Is D-CAPM Superior to CAPM? The Case of Pakistan Stock Exchange

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Abstract

For the application of the Capital Asset Pricing Model, one of the assumptions is that expected returns follow the normal distribution, which is not usually in-case of low size and more volatile emerging markets. In this case, semi-variance methodology seems more suitable and may produce results that may be robust than the traditional CAPM. The basic purpose of this paper is tantamount to empirically investigate the literature shift from traditional CAPM to semi-variance CAPM of an emerging country i.e. Pakistan. For this purpose, the researcher uses monthly data of all stocks of PSX, ranging from 2000 to 2017. The Fama-Macbeth methodology is utilized to derive the risk and returns relationship on all the stocks for both traditional CAPM and Semi-Variance CAPM. The results of the study provide evidence for the presence of a positive relationship between the systematic risk (both traditional beta and downside beta) with expected return, but, still mean-variance risk shows more explanatory power than the semi-variance risk. The current study recommends the application of the traditional CAPM as well as downside CAPM for the estimation of cost of equity for an emerging market i.e. Pakistan.

Keywords: Traditional CAPM, Downside CAPM, Downside Beta, Fama-Macbeth.

Introduction

Every investor while evaluating the investment must not only consider the accuracy of its future cash flows, but, also the accuracy of the discount rate. Capital asset pricing model is a traditionally recommended model for the estimation of the discount rate. This model is widely used for the estimation of cost of equity (Bekaert & Harvey, 1995). In the developed world like the UK, regulators mostly use CAPM (Jenkinson, 2006). Surveys carried out by Bruner, Li, Kritzman, Myrgren, & Page (2008), and Graham & Harvey (2001) point out that CAPM is a widely used method between the practitioner and the academician in U.S. firms. In addition to that, 74% and 85% of respondents in other surveys claim to have used the CAPM method for the calculation cost of equity (Brigham & Ehrhardt, 2013). However, there are variations in the operationalization of CAPM amongst practitioners (Bruner, Eades, Harris, & Higgins, 1998).

The Capital Asset Pricing Model was originally developed by Sharpe (1964)for the calculation of cost of equity in terms of the required rate of return. The CAPM describes that return is a linear function of the market risk premium plus the risk free rate.

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The basic assumptions of this model are that there exists a linear and positive relationship between systematic risk and expected return, and that market risk premium is the only factor that explains the variations of the expected returns. But there exists an immense evidence in literature that the same model cannot be applied for the calculation of cost of equity in emerging economies i.e. Pakistan. One of the major reasons is that emerging economies are less integrated, more volatile and small in size as compared to the developed economies (Bekaert & Harvey, 2002; Sabal, 2004). Consequently, the same CAPM is not able to serve the emerging and developed economies at the same time (Solinik, 1974). Another, well-known limitation of CAPM in emerging economies is that their returns are more skewed than as CAPM predicted. So the results of mean-variance CAPM show weak estimation of cost of equity for emerging countries. Along with this, investors also dislike below side deviation than upside deviation. So, there is a powerful argument to replace the total risk against downside risk while estimation of the expected returns, especially in emerging markets (Estrada, 2007). The capital asset pricing model when used downside risk as beta is usually called as mean semi-variance CAPM (MS-CAPM) than mean-variance CAPM (MV-CAPM).

The purpose of this study is twofold; first this study employee the traditional CAPM on current data and re-investigate the basic risk and return relationship in emerging countries by taking non-normality assumption into account. Secondly, study offers an investigation of whether the downside beta or the upside beta offers a better explanation of investors' risk perception than does the conventional beta.

The empirical findings of the study are very important to corporate manager, investors and project managers while evaluating their investment opportunities that are mostly based on the accuracy of their discount rates. More specifically, results helps the corporate managers dealing with the emerging economies to choose more appropriate discount model to measure and quantify risks involved with their investment. Results of the study are also useful for stock market investors to set up their required rate of return in emerging economies and help project manager to choose more appropriate hurdle rate to any project.

Literature Review

Many studies also compare the mean-variance and mean-semivariance models to calculate the downside risk. Jahankhani (1976) compares two different models of the downside risk: mean-variance CAPM and mean- semivariance CAPM; the results of the two model indicate the significant relationship between beta and return but, mean semi-variance produces superior results than others. However, due to a small sample period (1951-1969), results are regarded as a sample biased.

