Testing Capital Asset Pricing Model on KSE Stocks

Salman Ahmed Shaikh*

Abstract

Capital Asset Pricing Model (CAPM) is one of the first asset pricing models to be applied in security valuation. It has had its share of criticism, both empirical and theoretical; however, with its intuitive appeal and simplicity, it has established itself as a useful tool used in practice. One of the most important implications of the model is that the expected stock returns are determined by their corresponding level of systematic risk and not the unsystematic risk. We test the CAPM on 30 stocks traded at Karachi Stock Exchange (KSE) using the Sharpe-Lintner (1965) approach. The evidence does not validate standard CAPM model.

Keywords: Capital Asset Pricing Model, Asset Pricing, Arbitrage Price Theory, Capital Markets*, Market Portfolio, Security Market Line, Capital Market Line*

Introduction

CAPM hypothesizes that investors require higher rates of return for greater levels of risk. It is a single factor model because it is based on the hypothesis that required rate of return can be predicted using one factor, i.e. systematic risk. Despite challenges, restricted assumptions and mixed evidence on its validity, CAPM is still widely used in applications, such as estimating the cost of capital for firms and evaluating the performance of managed portfolios.

CAPM is based on the following important assumptions:

- All investors are rational and risk averse.
- All investors have identical expectations about expected returns, standard deviations, and correlation coefficients for all securities.
- All investors have the same one-period investment time horizon and they aim to maximize economic utilities.
- All investors can borrow or lend unlimited amount of money at the risk-free rate of return.
- There are no transaction costs and taxes.

* Salman Ahmed Shaikh, Research Associate, at Institute of Business Administration (IBA), Karachi. Email: salmanashaikh@iba.edu.pk

- There are no personal income taxes so that investors are indifferent between capital gains and dividends.
- There are many investors, and no single investor can affect the price of a stock through his or her buying and selling decisions. Therefore, investors are price-takers.
- Capital markets are in equilibrium.

The standard algebraic form of CAPM is as follows:

$$E(R_i) = R_F + (R_M - R_F)b_i$$

Where,

$E(R_i)$ = Expected return on capital asset 'i'.

R_F = Risk free rate of interest; proxy usually used is return on treasury securities.

R_M = Return on market portfolio; proxy usually used is return on broad market index.

b_i = Index of systematic risk.

b_i is computed as covariance between asset 'i' return and market return divided by the variance of the market return:

$$b_i = \frac{Cov(R_i, R_M)}{Var(R_M)}$$

The beta of the market portfolio is always equal to 1. The beta of a security compares the volatility of its returns to the volatility of the market returns.

b_i = 1.0 - the security has the same volatility as the market as a whole

b_i > 1.0 - the security has more volatility than the market as a whole

b_i < 1.0 - the security has less volatility than the market as a whole

In CAPM, $E(R_i)$ is positively associated with R_F, R_M and b_i.

Literature Review

Writing his doctoral dissertation in statistics, Markowitz originated Modern Portfolio Theory (MPT). Most important points of his work were:

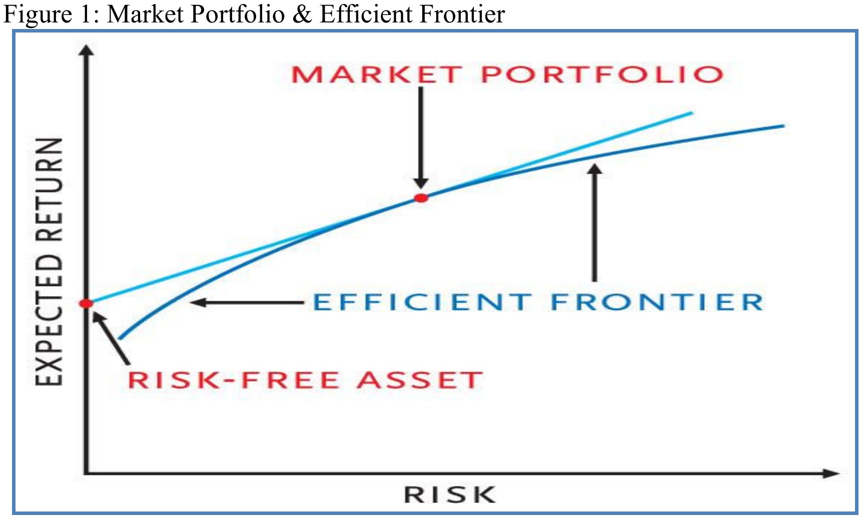
a) His model describing the impact on portfolio diversification of the number of securities in a portfolio and their covariances,
b) His suggestion that a security's contribution to portfolio risk is more important than a security's actual risk level and
c) His suggestion that investors should seek to maximize expected returns and minimize portfolio variances.

