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Impact of Capital Asset Pricing Model (CAPM) on Pakistan (The Case of KSE 100 Index)

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Abstract
In this paper the estimated return on stock model i.e. Capital Asset Pricing Model (CAPM) is employed in order to get information whether it better estimates the return on stock in Pakistani capital market. For this purpose time series monthly data from secondary sources for a period of 2003 to 2007 has been taken. CAPM were tested for the five sizes and book to market portfolios from Karachi Stock Exchange. Pakistan T-bill rate is taken as risk free rate. However basic problem with (CAPM) was predictive power and Robustness of results. For this purpose capital asset pricing model was applied. Dependent variable portfolio represented by ER_{p_t}. The excessive return shows the return above that of the risk free rate R_f that is required by the investor for taking additional risk. While independent variables were market risk premium. Research Findings show that CAPM better estimates the return in Pakistani capital market. In case of CAPM, it was able to show the existence of risk premium as the only factor affecting the stock return.
Key Words: CAPM, Market portfolio, KSE, Risk Premium.

1. Introduction

For individual cost of equity and estimation of expected returns being very important for decision related to portfolio management, as well as evaluation of performance. So many models have been developed to facilitate financial managers and investors to predict the expected return on a stock. The important model for these prediction are a single factor model (CAPM: Capital Asset Pricing Model) developed by William Sharpe (1964) and John Lintner in 1965 for which William Sharpe was given Nobel Prize in 1990 and a three factor model suggested by Fama and French (1992), in fact this model was developed after CAPM was heavily criticized on number of grounds. As James Davis (2006) said CAPM "is one of important asset pricing model" and "the importance of this model comes because it consist of only one factor related to Risk. The concept about CAPM is so logical that is widely accepted and understand by researchers" and the Fama and French three factor model is "Perhaps the most promising alternative" and "the most widely used model of stocks return in the academic finance literature". Both of the models have been criticized on different grounds for example CAPM talks of market portfolio which is assumed to consist of all assets in all the markets which is practically impossible because they may include not only traded financial assets but also consumer durables, real estate. Second CAPM says that there is only one significant beta but in practice many significant

The equation for the CAPM model that explains the expected return on portfolio or stock i follow as:

$$E(R_i) = R_f + \beta_i[(E(R_m) - Rf] \text{ ---------- (1)}$$

Here

$E(R_i)$ is the expected return calculated based on its risk to market portfolio

R_f is the risk-free interest rate,

$E(R_m)$ is the expected return on the market portfolio,

And β_i, the CAPM risk of stock i, is the slope in the regression of its excess return on the market's excess return.

The equation for the time series regression can be seen in (2) with the excess return on portfolio i as the dependent variable and the excess return on the market as the independent variable:

$$R_i - R_f = \alpha + \beta_i[R_m - R_f] + \mathrm{E}_i \text{ ---------- (2)}$$

In the CAPM model β_i or Beta is the sole factor when it comes to pricing risk. We can intuitively see why people initially embraced this model, and it was due to its simplicity. In the context of the CAPM, an investor is only rewarded for systematic or non-diversifiable risk which is represented by β. The excess premium that is afforded to portfolio or stock i is solely a function of its volatility to the expected market risk premium, or the β factor, multiplied by the expected market risk premium. The advantages of this model were that given historical returns on the portfolio, and the selection of another variable such as the KSE 100 as a proxy for the market, that it is very simple to calculate β for a time series regression. If CAPM is used then and estimate for beta is obtained using simple OLS regression and this estimate is multiplied by an estimate for the risk premium on the market to obtain an estimate for excess/or less return on equity for that stock. So CAPM uses only one variable that is "risk premium on the market" to estimate the return on equity for a stock, which may cause some problems. For example, the CAPM says that the risk of a stock should be measured relative to a comprehensive "market portfolio" that in principle can include not just traded financial assets, but also consumer durables, real estate and human capital. Even if we take a narrow view of the model and limit its preview to traded financial assets, is it legitimate to limit further the market portfolio to common stocks (a typical choice), or should the market be expanded to include bonds, and other financial assets, perhaps around the world. The CAPM's empirical problems may reflect theoretical failings, the result of many simplifying assumptions. But they may also be caused by difficulties in implementing valid for tests of the model.