Harlow (1991) works on the asset allocation in the downside framework, and argues that the downside-risk approach to investment decisions is a good intuitive measure of risk. This study states that the downside side risk is a better measure of risk as it results in higher realized returns. Their results also report that downside risk provides improved risk and returns tradeoff in bond market. The author further reports that the downside beta framework results in significantly higher allocation of bonds and, hence, results in greater downside risk protection by providing higher levels of returns.

Fabozzi & Francis (1977) develop another technique for incorporating the downside risk by testing beta as a random coefficient. They calculate beta in up and down market and conclude their study by saying that beta is not statistically different for both market. Subsequently, Kim & Zumwalt (1979) also reports the same results. However, this study comes up with a two slopes model, which incorporates variations due to high and down market. Their results confirm that investors are rewarded extra for accepting the downside risk, but, the upside risk is negatively priced. Alexander, Benson, & Eger (1982) criticizes Fabozzi & Francis (1977) and concludes that their random beta coefficient is an overestimation. Chen (1982) concludes that this issue is due to the problem of multicollinearity in regression setting and proposes using time varying regression than second pass regression to rectify the issue.

Estrada (2002) works on one of the characteristics of CAPM, which is the measure of risk by beta, which earlier follows mean variance behavior in equilibrium. According to the author, beta is measured through the variance of returns, which are a restrictive and questionable measure of risk in emerging countries stocks where market fundamentals are different from that of developed markets. The author recommends semi-variance of returns to measure risk and generate an alternative measure of risk for diversified investors called downside beta on mean-semi variance equilibrium. Their empirical results clearly support the D-CAPM over beta and the CAPM. He uses twenty-eight emerging market data and reports that the world portfolio is unable to explain the original risk and return relationship in emerging markets. Alternatively, the downside beta performs well in almost all market and produces significant positive relationship between downside beta and cross sectional returns. Harvey (2000) already reports similar findings that the downside beta is a more appropriate tool for explaining the cross sectional returns of stocks than that or mean variance beta.

According to Ang, Chen, & Xing (2006), investor not only demands the high return for holding assets that co-move with declining market but it also benefits in terms of return for holding those assets which co-move in rising markets. Thus Estrada (2002) extended his model by including the upside beta to isolate return that incurs due to upside

risk factor. Thus the inclusion of upside risk factor into the model provides an extra insight of the contribution of return due to upside and downside movement of markets.

In another study, Estrada (2002) empirically tests his mean-semi-variance model by taking the sample of both emerging and developed markets. Study compares both betas and downside betas for all countries world index. Results of MVB and MSB reveal that downside risk explains 45% variations in returns in both emerging and developed markets and 55% variations alone in emerging markets which are far better than the original CAPM. Results also reveal that means returns are more sensitive with the change of downside beta than the original beta for both emerging and developed markets. Furthermore, means returns calculated from MSB model are higher and compatible than those calculated from MVB models. Finally, the author also reports that MSB model is also superior to that of over three-factor models.

In another study, Estrada & Serra (2005) investigates a cross section of 1600 companies from 30 different countries for a period of 25 years. According to them, economic significance is more important for practitioners than statistical significance. For cross sectional analysis, the study applies Fama-MacBeth methodology and GMM. The study reports that risk variables and cross sectional returns of stocks have weak explanatory power. According to the authors, the reason of this failure is due to cross sectional variation from country to country. However, the result of economic analysis reveals that global downside beta significantly explains cross-section of stock returns when stocks are imbalanced for every five years.

Chong & Phillips (2012) uses Sortino ratios for the calculation of downside risk. This study reports that value drive from traditional beta is quite different from value drive from downside beta. They also report that valuations based traditional beta would produce more value when the market shows higher downside risk, but, it produces a lower value when the downside risk is less. The author concludes that the downside risk is not correctly reflected in the capital asset pricing model.

