

A test of the CAPM on Philippine common stocks

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Abstract

This paper presents the results of an empirical test of the capital asset pricing model (CAPM) on the returns on Philippine common stocks from 1990 to 2000. The test uses the two-step cross sectional regression (CSR) procedure to compute for the beta of each asset and the parameters of the Sharpe-Lintner version of the CAPM. The basic data used in the study consist of average monthly returns of 50 representative common stocks drawn from a stratified random sampling process.

Test results show that there are sub-periods that support the predictions of the CAPM, but other sub-periods yield results that run counter to the CAPM predictions. These results are unaltered after incorporating the Shanken correction factor that addresses the error-in-variables problem inherent in CSR. Further tests also show that, in the short run, factors other than risk explain the cross section of asset returns and that the relationship between return and risk may not be linear.

JEL classification: G12, C31

Keywords: Asset pricing, capital asset pricing model

1. Introduction

The capital asset pricing model (CAPM) is the first equilibrium model of asset pricing under uncertainty. Developed by Sharpe [1964] and Lintner [1965], the model establishes the link between the risk and return of assets based on the fundamental portfolio framework of Markowitz [1959]. According to the CAPM, in a frictionless one-period economy with infinitely divisible assets and no asymmetric information, the portfolio of all invested wealth, or the market portfolio, will itself be a mean-variance efficient portfolio. The model predicts that the expected return on assets is equal to the sum of the return on a risk-free asset and the product of the beta of the asset (i.e., the covariance of the asset's return with the return on the market portfolio divided by the variance of the market return) and the expected return on the market portfolio.

* Assistant Professor, UP College of Business Administration. The author wishes to thank the editor, professors at the College of Business Administration, and an anonymous referee for their comments that significantly improved the paper. This study was supported by the UP Business Research, Inc.

Apart from being the first model of its kind, the CAPM draws its appeal from the convenience in applying linear regression estimation techniques. Many empirical studies have emerged to investigate the pricing implications of the CAPM. Initially, key empirical studies seemed to support the mean-variance efficiency of the market portfolio (e.g., Black, Jensen, and Scholes [1972], Fama and MacBeth [1973], and Blume and Friend [1973]). However, further studies identified some inconsistencies between the predictions of the CAPM and the empirical relationship between return and risk (e.g., Pratt [1967], Friend and Blume [1970], and Miller and Scholes [1972]), and gave rise to refinements, modifications, and advances in model specification and estimation procedures (e.g., Black [1972], Merton [1973], Ross [1976], Hansen and Singleton [1982], Campbell [1993] and [1996], Cochrane [1996], and Fama and French [1996]).

More recently, studies continue to enrich the literature on asset pricing by developing new approaches in assessing different asset pricing models. For instance, Hansen and Jagannathan [1997] developed a methodology for examining specification errors in asset pricing models. Using this methodology, Hodrick and Zhang [2000] evaluated several asset pricing models and found that, except for Campbell's dynamic asset pricing model, none of the models correctly prices returns that are scaled by the term premium. Empirical findings like these raise new questions and, as a consequence, open new avenues for basic and empirical research in asset pricing.

In the Philippines, the literature on asset pricing remains limited. There are only a handful of empirical tests of asset pricing models largely focusing on areas that have addressed the anomalies of the CAPM. (e.g., Perez [1979], Francisco [1983], Mangaran [1993], and Bautista [1999]). A related but altogether different line of inquiry where the literature is more sparse is market efficiency (or rational expectations in the macroeconomics literature). The studies by Cayanan [1994] and Bautista [1996]¹ fall in this category.

Meanwhile, the CAPM continues to be used in the Philippines in estimating asset returns and cost of capital without establishing empirical support for the cross-sectional relationship between returns and risk. Thus, a baseline study for an empirical test on the CAPM for the Philippines is in order.

Using 50 common stocks listed in the Philippines Stock Exchange (PSE) that were selected in a stratified random sampling process, this paper estimates the parameters of the CAPM based on the average monthly stock returns for the period 1990 to 2000. It employs the two-step cross sectional regression procedure to compute for the beta of each asset and the parameters of the Sharpe-Lintner version of the CAPM. The Shanken correction factor is used to address the error-in-variable problem that is inherent in the CSR

¹Although symmetric information is one of the key assumptions in deriving the CAPM, it cannot be said that empirical support of the CAPM implies market efficiency. See Lintner [1969] and Black [1972] for detailed explanations.

The remainder of this paper is organized as follows: Sections 2 presents the methodology. Sections 3 and 4 present the data and discuss the empirical results, respectively. Section 5 concludes.

