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CAPITAL ASSET PRICING MODEL AND ARBITRAGE PRICING THEORY IN THE BURSA MALAYSIA: AN EMPIRICAL STUDY

SARINA MALAR A/P KRISHNAMURTHY

MATHEMATICS WITH ECONOMICS

SCHOOL OF SCIENCE AND TECHNOLOGY

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SARINA MALAR A/P KRISHNAMURTHY

THIS DISSERTATION IS PRESENTED TO FULFILL THE CONDITONS OF OBTAINING A BACHELOR OF SCIENCE DEGREE (HONOURS).

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Ijazah: SARJANA MUDA SAINS KEPUJIAN (MATEMATIK DENGAN EKONOMI)

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DECLARATION

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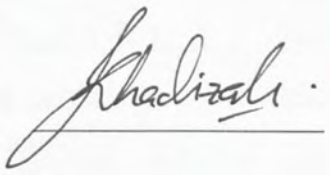
	(KHADIZAH GHAZALI)	
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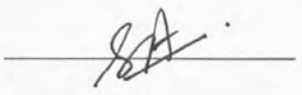
	(SURIANI HASSAN)	
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ABSTRAK

Kajian ini membandingkan aplikasi *Capital Asset Pricing Model (CAPM)* dan *Arbitrage Pricing Theory (APT)* di pasaran saham Malaysia untuk menentukan model mana yang dapat menerangkan pergerakan pasaran saham degan lebih baik. Data yang digunakan dalam kajian ini ialah pulangan bulanan bagi 50 saham yang yang dipilih secara rawak daripada papan utama Bursa Malaysia di antara tempoh Januari 1991 hingga Disember 2000. Data ini digunakan untuk menguji kedua-dua model *CAPM* dan *APT* secara berasingan. *CAPM* diuji dengan meregresikan beta setiap saham manakala *APT* diuji menggunakan kaedah Analisis Komponen Utama. Akhirnya, kedua-dua model ini dibandingkan dengan menggunakan kaedah nisbah ganjil kebelakang (*posterior odds ratio). APT* memberikan gambaran yang lebih baik dalam menerangkan 89% pergerakan saham di Malaysia. Dalam kajian ini, model *CAPM* juga didapati berjaya menerangkan pergerakan saham di Malaysia tetapi model *APT* berjaya menerangkan kelakuan saham dengan lebih berkesan. Ini adalah disebabkan model *APT* merupakan model linear yang terdiri daripada beberapa faktor manakala *CAPM* bergantung kepada satu faktor sahaja. Daripada kajian ini, didapati empat komponen makroekonomi memberikan gambaran pergerakan saham di Malaysia. Empat komponen yang digunakan untuk menerangkan pergerakan saham di Malaysia ialah perubahan yang tidak dijangka dalam kadar faedah yang tak berisiko, perubahan yang tidak dijangka dalam kadar bunga, perubahan yang tidak dijangka dalam pengeluaran industri serta inflasi yang tidak dijangka.

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ABSTRACT

This paper compares the Capital Asset Pricing Model (CAPM) and the Arbitrage Pricing Theory (APT) in the Malaysian stock market to determine which model explains the market better. In this study, we use the monthly returns of 50 randomly selected firms from the Bursa Malaysia Main Board over the period of January 1991 to December 2000. The data was used to run two separate tests on the CAPM and the APT. The CAPM is regressed to obtain betas for each period and the principal component analysis is used to determine the number of retainable factors for the APT. Four factors were retained; therefore the APT is a four-factor linear model. Consequently, both models' validity is tested using the linear regression method. Finally, the posterior odds ratio is used to compare the two models. The APT is a better explanation tool in the Malaysian stock market with an ability of 89% to describe the behaviour of the market. The CAPM is not a rejected model in this case, only that the APT has managed a more rounded explanation of the market's movement, due to its multi-index properties. As a multi-index model, the APT uses four macroeconomic variables to explain the market. In this case, the four components are assumed to be the unexpected change in the risk free rate of interest, unexpected change in the term structure of interest rates, unexpected change in industrial production, and unexpected inflation.

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LIST OF SYMBOLS

APT	Arbitrage Pricing Theory
CAPM	Capital Asset Pricing Theory
Cov	Covariance
β	Risk estimates
σ^2	Systematic risk of the universe
r_i	Return of stocks *i* over a time period
r_m	Returns of the entire market
E	Expectation operator
r_f	Risk free interest rate
λ_k	Price of risk related *k*-th factor
λ_0	Riskless asset (zero beta)
α	Measure of effectiveness between CAPM and APT
b_{ij}	Sensitivity of the return of asset *i* to factor *j*
R_{APT}	Expected return of APT
R_{CAPM}	Expected return of CAPM
e_i	Error term
Z_{it}	Returns *i* number of stocks over the sample period of *t*
Z_{mt}	Excess market returns

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α_{im}	Stocks' excess return when risk is zero
ε	Disturbance term
$\overline{R_i}$	Average return for each period
$\hat{\beta}$	Estimated beta
$\hat{b}$	Estimated factor loadings
SSE	Sum of square error

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CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

Share prices behaviour and the risk-return relationship, have long been of interest to researchers. In 1900, Louis Bachelier pioneered the quest to explain complex movements of stock prices on the Paris Bourse. He was the first to study the fluctuations in the prices of stocks and shares and their probability distribution (Cagnetti, 2002).

