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ALTERNATIVE METHODOLOGIES FOR TESTING CAPM IN THE PHILIPPINE EQUITIES MARKET

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The two approaches of validating CAPM are tested using monthly data of stock returns in the Philippine market. Results indicate that the conditional relationship proposed by Pettengill, Sundaram, and Mathur (1995) perform better than the Fama and Macbeth (1972) approach in explaining risk return trade-off. Furthermore, the ability of beta in explaining asset returns is revived.

I. INTRODUCTION

In literature, there is a profusion of tests on the validity of the Capital Asset Pricing Model (CAPM). Results point to directions of either supporting or rejecting the model. Notably, the model found support in a study by Modigliani and Pogue (1974) and in a paper by Fama and Macbeth (1972). On the other hand, Tinic and West (1984) and Fama and French (1992) rejected the model.

Among studies rejecting the model, Fama and French (1992) gained the most prominence since it was able to cast the strongest doubt on the model's ability to predict the relationship between beta risk and return. Rather than attributing asset returns to beta as specified in CAPM, their study found that firm size and the book-to-market equity ratio are far superior in explaining asset returns.

Yu (2003) empirically explored the model's validity in the Philippine setting.[1] Dividing the study's test period into 6 subperiods, he found evidence for either rejecting or confirming the model among the subperiods. Another finding of Yu (2003) is that the relationship between risk and return is nonlinear. Similar to Fama and French (1992), he also found evidence that factors other than beta explain asset returns. Thus, Perold (2004) suggests that "more than one systematic risk factor may be at work in determining asset prices."

Majority of the empirical tests on CAPM follow the methodology pioneered by Fama and Macbeth (1972), and hereinafter, referred to as the "traditional approach." Under this method, the data set is divided into two: the estimation and the testing periods. In the estimation period, the beta is estimated by running a regression of realized returns of an asset against market returns.[2] The resulting beta of the first regression is used to proxy for the true beta of the asset and is regressed against the excess return of the asset. Generally, this regression takes the following form:

$$\hat{R}_{it} - \hat{R}_{ft} = \hat{\gamma}_{0t} + \hat{\gamma}_{1t}\hat{\beta}_i + \hat{\mu}_{it} \qquad (1)$$

where the left-hand side is the return of the asset in excess of the risk-free rate and $\hat{\beta}_i$ is the estimated beta from the first regression.

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The most crucial feature of this method is its test of hypothesis whereby it specifies that if γ_1 in Equation (1) is insignificantly different from zero, then CAPM is taken to be rejected. This simplicity explains its popularity among researchers.

However, the traditional approach is not without critics. Foremost are Pettengill, Sundaram, and Mathur (1995), hereinafter referred to as PSM, who offered an alternative approach for testing CAPM's validity. Firstly, they argue that focusing on the hypothesis that CAPM is valid only when $\hat{\gamma}_1$ is statistically significant and positive does not directly examine the model's validity. This argument proceeds from the premise that CAPM does not imply that there is a zero probability that R_m is less than R_f. This non-zero probability of R_m being less than R_f is explained by the specification of the model in terms of expected values, that is, the expected returns on the asset, $E(R_i)$, and the market, $E(R_m)$, are averages of all possible returns (both positive and negative) in any given period. Hence the model implies that there may be a non-zero probability of realizing returns below the risk-free rate.

Their second critique is on the relationship between beta and returns. They argue that although CAPM implies that high beta portfolios should have higher expected returns than low beta portfolios, it does not necessarily mean that there is a zero probability that high beta portfolios would earn lower returns than low beta portfolios. Intuitively, this would mean that if the relationship of high beta and high returns always holds, then no investor would hold low beta portfolios.

Based on these arguments, they inferred that there is a "conditional" relationship between beta and returns. That is, a positive relationship between beta and return is expected when $R_m > R_f$ (up market). Thus, high beta stocks earn higher returns than low beta stocks when the market is up. Conversely, there is a negative relationship when $R_m < R_f$ (down market). This does not mean that beta is negative during the down market. Rather, what this means is that when $R_m < R_f$, the return of low beta stocks is higher than high beta stocks.

