EVALUATION OF THE CAPITAL ASSET PRICING MODEL FOR PREDICTING RISK-RETURN PARAMETERS IN THE TRINIDAD AND TOBAGO ENVIRONMENT

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ABSTRACT

This paper investigates the application of the Capital Asset Pricing Model (CAPM) in the Trinidad and Tobago business environment for predicting risk-return parameters.

By testing empirically the degree to which the CAPM predicts the behaviour of security returns, and using "fully reflecting" public information from the stock exchange of listed firms, the model's predictive behaviour is compared with some common financial measures as well as simple forms of arbitrage.

R^2 and F statistics based on the regression equations indicate good degrees of belief in the CAPM model and in some cases greater explanatory and predictive capability than several other accounting and finance measures.

1.0 INTRODUCTION

Decision rules (for the economic evaluation of investment projects) based on Net Present Value (NPV) or internal rate of return (IRR) are evaluated using a discount rate which reflects the alternative annual rate of return that the firm can earn on capital in the market.

If the expected return of a project outweighs the increase in risk, one would expect the price of the firm's stock to rise if the project is undertaken. The converse situation applies when the increase in risk outweighs the increase in expected returns and the stock price will be expected to fall. Thus, the decision-maker has to seek an optimum balance between risk and return and choose that combination of risk and profit which maximises the market value of the firm's stock.

In the business environment, a firm's business risk relates to its industrial sector and to the general conditions of the economy. Also, introducing financial leverage intensifies the variability of earnings per share and induces financial risk. Approaches to business or project evaluation depend upon the market's evaluation of the risk-return tradeoff implicit in the business or projects to be incorporated in the firm's portfolio.

1.1 The Capital Asset Pricing Model and Capital Investment Projects

In using the assumption of the maximisation of the market value of the existing shareholders' equity as the goal of the firm, a direct implication of this assumption is that the firm should choose its investment programme and financing policy so as to maximise the price value of its common stock.

A model of the securities market which examines the equilibrium relationship between expected return and risk can be derived from the Capital Asset Pricing Model (CAPM). This model is used to help determine the discount rate (cost of capital) to be used in firms' financial decisions.

Although the model rests on very restrictive assumptions, it provides significant insights into the problem of capital budgeting under uncertainty and can help firms devise operational rules of thumb for reaching investing and financing decisions in practice. Earlier work ([2], [22], [23]), demonstrated that the main principles of the CAPM prevailed under successive relaxation of the above assumptions.

Given the assumption of a perfect capital market, each project should be evaluated using an appropriate discount rate equal to the risk-free interest plus a risk

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premium which depends solely on the project's beta (β_i) [24].

The CAPM model represents the linear relationship between mean return [$E(x_i)$] and risk (β_1). where by definition:

$$\beta_i = \frac{Cov(x_{it} x_{mt})}{\sigma^2_m}$$

where x_{it} and x_{mt} denote the rate of return on security i and the market portfolio in period t, respectively [17], [26].

Under equilibrium conditions, the required rate of return for each individual project is given by:

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

where

- β_i denotes the systematic risk of the i^{th} project
- R_i denotes the expected rate of return on stock i
- r_f denotes the risk-free rate of return
- R_m denotes the rate of return on the market as a whole

Because of possible covariance between the cash flows of new investment proposals and those generated by existing projects, the combinations should include existing cash flows as well as those from newly proposed investment. The firm is faced with the problem of choosing an optimal combination of projects portfolio out of the subsets of efficient combinations (portfolios).

The efficient investment combinations facing the firm lie on the efficient envelope curve, based on the portfolio selection model. The optimal capital budget is the point of tangency between the opportunity line, and the curve of efficient combinations, and represents the optimal investment combination. This identification of the tangency portfolio with the aggregate market portfolio is the essence of the Sharpe-Lintner CAPM.

The application of a single-valued risk-adjusted discount rate to all individual projects represents a rule-of-thumb solution. Such a rule assumes that the individual characteristics of the alternative projects do not change the average risk level of the firm. However, where the firm must choose among investment opportunities with risk characteristics which materially change the average risk level of the firm, both the optimal investment mix and the appropriate discount rate must be simultaneously determined.

1.2 Literature Review

Myers and Turnbull [25] investigated the appropriateness of using the CAPM for capital budgeting purposes. They derived expressions for the *"market value of a long-lived capital investment project, assuming that the capital asset pricing model (CAPM) holds in each period"*.

They pointed out that the purpose of capital budgeting is to find assets that are worth more than they cost. Projects are usually accepted if the present value (PV) of the future cash flows is greater than the required investment. The discount rate, r, would be the opportunity cost of capital appropriate to the project. To deal with uncertainty, expected cash flows could be used and a risk premium added to the discount rate. Myers and Turnbull [25] however developed a more sophisticated model to evaluate the present value.

They found that when the CAPM is used to obtain a risk adjusted rate, and this rate is used to discount cash flows, the error introduced is not serious. They concluded that *"relatively simple and general evaluation formulae can be developed from the CAPM"*. They also highlight a more fundamental problem. They found that for firms with valuable growth opportunities the observed beta was an overestimate of the appropriate hurdle rate for capital investment.

Hamada [12] in his discussion of the paper [25] points that one should be pessimistic about the use of the CAPM in capital budgeting. He is clearly in favour of the certainty-equivalent approach as opposed to the risk-adjusted cost of capital approach.

