously do not dislike upside volatility; they only dislike downside volatility. Second, the semi variance is more useful than the variance when the underlying distribution of returns is asymmetric and just as useful when the underlying distribution is symmetric; in other words, the semi variance is at least as useful a measure of risk as the variance. And third, the semi variance combines into one measure when the information are provided by two statistics, variance and skewness, thus making it possible to use a one-factor model to estimate required returns (Estrada, 2007; pp.170). Furthermore, the semi variance of returns can be used to generate an alternative behavioral hypothesis, namely, Mean Semi-variance Behavior (MSB).

As shown in Estrada (2002), MSB is almost perfectly correlated with the expected utility as well as with the utility of expected compound return, and can therefore be defended along the same lines used by Levy and

Markowitz (1979) and Markowitz (1991) to defend MVB. Hogan and Warren (1974); Bawa and Lindenberg (1977) and Harlow and Rao (1989) proposed CAPM-like models based on downside risk measures. Hogan and Warren (1974) called their framework the E-S model and defined a downside beta based on a different definition of co-semi variance, their co-semi variance (Σ_{iM}^{HW}) is given by:

$$\Sigma_{iM}^{HW} = E\{(R_i - R_f)Min[(R_M - R_f),0]\} \quad (1)$$

BRIEF LITERATURE REVIEW: APPROACHES AND RESULTS

Studies concerning the effect of skewness on the relationship

Beyond the analysis of return of beta, several authors have considered the impact of skewness on expected returns. Skewness reflects the presence of too many large positive or negative observations in the distribution. A normal distribution is symmetric, which means that the balance exists between positive and negative observations. In contrast, positive skewness indicates an abnormal number of large positive price changes. Investigators considered skewness as a means to possibly explain the prior results wherein the model appeared to underprice low-beta stock, so investors received returns above expectations or to overprice high-beta stock, so investors received returns lower than expectations. Some early skewness implying that investors preferred stocks with highly positive skewness provided an opportunity for very large returns (Reilly and Brown, 2003). Kraus and Litzenberger (1976) tested a CAPM with a skewness term and confirmed that investors were willing to pay for positive skewness. They concluded that their three-moment CAPM corrects for the apparent mispricing of high and low risk stocks encountered the standard CAPM. The importance of skewness was supported in studies by Sears and Wei (1988) and subsequently by Lim (1989).

Summary of CAPM risk-return empirical results

Most of the early evidence regarding the relationship between the rate of return and systematic risk of portfolios supported the CAPM. The efficient markets literature provided extensive evidence that size, the P/E ratio, financial leverage, and the book -to-market value ratio have explanatory powers regarding return beyond beta (Reilly and Brown, 2003). The Fama-French study considered most of the variables suggested and concluded that beta was not related to the average return on stocks when included with other variables or when considered alone. Moreover, the two dominant variables were size and the book value to the market value ratio. A subsequent study by Dennis et al. (1995) confirmed the Fama-Frech results and showed that this superiority of the three-factor model prevailed after assuming 1 per cent transaction costs and annual rebalancing- the optimal results were derived rebalancing every four years. Alternatively, in contrast to the Fama-French study that measured beta with monthly returns, Kothari et al. (KSS) (1995) measured beta with annual returns to avoid trading problems and found substantial compensation for beta risk. Harvey (1995), perhaps the pioneer study on the cross-section of returns in Emerging Markets (EMs), found that betas in most markets were low and largely not significant. Subsequent researches produced somewhat contradictory evidence, though clearly leaning towards pointing that beta and returns were unrelated (Bekaert et al., 1997; Rouwenhorst, 1999; Estrada, 2000; Barry et al., 2002; Serra, 2003). Furthermore, Bekaert et al. (1997); Harvey (2000) and Estrada (2000, 2002) found a significant relationship between the standard deviation and mean returns, thus implying that not only systematic but also local risks were priced in EMs.

OVERVIEW OF THE PRICING MODELS

MVB and CAPM

CAPM explains about the relation between the risk-return and asset according to the market return. By this model, during a period of time, the return rate of common stock is measured when the stock price is available and the result is used as market indices for measurement of stock operation. In CAPM method, all of the assets are considered, but practically there are some problems for measurement of the return of all assets or gaining a general market index.