2. Literature Review

It is a global phenomenon "Higher the risk higher will be the return". If we take the same statement for financial markets then this can be restated as higher the risk of the financial assets higher the return demanded. But the problem is how to quantify the risk so as to measure the return demanded for it. If this can be solved it will be of great help in problems like capital budgeting, cost benefit analysis, portfolio selection and for other decision relating to the knowledge of risk and return.

In 1977, Roll questioned the testability of CAPM, his main critique being that the CAPM cannot be tested or applied until the structure of the true market portfolio is known and all securities are included. Using a proxy incurs two problems, namely the proxy might be efficient when the true market portfolio is not and the reverse, the proxy might not be efficient when the market portfolio is. Furthermore, there is a possibility of benchmark error as using different proxies' yields different results and conclusions and inappropriate proxy might be taken. In addition, in reality, the return on the market

Basu (1977) studied common stock and made clear that whenever sorted of the stock based on E/P ratios, the future returns on higher Earning/Price ratio often the value of the stock shows results higher than forecasted by Capital Assets Pricing Model and future returns on Lower Earning/Price ratio stocks are less than forecasted by CAPM. When stocks are sorted on market capitalization (price times shares outstanding), average returns on small stocks are higher than predicted by the CAPM. Statman (1980**)** showed that "value" stocks or stocks with high book-to-market equity ratios had returns that were not captured by market betas.

3. Research Methodology

In 1991 KSE started as an open market but the volume of traded securities remained low till the start of 2002, within this period the investment activity remained low and no noteworthy foreign investment was seen, but in the start of the new millennium environment changed and KSE started to show signs of activity which increased with time till 2008. The world financial crisis 2008 and political instability started making all its previous bull rallies into bearish. KSE 100 index on several instances broke its previous records which was a sign of investors confidence (In April 17, 2006 market capitalization in KSE was about US $ 57 Billion which was 46% of Pakistan GDP for the year 2005-2006). Pakistan was seen as an emerging market and foreign investors were encouraged to invest in it (In 2002 KSE was declared as the best performing stock exchange in the world in terms of percentage increase in local market index value).

3.1 Capital Asset Pricing Model

3.1.1 Model Specification

The model used for CAPM and will be as;

$$E(R_i) = R_f + \beta_i[E(R_m) - R_f]$$

Where

$E(R_i)$ is the expected return on stock calculated based on its risk to market portfolio.

R_f is the risk-free interest rate,

$E(R_m)$ is the expected return on the market portfolio,

β_i, the CAPM risk of stock *i,* is the slope in the regression of its excess return on the market's excess return.

The model can be shown as

$ER_{pt} = \alpha_p + \beta_t(RP_t) + E_t$ For CAPM

Where $ER_{pt} = R_{Pt} - R_f$ and

R_{p_t} = average return of equally weighted portfolio.

3.1.2 Dependent variable

The dependent variable for both CAPM is the highest return of the portfolio shown by ER_{p_t}. The more than above return shows the return above that of the free rate associated with risk R_f that is required by the investor for taking additional risk.

3.1.2.2 Independent variables

The independent variable for Capital Assets Pricing Model is the market risk premium.

3.2.1 Hypothesis

$$ER_{it} = \alpha_i + \beta_t(R_m - R_f) + E1$$

$$H_1 : \alpha_i \equiv 0 or \alpha_i \neq 0$$

But statistically insignificant

$$H_2 : \beta_t \neq 0$$

3.3 Sample Selection and Criteria

To test the CAPM using monthly data of KSE stocks taken from different sectors, data from the period of Jan 2002 to Dec 2008 is taken. Updated data could not be taken because stock exchange in Pakistan was freezed from 27 August 2008 to 12 Dec 2008 and data of consecutive 60 months is required for these models.

1. The selected companies must have the price data for the period Jan 2003 to Dec 2007.
2. Companies having negative equity for the period were ignored e.g. Wazir Ali industries and Pakistan International Air line.
3. KSE 100 index of 2008 was analyzed both on the capitalization of market and B/M ratio.
4. A sample of 20 companies were selected for the study, 20 top and bottom companies on the basis of market capitalization, 20 top, 20 middle and 20 bottom companies were selected on the basis of B/M ratio.

4. Empirical Results and Analysis

4.1 CAPM Illustrated

How CAPM is used for calculation of expected return will first be illustrated with simple supposed data for understanding and then applied to original data.

Example

Let us consider an example. The estimated rates of return and Beta coefficients of some securities are as given below.