In a study done by Brown et al [6], they demonstrated how duration could be incorporated into the calculation of net present value. Their paper focused on the incorporation of liquidity risk into the discounted cash flow analysis.

The section of their paper that is relevant is their derivation of the hurdle rate used. The CAPM is used because in their own words *"it is theoretically sound and objective"*. The authors then go on to modify the CAPM to account for liquidity risk since beta only measured systematic risk. They view the CAPM as a special case of their more general equation applicable to a uniform series of returns.

Kulatilaka [21] looked at the question of investment in robotics. He attempted to remove the *'subjectivity'* that normally accompanies an investment in robotics. He identifies a key issue as arriving at a discount rate which incorporates the systematic risk associated with each cash flow. To achieve this, he uses the CAPM to evaluate the opportunity cost of capital for each project. This analysis, he suggests, is a way of including such factors as improved quality and strategic advantages in a capital budgeting framework.

A more recent study, Khan and Fiorino [18] looked at the evaluation of four actual energy efficient projects. These projects were evaluated using the traditional measures of internal rate of return (IRR) and payback period (PP). These results were compared with those obtained using the CAPM. The authors believed that the use of the CAPM would be relevant here because they felt that energy efficient projects were subject to much of the inherent systematic risk of a well-diversified portfolio. They found that the two traditional methods and the CAPM yielded different results. They concluded that using a blanket minimum attractive rate of return (MARR) or (PP) was inappropriate because all projects do not have the same risk factor. They believed that the CAPM model was a meaningful way to incorporate individual project risk into the selection criterion.

Mullins [24] looked at the application of the CAPM with respect to estimating a firm's cost of equity capital. He mentions that this is an important, but difficult, task for financial managers. The CAPM can give useful information in this regard because of the objective results the model can yield. He does caution, however, that the CAPM cannot be used in isolation because *"it necessarily simplifies the world of financial markets"*. He points out that the CAPM's deficiencies are no worse than other approaches and that the model represents a new and different approach to an important task.

Hill and Dimnik [13] examine the cost justification of new technologies. They indicate that one flaw in the justification process is that some projects are required to clear higher hurdle rates simply because they involve new technology. They do mention that this practice is neither logical nor theoretically justified. They offer two approaches to correcting this bias. The first is that if management believes that the initial costs have been accurately forecasted a lower than normal discount rate should be used. Their second method is to use a high hurdle rate initially and a lower one once the system becomes operational. Both these methods however require a subjective judgment of hurdle rate. As demonstrated by Kulatilaka [21] the CAPM gives a more objective framework which achieves the same objective.

Brigham et al [5] indicate that, theoretically, capital budgeting is a relatively straightforward, mechanical exercise. However, due to uncertainty in cash flows what looks like a good project can turn out to be a disaster. They identify three types of project risk: market or beta risk, intra-firm total risk, and the project's own stand-alone risk. They outline two methods for incorporating project risk into the capital budgeting process. The first is the certainty-equivalent method. In this method the cash flows in each year are adjusted to reflect project risk. The second method is the risk-adjusted discount rate method. In this case different projects are discounted at different rates based on their different risk levels. It is this method that employs the capital asset pricing model (CAPM) to obtain the varying discount rates. This latter method is the one favoured by the authors because of the fact that the certainty-equivalent method is difficult to implement in practice.

A survey done by Kim et al [19] looked at whether business executives were using methods advocated by academics. They found that most of the firms surveyed used discounted cash flow techniques to evaluate projects. However, only 29% adjusted project estimates using a risk adjusted discount rate. And only 7% used the certainty-equivalent approach. The former method was preferred because of its relative simplicity. The authors also found that most of the adjustment for risk was done subjectively and this included the risk adjusted rate. The CAPM approach can be used to evaluate project risk on a valid basis.

Another article by Spahr et al [27] makes the case that the CAPM does provide a framework for analysis of the capital budgeting problem. They do however point out studies which show that investors do not hold the "market"portfolio and so cannot be considered adequately diversified. They go on to show that the CAPM does not hold as a general equilibrium model but has to be modified to form a firm-specific or partial equilibrium model. Bohl and Murphy [3] studied the effect of debt on the capital budgeting model. Part of their analysis is also based on the capital asset pricing model.

1.3 Objectives and Empirical Implications

This paper looks at the CAPM in the Trinidad and Tobago environment. It seeks to compare this model's predictive behavior with some common financial measures as well as a simple form of the Arbitrage Pricing Theory (APT), based on public data.

The main purpose of this paper was to analyse the effectiveness of using the CAPM to estimate the risk-return parameter on a firm's stock. The CAPM was compared with three linear models relating the security's return with:

1. Earnings per share
2. Return on Assets and
3. Dividend Yield

The CAPM was also compared with two simple models based on the APT.

There are two hypotheses which this study is attempting to test. They are:-

1) The relationship between market returns and stock returns, as given by the CAPM, is as strong as the relationship between stock returns and accounting variables or the APT.

2) The CAPM predicts stock returns as well as models based on accounting ratios or the APT.

The efficient market hypothesis (EMH) in the academic and professional finance community projects the view that a market is efficient if security prices *"fully reflect"* the information available. *"Fully reflecting"* the information is taken to mean that knowledge of the information would not allow anyone to profit from it, as security prices already incorporate the information. Further, the information is assimilated in the prices correctly and instantaneously as soon as it became known. Thus, no trading advantages could accrue to users of financial statements as the information contained in them was instantaneously absorbed in prices as soon as the information becomes public.