2. Methodology

2.1. The model: CAPM

Modifications and refinements added to the initial specification of Sharpe and Lintner have produced different versions of the CAPM. In this study, the empirical investigation is limited to the basic Sharpe-Lintner version.

The simple CAPM version relies on four key assumptions [Black 1972], namely,

- a. All investors have the same opinion about the possibilities of end-of-period values of all assets. They have a common joint probability distribution for the returns on available assets.
- b. The common probability distribution describing the possible returns on the available assets is joint normal or joint stable with a single characteristic exponent.
- c. Risk-averse investors choose portfolios that maximize their expected end-of-period utility of wealth. The utility function increases at a decreasing rate as wealth increases.
- d. An investor may take a long or short position of any size in any asset, including the riskless asset. Any investor may borrow or lend any amount at the riskless rate of interest.

Following these assumptions, it can be shown that the expected return on the i^{th} asset is as follows:

$$E[R_i] = R_f + \beta_{im} (E[R_m] - R_f) \quad (1)$$

where:

R_m : return on the market portfolio

R_f : return on the risk-free rate

$\beta_{im} : \text{Cov}(R_i, R_m) / \text{Var}(R_m)$

Alternatively, the Sharpe-Lintner version of the CAPM may be expressed in terms of the returns in excess of the risk-free rate. Defining Z_i as the return on the i^{th} asset in excess of the risk-free rate (i.e., $Z_i = R_i - R_f$), the CAPM equation can be expressed as:

$$E[Z_i] = \beta_{im} E[Z_m] \quad (2)$$

where:

Z_m : excess return on the market portfolio of assets

β_{im} : $Cov(Z_i, Z_m)/Var(Z_m)$

Inasmuch as empirical tests on the Sharpe-Lintner version of the CAPM use excess returns, the latter expression is used in this study.²

Empirical tests of the CAPM center on the three main implications of equation (2) [Campbell et al, 1997]:

1. The intercept is equal to zero;
2. The beta accounts for the entire cross-sectional variation of expected excess returns over the risk-free rate; and
3. The market risk premium is positive (i.e., $E[Z_m] > 0$).

2.2. Estimation procedure: cross sectional regression

Fama and MacBeth [1972] developed the cross sectional regression approach which involves a two-pass procedure. In the first pass, the betas are derived from the OLS estimate of the following time series regression:

$$Z_{it} = \alpha_i + \beta_{im}Z_{mt} + e_t \quad t = 1, 2, \dots T \text{ for each asset } i. \quad (3)$$

Given β_{im} , the beta estimate for each asset, the procedure moves on to the second pass that involves an OLS estimate of the cross sectional regression of

$$Z_{it} = \gamma_{0t} + \gamma_{1t}\beta_{im} + \varepsilon_t \quad \text{for each time } t, t = 1, 2 \dots T. \quad (4)$$

Let

$$\gamma_0 = E[\gamma_{0t}]$$

$$\gamma_1 = E[\gamma_{1t}].$$

Using the standard t-test, the CAPM predicts that

1. the intercept, γ_0 , is not statistically different from zero, and
2. the coefficient, γ_1 , which represents the market risk premium, is positive and is statistically different from zero.

There have been modifications to the cross sectional regression procedure developed by Fama and MacBeth. Black, Jensen, and Scholes [1972] used 10 portfolios derived from all of the stocks in the New York Stock Exchange from 1931 to 1965, rather than individual assets, to obtain sufficient dispersion in asset

² Theoretically, the risk-free rate is non-stochastic. Thus, equations (1) and (2) are equivalent. However, representations of the risk-free rate are stochastic; Consequently, the betas in the two equations differ.

betas. Cochrane [2001] outlined a technique that uses average asset returns in estimating equations (3) and (4). This study adopts the methodology outlined by Cochrane.

Since the betas that are generated in the first pass are simply estimates of the true betas, they are subject to errors. Consequently, the estimates of the cross-sectional regression suffer from error-in-variables. To correct the error-in-variables, this study employs the approach developed by Litzenberger and Ramaswamy [1979] and refined by Shanken [1992].³ This approach multiplies the variance of the parameter estimates by an adjustment factor $(1 + (\mu_m - \gamma_0)^2 / (\sigma_m)^2)$, where...

μ_m : mean of market return

γ_0 : parameter estimate as defined in equation (4)

σ_m^2 : variance of market return

3. The data

3.1. Sample selection process

This study uses monthly returns from 1990⁴ to 2000 on 50 publicly traded common stocks in the Philippine Stock Exchange (PSE) that were introduced prior to 1999. The returns on common stocks introduced to the local bourse after 1999 are not included since they have yet to establish a reasonably long historical price series that is suitable for analysis.