PSM also examined if there is a reward for holding risk. They posited that two necessary conditions must be satisfied. First, market excess returns are, on average positive. Second, the relationship between risk and return is symmetrical in either periods of up or down markets. If these two conditions are met, then the conditional CAPM is validated.

Interestingly, applying their "conditional" methodology for testing CAPM's predictions for returns of US stocks for the period 1926 to 1990 strongly confirmed the model.

This paper attempts to compare the results of the two methodologies of testing CAPM using Philippine data. In part, its contribution to literature is providing evidence for the appropriateness of either methodology when testing CAPM in the Philippines. This importance cannot be overemphasized especially that the use of CAPM is prevalent in Philippine corporate finance.

The rest of the paper is organized as follows: Section II discusses the methodology. Section III discusses the results of the two alternative methodologies. Section IV concludes.

II. METHODOLOGY

A. Traditional Approach

To test the traditional relationship between beta and returns, the modified three-step portfolio approach developed by Fama and Macbeth is used in this study.

Portfolio formation	January 1992 to December 1993
Initial estimation	January 1994 to December 1997
Testing	January 1998 to December 2002

In the portfolio formation period, individual stock betas are estimated using the Ordinary Least Squares (OLS) regression model:

$$\hat{R}_{it} = \hat{\alpha}_i + \hat{\beta}_i \hat{R}_{mt} + \hat{\mu}_{it} \qquad (2)$$

where

$\hat{\beta}_i$ = estimate of true β for stock i.

μ_{it} = error term which is assumed to be random.

These $\hat{\beta}_i s$, once determined, are used as the basis to form ten portfolios. The ten companies with the highest beta values shall form part of the first portfolio and so on. Since there are 103 companies in the sample, 3 portfolios have 11 companies while the rest have 10.

In the initial estimation period, estimates of portfolio betas $(\hat{\beta}_p)$ are made by running the regression:

$$\hat{R}_{pt} = \hat{\alpha}_p + \hat{\beta}_p \hat{R}_{mt} + \hat{\mu}_{pt} \qquad (3)$$

where

$\hat{R}_{pt}$ = equally weighted average return of

This approach requires that the data be divided into three: portfolio formation period, initial estimation period, and testing period.

stocks in portfolio p.

$\hat{\beta}_p$ = estimate of true β for portfolio p.

$\hat{\mu}_{pt}$ = error term which is assumed to be random.

Finally, once $\hat{\beta}_p s$ are obtained from equation (3) and using the data from 1998 to 2002, various hypotheses of the CAPM model are tested using the cross-sectional regression of the forms:

$$\hat{R}_{pt} - \hat{R}_f = \hat{\gamma}_{0t} + \hat{\gamma}_{1t}\hat{\beta}_{p,t-1} + \hat{\mu}_{pt} \qquad (4)$$

$$\hat{R}_{pt} - \hat{R}_f = \hat{\gamma}_{0t} + \hat{\gamma}_{1t}\hat{\beta}_{p,t-1} + \hat{\gamma}_{2t}\hat{\beta}^2_{p,t-1} + \hat{\gamma}_{3t}\hat{S}_{p,t-1} + \hat{\mu}_{pt} \qquad (5)$$

where

$\hat{\beta}_{p,t-1}$ = $\hat{\beta}_p$ obtained from regression equation (3)

$\hat{\beta}^2_{p,t-1}$ = squared value of $\hat{\beta}_p$ obtained from regression equation (3).

$\hat{S}_{p,t-1}$ = standard deviation of the error term in equation (3).

Equation 4 tests for the positive relationship between risk and return. Equation 5 includes two additional variables. $\hat{\beta}^2_{p,t-1}$ tests for the linearity assumption of CAPM and $\hat{S}_{p,t-1}$ tests for factors other than β which can explain asset returns.