More technically, MPT models an asset's return as a normally distributed function. It defines risk as the standard deviation of return, and models a portfolio as a weighted combination of assets, so that the return of a portfolio is the weighted combination of the assets' returns. By combining different assets whose returns are not perfectly positively correlated, MPT seeks to reduce the total variance of the portfolio return. MPT also assumes that investors are rational and markets are efficient.

Sharpe (1964) assumes that every investor is a mean-variance portfolio selector. He further supposes that these investors all share the same expectation as to returns, variances, and covariances. But if the inputs to the portfolio selection are the same, then every investor will hold exactly the same portfolio of risky assets. And because all risky assets must be held by somebody, an immediate implication is that every investor holds the "market portfolio".

It does not imply that every investor has the same degree of risk aversion. Investors can always reduce the degree of risk they bear by holding riskless bonds along with the risky stocks in the market portfolio; and they can increase their risk by holding negative amounts of the riskless asset; that is, by borrowing and leveraging their holdings of the market portfolio.

Figure 1: Market Portfolio & Efficient Frontier



Lintner (1965) performed the first empirical test of the CAPM using a two-stage regression. He rejected the CAPM based on his tests; however, his two stage regression procedure was performed on individual stocks rather than portfolios.

This enabled beta estimation errors to cloud his results. Black, Jensen and Scholes (1972) found evidence to support the CAPM based on their test of portfolios. Fama and MacBeth (1973) found that while the riskless rate and beta explained the structure of security returns, beta squared and unsystematic variances did not. These results and those published in numerous papers afterwards lent support to the validity of CAPM.

But, later on, Fama and French (1992) found that stock betas did not explain long term return relationships, although firm size and market-to-book ratios did. Basu (1977) and Fama and French (1992) found that firms with low price to earnings ratios outperform firms with higher P/E ratios. Fama and French (1992) found that the P/E ratio, combined with firm size predict security returns significantly better than the CAPM.

Alongside CAPM, Ross (1976) published the seminal paper on Arbitrage Pricing Theory (APT). This equilibrium asset pricing model does not require as restrictive assumptions as does the CAPM. The APT states that security returns will be linearly related to a series of factors.

Although the single-beta CAPM managed to withstand more than thirty years of intense econometric investigation, the current consensus within the profession is that a single risk factor, although it takes us an enormous length of the way, is not quite enough for describing the cross-section of expected returns.

In empirical studies, besides the market factor, two other risk factors have been identified for common stocks.

a) Size effect - Small firms seem to earn higher returns than large firms, on average, even after controlling for beta or market sensitivity.
b) Book Value / Market Value - Firms with high book-to-market ratios appear to earn higher returns on average over long horizons than those with low book-to-market ratios after controlling for size and for the market factor.

Tests of CAPM in Pakistan

Javid & Ahmad (2008) in an empirical study tested the standard CAPM and concluded that the Sharpe-Lintner CAPM is inadequate for Pakistan's equity market in explaining economically and statistically significant role of market risk for the determination of expected return.

Iqbal & Brooks (2007) investigated the applicability of the CAPM in explaining the cross section of stock return on the Karachi Stock Exchange for the period September 1992 to April 2006. They conducted tests on individual stocks as well as size sorted portfolios and industry portfolios. They employed three data frequencies namely: daily, weekly and monthly data. They also corrected beta for thin trading. Contrary to earlier studies on emerging markets, the premium for beta risk and the skewness had the expected signs. The risk return relationship however appeared to be non-linear.

Issues in Testing Asset Pricing Models

Dual Hypothesis Problem

The market efficiency hypothesis says nothing about the structure of stock prices. Inefficiency would imply that abnormal returns can be consistently achieved. We can define abnormal return as the difference between actual and expected return.

This means that we have to know the expected return. For that, we use different asset pricing models like CAPM to find a risk-adjusted return that the market will be rewarding.

Defining abnormal return inherently involves assuming a pricing model. If we find abnormal returns, we conclude that the market is inefficient. But then, we can also say that the pricing model we used is invalid.

The challenge here is that testing market efficiency inevitably involves testing a joint hypothesis:

- H_0: Both market is efficient and the pricing model is valid.
- H_1: EITHER market is inefficient OR the pricing model is invalid.