For decades, researchers have tried to explain the risk return relationship. However, it was only with the Capital Asset Pricing Model (CAPM) developed by William Sharpe in 1964, that one of the important problems of modern economics was formalized: the quantification of the trade-off between risk and expected return. The model, which is a measure of systematic risk relative to the market portfolio, (indicated by β) is the sole determinant of return. Therefore, any additional variability caused by events peculiar to the individual asset can be diversified away; meaning capital markets do not reward risks borne unnecessarily.

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Later in 1976, Stephen Ross introduced the Arbitrage Pricing Theory (APT) as an alternative to the CAPM. The APT is a multifactor model and it has more explanatory power compared to the CAPM, thus allowing it to overcome weaknesses of the CAPM (Cagnetti, 2002).

An enormous amount of literature has been written on the two models. Although it is widely believed that the APT performs better than the CAPM, many academicians still debate on the issue of which method is better whereas others question the testability of both methods.

The focus of this paper is to test and compare both CAPM and APT in the Malaysian stock market. The Malaysian market has been undergoing above average growth rates (Clare and Priestly, 1998) due to government privatisation programmes and the increase in the flow of foreign direct investments (FDI). A variety of tests will be used to asses which model better explains the inherent risk in the booming Malaysian market.

1.2 CAPITAL ASSET PRICING MODEL

In 1952, Harry Markowitz laid down the foundation for modern portfolio management. 12 years later, in 1964, William Sharpe and John Lintner extended the portfolio theory and developed the Capital Asset Pricing Model. This model was developed to introduce the notions of systematic and specific risk. Thus, one of the important problems of

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modern financial economics was formalized: the quantification of the trade-off between risk and expected return.

Basically the CAPM gives us a prediction of the relationship that we should observe between the risk of an asset and its expected return. This relationship serves two vital functions. First, it provides a benchmark rate of return for evaluating possible investments. For example, if we are analyzing securities, we might be interested in whether the expected return we forecast for a stock is more or less than its 'fair' return given its risk (Bodie *et al*, 2002). Second, the model helps us to make an educated guess on the return expected of assets, which have not been traded yet in the marketplace.

The capital asset pricing model is a set of predictions concerning equilibrium expected returns on risky assets. The CAPM divides the risk of holding risky assets into systematic and specific risk. Systematic risk is the risk of holding the market portfolio. As the market moves, each individual asset is more or less affected. To the extent that any asset participates in such general market moves, that asset entails systematic risk. On the other hand, specific risk is the risk which is unique to an individual asset. It represents the component of an asset's return which is uncorrelated with general market moves.

According to CAPM, the marketplace compensates investors for taking systematic risk, but not for taking specific risk. When an investor holds the market portfolio, each individual asset in that portfolio entails specific risk, but through

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diversification, the investor's net exposure is just the systematic risk of the market portfolio.

Systematic risk is measured using beta (β). According to CAPM, the expected return of a stock equals the risk-free rate plus the portfolio's beta multiplied by the expected excess return of the market portfolio. The expected excess return of the market portfolio is known as risk premiums. The risk premium on individual assets will be proportional to the risk premium on the market portfolio and the beta coefficient of the security relative to the market portfolio. Formally, beta is defined as

$$\beta_i = \frac{Cov(r_i, r_M)}{\sigma_M^2} \tag{1.1}$$

where r_i = the returns of individual stocks over a certain time period,

r_M = the returns of the entire market over a certain time period; and

σ_M^2 = the systematic risk of this universe.

Hence, the risk premium on individual securities is

$$E(r_i) = r_f + \beta_i \left[E(r_M) - r_f \right] \tag{1.2}$$

where E = the expectation operator,

$E(r_M)$ = the expected market return,

r_f = the risk free interest rate (simple return); and

β_i = the market's beta

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Formula 1.2 is the essential conclusion of CAPM. It states that a stock's (or portfolio's) excess return depends on its beta and not its volatility. Therefore it can be stated that excess return depends on systematic risk and not total risk.

CAPM is called a "capital asset pricing model" because given an expected future price and a beta for a stock, investors will bid its current price up or down to ensure that formula 1.2 is satisfied for that stock. Accordingly, based on assumptions about a stock's price behaviour, formula 1.2 determines the stock's current price.