In choosing the 50 representative samples, this study employs a two-stage stratified random sampling process described below.

STAGE 1. From the population of 309 issues listed in PSE at the end of year 2000, the following were initially excluded:

- | | |
|--|-----------|
| • Suspended or halted common stocks (as of Dec 2000) | 15 issues |
| • Preferred Stocks | 38 issues |
| • Warrants, Philippine Deposit Receipts, etc. | 10 issues |

The balance is composed of 246 locally tradable common stocks.

STAGE 2. From the balance of 246 stocks, 50 were chosen: five from each decile based on market-capitalization.

Chart 1 illustrates the sample selection process. Table 1 enumerates the stocks that were chosen from each decile and their respective sectoral classification and market capitalization.

³ An alternative approach adopted by Fama and Macbeth minimizes the error-in-variables problem by grouping the stocks into portfolios and increasing the precision of the beta estimates.

⁴ Data availability is the main consideration in choosing the starting year of the sample. The longest time series that is available to the author starts with the year 1990.

3.2. Profile of the sample

The sample generated from the selection process is a good representation of common stocks in the Philippines. The 50 representative stocks comprise 23 percent of the total market capitalization of all tradable common stocks. In terms of number, the sample accounts for about a fifth of the total number of common stocks. In addition, each sector is represented in the sample, albeit in varying degrees (Table 2). In terms of returns, the sample has considerably higher returns compared with the composite market index and the 91-day Treasury bill rates. This is due principally to the dividends that were given by the companies. (Chart 2)

3.3. Asset returns

SIMPLE RETURNS. The net monthly return of an asset is computed as⁵:

$$R_i = \{P_{(t+1)} - P_t\} / P_t \quad (5)$$

where:

R_i : return on asset i ,

$P_{(t+1)}$: price per share of asset i at the end of the month $t + 1$, and

P_t : price per share of asset i at the end of the month t .

SIMPLE RETURNS WITH DIVIDENDS. If a dividend is declared, the net return is computed as follows:

$$R_i = \{P_{(t+1)} + D_t - P_t\} / P_t \quad (6)$$

where:

D_t : dividend declared within the period $(t, t + 1]$.

Inasmuch as dividend can either be a stock dividend or a cash dividend, equation (6) can take on any of the following forms:

- Returns with stock dividend

$$R_i = \{P_{(t+1)}[1 + SD_t] - P_t\} / P_t, \quad (7)$$

where:

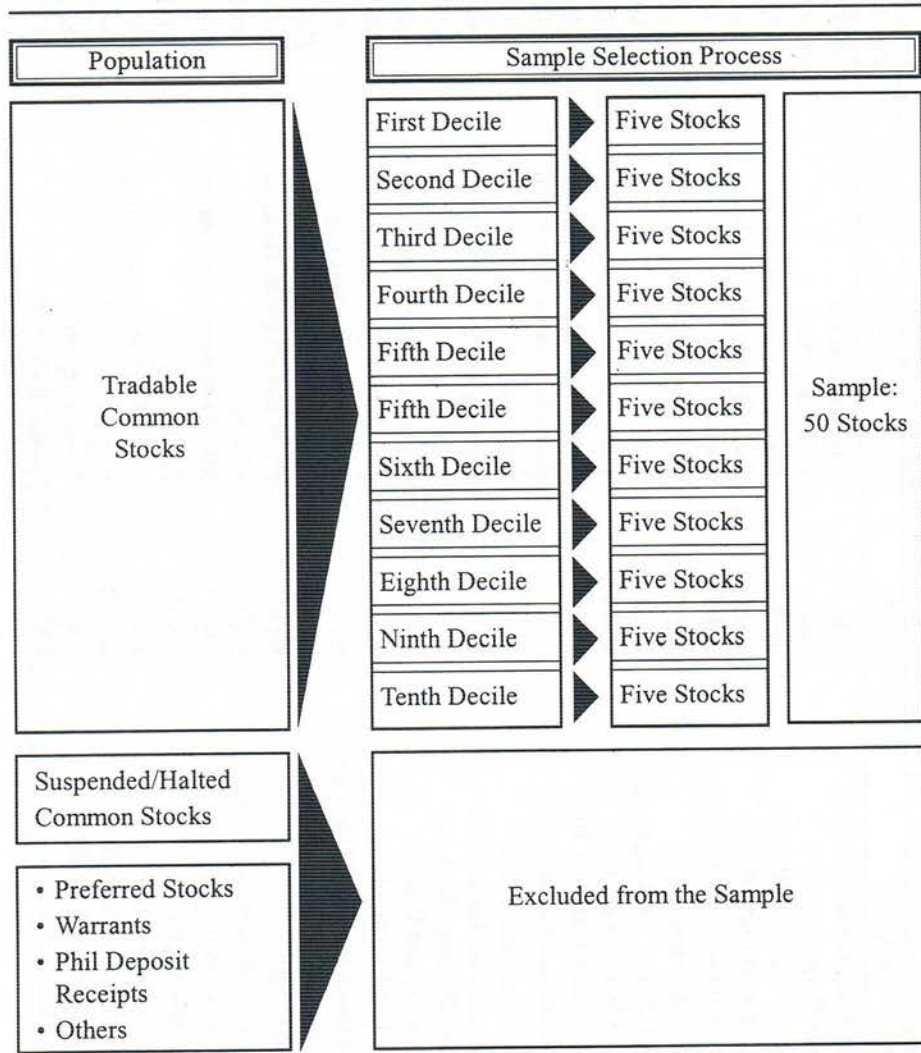
SD_t : stock dividend declared within the period $(t, t + 1]$, in percent.