To avoid the problem of non-constancy of βs, the value of $\hat{\beta}_{p,t-1}$ is updated annually. For example, in running the cross-sectional regression equation (4) for the year 2000, the value of $\hat{\beta}_{p,t-1}$ is adjusted by re-running regression equation (3) to include the data from 1998 and 1999. Since $\hat{\beta}_{p,t-1}$ is updated, consequently, $\hat{\beta}^2_{p,t-1}$, and $S_{p,t-1}$ are also updated. Using the standard t-test to measure the significance of the coefficients $\hat{\gamma}_{0t}$, $\hat{\gamma}_{1t}$, $\hat{\gamma}_{2t}$, and $\hat{\gamma}_{3t}$, the unconditional CAPM predicts the following hypotheses:

CAPM Predictions	Expected Value
1. $\hat{\gamma}_{0t}$ is equal to the risk-free rate.	$\gamma_{0t} = 0$
2. $\hat{\gamma}_{1t}$, which represents the risk premium, is positive.	$\gamma_{1t} > 0$
3. $\hat{\gamma}_{2t}$, which represents non-linear risk-return relation, is equal to zero.	$\gamma_{2t} = 0$
4. $\hat{\gamma}_{3t}$, which represents factors other than β to explain asset returns, is equal to zero.	$\gamma_{3t} = 0$

B. Conditional Approach

To test the conditional CAPM as proposed by PSM, regression equation (6) is used and is expressed below:

$$\begin{aligned}\hat{R}_{pt} - \hat{R}_f = \; & \hat{\varphi}_{0t} + \hat{\varphi}_{1t}\delta\hat{\beta}_{p,t-1} \\ & + \hat{\varphi}_{2t}(1-\delta)\hat{\beta}_{p,t-1} \\ & + \hat{\varphi}_{3t}\hat{\beta}^2_{p,t-1} \\ & + \hat{\varphi}_{4t}S_{p,t-1} + \mu_{pt}\end{aligned} \tag{6}$$

where

δ = Dummy variable. A dummy variable is used to indicate the positive ($R_m > R_f$) and negative ($R_m < R_f$) excess market returns. When $R_m > R_f$, $\delta = 1$, while $\delta = 0$ means $R_m < R_f$.

Regression equation (6) shows that when realized market return is higher than the risk-free rate, there is a positive relationship between beta and realized portfolio returns. On the other hand, when realized market return is lower than the risk-free rate, a negative relation exists between beta and the realized portfolio return. Regression equation (6) also includes $\hat{\beta}^2_{p,t-1}$ and $S_{p,t-1}$ to test the linearity and non-β factor assumptions of CAPM, respectively. The following hypotheses are used to test the validity of the conditional CAPM:

CAPM Predictions	Expected Value
1. $\hat{\varphi}_{0t}$ is equal to the risk-free rate.	$\hat{\varphi}_{0t} = 0$
2. $\hat{\varphi}_{1t}$, which represents the risk premium, is positive during up market.	$\varphi_{1t} > 0$
3. $\hat{\varphi}_{2t}$, which represents the risk premium, is negative during down market.	$\varphi_{2t} < 0$

4. $\hat{\varphi}_{3t}$, which represents non-linear risk-return relation, is equal to zero.	$\hat{\varphi}_{3t} = 0$
5. $\hat{\varphi}_{4t}$, which represents factors other than β to explain asset returns, is equal to zero.	$\hat{\varphi}_{4t} = 0$

A test for positive risk-return relationship is also examined by investigating the two conditions posited by PSM – that is, first, $R_m - R_f$ is on average positive, and second, the risk-return relationship is symmetrical between periods of positive and negative excess market returns. To test the first condition, the average market excess returns are calculated and standard t-test is used to determine if market excess returns are positive. To test for symmetry, the coefficients, $\hat{\varphi}_1$ and $\hat{\varphi}_2$, are compared by using the standard t-test with the following hypotheses:

$$H_0 : \hat{\varphi}_1 + \hat{\varphi}_2 = 0$$

$$H_a : \hat{\varphi}_1 + \hat{\varphi}_2 \neq 0$$

C. *Data*

Since the model is expressed in terms of expected value, then to test the validity of CAPM, realized returns are used to proxy for expected returns.[3]