2.0 MODELING METHODOLOGIES (MODEL AND DATA RELATIONSHIPS)

2.1 Data

The Data source consisted of the twenty five stocks listed on the stock exchange. These securities met the following *"fully reflecting"* requirements.

1) They were be listed in the Annual Report of the Trinidad and Tobago Stock Exchange for each of the years 1989 to 1993.

2) Data included earnings per share (EPS), return on asset (ROA) and dividend yield values for each of these years.

The EPS and dividend yield data were obtained directly from the report. The return on assets was calculated from the net profit and total asset data in the annual reports. To calculate return on a security the closing price of the stock and its dividend for the year were used.

The stock exchange divides the stocks into seven broad categories: banks, conglomerates, manufacturing (i), manufacturing (ii), property, trading and preferred stocks. The stocks have been kept in these categories and given a number to replace the company names.

The percentage change in the Trinidad and Tobago Composite Stock Price Index (TTCSPI) was taken as a proxy for the market return, Rm.

Data for the calculation of the risk-free rate, R_f, was obtained from the Quarterly Statistical Digest published by the Central Bank of Trinidad and Tobago. This gives data on the average discount rate of the Government of Trinidad and Tobago's 91 day treasury bill at the end of each month. To obtain the discount rate for the year, the mean of the monthly discount rates was taken.

Figures for the gross domestic product (GDP) were taken from the Quarterly Statistical Digest. This gives the average real GDP growth rates with the year 1985 having a value of 100.

2.2 Models

2.2.1 CAPM Model

To analyse the data, the following regression model was adopted:

$$(R_i - R_f) = \sigma_i + \beta_i (R_m - R_f) + e_i$$

σ_i is a parameter introduced to perform the regression analysis. For the CAPM, σ_i should be zero. In practice however, it is usually a small value and this was what was expected. It was assumed that the mean value of e_i was zero and that the values were independent and identically distributed. Data for the years 1989 to 1992 were input into this model and a least squares analysis used to estimate β_i . Using this estimate for β_i in the model, the expected return for 1993 was calculated. This was then compared with the actual return measure for that period.

2.2.2 EPS Model

The Stock Exchange defines earnings per share as the amount earned during a given period for each share outstanding. A linear regression model was used relating EPS to the return, (R_i) for an individual security. The results of this model are then compared with the CAPM. The regression model is given by:

$$R_i = A_i + \beta_i (EPS_i) + e_i$$

A_i and β_i are estimated for each security using a least squares analysis. In this model it is assumed that the e_i's are independent and identically distributed with means equal to zero. The theoretical result was compared with the actual return for 1993 and the results of the CAPM model.

2.2.3 ROA Model

The figures for net profit and total asset were taken directly from the annual Reports of the Stock Exchange. This approach was chosen because of ease of data collection.

A linear regression model was used relating ROA to the return, R_i, for each stock. By expressing earnings as a return measure, a more meaningful relationship was examined between stock returns and earnings. The regression model was given by:

$$R_i = A_i + \beta_i (ROA_i) + e_i$$

2.2.4 Dividend Yield

Hochman [14] developed an equation relating beta to three risk measures: operating risk, financial risk and growth. He used the dividend yield measure as a surrogate growth measure. He contended that the dividend yield ratio would tend to be low for high growth companies. Therefore if growth was positively related to beta then there should be a negative relationship between beta and dividend yield.

Since dividend yield is provided in the Annual Report of the Stock Exchange it was decided to form a simple regression model to see if stock returns and dividend yield are related in the local environment. The Stock Exchange defines dividend yield from the equation.

$$\text{Dividend yield} = \frac{\text{Dividends}}{\text{market value at year end}}$$

The regression model took the form

$$R_i = A_i + \beta_i (YLD_i) + e_i$$

where YLD_i = dividend yield

2.3 APT Model

The basic assumption of the APT is that stock returns are generated by a small number of independent economic factors that are common to the set of securities under consideration. These factors are not, however, easily identifiable. The APT model can be described by the equation:

$$R_i = E(R_i) + \sum_{i=1}^{M} \beta_i (F_i - \bar{F}_1)$$

where:

R_i = return on stock
$E(R_i)$ = the expected return on security i
$\underline{F_i}$ = value for the ith factor
$\overline{F_i}$ = expected value for the ith factor
β_i = the risk premium for the ith factor

For this paper, two forms of the APT were used. The first was a single factor model relating the GDP to the security returns. This was called APT-1. The second was a two factor model which used the excess market return as well as GDP to estimate returns.

2.3.1 APT-1

This model consisted of a single factor Gross Domestic Product (GDP). This measure was chosen because it was believed to have an effect on stock prices. The general form of the model was therefore

$$R_i = E(R_i) + \beta_i(GDP_i - \overline{GDP_i}) + e_i$$

The β_i represents the risk premium associated with the GDP factor. The value $\overline{GDP_i}$ was found by calculating the average value for the gross domestic product for the period 1988 to 1992. The expected stock return, $E(R_i)$ was calculated by taking the average (mean) of the stock returns for the years 1989 to 1992.

For the arbitrage pricing theory model to be applied efficiently the factors should be as relevant to the group of firms as possible. The Central Bank produces GDP figures based on sectors. It was decided to use these sector figures for related groups of stocks in the belief that the results obtained would be significant.