- Returns with cash dividend

$$R_i = \{P_{(t+1)} + CD_t - P_t\} / P_t, \quad (8)$$

⁵ In case an asset was not traded in a given month, it is assumed that its price is equal to the previous month-end price.

Chart 1. Sample Selection Process



where:

CD_t : cash dividend per share declared within the period $(t, t + 1]$.

The data on month-end prices of the representative common stocks and on dividends were gathered from the Research Division of PSE.

Table 1. Sample Common Stocks

Decile	Company	Code	Sector	Php Million
First	1 Phil. Long Distance Tel. Co.	TEL	Communication	145,730.02
	2 Ayala Corp.	AC	Holding Firms	109,279.86
	3 Bank of the Phil. Islands	BPI	Banks	91,544.50
	4 San Miguel Corp. A	SMC	Food, Beverages & Tobacco	87,019.34
	5 Metropolitan Bank & Trust	MBT	Banks	59,791.62
Second	6 Metro Pacific Corp.	MPC	Holding Firms	11,159.34
	7 Rizal Comm. Banking Corp.	RCB	Banks	10,997.36
	8 First Metro Invest. Corp.	FMIC	Financial Service	10,521.73
	9 La Tondena Distillers, Inc.	LTDI	Food, Beverages & Tobacco	9,805.19
	10 Jollibee Foods Corp.	JFC	Food, Beverages & Tobacco	9,752.96
Third	11 Robinsons Land Corp.	RLC	Property	4,226.33
	12 Filinvest Dev. Corp.	FDC	Holding Firms	3,930.06
	13 Centro Escolar University	CEU	Others	3,724.14
	14 Union Cement Corp.	UCC	Constn & Other related Products	3,614.38
	15 Pure Foods Corp. A	PF	Food, Beverages & Tobacco	3,431.94
Fourth	16 Int'l Container Term'l Services	ICT	Transportation Services	1,791.87
	17 Cityland Dev't Corp.	CDC	Property	1,775.49
	18 RFM Corp.	RFM	Food, Beverages & Tobacco	1,696.24
	19 Lepanto Cons. Mng. Co. B	LCB	Mining	1,650.75
	20 Phil. Seven Corp.	SEVN	Mfg, Distribution & Trading	1,637.04
Fifth	21 C&P Homes, Inc.	CMP	Property	911.25
	22 Jardine Davies, Inc.	JDI	Mfg, Distribution & Trading	877.66
	23 Cebu Prop. Ventures B	CPVB	Property	842.55
	24 Trans-Asia Oil & Energy	TA	Power & Energy	838.59
	25 First Abacus Financial	FAF	Financial Service	835.24

Table 1. Sample Common Stocks (continued)