Jensen (1978) points out that in most cases our tests of market efficiency are, of course, tests of a joint hypothesis; market efficiency and, in the more recent tests, the two parameter equilibrium model of asset price determination. The tests can fail either because one of the two hypotheses is false or because both parts of the joint hypothesis are false.

Roll's Critique

The market portfolio in practice would necessarily include every single possible available asset, including real estate, precious metals, stamp collections, jewelry, and anything with any worth. The returns on all possible investments opportunities are unobservable.

Validity of the CAPM is equivalent to the market being mean-variance efficient with respect to all investment opportunities. Without observing all investment opportunities, it is not possible to test whether this portfolio, or indeed any portfolio, is mean-variance efficient. Consequently, it is not possible to test the CAPM.

Testing CAPM: First Pass & Second Pass Regressions

Using data for 30 stocks of companies listed at KSE, we use the Lintner (1965) approach to test CAPM.

Methodology

First, we run the time series regression for each individual stock to estimate the beta using the daily price data from CY2008 to CY2012.

Second, we run the cross section regression using the beta and fitted values of step 1 regression.

First pass regression is estimated as follows:

$$er = \beta_0 + \beta_1 kseer + \mu$$

Where,

er = Average Monthly Return on Stock – Risk Free Rate [1]

kseer = Average Monthly Return on Market – Risk Free Rate

In Table 1, we report the results from first pass regression. 'aer' represents average expected excess return and 'beta' represents index of systematic risk.

Table 1: First Pass Regression Estimates

Companies	aer	beta	Companies	aer	beta
OGDC	0.004119	1.086334	FFC	-0.00233	0.734781
PPL	-0.00842	0.699075	FFBL	-0.00468	0.815295
POL	0.004179	1.286127	ENGRO	-0.01501	1.071098
ATRL	-0.00068	1.514084	ICI	-0.00307	1.214486
NRL	-0.00947	1.162895	HUBCO	-0.00036	0.691666
FATIMA	0.016688	0.626358	KAPCO	-0.009	0.379464
NBP	-0.02455	1.251501	APL	-0.00465	0.810522
BAFL	-0.02063	1.153626	AHCL	-0.02164	1.703751
HBL	-0.01281	1.159852	EFOODS	0.038933	2.500597

[1] For risk free rate, one year T-bill rate is taken. T-Bill auction takes place approximately twice in a month. Average cut-off yield for the month for 1 year maturity is taken and then it is converted into monthly return.

UBL	-0.01267	1.197599	JSCL	-0.03357	1.643934
MCB	-0.01304	1.278539	LUCK	0.00331	1.34033
BAHL	-0.01946	0.354288	NML	-0.00513	1.445135
PTCL	-0.01687	0.923967	AICL	-0.02095	1.3691
PSO	-0.01214	1.212212	MTL	0.008013	0.471538
AKBL	-0.02862	1.19371	DGKC	-0.00575	1.591042

Next, we run second pass regression, estimated as follows:

$$aer = \beta_0 + \beta_1 beta + \beta_2 variance + \mu$$

Where the variables are as defined as before. Table 2 reports the results.

Table 2: Cross Section Regression

Source	SS	df	MS
Model	.000739179	2	.00036959
Residual	.005169308	27	.000191456
Total	.005908488	29	.000203741

Number of obs =	30
F(2, 27) =	1.93
Prob > F =	0.1646
R-squared =	0.1251
Adj R-squared =	0.0603
Root MSE =	.01384

aer	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
beta	.0068865	.0059288	1.16	0.256	-.0052784	.0190515
variance	-.3903491	.2156165	-1.81	0.081	-.8327575	.0520594
_cons	-.011305	.0070269	-1.61	0.119	-.025723	.0031131

Analysis & Interpretation

If CAPM is correct, then intercept term must be zero. In our estimate, it is less than zero, but statistically insignificant even at 10% level.