Therefore, for the banks and property stocks, the GDP figures under the category of Finance, Insurance and Real Estate were used. This value was called GDPFIN. The resulting model was therefore

$$R_i = E(R_i) + \beta_i(GDPFIN_i - \overline{GDPFIN_i}) + e_i$$

For the trading stocks, the GDP figures under the category of Distribution were used as the relevant measure. The value was called GDPDIST. The resulting model was therefore.

$$R_i = E(R_i) + \beta_i(GDPDIST_i - \overline{GDPDIST_i}) + e_i$$

For the conglomerates, manufacturing, and preferred shares, the GDP figures under the category of Manufacturing were used. This value was called GDPMANU. The resulting model was:

$$R_i = E(R_i) + \beta_i(GDPMANU_i - \overline{GDPMANU_i}) + e_i$$

2.3.2 APT-2

The second model using the arbitrage pricing theory used two factors. The two factors used were the Gross Domestic Product (GDP) and the excess market return, $(R_m - R_f)$, as used in the CAPM. The general form of the model was therefore:

$$R_i = E(R_i) + \beta_1(GDP_i - \overline{GDP_i}) + \beta_2(R_m - R_f) + e_i$$

3.0 DATA ANALYSIS AND RESULTS

A statistical software package, SYSTAT 5.2.1 was used to calculate the regression parameters and perform other statistical tests.

The following methods and statistics were used.

Minimum Mean Square Error (MSE)

When the goal of the model is to minimise the precision of predictions, an estimator with very low variance and some bias may be more desirable than an unbiased estimator with high variance. This criterion of minimising mean square error is useful in this regard.

R-squared (R^2) of the Regression Equation

Although R^2 is only a descriptive statistic, a high value of R^2 is associated with a good fit of the regression line and a low value of R^2 with a poor fit.

F distribution

The test statistic based on the F distribution was used to test joint hypotheses involving the regression parameters and also to test the equality of two variances.

The test statistic F at the 5 percent level of significance is defined as

$$F \text{ ratio} = \frac{\text{explained variance}/(n_1-1)}{\text{unexplained variance}/(n_2-2)}$$

n_1-1, n_2-2 degrees of freedom

t distribution

The t distribution was used to test hypotheses on the mean of the random variables of other models against the mean value of the CAPM.

A 5 percent significance level was used.

Tables 1-8 provide the summary results of the CAPM and other methods for predicting the rate of return.

4.0 DISCUSSION

The R^2 values are given in Table 1 for each model. A hypothesis test was carried out to see if the mean R^2 value for the CAPM was significantly greater than the R^2 value for the other models. It should be noted that the mean R^2 for the APT-2 model was greater than the CAPM model. The test was therefore modified to see if the mean value of the APT-2 model was significantly greater than the mean value of the CAPM. The t-statistic obtained is shown in the row labelled 'calculated t'. Below this row are the critical t values, at the 5% level of significance.

As can be seen for all the models, the calculated t value was greater than the critical t value. This meant that the relationship between stock returns and market returns was significantly stronger than the former's relationship with the EPS. ROA, dividend yield and GDP. However, the GDP along with market return (APT-2) gave a significantly higher mean R^2 than the CAPM model. This would appear to indicate that GDP may add some information to market returns.

Table 2 shows the results for the differences in returns. The difference was taken as the actual less the expected return. The results are tabulated for each model and a mean and standard deviation again calculated. In addition, the mean square error was given for each model. This was taken (as suggested by White et al [30]) because it considers the size of the error and not its direction. Another hypothesis test was carried out to determine whether the standard deviation of the difference for the CAPM model was significantly less than for the other models. The calculated F values are shown, with the critical values below them. In the test, if the calculated F value was greater than the "critical F" value, then it could be concluded that at the 5% level there was a significant difference. Otherwise, it would be concluded that there was not enough evidence to suggest a difference.

The CAPM had both the smallest standard deviation and mean square error (MSE). However, it had a large negative mean difference of 19.18. This meant that it seemed to overestimate returns.

Looking at the F values, the calculated F value was lower than the critical F value for three models; ROA, APT-1 and APT-2. This seems to indicate that the CAPM model has a significantly smaller standard deviation of difference in returns than these models. For the other two models, the EPS and dividend yield, there is not enough evidence at the 5% level to indicate a difference in standard deviation.

It is worth noting that if one were to rank the models by mean R^2 the order would be: APT-2(0.69), CAPM (0.56), dividend yield (0.39), ROA (0.34), APT-1 (0.25), EPS(0.19). However, if MSE was used as the ranking criterion the order would be CAPM (1707.86), EPS (2044.00), dividend yield (2769.26) , APT-1 (2801), ROA (4624.62) and APT-2 (5570.49).

Table 3 shows that the CAPM model and the APT-2 model have the largest F values.

The combined rankings of the two Tables (1 and 2) are seen in Table 4.

If one were to add or multiply the rankings for each model, the following results would be obtained.

		ADD	MULTIPLY
CAPM	=	3	2
Div. Yield	=	6	9
APT-2	=	7	6
EPS	=	8	12
ROA	=	9	20
APT-1	=	9	20

The CAPM appears to be the superior model followed by dividend yield, APT-2, EPS, ROA and APT-1.