The common stock is used for explaining the model. The first hypothesis of CAPM is a kind of linear relationship between the stock return of each activity and the stock market return during same periods. The model calculations formula, by at least squares sum (regression analysis) is as follows:

$$Ki = \alpha + \beta Rm + e \quad (2)$$

Where Ki shows return rate of common stock in a company, α is constant value, β is sensitivity coefficient (beta), e is error in regression equation, and Rm shows return rate of market portfolio.

According to the mathematical expectation supposition, error is equal to zero in the regression equation (points distances from estimated line). In CAPM, the beta coefficient is very important for experimental tests and is useful for portfolio assessment. The main reason is that the beta coefficient of a share is less constant towards the portfolio beta from one period to another period. In addition, researches have shown that beta of common share during long periods, more than a period, tends to one. CAPM has been formed on the basis of the market risk premium model, which means it is supposed that investors expect to gain higher returns by accepting more risks. Also, they expect to gain acceptable returns from the asset which can be risked. In CAPM, if we suppose short term treasury papers of a company as an asset which can be risked, investors should gain a return more than a return of treasury papers, because they accept more risk. According to CAPM supposition, the equation is used for line calculation of securities market is as follow:

$$Ki = Rf + \beta(Rm - Rf) \quad (3)$$

Where Rf shows risk free rate of return, β is beta coefficient, Rm is return rate based on market index, and Rm-Rf represents premium or excessive return of market (risk premium) towards risk free rate of return.

CAPM explains that the expected return rate of an asset is a function of two parts: the risk free rate of return and the risk premium. So Ki equals the risk free rate of return added to the risk premium.

The main variable of this model is the beta coefficient that determines the amount of demanded premium (bonus) by investors for portfolio investment. For each of the securities, the beta coefficient is measured according to the sensitivity coefficient of securities return rate towards market. CAPM can relate the expected return rate of each of securities like i, or P (portfolio), with a suitable standard of securities risk, i.e. its beta. Beta is a suitable standard of risk that cannot change it through variety and investors should consider its own portfolio management in decision processes. In the standard MVB framework, an investor's utility (U) is fully determined by the mean (μ_p) and variance (δ_p^2) of returns of the investor's portfolio; that is U = U(μ_p, δ_p^2) . In such framework, the risk of an asset i taken individually is measured by the asset's standard deviation of returns (δ_i), which is given by:

$$\delta i = \sqrt{E[(R_i - \mu_i),0]^2} \quad (4)$$

Where R and μ represent the returns and mean returns, respectively. However, when asset i is just one out of many in a fully diversified portfolio, its risk is measured by its covariance with respect to the market portfolio (δ_{im}), which is given by:

$$\delta_{im} = E[(R_i - \mu_i)][(R_m - \mu_m)] \quad (5)$$

In Equations 3, 4 and 5, Ri and Rm are obtained through the following equations:

$$Ri = \frac{(1+\alpha)P1 + DPS - p.}{P.} \quad (6)$$

$$Rm = \frac{I_2 - I_1}{I_1} \quad (7)$$

where Ri shows realized return, α is percentage of capital increase, P. is first price of the term, DPS is distributed profit among stock holders, P1 is last price of the term, I_1 is total index of previously, I_2 is total index of the day, and Rm shows market return (In this research the market return rate is monthly calculated).

A more useful measure of risk can be obtained by dividing this covariance by the product of asset i's standard deviation of returns and the market's standard deviation of returns, thus obtaining asset i's correlation with respect to the market (ρ_{im}), which is given by:

$$\rho_{im} = \frac{\delta_{im}}{\delta_i . \delta_m} = \frac{E[(R_i - \mu_i)(R_m - \mu_m)]}{\sqrt{E[(R_i - \mu_i)]^2 E[(R_m - \mu_m)]^2}} \quad (8)$$

Alternatively, the covariance between asset i and the market portfolio can be divided by the variance of the market portfolio, thus obtaining asset i's beta (β_i), which is given by:

$$\beta_i = \frac{\delta_{im}}{\delta_m^2} = \frac{E[(R_i - \mu_i)(R_m - \mu_m)]}{E[(Rm - \mu m)^2]} \quad (9)$$

This beta can also be expressed as β_i = ($\delta i / \delta m$) ρ_{im} and is the most widely used measure of risk. It is also the only firm-specific magnitude in the model most widely used to estimate required returns on equity, the CAPM, which is given by:

$$E(Ri) = Rf + MRP\beta_i \quad (10)$$

where E (Ri) and Rf denote the required return on asset i and the risk-free rate, respectively, and MRP shows the market risk premium, defined as MRP=E(Rm)-Rf, where E (Rm) represents the required return on the market (Estrada, 2002a).