The research of both Post & Vliet (2004) and Houda & Dorra (2012) discusses the inability of skewness and kurtosis to predict stocks returns in higher moments. Post & Vliet (2004) concludes that skewness violates the risk aversion assumption for predicting the cubic asset kernel. While Houda & Dorra (2012) criticize the kurtosis and imply that investors dislike extreme moments in both negative and positive directions not as the researcher pointed out in negative skewness only. Their study concludes that both the downside risk and the higher order co-movement, should be considered in the valuation of the cost of equity. The study also reports that normal beta fails to explain the returns, but, the downside beta has more explanatory power; the sign of coefficient is negative than theory, however. According to the authors, this may be due to the immaturity of the

French market. Ang, Hodrick, Xing, & Zhang (2006) to calculate the expected return by the downside as well as co-skewness methods. They report that the expected return is higher with downside beta than with co-skewness and the risk premium was also different. They also report that risk premium captured by downside beta is different from the risk premium associated with the co-skewness. Momcilovic, Zivkov, & Begovic (2017) work on MVB beta and MSB beta on Slovenian, Croatian and Serbian Capital Markets and report that downside beta with by explaining the expected return variations by 28% than that of original beta 25%. However, both betas are statistically significant and have a positive relationship between risk and returns. The contextual review of literature reveals that there is a lack of empirical studies on the validity of MS CAPM in the case of the Pakistani stock market. Abbas, Ayub, Sargana, & Saeed (2011) conduct a theoretical review of the validity of capital asset pricing model in relationship to the downside CAPM and their study conclude to use of downside CAPM for emerging markets. A major contribution is in this area is seen by Rashid & Hamid (2015) for the Pakistan stock Market. However, their analysis is on the financial sector specifically on the banking sector. This study enhances the existing work by incorporating all the available data on the non-financial sector trading on the Pakistan Stock Exchange (PSX).

Data and Methodology

The study uses, monthly share prices, adjusted for stock dividends, stock splits, and rights issues, for the sample period running from June 2000 to June 2017. The monthly data over the longer investment horizon has more about trend and less about the noise that one may see in daily data. KSE-100 market index has been used as a proxy for market returns. Three-month risk-free rate has been taken as a proxy for the risk-free rate. The data are collected from DataStream for all non-financial firms and the stock market index of Pakistan Stock Market. All those companies are included in the sample that has roughly 90% of the total trading activity and market capitalization and hence the selected sample is a good representation of the overall market.

The monthly stock returns of all the available stocks, as well as market, are calculated by using formula $R_t = \ln\left(\frac{p_t}{p_{t-1}}\right)$. On the recommendation of Cederburg & O'Doherty (2016), the study applies Fama-Macbeth (1973) cross sectional regressions, after deriving the 36 months rolling time series beta to test the basic risk and return relationship between expected return and systematic beta. This methodology applies to two steps for validating the capital asset pricing model. In first step, rolling beta has been generated by using 36 month windows and in second steps these betas are regressed in a cross-sectional setting against their average company return.

The estimation of downside side beta is done by using Estrada (2003) method. Its estimation is different from traditional CAPM beta. In the first step, only

negative/positive firms' excess returns are taken as dependent variables against negative/positive excess returns of the market without intercept (Rashid & Hamid, 2015). This step provides downside/upside betas for the relevant company. Then, in the second step, average firm returns are regressed against these betas for further testing the downside CAPM.

To test the traditional and downside CAPM, a number of hypotheses have been developed. Each hypothesis is tested by using different statistical model to check the validity of traditional and downside CAPM. The first hypothesis is developed to test the basic risk and return relationship. For this purpose, traditional/downside beta is regressed against their mean excess returns by using the following equation;

Hypothesis 1: There exists a positive relationship between Risk (Mean-Variance/Semi-Variance) and expected Return.

$$R_i - R_f = \lambda_o + \lambda_1 \beta_i + \mu_i$$ ---------- (For CAPM) ---------- (Eq. 1A)

$$R_i = \lambda_o + \lambda_1 \beta_i^D + \mu_i$$ ---------- (For D-CAPM) --------- (Eq. 1B)

The second hypothesis is developed to test the non-linearity of the CAPM, for this purpose traditional beta and downside beta square term has been added to existing model.

Hypothesis 2: There exists a linear and positive relationship between Risk (Mean-Variance/Semi-Variance) and expected Return.

$$R_i - R_f = \lambda_o + \lambda_1 \beta_i + \lambda_2 {\beta_i}^2 + \mu_i$$ ---------- (For CAPM) ------- (Eq. 2A)

$$R_i = \lambda_o + \lambda_1 \beta_i^D + \lambda_2 \beta_i^{2D} + \mu_i$$ ---------- (For D-CAPM) ------ (Eq. 2B)

In the third hypothesis, adequacy of beta/downside beta has been tested along with basic risk and return relationship, for this purpose residual term has been added to original model. The significant of the residual term would indicate that traditional beta and downside beta is not the only variable that explains the variations of mean returns and vice versa.