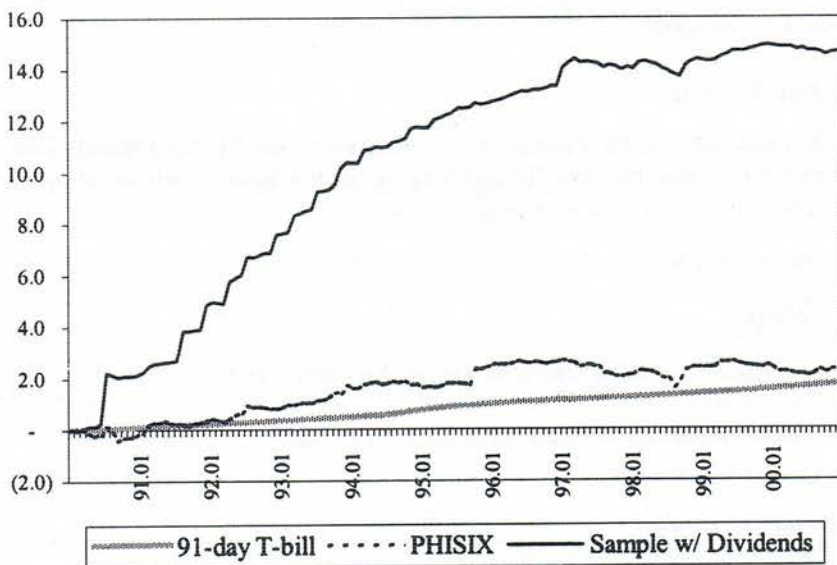
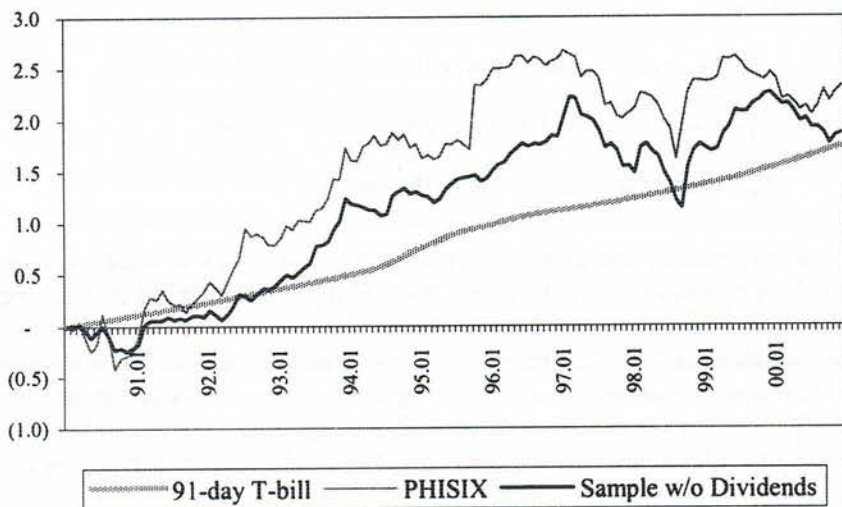
Decile	Company	Code	Sector	Php Million
Sixth	26 Republic Glass Hldg. Corp.	REG	Constn & Other related Products	589.63
	27 Piltel	PLTL	Communication	578.10
	28 Kuok Phil. Prop.	KPP	Property	576.28
	29 Cen Azucar de Tarlac	CAT	Mfg, Distribution & Trading	544.57
	30 Guoco Holdings (Phil.)	GUO	Holding Firms	544.28
Seventh	31 Crown Equities, Inc.	CEI	Holding Firms	425.00
	32 Interphil Labs Inc. A	ILI	Mfg, Distribution & Trading	411.75
	33 House of Investments, Inc.	HI	Holding Firms	408.00
	34 Abra Mining & Industrial	AR	Mining	401.21
	35 Manila Mining Corp. A	MA	Mining	393.91
Eighth	36 Philex Mining Corp. B	PXB	Mining	278.83
	37 Dizon Copper Silver Mines	DIZ	Mining	268.88
	38 Alcorn Gold Res. Corp.	APM	Holding Firms	264.37
	39 Bagoio Gold Holdings Corp.	B	Holding Firms	255.92
	40 ATN Holdings, Inc.	ATN	Holding Firms	254.40
Ninth	41 MRC Allied Ind. Inc.	MRC	Property	190.00
	42 First E-Bank Corp.	FSTE	Banks	183.93
	43 Leisure & Resorts Corp.	FER	Hotel, Recreation & Other Service	181.58
	44 MBF, Inc.	MBF	Holding Firms	175.89
	45 F&J Prince Holdings Corp.	FJP	Holding Firms	172.80
Tenth	46 United Paragon Mining Co.	UPM	Mining	130.12
	47 Atok-Big Wedge. Inc. B	ABB	Holding Firms	126.52
	48 Interport Resources. B	IRCB	Oil	118.00
	49 Pacifica	PA	Oil	116.64
	50 Seafont Resources Corp.	SPM	Holding Firms	114.10