This follows because in both the tests of association and prediction the CAPM performed consistently well. The dividend yield model also had the same rank for both tests. With respect to the dividend yield model most of the coefficients obtained (b) were negative which is in agreement with the results obtained by Hochman [14]. The ROA model did not perform well. This shows that in the Trinidad and Tobago environment, expressing earnings as a return measure does not seem to yield better results. This however, could be due to the fact that a surrogate ROA measure was used and not the ratio as defined by White et al [29].

If one were to divide the R^2 values into deciles and show the percentage of R^2 values in each decile

COMPANY	MODELS					
	CAPM	EPS	ROA	DIVIDEND	APT-1	APT-2
Bank 1	0.82	0.24	0.03	0.76	0.71	0.87
Bank 2	0.94	0.00	0.68	0.77	0.83	1.00
Bank 3	0.38	0.01	0.48	0.14	0.41	0.44
Bank 4	0.93	0.42	0.30	0.10	0.61	0.93
Con 1	0.81	0.09	0.03	0.19	0.01	0.82
Con 2	0.45	0.00	0.90	0.32	0.01	0.49
Manu 1	0.66	0.02	0.00	0.33	0.01	0.72
Manu 2	0.39	0.72	0.24	0.68	0.36	0.64
Manu 3	0.94	0.00	0.75	0.05	0.01	1.00
Manu 4	0.62	0.68	0.38	0.41	0.38	0.86
Manu 5	0.46	0.17	0.64	0.66	0.01	0.46
Manu 6	0.19	0.24	0.31	0.41	0.16	0.30
Manu 7	0.71	0.02	0.49		0.03	0.70
Manu 8	0.59	0.14	0.17	0.53	0.00	0.60
Prop 1	0.35	0.09	0.17		0.00	0.93
Prop 2	0.28	0.03	0.02	0.02	0.39	0.39
Trade 1	0.96	0.19	0.10	0.36	0.36	0.96
Trade 2	0.28	0.50	0.47	0.48	0.13	0.27
Trade 3	0.53	0.15	0.53	0.33	0.37	0.55
Trade 4	0.67	0.04	0.40	0.51	0.00	0.96
Pref 1	0.49	N.A.	0.81	N.A.	0.01	0.49
Pref 2	0.46	N.A.	0.03	N.A.	0.03	0.57
Pref 3	0.30	N.A.	0.50	N.A.	0.69	0.85
Pref 4	0.77	N.A.	0.79	N.A.	0.29	0.95
Pref 5	0.00	N.A.	0.13	N.A.	0.34	0.41
Mean	0.56	0.19	0.34	0.39	0.25	0.69
Std. dev.	0.26	0.22	0.26	0.23	0.26	0.24
Maximum	0.96	0.72	0.81	0.77	0.83	1.00
Minimum	0.00	0.00	0.00	0.02	0.00	0.27
Calc. t	Reference	5.073	2.992	2.218	4.215	1.837
Critical t	-	1.681	1.678	1.684	1.678	1.678

Table 1: Summary of R^2 Values

COMPANY	MODELS					
	CAPM	EPS	ROA	DIVIDEND	APT-1	APT-2
Bank 1	-20.70	28.99	0.24	-8.69	64.23	1.10
Bank 2	5.57	11.59	121.83	124.99	113.33	30.53
Bank 3	40.90	-9.56	44.88	2.29	37.74	14.98
Bank 4	-4.10	50.64	-0.28	21.96	58.49	-1.54
Con 1	-58.96	-14.04	-38.82	-13.16	-50.97	-107.68
Con 2	-76.70	-98.19	-100.48	31.51	-105.24	-175.77
Manu 1	77.71	95.97	82.21	100.66	87.60	64.98
Manu 2	5.22	67.38	10.00	108.04	33.13	21.66
Manu 3	-29.53	-36.45	13.02	-33.75	-36.77	-74.10
Manu 4	-19.83	14.33	-20.03	-3.45	-12.84	-24.30
Manu 5	-57.81	-71.39	-58.98	-34.57	-55.12	-79.81
Manu 6	-31.47	-36.86	-34.32	-63.41	-34.58	-46.33
Manu 7	-16.06	0.58	53.81		3.03	-22.84
Manu 8	-52.49	50.01	261.70	-29.78	-46.71	-141.34
Prop 1	-.248	0.03	0.36		-3.13	-27.44
Prop 2	-22.93	-21.91	-14.42	-19.06	23.01	15.98
Trade 1	-67.62	-29.27	-40.21	-48.79	-67.83	-99.45
Trade 2	-32.93	41.40	18.64	17.50	-21.10	-38.45
Trade 3	-.851	-4.23	27.23	11.84	-1.12	-6.46
Trade 4	9.61	10.08	22.95	15.69	8.80	1.40
Pref 1	-99.22	N.A.	-7.74	N.A.	-109.20	-204.99
Pref 2	8.59	-	9.29	-	14.17	35.04
Pref 3	-13.41	-	2.21	-	-5.32	-9.44
Pref 4	-6.89	-	0.27	-	-4.30	-7.83
Pref 5	-6.14	N.A.	-9.78	N.A.	-3.31	-2.13
Mean	-19.18	2.46	13.00	9.99	-4.56	-35.37
Std. dev.	37.36	46.32	68.13	53.16	53.82	67.08
MSE	1707.86	2044.00	4624.62	2769.26	2801.94	5570.4
Maximum	77.71	95.97	261.70	124.99	113.33	64.98
Minimum	-99.22	-98.19	-100.48	-6.41	-109.20	-204.99
Calc. F	Reference	0.651	0.301	0.494	0.482	0.310
Critical F	-	0.493	0.505	0.483	0.505	0.505