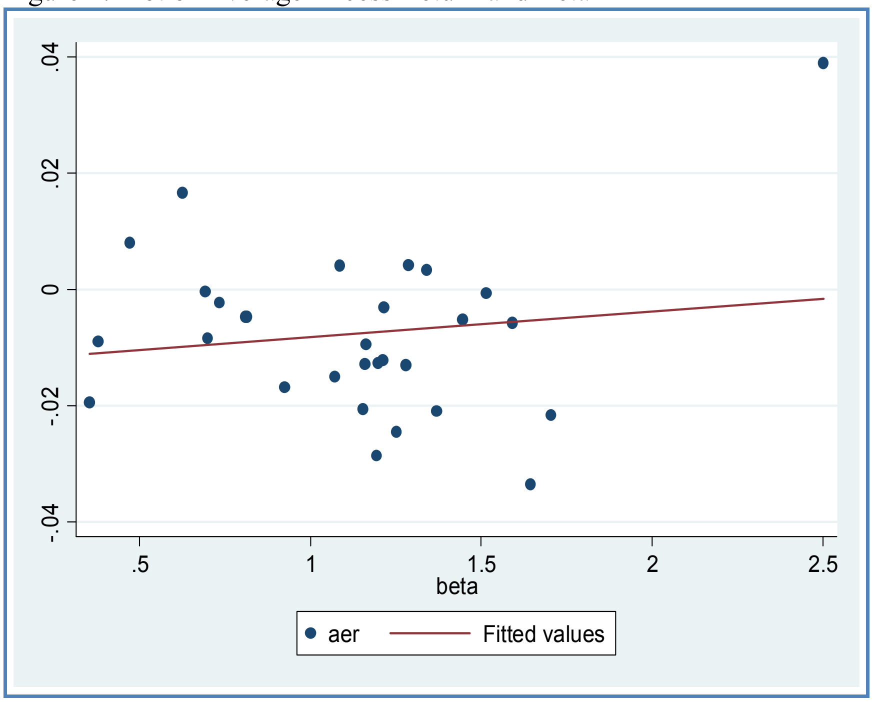
If CAPM is correct, coefficient of beta must be equal to average excess market return. In our estimates, beta coefficient is marginally positive while average market excess return is marginally negative.

The period of study coincides with tight monetary policy adopted by the central bank which kept the risk free rate at high levels. Along with that, the 2008 equity market crisis also led to the decline in stock returns. Both these factors could be partly responsible for the near to zero excess returns in monthly stock returns.

Apriori, variance of the error term in first pass must not be other than zero in second pass cross-sectional regression. Here, the estimated value of coefficient is less than zero.

Next, when we plot the average excess return against beta, we see a linear positive relationship which means that systematic risk is compensated with excess return in the market. Figure 1 illustrates the result. But, overall, our regression estimates suggest that standard CAPM is not able to provide the results which could validate it.

Figure 1: Plot of Average Excess Return and Beta



Conclusion

Capital Asset Pricing Model (CAPM) is one of the first asset pricing models to be applied in security valuation. It has had its share of criticism, both empirical and theoretical; however, with its intuitive appeal and simplicity, it has established itself as a useful tool in practice. In this study, we tested the CAPM using 5 year data on 30 stocks traded at KSE using the Sharpe-Lintner (1965) approach. Overall, our regression estimates suggest that standard CAPM is not able to provide the results which could validate it.

References

Black, Fischer & Scholes, Myron S, (1972). The Valuation of Option Contracts and a Test of Market Efficiency, *Journal of Finance, American Finance Association*, 27(2), pp. 399-417.

Fama, Eugene F. (1965). Random Walks in Stock Market Prices, *Financial Analysts Journal*.

Fama, Eugene F. & James D. MacBeth (1973). Risk, Return and Equilibrium: Empirical Tests, *The Journal of Political Economy*, 81(3), pp. 607-636.

Fama, Eugene F. & Kenneth R. French (1992). The Cross-Section of Expected Stock Returns, *Journal of Finance*, 47(2), pp. 427-65.

Iqbal, Javed and Brooks, Robert Darren (2007). A Test of CAPM on the Karachi Stock Exchange. *International Journal of Business*, 12 (4), pp. 429-444.

Javid, Attiya Y. & Ahmad, Eatzaz (2008). Test of Multi-moment Capital Asset Pricing Model: Evidence from Karachi Stock Exchange, *PIDE-Working Papers*, No. 49, Pakistan Institute of Development Economics.

Lintner, John (1965). The valuation of risk assets and the selection of risky investments in stock portfolios and capital budgets, *Review of Economics and Statistics*, 47 (1), pp. 13-37.

Markowitz, Harry. (1952). Portfolio Selection, *The Journal of Finance*, 7 (1), pp. 77-91.

Roll, Richard (1977). A critique of the asset pricing theory's tests Part I: On past and potential testability of the theory, *Journal of Financial Economics,* 4 (2), pp. 129–176.

Ross, Stephen (1976). The arbitrage theory of capital asset pricing, *Journal of Economic Theory*, 13 (3), pp. 341–360.

Sharpe, William F. (1964). *Capital asset prices: A theory of market equilibrium under conditions of risk*, Journal of Finance, 19 (3), pp. 425-442.