Table 2. Profile of the Sample

Sector	Market Capitalization (in Php Millions)			Number of Issues		
	Sample A	Sector B	% Share A/B	Sample C	Sector D	% Share C/D
Banks and Financial Services	173,874.40	1,594,233.60	10.9	6	25	24.00
Banks	162,517.40	302,280.10	53.8	4	18	22.20
Financial Services	11,357.00	1,291,953.60	0.9	2	7	28.60
Commercial- Industrial	399,335.50	778,609.20	51.3	30	159	18.90
Communication	146,308.10	249,388.20	58.7	2	14	14.30
Power & Energy	838.60	61,433.50	1.4	1	4	25.00
Transportation Services	1,791.90	8,484.10	21.1	1	6	16.70
Constn & Other Related Products	4,204.00	8,624.70	48.7	2	14	14.30
Food, Beverages & Tobacco	111,705.70	170,247.30	65.6	5	16	31.30
Holding Firms	127,110.50	238,382.40	53.3	13	66	19.70
Manufacturing, Distribution & Trading	3,471.00	26,708.20	13.0	4	29	13.80
Hotel, Recreation and Other Service	181.60	10,976.70	1.7	1	8	12.50
Others	3,724.10	4,364.10	85.3	1	2	50.00
Property	8,521.90	153,865.40	5.5	6	28	21.43
Mining	3,123.70	9,064.10	34.5	6	19	31.60
Oil	234.60	5,900.00	4.0	2	15	13.30
Grand Total *	585,090.20	2,541,672.30	23.0	50	246	20.33

*Excludes preferred shares, warrants, Philippine deposit receipts, and suspended/halted issues

Chart 2. Cumulative log returns



3.4. Market returns

The net market return per month is computed as:

$$R_m = \{P_{m(t+1)} - P_{mt}\} / P_t, \quad (9)$$

where:

R_i : net market return per month,

$P_{m(t+1)}$: market price at the end of the month $t + 1$, and

P_{mt} : market price at the end of the month t .

By convention, the aggregate composite stock index is used as a proxy variable in estimating market returns. In the Philippines, there are two aggregate indices to choose from: the Phisix and the all-shares index. The Phisix is a market-value-weighted index of 33 representative companies from different sectors of the local bourse. All-shares index encompasses all shares that are traded in the PSE. Both indices are readily made available by the PSE at the end of the trading of each day. The time series can be sourced from the Research Division of the PSE.

This study uses Phisix principally because of data availability. The all-shares index, which was more recently introduced, does not extend to the earlier years covered by the study.

3.5. Risk-free rate

Notwithstanding its limitations⁶, this study uses the 91-day Treasury Bill rate to represent the risk-free rate. To compute for the net monthly rate of return on the risk-free asset, the following formula is used:

$$R_f = \{1 + TBR\}^{1/2} - 1, \quad (10)$$

where:

R_f : monthly rate of return on the risk-free asset, and

TBR : annual rate of return on 91-day T-bill rate.

4. Empirical results

This study considers the period 1990 to 2000. For the purpose of testing the CAPM, several sub-periods were used. (Table 3)

⁶ The CAPM model assumes that the risk-free rate is fixed; However, the treasury bill rate is a stochastic variable. Most empirical studies on the CAPM use the 91-day Treasury Bill rate since it is the closest representation of a risk-free asset.

Table 3. Description of Sub-periods

<i>Period</i>	<i>Time frame</i>	<i>Description</i>
Period 1	1990.02 – 2000.12	Entire sample period
Period 2	1990.02 – 1995.06	First half of the sample period
Period 3	1995.07 – 2000.12	Second half of the sample period
Period 4	1990.02 – 1992.06	Pre-foreign exchange deregulation
Period 5	1992.07 – 1997.06	Post foreign exchange deregulation; pre-financial crisis
Period 6	1997.07 – 2000.12	Post foreign exchange deregulation; post-financial crisis

At the first instance, most of the regression results generally show support for the CAPM model in predicting the returns on common stocks in the Philippines.

TEST 1—*Intercept is equal to zero*. Using t-test, there is evidence to accept the hypothesis that the intercept is equal to zero, except for periods 1 and 6;

TEST 2—*Beta accounts for most of the cross-sectional variation of expected excess returns*. Except for period 6, which is saddled with uncertainties caused by the financial crisis in the Southeast Asian region, all sub-periods show that risk accounts for at least half of the total variation in returns across assets;

TEST 3—*The market premium is positive*. Except for period 6, all sub-periods show that there is a positive relationship between risk and return. In addition, there is enough evidence to show that risk is statistically significant in affecting the level of returns.

On balance, only periods 2, 3, 4, and 5 confirm all the predictions of the CAPM. (Tables 4 to 6). These results remain unaltered even after correcting for the error-in-variables⁷. (Table 7)

The variation in the results across different sub-periods is reminiscent of the findings of Fama and MacBeth [1972] and Fama and French [1972]. Using data from 1926 to 1968, Fama and MacBeth established a positive relationship between risk and return. In contrast, Fama and French used data from 1963 to 1990 and found a negative relationship between risk and return. When Fama and French conducted a re-run of their regressions for the period 1945 to 1965, their results showed a positive linear relationship between risk and return.