Hypothesis 3: Excess market premium is the only risk factor that describes expected return of Pakistani's Market.

$$R_i - R_f = \lambda_o + \lambda_1 \beta_i + \lambda_2 U_i + \mu_i$$ ---------- (For CAPM) ------- (Eq. 3A)

$$R_i = \lambda_o + \lambda_1 \beta_i^D + \lambda_2 \cup_i^D + \mu_i$$ ---------- (For D-CAPM) ------- (Eq. 3B)

The fourth hypothesis has been made to test the joint hypothesis for both traditional and downside CAPM. All the above factors have been accumulated to test the joint effect of all factors on the mean returns of firms in cross sectional setting.

Hypothesis 4: There exists a linear and positive relationship between Risk (Mean-Variance/Semi-Variance) and expected Return and excess market premium is the only risk factor that explain the variations of expected return.

$$R_i - R_f = \lambda_o + \lambda_1 \beta_i + \lambda_2 {\beta_i}^2 + \lambda_3 U_i + \mu_i$$ ---------- (For CAPM) ------- (Eq. 4A)

$$R_i = \lambda_o + \lambda_1\beta_i^D + \lambda_2\beta_i^{2D} + \lambda_2 \cup_i^D + \mu_i$$ ---------- (For D-CAPM) ------- (Eq. 4B)

Results and Discussion

In the first step of analysis, Panel Unit Root has been performed to check the stationarity of the data. For this purpose Im-Pesaran-Shin unit root test has been performed and disclosed in table 1. Both the series has unit root as I (0), so there is stationarity in the data.

Table 1: *Im-Pesaran-Shin unit-root test*

Variables	t-bar	t-tilde-bar	Z-t-tilde-bar	p-value
Pak-Stock Returns	-16.169	-11.071	-140	.000
Pak-Market Returns	-14.870	-10.696	-130	.000

Descriptive analysis of stock returns and market returns have been reported in table 2. Results indicate that on average, one can earn on stocks about 1.2% return on monthly basis which deviates 15.8% on both tails; whereas market provides 1.3% return per month. Both returns reports leptokurtic behaviors while market returns are highly negative skewed.

Table 2: *Descriptive Analysis*

Variables	Mean	Std.Dev.	Min	Max	Skew.	Kurt.
Pak-Stock Returns	.012	.158	-3.05	3.137	.372	27.898
Pak-Market Returns	.013	.143	-3.404	.294	-16.707	395.862

Further, empirical results are obtained by using Fama & Macbeth (1973) two pass regressions for each model. The results of second pass cross sectional regression for traditional CAPM has been reported in table 1 where the dependent variable is mean returns and independent variables are systematic risk, square term of systematic risk, and residual term.

Table 3: *Results for traditional CAPM using Fama-Macbeth (1973)*

Variables	(1A)	(2A)	(3A)	(4A)
β_i	.016**	.070***	.019***	.093***
	(.007)	(.010)	(.007)	(.016)
β_i^2		-.061***		-.090***
		(.009)		(.018)
U_i			-7.862***	5.557*
			(1.575)	(2.995)
Constant	-.098***	-.088***	-.066***	-.106***
	(.004)	(.004)	(.007)	(.010)
R-squared	.039	.337	.210	.357
RMSE	.034	.029	.031	.028

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 3 reports the basic risk and return relationship in CAPM. According to Lintner (1965); Mossin (1966); Sharpe (1964) CAPM exhibits positive and linear relationship between systematic risk and mean returns of a stock and that only systemic risk is responsible to explain the variations of dependent variable. Model 1A reports the results for the first hypothesis, the significant and positive value of beta indicates that beta factor is significantly explaining the means returns in PSX but its prediction power is weak. This indicates that traditional CAPM will be helpful for the identification of risk and return relationship in firms registered at Pakistani's stock markets.

Model 2A, exhibits the results for the second hypothesis which tests the non-linearity in the capital asset pricing model. The significant value of beta square indicates that the risk and return relationship is non-linear instead as CAPM claims. Model 3A tests the hypothesis for adequacy of beta factor for explaining the mean returns of PSX. Here, results for the residual term are significant which indicate that only beta factor is not sufficient for explaining the mean returns. But the significance of residual may be due to the use of individual security in cross sectional analysis which can be handle by using portfolio construction (Black, Jensen, & Scholes, 1972).