Monthly share prices for 103 stocks listed in the Philippine Stock Exchange (PSE) for the period January 1992 to December 2002 are used in this study.[4] The main consideration in choosing these samples is that shares must be continuously listed during the said period. End of the month share prices are not adjusted to account for cash and stock dividends and stock splits due to unavailability of data resulting in the underestimation of stock returns. However, this is not expected to materially affect the results of the study because, as pointed out by Ybañez (2001), companies listed in the PSE typically pay low cash yields ranging from 0% to 2% per year, which average roughly about 0.8%.

Stock price returns are calculated using the formula:

$$\hat{R}_{it} = \ln\left(\frac{P_{it}}{P_{i,t-1}}\right) \qquad (7)$$

where

$\hat{R}_{it}$ = return on stock *i*.

P_{it} = price per share of stock *i* at the end of the month *t*.

$P_{i,t-1}$ = price per share of stock *i* at the end of the month *t-1*.

The 91-day treasury-bill rate is used as a proxy for the risk-free rate. Since interest rates are quoted on an annual basis, the formula below is used to estimate monthly returns:

$$\hat{R}_f = \sqrt[12]{1 + TBR} - 1 \qquad (8)$$

where

$\hat{R}_f$ = monthly rate of return on the risk-free asset.

TBR = annual rate of return on 91-day treasury bills

The Phisix is used as a proxy for the market portfolio. The Phisix is an index which is calculated using the weighted average market value of 33 listed shares which represent all sectors in the PSE. The market returns are calculated as:

$$\hat{R}_{mt} = \ln\left(\frac{P_{mt}}{P_{m,t-1}}\right) \qquad (9)$$

where

$\hat{R}_{mt}$ = monthly return on the market.

P_{mt} = value of the Phisix at the end of the month *t*.

$P_{m,t-1}$ = value of the Phisix at the end of the month *t-1*.

III. RESULTS

A. Traditional Approach

Table 1
Summary Results of Regression Equations 4 and 5

Regression Equation	$\hat{\gamma}_0$	$\hat{\gamma}_1$	$\hat{\gamma}_2$	$\hat{\gamma}_3$
4	-0.0208 (-1.8575)***	-0.0015 (-0.0920)		
5	-0.0102 (-0.4261)	0.0107 (0.1135)	-0.0073 (-0.1004)	-0.1801 (-0.6895)

t-values are presented in parentheses.
**** Significant at 10% level.*

Summarized in Table 1 are the results under the traditional test of CAPM. Using regression equation (4), the estimated coefficient of beta is insignificantly different from zero and has the incorrect sign. Also, the value of the estimated intercept is significantly different from zero. This two results points to the rejection of CAPM since the traditional test predicts an insignificant value for the intercept and a positive significant value for the beta coefficient.

There is no improvement in the estimated value of beta when equation (4) was expanded to equation (5) to include variables for testing: (a) the linearity assumption of CAPM, and (b) the possible effects of factors other than beta in explaining asset returns. However, as predicted by CAPM, the regression shows that there is a linear relationship between risk and return and that factors other than beta do no affect returns. Notably, these two results contradict Yu (2003) and a possible explanation is the bigger sample size considered in this study.

Taken together, the estimation results of the traditional method point to the conclusion that there is a weak relationship between risk and return, thus. rejecting CAPM.

B. Pettengill, Sundaram, and Mathur's (1995) Methodology

Table 2 summarizes the results when the "conditional" relation between beta and return is examined. Regression equation (6) is used to examine the "conditional" relation proposed by PSM.