Table 2: Summary of Difference in Returns

COMPANY	MODELS					
	CAPM	EPS	ROA	DIVIDEND YLD	APT-1	APT-2
Bank 1	9.14	0.62	0.07	6.28	4.81	3.23
Bank 2	28.82	0.00	4.19	6.64	9.56	32096.39
Bank 3	1.25	0.01	1.82	0.31	1.37	0.39
Bank 4	25.17	1.47	0.85	0.20	3.18	6.31
Con 1	8.67	0.20	0.07	0.48	0.01	2.23
Con 2	1.66	0.00	0.19	0.92	0.01	0.48
Manu 1	3.96	0.04	0.01	1.00	0.02	1.26
Manu 2	1.29	5.10	0.62	4.17	1.10	0.88
Manu 3	30.18	0.00	6.07	0.10	0.02	105.43
Manu 4	3.28	4.15	1.24	1.38	1.23	2.99
Manu 5	1.72	0.40	3.57	3.96	0.01	0.42
Manu 6	0.48	0.62	0.91	1.41	0.38	0.21
Manu 7	4.80	0.03	1.89		0.06	1.14
Manu 8	2.93	0.32	0.42	2.21	0.00	0.75
Prop 1	1.07	0.20	0.40		0.01	6.34
Prop 2	0.28	0.03	0.02	0.02	0.39	0.39
Trade 1	48.76	0.46	0.22	1.11	1.12	12.59
Trade 2	0.76	2.00	1.77	1.84	0.30	0.19
Trade 3	2.21	0.36	2.26	1.00	1.18	0.61
Trade 4	4.11	0.09	1.34	2.11	0.00	11.78
Pref 1	1.94	N.A.	8.52	N.A.	0.02	0.48
Pref 2	1.71	N.A.	0.05	N.A.	0.07	0.66
Pref 3	0.86	N.A.	1.98	N.A.	4.51	2.93
Pref 4	6.53	N.A.	7.46	N.A.	0.83	8.68
Pref 5	0.01	N.A.	0.36	N.A.	1.04	0.35

Table 3: F. Values

RANK	R^2	MSE
1	APT-2	CAPM
2	CAPM	EPS
3	Div. Yield	Div. Yield
4	ROA	APT-1
5	APT-1	ROA
6	EPS	APT-2

Table 4: Combined Rankings

for each model, the implications would be more clearly seen. This is shown in **Table 5** below.

One possible explanation for the differences in returns for the CAPM, APT-1, and APT-2 models was the constant of the regression model. To perform the regressions, a constant was introduced for all three models. However, this constant played no part in estimating returns for the year 1993 in these models (as it did for the others). The Systat programme also provided the t value of the constant. At the 5% level, the constant is considered significantly different from zero if the t value is above 4.303 or below - 4.303. The values for the constants are given for the CAPM, APT-1 and APT-2 models in **Table 6**. These show that the constants for both the CAPM and APT-2 models were relatively large. The value of the constant appeared smaller for the APT-1 model.

This shows that the non-inclusion of the constant may indeed be a source of error. However, both the CAPM model and the APT-2 model appeared to overestimate returns. This can be seen from the large negative differences that were obtained for both models in **Table 2**. The constants for the CAPM model however appear to be large and positive. If they were included in the model the overestimation of returns would be even larger. However, for the APT-2 model the constants appear to be negative. This would lower the estimated returns which should give more accurate results. It therefore appears that the omission of the constant is more significant in the case of the APT-2 model than for the CAPM.

Another possible reason for the relatively poor prediction results could be that there was some change in 1993 which made past data irrelevant. One such possibility was the change in monetary policy by the Government. The change from a fixed to a floating dollar, caused an almost immediate devaluation of the Trinidad and Tobago dollar. This was in fact mentioned as a major event by the Exchange in their 1993 report.

In addition to the MSE criterion for measuring accuracy of prediction, another possible piece of useful information is the percentage of times the CAPM gives a better prediction than the other models. This was found by Young et al (30). The results are given in **Table 7**.

Interestingly, this seems to show that the CAPM model is superior to the others except for the APT-1 model. This is quite curious because the other performance measures outrank the APT-1 model. These results may be interpreted to mean that the APT-1 model is sometimes accurate but when it is inaccurate, it is very inaccurate. However, these results seem to reinforce the other results that the CAPM is, in general, superior to the other models in terms of predicting future returns. Also, there appears to be little difference between the CAPM, EPS and dividend yield models in terms of prediction.