MSB and D-CAPM

In the alternative MSB framework, the investor's utility is given by $U = U(\mu_p, \Sigma_p^2)$, where Σ_p^2 denotes the downside variance of returns (or semi variance for short) of the investor's portfolio. In this framework, the risk of an asset i taken individually is measured by the asset's downside standard deviation of returns, or semi deviation (Σ_i) for short, which is given by:

$$\Sigma_i = \sqrt{E\{\min[(R_i - \mu_i),0]^2\}} \tag{11}$$

Equation 11 is, in fact, a special case of the semi deviation, which can be more generally expressed with respect to any benchmark return B (Σ_{Bi}) as:

$$\Sigma_{Bi} = \sqrt{E\{\min[(R_i - \mu_i),0]^2\}} \tag{12}$$

Given that throughout this article, I will use as the only benchmark for asset i, the arithmetic mean of its distribution of returns and I will show the semi deviation of asset i simply as Σ_i.

In a downside risk framework, the counterpart of asset i's covariance to the market portfolio is given by its downside covariance or co-semi variance (Σ_{iM}) for short, which is given by:

$$\Sigma_{iM} = E\{Min[(R_i - \mu_i),0]\,Min[(R_m - \mu_m),0]\} \tag{13}$$

This co-semi variance is also unbounded and scale-dependent, but it can also be standardized by dividing it by the product of asset i's semi deviation of returns and the market's semi deviation of returns, thus obtaining asset i's downside correlation (Θ_{iM}), which is given by:

$$\Theta_{iM} = \frac{S_{im}}{S_i.S_m} = \frac{E\{Min[(R_i-\mu_i),0]\times Min[(R_m-\mu_m),0]\}}{\sqrt{E\{Min[(R_i-\mu_i),0]^2\}\times E\{Min[(R_m-\mu_m),0]^2\}}} \tag{14}$$

Alternatively, the co-semi variance can be divided by the market's semi variance of returns, thus obtaining asset i's downside beta (β_i^D), which is given by:

$$\beta_i^D = \frac{S_{im}}{S_m^2} = \frac{E\{Min[(R_i - \mu_i),0]\ Min[(R_m - \mu_m),0]\}}{E\{Min[(Rm - \mu m),0]^2\}} \tag{15}$$

This downside beta, also expressed as $\beta_i^D = (\Sigma i / \Sigma_M)\Theta_{iM}$, can be articulated into a CAPM-like model based on downside risk. Such a model, which is the one stated in the present research, is the downside CAPM, or D-CAPM for short, and is given by:

$$E(Ri) = Rf + MRP\beta_i^D \tag{16}$$

As can be seen by a straight forward comparison of Equation 10 and 16, the D-CAPM replaces the beta of the CAPM by the downside beta, the appropriate measure of systematic risk in a downside risk framework (Estrada, 2002a).

RESEARCH OBJECTIVES

The main research objectives are summarized as follow:

- D-CAPM potential test as compared with CAPM in determining the expected return rate of automobile manufacturing companies.
- Determining the risk premium correlation rate as an independent variable with the expected return in both models.
- Determining the deviation rate of the expected return from the realized return in the two models.

METHODOLOGY AND DATA GATHERING METHOD

The methodology of the present research is a survey one and of correlation type in which the main objective is to determine the relation between a few quantitative variables. In the correlation research, the principal goal is to find out whether there is a relation between two or several quantitative variables and if this is so, what the extent and limit thereof is. Furthermore, part of the research is carried out using the causal-comparative method, that is, comparison is made between two subsets already happened.

To gather the required data, the library method has been used. Moreover, financial statements, notes to the financial statements and financial reports of the 19 companies under study have also been in use, all of which is released by Tehran stock exchange organization and, therefore, available in its archive. Such information and data are of secondary data type and bear proper validity and authenticity. Population of this research is all automobile manufacturing companies admitted to Tehran stock exchange organization.