Table 1: Estimated rates of return and Beta coefficients of some securities

Security	Estimated return (%)	Beta
A	30	1.6
B	24	1.4
C	18	1.2
D	15	0.9
E	15	1.1
F	12	0.7

The risk free rate of return is 10 percent while the market return is expected to be 18 percent. We can use CAPM to determine which of these securities are correctly priced. For this we have to calculate the expected return on each security using the CAPM equation

Given that $R_{f=}$ 10 and R_m = 18

The equation becomes $R_i = 10 + \beta_i(18 - 10)$

The expected return on security A can be calculated by substituting the Beta vale of security A in the equation. Thus

$R_i = 10 + 1.6(18 - 10)$

= 10 + 12.8

= 22.8 percent

4.1.2 Descriptive statistics

The monthly returns between January 2003 and December 2007 were computed on five sorted portfolios. Table 1 represents the descriptive statistics of these portfolios.

Table 2: Descriptive statistics of monthly returns from period 2003-2007

Descriptive statistics of monthly returns (2003-2007)					
	A	B	C	D	E
Mean	4%	5%	0%	6%	3%
Median	4%	5%	-2%	6%	2%
Maximum	20%	29%	40%	30%	19.55%
Minimum	-09%	-36%	-32%	-20%	-23%
Std.Dev	7%	10.92%	09%	20%	10%

A= Big size with low B/M portfolio
B= Big size with Medium B/M portfolio
C= Small Size with Low B/M portfolio
D= Small Size with Medium B/M portfolio
E= small size with High B/M Portfolio.

Table 3: Correlations between sorted Portfolio returns

	A	*B*	*C*	*D*	*E*
A	99%				
B	51%	199%			
C	60%	39%	99%		
D	59%	60%	70%	99%	
E	68%	49%	60%	69%	99%

Table 4: CAPM combined portfolio result

CAPM regression result				
A	β1	t(α)	t(β1)	R-square
0.000752	0.9069*	0.1501	13.5377	0.3994

* Significant at 99% ** Significant at 95%

The result was astonishingly very accurate the intercept was insignificant at 99% and 95% confidence interval and risk premium was significant at 99% and 95% confidence interval.

5. Conclusion and Recommendations

Rate of return or asset pricing is one of the hottest topics for financial economists. From the past half a century they are trying to create a model that can be called the best of all and can be used universally but it is very difficult because different market have different characteristic, so a model that can be considered better in one market may not work in other environment. During this time many models for asset pricing were developed some got in the lime light while other vanished without leaving any kind of impression. We are facing a similar problem with CAPM and Fama and French three factor model CAPM. Some researchers advocate for the single factor beta as the most viable risk factor determining returns; other report that beta has been long gone. It is proposed that different combinations could be tried to see existence of size and value premium like the monthly data can be replaced with daily or weekly data. The time period under consideration can be changed to include other years. It is also proposed that on the same data set the model should be tested without sorting the portfolios and its robustness should be checked for other time periods or there is a possibility to increase the sample size

then maybe we can have some signs of size and value premium. Asset pricing is one of core topic in the investment decisions and continuous improvements are being made to create a robust model. But many difficulties are being faced when used to analyze the human behavior. Financial economists have encountered tremendous problems whenever they tried to model investor's psychology and the result for a particular time period might not be representative of actual investment behavior in subsequent time periods. Future is uncertain so is human thinking no one can comment for sure what thing they are going to consider important at one time period it is very complex to figure out the reaction for any change that may happen.

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Table 5: Twenty selected companies having Highest market capitalization

Mkt Cap (in Millions)	Companies Name
27,708.75	Arif Habib Sec.
28,587.18	Pak Tobacco XD
31,107.68	UniLever Pak. Ltd.
33,200.83	Royal Bank Ltd XR
33,273.57	Kot Addu Power Co.
37,411.57	Allied Bank
37,974.90	Engro Chemical XD
44,844.38	Pak Oilfields Ltd.
45,879.78	P.S.O.
47,373.52	Fauji Fertiliz XD
60,473.63	Nestle Pakistan
61,558.20	Stand.Chart.Bank
69,049.80	United Bank
73,786.79	Jah.Sidd. Co.
83,436.63	National Bank
105,083.55	Habib Bank Ltd
118,881.00	P.T.C.L.A
146,231.41	MCB Bank Ltd.
160,699.67	Pak PetroleumXB
406,136.67	Oil and Gas DevSPOT XD