In the fourth model, joint hypothesis is estimated for all the above factors and results indicate that beta is still significantly explaining the variations in mean returns but having a non-linear behavior over the period of time. All the intercepts are negative and significant that clearly indicates the consistent mispricing phenomena in the stock market.

The explanatory power of all Models indicates that model 4 has highest explanatory power that is 35.7% than all others. Root Mean Square Error (RMSE) has been obtained for all model and model 4 has the least value for it, which indicate that model 4 is a more appropriate model for determining the risk and return relationship in Pakistan Stock Market. These results provide a better explanation of risk and return analysis than Iqbal, Brooks, & Galagedera (2010) and Rashid & Hamid (2015), as these studies provide insignificant results for CAPM, that may be due to that they do not estimate beta based on month to month rolling window.

Further, time invariant downside beta is calculated using Estrada (2003) methodology and its validity is tested using the Fama & Macbeth (1973) methodology in the next step. The results are reported in Table 3.

Table 4: *Results for Downside CAPM*

Variables	(1-B)	(2-B)	(3-B)	(4-B)	(5-B)
β_i^D	.0026**	.0116**	.0066**	.0071**	.0021**
	(.0011)	(.0056)	(.0023)	(.0021)	(.0010)
β_i^{2D}		-.0091*		-.0062	
		(.0053)		(.0055)	
$\cup_i^D$			-.0546**	-.0460*	
			(.0242)	(.0253)	
β_i^U					.0073**
					(.0028)
Constant	.0115***	.0111***	.0165***	.0155***	.0103***
	(.0009)	(.0009)	(.0024)	(.00257)	(.0010)
R-squared	.123	.137	.154	.164	.167
RMSE	.0081	.0081	.0080	.0080	.0080

Standard errors in parentheses ** p<0.05, * p<0.1

All the hypotheses are again revisited on downside beta with the help of cross-sectional regression against mean returns of all firms. Results clearly indicate that downside beta is also significantly explaining the mean returns for all the hypotheses but their explanatory power is low than as traditional beta which is the maximum reported 16.7% for model 5(B). Root Mean Square Error (RMSE) indicates that the model 5(B) produces more consistent results than other models. These results are consistent with results of Rashid & Hamid (2015). Traditional as well as downside model results indicate that basic assumptions of the CAPM model are strongly violating in the contextual setting of Pakistan. Both models report statistically significant risk and return relationship but traditional CAPM provides high explanatory power than downside model. RMSE of both models indicate that the joint hypothesis model is more suitable model for the calculation of cost of equity than other models.

Conclusion

In emerging economies, where market fundamentals are different from those of developed economies, calculation of the cost of equity is more challenging. Estrada (2007) clearly suggests the use of downside CAPM instead of traditional CAPM in this scenario. Returns of emerging markets are more skewed than as expected by traditional CAPM. Along with this, investors also dislike downside deviation than upside deviation. This develops a strong argument to use downside risk for predicting the expected returns, especially in emerging markets

After reviewing the results for traditional as well as downside beta (ß), R^2 clearly indicates that traditional model outperform than downside beta CAPM although highly negative skewed behavior was observed in Pakistan Stock Market. However, the problems of non-linearity, and inadequacy of beta factor still persistent. Joint hypothesis of both models has the lowest RMSE which indicate that investors account for non-

linearity and other factors in CAPM while evaluating their investments. But these issues can be handled by applying results in portfolio setting.

The results of the study help investors, companies and project managers in determination of an appropriate discount rate that fully reflects all the risk associated with their investments. Investors will make well diversified and efficient portfolios; company's managers will adjust their discount rate for future investments and project managers will adjust their required rate of return for bedding any project in Pakistan. This study recommends the use of different versions of CAPM models for the estimation of cost of equity. Although traditional CAPM has more predictive power but continuous negative intercept indicates that there exists mispricing of stocks that may bias the slope as well. Downside CAPM can be used as an alternative in such scenario. Finally, the future research can focus on the estimation of the discount rate under mean-variance and semi-variance framework with the adjustment of more risk factors such as exchange rate risk, country default risk and industry specific risk as well as project specific risk factors in a multivariate CAPM setting.

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