Determination of risk free return rate

For accumulation of stock expected return rate of each automobile manufacturing company, the risk free return rate should be monthly used. The risk free return rate, which is a rate that an investor receives when there is no risk, will equal to the expected value in every term, because the variance is zero. This rate is guaranteed to be paid by governments or other organizations and is different in various financial markets of countries. In Iran, profit rate of banks short term deposit is usually used. The rates in the 5-year period of 2002 - 2006 are shown in Table 1.

Research hypotheses

The research hypotheses can be summarized as follows:

Table 1. Profit rate of short term deposit of Iranian governmental banks.

Year	Profit rate (%)
2002	17
2003	17
2004	17
2005	15.5
2006	15.5

H_{1A}: risk premium correlation rate with D-CAPM expected return is greater than risk premium correlation rate with CAPM expected return.
H_{1B}: CAPM traditional beta is smaller than D-CAPM downside beta.
H_{1C}: expected return rates of both models, CAPM and D-CAPM, are different from each other.
H_{1D}: deviation rate of expected return from realized return in D-CAPM is smaller than deviation rate of expected return from realized return in CAPM.

RESULTS OF DATA ANALYSIS AND HYPOTHESES TEST

In order to apply the regression analysis test and comparison test of the two means under the group of variables studied, the distribution of the research data has been reviewed and tested drawing on Kalmogruf-Asmirnof test, the results of which show that all the research variables fail to have the normal distribution (Table 2).

Hypothesis 1: H_{1A}

Considering the first hypothesis as defined in this work, risk premium correlation rate with D-CAPM expected return is greater than risk premium correlation rate with CAPM expected return. The results of testing the first hypothesis are presented in Tables 3 and 4.

In view of the statistical results appeared in Table 3, no significant relation between risk premium and CAPM expected return is observed and at a significant level of only 5%, researchers' hypothesis is confirmed. Furthermore, the rate of P-value is greater than alpha level.

The results of Table 4 show that there is a significant relation between risk premium and DCAPM expected return. The rate of P-value is smaller than alpha and, thus, the research first hypothesis is confirmed.

Hypothesis 2: H_{1B}

Considering the second hypothesis as defined in this work, CAPM traditional beta is smaller than downside beta in D-CAPM. The results of testing the second hypothesis are presented in Table 5.

Considering that the distribution of the two variables, β and downside β, is not normal, Mann-whitney test has been used. According to this test, Table 5 reveals that the rate of P-value is smaller than alpha and, thus, being 95% sure, the research second hypothesis is confirmed.

Hypothesis 3: H_{1C}

Considering the third hypothesis as defined in this work, the expected rates of return are different in the two models. The results of testing the third hypothesis are shown in Table 6.

Considering that the distribution of two variables of the expected return (ki and kj) is not normal, Mann-Whitney test has been used. Based on statistical findings of Table 6, I can, being 95% sure, claim that the expected return rates of the two models have a significant difference with each other. In this survey, kj stands for the expected return derived from downside β and ki stands for the expected return derived form traditional β. P-value is also smaller than alpha and, thus, the research third hypothesis is confirmed.

Hypothesis 4: H_{1D}

Considering the fourth hypothesis as defined in this work, deviation rate of expected return from realized return in D-CAPM model is smaller than deviation rate of expected return from realized return in CAPM model. The results of testing the fourth hypothesis are shown in Table 7.

For this test, realized return (Ri) was calculated and then total deviations squared for each of the 19 automobile manufacturing companies were measured. As the variables are not normal, Mann-Whitney test has been used. As per Table 7, the results from this test indicate that the error of expected return from realized return in D-CAPM is not smaller than the error of expected return from realized return in CAPM and, thus, the research forth hypothesis is rejected.

DISCUSSION AND CONCLUSION

The main purpose of the present research was to compare the two widely-used pricing models, CAPM and D-CAPM, in the automobile manufacturing industry in order to suggest more suitable model that can be used to estimate the expected return rate in such industries.

One of the CAPM suppositions is the availability of symmetric market, however, studies show that we may witness asymmetric market in some cases, that is, some factors affect the risk premium in addition to the expected asset return rate.