Together with the results of the studies done in the US, this study confirms that the CAPM prediction on the positive link between risk and return may fail in the short run. Short-run episodes where the relationship can turn out to be positive or negative cannot be discounted. Within such time frame, factors other than the beta can affect asset returns. A positive relationship will appear as long as the

⁷ This result is consistent with the observation of Cochrane [2001] that, for a monthly interval, the Shanken correction factor is quite small and ignoring it makes little difference.

long-run relationship is not significantly altered by these alternative factors (e.g., periods 1 to 5). A negative relationship can emerge if these alternative factors become so significant in reversing the prediction of the CAPM.

To further test if there are other factors that affect asset returns in shorter time periods, the average excess returns were regressed against three variables: the beta, the square of the beta, and the variance of excess returns (patterned after the test conducted by Fama and Macbeth). The square of the beta tests the possibility of a non-linear relationship between risk and return. The variance of excess returns tests if there is another factor that explains cross sectional variation in excess returns. CAPM predicts that the square of the beta and the variance of the excess returns have zero coefficients.

Results show that, in most cases, the two additional variables are significant in explaining cross sectional variation in asset returns. (Tables 8 and 9) As such, the CAPM prediction fails in all subperiods. This result provides further proof that, in the short run, risk (as measured by beta) does not fully explain the cross sectional variation in excess returns, and that the relationship between return and risk may not be linear.

Thus, short-run estimates of the single-factor CAPM result in specification errors leading to biased estimates of the market premium. Such bias could also be the reason behind the negative relationships that are found by some studies.

5. Findings and conclusions

This study tests the CAPM on Philippine common stocks using monthly returns from the period 1990 to 2000 of samples that were chosen from a stratified random sampling process. Based on a two-step cross sectional regression procedure outlined by Cochrane [2001], tests performed on the Sharpe-Linter version of the CAPM show results that support the predictions of the model for several sub-periods. However, there are also some periods for which no support is found. Further tests also reveal that, in the short run, factors other than risk explain the cross sectional variation of asset returns and that the relationship between return and risk may not be linear.

The limited empirical support for the CAPM is interpreted in the literature either as evidence against the CAPM itself or as an indication of the inadequacy of the testing methodology. Those that read limited empirical support as evidence against the CAPM may be classified into two main threads of research based on their objective: one, those that seek to verify the underlying assumptions of the CAPM (e.g., market efficiency) and two, those that seek to test the influence of other factors in explaining the cross-sectional variation in asset returns. Those that use limited empirical support for CAPM as evidence against testing methodology explore alternative estimation procedures.

In this paper, it has been shown that empirical support for the CAPM varies with the time period. It suggests that CAPM's prediction about the relationship between risk and return is based on a long-run relationship. Thus, it cannot be discounted that there are short-run episodes where the relationship can turn out to be positive or negative due to alternative variables that may affect excess returns in the short run.

Consequently, short-run estimates of the single-factor CAPM may result in specification errors. Omitted variables that significantly affect excess returns yields biased parameter estimate for the market premium.

The results of this study should serve as a caution for practitioners in the field of finance. Inasmuch as CAPM has always been taught as a tool for assessing the risk associated with the cash flow from a proposed investment project and for estimating the project cost of capital, a naïve use of the CAPM estimates may lead to a misleading assessment of risk and cost of capital. One has to know the underlying assumptions behind CAPM estimates: In addition to the timeframe, it is important to know the data used, estimation procedure employed, and the model specification adopted.

While this study uses data on asset returns, there are studies that use portfolio returns. For instance, Black, Jensen and Scholes [1972] used asset portfolio returns rather than asset returns to have sufficient dispersion in asset betas. Besides, the use of asset portfolios may contain the error-in-variables problem that arises in the second pass of the CSR. With regard to the data on market returns, it is common to use the composite stock price index in deriving market returns. But this is not without limitation. Alternative representation of market returns may provide better estimates of the CAPM (e.g., Jagannathan and Wang [1993]).

Estimation procedure is also important, as a number of refinements in estimating and evaluation of the CAPM have been developed. While this study uses ordinary least squares, there are alternative estimation procedures that may provide better estimates. Among these are the maximum likelihood estimation (MLE) and the generalized method of moments (GMM).

Model specification reveals the underlying assumptions behind the refinements in the simple CAPM. These include consumption-based CAPM, dynamic asset pricing model, production-based asset pricing model, the three-factor model (i.e., Fama and French [1996]) and the asset pricing model with time-varying beta. These models may be tested to confirm if they capture variations in asset returns in the short term.