In a similar investigation, Walters [28] performed a comparative analysis of the CAPM and APT in the Jamaica environment. The results obtained in that study

R^2 VALUE RANGE	MODELS					
	CAPM	EPS	ROA	YLD DIVIDEND	APT-1	APT-2
0.0-0.1	4	50	24	11	4	0
0.1-0.2	4	20	16	17	8	0
0.2-0.3	8	10	4	0	4	4
0.3-0.4	16	0	12	22	24	8
0.4-0.5	16	5	16	17	4	20
0.5-0.6	8	5	8	11	0	8
0.6-0.7	12	5	8	11	8	8
0.7-0.8	8	5	8	11	4	8
0.8-0.9	8	0	4	0	4	16
0.9-1.0	16	0	0	0	0	28

Table 5: R^2 Ranges

are quite different from those obtained in this study. The Walters [28] study looked at the CAPM and EPS on an individual security basis. In that study, two risk-free rates were used: Treasury Bills, and Certificates of Deposit. The results obtained for the mean error were 15.75 for the Treasury Bills, 23.33 for the Certificates of Deposit and 12.63 for the EPS. The standard deviations were 85.65 for the Treasury Bills 94.04 for the Certificates of Deposit and 151.51 for the EPS model. That study also looked at the CAPM AND APT on a portfolio basis. The APT also used the GDP measure. The mean error obtained was 1.223 for the APT, and 35.69 for the CAPM. The standard deviation was 29.48 for the APT and 7.426 for the CAPM which in turn was superior to the EPS model. The results of the study show that, in terms of prediction, the CAPM is clearly superior to the APT models formulated.

Looking at the overall results for both association and prediction the CAPM seems to perform particularly well. The Stock Exchange, in advising investors, tells them that the two measures they should look at before purchasing stocks are the EPS and dividend yield. The results of this study would also seem to indicate that, in addition to these, the CAPM should also be used to evaluate stocks. An argument can be made that since there is no significant difference at the 5% level, why use the CAPM. The fact is that an absence of statistical significance does not mean that there is no economic significance. The standard deviation and MSE for the CAPM are much lower than the dividend yield model. In addition to this, the CAPM model gives better predictions at least half of the time. This is sufficient reason to advocate its use. While the main aim of this project was to look at the CAPM against other measures, it is interesting to look at the CAPM in absolute terms.

Looking at the R^2 values, one can see that the mean value over the 25 stocks is 0.56. This is in general, larger than that found in other studies done in more developed countries (generally, an R^2 value around 0.20). This is interesting because it seems to indicate that the linear relationships as indicated by the CAPM is fairly strong. Although testing this linear relationship between market and security returns was not an aim of the project, the Systat package allowed for various plots to be made with the data. For some of the securities, the quadratic and linear plots are almost the same. For

	MODELS		
COMPANY	CAPM	APT-1	APT-2
Bank 1	3.62	25.33	-1.38
Bank 2	11.47	34.55	-0.47
Bank 3	54.46	14.82	5.20
Bank 4	-5.01	16.05	-9.35
Con 1	19.00	-4.11	-25.74
Con 2	55.30	6.85	-20.03
Manu 1	-0.18	2.49	-6.07
Manu 2	-15.76	-11.03	-15.38
Manu 3	22.78	2.84	-11.38
Manu 4	4.09	-8.88	-13.27
Manu 5	10.25	-2.37	-11.79
Manu 6	15.03	-10.74	-15.19
Manu 7	-4.32	-4.69	-14.56
Manu 8	35.71	-2.79	-38.84
Prop 1	2.84	-0.30	-10.59
Prop 2	-0.27	13.42	10.43
Trade 1	14.85	6.54	12.11
Trade 2	-2.74	4.37	-9.28
Trade 3	-3.13	2.09	-2.18
Trade 4	5.07	0.09	-5.79
Pref 1	56.28	-11.31	-47.75
Pref 2	-10.10	-4.42	3.55
Pref 3	-0.92	-7.29	-8.85
Pref 4	1.73	-2.02	-3.36
Pref 5	0.44	-2.29	-1.83

Table 6: Values of Regression Constants

EPS	..	..	55
ROA	..	..	56
YLD	..	..	50
APT-1	..	..	48
APT-2	..	..	64

Table 7: % Number of Times the CAPM Prediction is Superior

others though, the quadratic plot appears to give a better fit than the linear plot. This may indicate that the relationship between market and security returns may be non-linear. Similar results have been obtained in other studies [7]. One avenue of further research would be to see if a non-linear model gives superior results.

Looking at the results from 2, it is worth noting the large standard deviations obtain. The CAPM has the smallest standard deviation of 37.36. This was larger than expected. A standard deviation of between 10 and 15 is acceptable. The CAPM also had the smallest mean-square-error of 1707.86. The square root of this is 41.33. Again this gives an idea of the large magnitude of the absolute error of the market. As was previously mentioned however, the CAPM seems to be the best model overall. Clearly, as the stock market develops it would be necessary to repeat these experiments to see if any changes develop.

5.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the results and the discussion the main conclusions of this study can be summarised as follows:

1. The CAPM appeared, in general, to be a better predictor of stock returns than ROA, or GDP alone.

2. There appeared to be no significant difference between the CAPM and the EPS or dividend yield models when it came to prediction of future returns.

Based on these conclusions as well as the results obtained there are certain alternatives that are worth pursuing in relation to stock returns and the CAPM. Further research work is recommended as follows:

1. The CAPM should be tested using monthly or quarterly data. This is advantageous because more data points will be obtained.

2. The CAPM along with EPS and dividend yield data should be used in evaluating stocks and portfolios.

3. A non-linear model relating market and security returns should be tested. Some studies Caroll et al [7] suggest that a non-linear relationship may be more accurate.

4. The CAPM should be applied to capital budgeting decisions to see if there is any difference in the results as compared to traditional measures such as IRR.

6.0 REFERENCES

1. Bezion, U and Yagil, J. (1987). *"On the Discounting Formula for a Stream of Independent Risky Cashflows"*. Engineering Economist, Summer 1987.