Table 2
Summary Results of Regression Equation 6

Regression Equation	$\hat{\varphi}_0$	$\hat{\varphi}_1$	$\hat{\varphi}_2$	$\hat{\varphi}_3$	$\hat{\varphi}_4$
6	-0.0102 (-0.5710)	0.1048 (2.9214)*	-0.0461 (-1.3111)***	-0.0021 (-0.0955)	-0.1780 (-0.7603)

t-values are presented in parentheses.
* *Significant at 1% level.* **** Significant at 10% level.*

When the conditional relationship between risk and return is considered, the relationship between beta and returns is confirmed. Under regression equation (6), the significant estimated values of $\hat{\varphi}_1$ and $\hat{\varphi}_2$ are notable. In effect, the estimation indicates that when the market is doing well (up market), the positive relationship between risk and return holds in that high beta stocks earn higher returns. Furthermore, when market performance is poor (down market), a negative relationship between risk and return is observed. This means that during downturn periods of the economy, high beta shares tend to earn lower rates of return. Conversely, low beta shares tend to earn higher returns during economic downturns.

Similar to the results of traditional test, regression results show that there is linear relationship between beta and returns and, that, factors other than beta do not affect returns.

Given the promise of the results of the estimation using conditional relationship between risk and return, is CAPM now confirmed in the Philippines? The answer is a qualified yes.

To completely confirm the conditional CAPM proposed by PSM, it must be established that there is a positive reward for holding risk and that the risk-return relationship is symmetrical between periods of positive and negative excess market returns. Thus, these two conditions posited by PSM are examined. Tables 3 and 4 summarize the results:

Table 3
Summary Results of the Test for a Positive Tradeoff (First Condition)

Monthly Mean Excess Return	-0.0181.
Maximum Excess Return	0.3210
Minimum Excess Return	-0.3099
Standard Deviation	0.0962
t-value	-1.4555
p-value	0.1508
Number of observations	60

Table 4
Summary Results of the Test for a Positive Tradeoff (Second Condition)

	$\hat{\varphi}_1 + \hat{\varphi}_2 = 0$
t-value	1.1694
p-value	0.2427

As indicated in Table 3, the first criterion that there is a positive reward for holding risk, that is there is an excess market return, is not satisfied. By itself, this already indicates that the conditional CAPM as proposed by PSM does not hold for the sample considered in this study. A possible explanation for this is that the data used in the testing period, as explained in the methodology section, comprised of stock returns for the 60 months covering the period January 1998 to December 2002

This period coincides with the ensuing years where the aftermaths of the Asian crisis reverberated in the Philippine economy. Hence, only 21 months (35% of the sample) showed excess market returns while the remaining 39 months of the sample exhibited higher risk-free returns than market returns.

As shown in Table 4 where we conducted a test of symmetry for the resulting coefficients of equation (6), there is a symmetrical risk-return relationship between periods of positive and negative excess market returns. This indicates that the effect of beta on returns during up and down markets is consistent.[5]

IV. CONCLUSION

This paper is an exercise to test CAPM using two methodologies. The traditional method of testing CAPM in the Philippines shows that beta is weak in predicting asset returns. On the other hand, the conditional method strongly shows the significant effect of beta in explaining asset returns. However, the study stops short of concluding the validity of CAPM in the equities market. This is because one of the two conditions as described by PSM was not satisfied. It was pointed out that the failure of the data to satisfy the first condition was that our testing period mainly consisted of a down market.

The contribution of this paper to literature is its evidence for the role of beta in explaining returns in the Philippine equity market. Moreover, in the practical sense, the study also suggests that a portfolio of stocks may perform better when its funds are invested in high beta stocks during up market and in low beta stocks during down market.

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NOTES

[1] The data used were monthly returns of 50 shares listed in the Philippine Stock Exchange for the 1990-2000 period.

[2] $\hat{R}_i = \hat{\alpha}_i + \hat{\beta}_i \hat{R}_m + \hat{u}_i$

[3] The symbol ^ signifies the usage of estimated values instead of the true values.

[4] Data are extracted from DataStream International.

[5] Survivorship bias is considered to be negligible since only eight listed shares were delisted during the testing period covering 1998-2002. Furthermore, four of the eight delisting happened because of mergers with other listed corporations.