Table 4: Summary of Regression Results—Single-factor CAPM

	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6
<i>Constant</i>						
Coefficient	-4.09108	-2.24159	-2.84578	24.4629	-4.27437	2.657792
Std. Error	1.221852	1.22669	1.534373	15.9835	4.32261	1.159149
t-Statistic	-3.34826	-1.82735	-1.85469	1.5305	-0.98884	2.292882
Prob.	0.0016	0.0753	0.0698	0.136	0.3279	0.0263
<i>Beta</i>						
Coefficient	16.98319	14.25685	14.25952	7.56561	45.87442	-3.19664
Std. Error	0.337476	0.138618	1.976643	0.82943	3.406468	1.278548
t-Statistic	50.3241	102.8502	7.214008	9.12149	13.46686	-2.50021
Prob.	0	0	0	0	0	0.0159
R-squared	0.981399	0.996327	0.520201	0.72855	0.797674	0.115224
Adjusted R-squared	0.981012	0.996233	0.510205	0.71979	0.793276	0.096792
F-statistic	2532.515	10578.16	52.04191	83.2017	181.3562	6.251042
Prob(F-statistic)	0	0	0	0	0	0.015881

Table 5: Empirical test of Sharpe-Lintner Version of the CAPM vs Criteria

	<i>Test Hypothesis</i>	<i>Criteria</i>
Test 1	Intercept is equal to zero	p-value > 5%
Test 2	beta accounts for most of the cross-sectional variation of expected excess returns	R-squared > 50%
Test 3	The market premium is positive	slope is positive; p-value < 5%

Table 6: Summary of Test Results

	<i>Period 1</i>	<i>Period 2</i>	<i>Period 3</i>	<i>Period 4</i>	<i>Period 5</i>	<i>Period 6</i>
Test 1		✓	✓	✓	✓	
Test 2	✓	✓	✓	✓	✓	
Test 3	✓	✓	✓	✓	✓	neg. slope
OVERALL	FAIL	PASS	PASS	PASS	PASS	FAIL

✓ : passed the criteria

Table 7: T-stats: Original vs adjusted for error-in-variables

	<i>Period 1</i>	<i>Period 2</i>	<i>Period 3</i>	<i>Period 4</i>	<i>Period 5</i>	<i>Period 6</i>
<i>Orig. t-stat</i>						
γ_{0t}	-3.35	-1.83	-1.85	1.53	-0.99	2.29
γ_{1t}	50.32	102.85	7.21	9.12	13.47	-2.50
<i>Adjusted t-stat</i>						
γ_{0t}	-3.03	-1.70	-1.80	0.72	-0.83	2.18
γ_{1t}	45.49	95.51	7.01	4.31	11.28	-2.38

Table 8: Summary of Regression Results - Multifactor CAPM

	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6
<i>Constant</i>						
Coefficient	2.683477	1.201538	2.420791	5.539743	3.552355	-0.81869
Std. Error	0.58116	1.077124	0.822189	2.027539	0.721176	0.683411
t-Statistic	4.617451	1.115506	2.944322	2.73225	4.925781	-1.19795
Prob.	0	0.2718	0.0051	0.0106	0	0.2371
<i>Beta</i>						
Coefficient	-2.19134	5.095412	-13.9937	-0.84984	-6.52704	-1.50721
Std. Error	1.101749	1.818245	2.334115	1.808465	1.401847	1.102082
t-Statistic	-1.98897	2.802379	-5.99528	-0.46992	-4.65602	-1.3676
Prob.	0.0527	0.008	0	0.6419	0	0.1781
<i>Beta squared</i>						
Coefficient	-0.82441	-7.47402	13.56003	-0.0009	3.063435	-0.46356
Std. Error	0.0913	1.197938	1.131458	0.034644	0.376766	0.52368
t-Statistic	-9.02966	-6.23907	11.98456	-0.02587	8.130857	-0.8852
Prob.	0	0	0	0.9795	0	0.3807
<i>Variance</i>						
Coefficient	0.000378	4.78E-03	-1.34E-05	0.000112	0.000291	0.002241
Std. Error	2.41E-05	7.42E-04	2.89E-06	5.18E-05	1.91E-05	0.000198
t-Statistic	15.71243	6.435218	-4.61673	2.16684	15.22738	11.30886
Prob.	0	0	0	0.0386	0	0
R-squared	0.998041	0.99902	0.89988	0.996456	0.994988	0.782581
Adjusted R-squared	0.997914	0.998941	0.89335	0.996089	0.994646	0.768401
F-statistic	7812.913	0.99902	137.8156	2717.75	2911.453	55.19086
Prob(F-statistic)	0	0.998941	0	0	0	0

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