2. Black, F. (1972). *"Capital Market Equilibrium with restricted borrowing"*. Journal of Business, 45(3), July, 44-55.

3. Bohl, A. and Murphy, F.H. (1991). *"The Effect of the Mix of Equity and Debt on the Selection of Projects"*. The Engineering Economist. Fall 1991. 37(1): 61-75.

4. Brick, T.R. and Thompson, H.E (1978). *"The Economic Life of an Investment and the Appropriate Discount Rate"*. Journal of Financial and Quantitative Analysis". December, 1978.

5. Brigham, E.F. Kahl, A.L, Rentz, W.F. and Gapenski, L.C. (1991). Canadian Financial Management, 3rd ed. Toronto: Holt, Rinehart and Winston.

6. Brown, R.J. and Kulkarni, M.S. (1993). *"Duration and the Risk Adjustment of Discount Rates for Capital Budgeting"*. The Engineering Economist. Summer 1993. 38(4): 299-307.

7. Carroll, C. and Wei, K.C.J. (1988). *"Risk, Return and Equilibrium: An Extension"*. Journal of Business. 1988 61(4): 485-499.

8. Celec, S.E. and Pathway, R.H. (1979). *"Some Observations on Risk-Adjustment Discount Rates: A Comment"*. Journal of Finance, September 1979.

9. Constantinides, G.M. (1978). *"Market Risk Adjustment in Project Valuation"*. Journal of Finance, May 1978.

10. Fisher, Lawrence and Kamin, Tules H. (1988). *"Forecasting Systematic Risk: Estimates of "Raw" Beta that take Account of the Tendency of Beta to change and the Heteroskedasticity of Residual Returns"*. Journal of Financial and Quantitative Analysis, June 1988.

11. Fama, E.F. (1970). *"Efficient Capital Markets: A Review of Theory and Empirical Work"*. Journal of Finance, 25(2) May, 383-417.

12. Hamada, R.S. (1985). *"Discussion"*. Journal of Finance, May 1977. 32 (2): 333-336.

13. Hill, N and Dimnik, T. (1985). *"Cost Justifying New Technologies"*. Business Quarterly, Winter 85/86. 50(4): 91-96.

14. Hochman, S. (1983). *"The Beta Coefficient: An Instrumental Variables Approach"*. Research in Finance ed., H. Levy Volume 4. Greenwich, CT: JAI Press.

15. Hoskins, C.G. (1978). *"Capital Budgeting Decision Rules for Risky Projects Derived from a Capital Market Model Based on Senivariance"*. The Engineering Economist, Summer 1978.

16. Jaffe, Jeffrey F. (1985). *"Inflation, the Interest Rate and the Required Rate of Return on Equity"*. Journal of Financial and Quantitative Analysis, March 1985.

17. Jensen, M.C. (1972). *"Capital Markets: Theory and Evidence"*. Bell Journal of Economics and Management Science 3(2) Autumn, 357-98.

18. Khan, A.M. and Fiorino, D.P. (1992). *"The Capital Asset Pricing Model in Project Selection: A Case Study"*. The Engineering Economist. Winter 1992. 37(2); 145-159.

19. Kim, S.H. and Crick, T. (1986). *"Do Executives Practice what Academics Preach"?* Management Accounting. November 1986. 68 (5): 49-52.

20. Klammer, T.P. and Walker, A.C. (1985) *"The Continuing Increase in the Use of Sophisticated Capital Budgeting Techniques"*. California Management Review, Fall 1985.

21. Kulatilaka, N. (1984). *"Financial, Economic and Strategic Issues concerning the Decision to invest in Advanced Automation"*. International Journal of Production Research. 1984. 22(6): 949-968.

22. Mayers, D. (1973). *"Non-marketable Assets and the Determination of Capital Asset Prices in the Absence of a Riskless Asset"*. Journal of Business, 46(2), April, 258-67.

23. Merton, R. (1973). *"An Intertemporal Capital Asset Pricing Model"*. Econometrica 41(5), September, 867-87.

24. Mullins Jr., D.W. (1991). *"Does the Capital Asset Pricing Model Work"?* In Corporate Finance and the Capital Markets. 91-100 USA. Harvard University.

25. Myers, S.C. and Turnbull, S.M. (1977). *"Capital Budgeting and the Capital Asset Good News and Bad News"*. Journal of Finance. May 1977. 32(2): 321-333.

26. Rubinstein, M.E. (1973). *"A Mean-variance Synthesis of Corporate Financial Theory"*. Journal of Finance, 28(1), March, 167-81.

27. Spahr, R.W. and Martin S.A. (1980). "Project Pricing in Limited Diversification Portfolios". The Engineering Economist, 26(3): 207-222.

28. Walters, A. (1994). *"Comparative Analysis of the Capital Asset Pricing Model (CAPM) and the Arbitrage Pricing Theory (APT)"*. Industrial Engineering Project. Department of

Mechanical Engineering, The University of the West Indies, St. Augustine. (Unpublished).

29. White, G.J., Sondi, A.C and Fried, D. (1994). *"The Analysis and Use of Financial Statements"*. New York: John Wiley and Sons.

30. Young, S.D., Berry, M.A., Harvey, D.W. and Page, J.R. (1991). *"Macroeconomic Forces, Systemic Risk and Financial Variables: An Empirical Investigation"*. Journal of Financial and Quantitative Analysis, December 1991. 26(4): 559-564.■