The comparison of the models has been made through

Table 2. Results of variables distribution.

Variable	Number	Average	Standard deviation	A^2	P-Value	Test result
Rm	969	2.36543	7.34493	35.338	0.00	Distribution is not normal
β	969	0.377332	8.86160	184.548	0.00	Distribution is not normal
Ri	969	2.35192	31.9171	96.373	0.00	Distribution is not normal
(Rm-Rf)	969	0.554563	6.36624	21.421	0.00	Distribution is not normal
Ki	969	11.1211	143.506	192.817	0.00	Distribution is not normal
β^D	969	2.92762	11.7423	237.321	0.00	Distribution is not normal
Kj	969	-25.774	180.136	235.855	0.00	Distribution is not normal

Rm: return rate based on market index; β: beta coefficient; Ri: realized return or return rate of common stock in company; (Rm-Rf): premium or excessive return of market (risk premium) towards risk free rate of return; Ki: expected rate of return (CAPM); β^D: downside beta; Kj: expected rate of return (D-CAPM).

Table 3. Pearson correlation coefficient test between risk premium (*Rm-Rf*) and CAPM expected return rate (*Ki*).

Correlations	Ki; Rm-Rf
Pearson correlation of Ki and Rm-Rf	0.019
P-Value	0.562

Table 4. Pearson correlation coefficient test between risk premium (*Rm-Rf*) and D-CAPM expected return rate (*Kj*).

Correlations	Kj; Rm-Rf
Pearson correlation of Kj and Rm-Rf	0.076
P-Value	0.018

Table 5. Traditional β and downside β significant difference test.

Mann-Whitney Test and CI: B capm; B dcapm		
B capm	N = 969	Median = 0.0080
B dcapm	N = 969	Median = 0.4770
Point estimate for ETA1-ETA2 is -0.4440		
95.0% CI for ETA1-ETA2 is (-0.5849;-0.3100)		
W = 800739.5		
Test of ETA1 = ETA2 vs ETA1 < ETA2 is significant at 0.0000		
The test is significant at 0.0000 (adjusted for ties)		

Table 6. CAPM and D-CAPM significant difference test of expected return rates (*Ki* and *Kj*)

Mann-Whitney Test and CI: Ki; Kj		
Ki	N = 969	Median =15.500
Kj	N = 969	Median = 12.311
Point estimate for ETA1-ETA2 is 5.179		
95.0% CI for ETA1-ETA2 is (3.420;6.926)		
W = 1065658.0		
Test of ETA1 = ETA2 vs ETA1 not = ETA2 is significant at 0.0000		
The test is significant at 0.0000 (adjusted for ties)		

Table 7. Error comparison test of expected return and realized return of the two models.

Mann-Whitney Test and CI: Ri-Ki^2; Ri-Kj^2		
Ri-Ki^2	N = 19	Median =42414
Ri-Kj^2	N = 19	Median = 52025
Point estimate for ETA1-ETA2 is -8571		
95.3% CI for ETA1-ETA2 is (-36512;18868)		
W = 339.0		
Test of ETA1 = ETA2 vs ETA1 < ETA2 is significant at 0.1827		
Cannot reject at alpha = 0.05		

defining four hypotheses each focusing on the risk premium correlation rate as an independent variable with the expected return in the two models, CAPM traditional beta and D-CAPM downside beta, the expected return rate of the two models, and finally the deviation rate of the expected return from the realized return in both models.

The statistical results of testing the research hypotheses show that, as per D-CAPM, there is a significant relation between risk premium and expected return, and that high correlation between risk premium and expected return emphasizes suitability of the model in this respect. In addition, traditional β and downside β in both models have significant difference with each other. In other words, the results of the research in all 19 automobile manufacturing companies admitted to Tehran Stock Exchange reveal that traditional β rate is smaller than downside β rate. This can specifically affect expected return rate of investors. The significant difference test of expected return rate in the two models also shows that the rates of both models are different. However, no evidence has been found to prove that the error of expected return from realized return as per D-CAPM is smaller than the error of expected return from realized return as per CAPM. In other words, error difference of both models in terms of deviation between expected return and realized return is not significant.

To conclude, the statistical results of testing the research hypotheses prove the superiority of D-CAPM over CAPM to determine the expected return rate in automobile manufacturing companies.

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