1.3 ARBITRAGE PRICING THEORY

The Arbitrage Pricing Theory relies on the simple concept of arbitrage (Clare and Priestley, 1998). The APT begins with an assumption on the return generating factors. Assuming that asset markets are perfectly competitive and frictionless each asset return is linearly related to k factors plus its own idiosyncratic disturbance:

$$R_i = \lambda_0 + \lambda_1 b_{i1} + \lambda_2 b_{i2} + ... + \lambda_k b_{ik} + \varepsilon_i \qquad (1.3)$$

where R_i = the return on asset i at time t,

λ_k = the price of risk related to the kth factor;

λ_0 = a riskless (or a "zero beta") asset,

b_{ij} = the sensitivity of the return of asset i to the factor j.

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The risk premium on the asset is the sum of the λb. The no-arbitrage restriction is that the prices of risk are equal across all assets.

1.4 THE MALAYSIAN STOCK MARKET

The securities market in Malaysia started off as a formal organization in 1938 after the Malaya Stockbroker's Association was registered, where stocks from Singapore and Malaysia were jointly traded. However its operation was halted during the Second World War and was only to resume around the year 1945. During this period, no public shares were traded. Public shares were only traded after the Malayan Stock Exchange was constituted in 1960.

In 1965, when Singapore became an independent country, the stock exchange continued functioning as a single entity as the Stock Exchange of Malaysia and Singapore. This was possible because of the interchangeability of the two countries' currencies. In 1973, the currency interchangeability was terminated, leading to the formation of the Kuala Lumpur Stock Exchange and the Stock Exchange of Singapore as two separate entities. Stocks from each country, however, continued to be listed on both exchanges. In 1990, by order of the Malaysian government, all Malaysian stocks were delisted from the SES. On the same day, Singapore stocks were also delisted from the KLSE (Ding *et al*, 1999).

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Since 1992, the Kuala Lumpur Stock Exchange has operated a fully automated trading system. All buying and odd lots trading are fully automated. Today the Kuala Lumpur Stock Exchange is known as the Bursa Malaysia and has a total of 909 listed companies trading in the year 2004.

1.5 OBJECTIVE OF STUDY

The main purpose of this paper is to test and compare the capital asset pricing model (CAPM) and the arbitrage pricing theory (APT) in the Malaysian stock market. Test will be conducted to compare which model performs better in explaining the behaviour of share prices the Malaysian stock market.

1.6 SCOPE OF STUDY

The research is based on 50 randomly selected Malaysian stocks that are listed on the Bursa Malaysia Main Board over the period of January 1990 through December 2000. The data used are monthly returns (end of the month returns) of the 50 selected stocks.

1.7 CONCLUDING REMARKS

According to Clare and Priestly (1998), growth of the Malaysian stock market has triggered economic agents (both domestic and international) to asses the risk inherent in this market. So far most of the South East Asian (SEA) markets were evaluated using the

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capital asset pricing model and scarcely have past researchers used the arbitrage pricing theory to asses the SEA market risk.

Past researches have shown that empirical tests on the CAPM has been rather disappointing whereas the ATP performs better in explaining the behaviour of share prices in developed countries. Therefore, by comparing the two pricing models on the Malaysian market will allow further insight on which model will give a better assessment on the inherent risk of the developing Malaysian stock market.

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CHAPTER 2

LITERATURE REVIEW

2.1 OVERVIEW

Earlier studies which have sought to compare CAPM and APT methodologies have produced mix results. Gallo *et al.* (1996) have noted that in several studies, the CAPM and the APT have generated similar inferences, whereas in other literatures, performance of the asset pricing models not only differed between single index and APT methodologies, but also among competing APT models. Hence, it is said that the measurement of mutual fund performance is sensitive to the methodology chosen.

Past researches in the Southeast Asian markets, including the Malaysian market has shown that the APT performed better in explaining the market. However, most researchers who studied the Asian market have preferred to use the CAPM method to study the markets' movement. Therefore, here arises the question of which asset pricing model is better in explaining the movements of the Malaysian stock prices.

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2.2 DEVELOPMENT OF THE ASSET PRICING MODELS

2.2.1 Capital Asset Pricing Model

Publication of the Markowitz's Portfolio Selection (1959) triggered several academicians to study the relationship between the prices of assets and their risk attributes. Among them were W. Sharpe, Lintner and Mossin, who developed the earliest form of the Capital Asset Pricing Theory.

Following their findings, many researches have been conducted to relax strong assumptions that underpinned the original CAPM (Dimson *et al*, 1999). One of the most famous modifications was by Black, who showed how the model had to be adapted when riskless borrowing was not available. This version was known as the zero-beta CAPM. There were also other successful attempts. For instance, Brennen in 1970 found that the structure of the original CAPM was retained even when taxes were introduced into the equilibrium; and Mayer showed when the market portfolio included non-traded asset, the structure of the model was identical to the original CAPM.

According to Dimson *et al* (1999), the concepts of portfolio theory and the development of risk measurement, taken together with the CAPM, have had major impact on the theory and practice of investment management. It is now common to view a management portfolio as a blend of a passive portfolio and an active portfolio.

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