Table 6: Twenty Selected companies having Lowest market capitalization

Mkt Cap (in Millions)	Companies Name
146.54	Wazir Ali
415.23	Bannu Woollen
560.23	Nakshbandi Ind.
1,036.80	Agriautos Industries
1,096.70	Habib Mod
1,619.47	Askari Leasing XB
3,624.95	Pak Refinery Limited
3,655.22	Kohinoor Energy
3,863.93	Thal Limited
4,244.00	PICIC Growth
4,752.96	Colony Sugar Mills
4,783.70	Fauji Cement
4,805.46	Fazal Textile Ltd.
4,815.18	Pak.PTA Ltd.
4,921.72	Mybank LtdXR
4,945.82	Mari Gas XD
5,068.12	Pioneer Cement
5,106.34	JS Bank Ltd
5,206.76	Altern Energy

Table 7: Six portfolios formed at the intersection of two size and three B/M portfolios

Big Size with Low B/M companies

Pak Tobacco XD
UniLever Pak. Ltd.
Royal Bank Ltd XR
Nestle Pakistan
MCB Bank Ltd.
Oil and Gas DevSPOT XD

Big size with Medium B/M comp

Arif Habib Sec.
Jah.Sidd. Co.
P.T.C.L.A

Big size with High B/M Companies
No company was selected.

Small Size with Low B/M Companies

Pak.PTA Ltd.

Small Size with Medium B/M Companies

Agriautos Industries
Mari Gas XD
Pioneer Cement

Small Size with High B/M Companies

Bannu Woollen
Habib Mod
Kohinoor Energy
PICIC Growth
Fauji Cement
JS Bank Ltd
Arif Habib Bank

Table 8: CAPM: Regression result of Portfolio A
SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.814543
R Square	0.66348
Adjusted R Square	0.65713
Standard Error	0.036618
Observations	55

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*			
Regression	1	0.140113	0.1401	104.49	3.88E-14			
Residual	53	0.071066	0.0013					
Total	54	0.211179						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.009433	0.005131	1.8383	0.0716	-0.00086	0.01973	-0.0009	0.01973
Rm-Rf	0.701965	0.06867	10.222	4E-14	0.564229	0.8397	0.5642	0.8397

Table 9: CAPM: Regression result Portfolio B
SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.472
R Square	0.223
Adjusted R Square	0.208
Standard Error	0.107
Observations	55

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*			
Regression	1	0.173880421	0.17388	15.21904	0.000272			
Residual	53	0.605535119	0.011425					
Total	54	0.77941554						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.013	0.0149	0.8617	0.3927	-0.0171	0.0429	-0.0171	0.0429
Rm-Rf	0.782	0.2004	3.9011	0.00027	0.3799	1.184	0.3799	1.184

Table 10: CAPM: Regression result for Portfolio C
SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.685
R Square	0.469
Adjusted R Square	0.459
Standard Error	0.083
Observations	55

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*			
Regression	1	0.322834899	0.322835	46.80303	8.12E-09			
Residual	53	0.365579987	0.006898					
Total	54	0.688414886						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-0.033	0.011638437	-2.85038	0.006208	-0.05652	-0.00983	-0.05652	-0.00983
Rm-Rf	1.066	0.155750507	6.841274	8.12E-09	0.753136	1.377928	0.753136	1.377928

Table 11: CAPM: Regression result for Portfolio D
SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.686
R Square	0.47
Adjusted R Square	0.46
Standard Error	0.085
Observations	55

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*			
Regression	1	0.340466469	0.340466	47.0677	7.56E-09			
Residual	53	0.383378019	0.007234					
Total	54	0.723844487						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.019	0.011918375	1.63122	0.108773	-0.00446	0.043347	-0.00446	0.043347
Rm-Rf	1.094	0.159496761	6.860591	7.56E-09	0.774332	1.414152	0.774332	1.414152

Table 12: CAPM: Regression result for Portfolio E

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.732
R Square	0.536
Adjusted R Square	0.528
Standard Error	0.061
Observations	55

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*			
Regression	1	0.225809906	0.22581	61.32494	2.08E-10			
Residual	53	0.195155924	0.003682					
Total	54	0.42096583						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-0.005	0.008503434	-0.57027	0.570904	-0.0219	0.012206	-0.0219	0.012206
Rm-Rf	0.891	0.11379656	7.831024	2.08E-10	0.662897	1.119391	0.662897	1.119391