

International Portfolio Diversification: A Malaysian Perspective

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Abstract

The main purpose of this study is to provide evidence whether international portfolio diversification gain exists in equity investment from a Malaysian perspective. The study considers currency risk (based on selected countries) besides incorporating the effects of price volatility in the portfolio construction. Risk of foreign equity investments is represented by the standard deviation of returns and the currency exchange rate risk. The Markowitz Efficient Frontier Model as amended by Solnik (1973) is estimated by using standard procedures in forming efficient portfolios. A computer programme to plot the efficient frontier has been specially developed for the purpose of this study. Several divisions of studies have been done to gain a better understanding of the benefits of international portfolio diversification. Besides comparing the internationally diversified portfolio to a locally diversified portfolio, countries are also grouped into those of developed and emerging nations to evaluate the benefits of diversifying into a group of countries. A time series analysis of 20 countries stock market indices is broken into several series of pre-, during- and post-crisis periods where comparisons are made to evaluate the benefits of international portfolio diversification during these periods. This study also includes an analysis of the effects of international portfolio diversification if the allocation of asset for Malaysia is fixed at several minimum pre-determined levels. The results from this study are expected to reveal evidence on gains from international portfolio diversification for Malaysian investors after considering currency risk and price volatility.

Key words: International, portfolio, diversification.

I. Introduction

One of the key issues in international equity investment is the measurement of diversification gain or losses. Is there a positive diversification value as a result of international investment? A simple understanding of a positive diversification value is that an international equity investment will lead to higher return and lower risk of portfolios of funds which assumes low volatility and stable currency risk. A positive diversification value is also true if such investment leads to either higher return at the same level of risk or the same return at a lower level of risk.

International investment has gained credence among institutional portfolio managers in developed countries because of enhanced portfolio returns and reduced risk from global diversification. However, with currency exchange rate volatility, the enhanced return appears to be negated and fluctuating exchange rates have caused currency risk to be considered the most common risk of overseas investment.

Hence, the objectives of the study among others are:

- to evaluate the potential gains from international portfolio diversification from a Malaysian perspective;
- to incorporate the effect of currency exchange rate uncertainty and price volatility on international equity investments;
- to find the right allocation of assets in a portfolio of Malaysian and international equities that will provide an optimal risk-return trade-off;
- to analyse the differences in potential gains between diversifying in mature stock markets and in less mature stock markets;

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- to evaluate the benefits of international portfolio diversification in different periods of pre-, during- and post-crisis over a 17-year period from 1987 to 2003;
- to analyse the effects of international portfolio diversification if the allocation of asset for Malaysia is fixed at several pre-determined levels; and
- to introduce a quantitative measure which provides a guide to the superiority of efficient frontiers for ease of comparison.

The cost of participation in foreign markets previously has been high due to high transaction costs, the high cost of acquiring information, and other related expense. However, globalisation and dissemination of information is eliminating these hurdles, allowing investors to diversify internationally. Investors are no longer constrained by high transaction costs or by the difficulty of acquiring information to invest abroad. Over the past two decades, many national markets have been deregulated and opened to foreign investment. Good-quality information on most markets is more easily available and transaction costs have been drastically reduced. In recent years, cross-border portfolio investment has become an increasingly important feature of global capital markets, with capital controls being relaxed and transactions costs declining in many securities markets.

The globalisation of securities markets is re-focusing attention on stock markets throughout the world. Investment managers and pension consultants in many developed countries continue to extol the fundamental virtue of diversification into overseas investing, suggesting potential high returns by a reduction in overall risk. International diversification in a portfolio reduces exposure to risk specific to a particular economy. It protects investors from substantial losses if one equity market or one currency faces a sudden crisis.

The importance of currency risk to international investments can be traced back to the collapse of the globally exchange rate systems (The Bretton Wood Agreement) in 1971. As a result of international financial instability, the currency exchange rates started to fluctuate and become volatile; hence exposed investors to greater currency risk internationally. If the hypothesis that investing internationally offers benefits in terms of portfolio risk reduction and return enhancement is true for many developed countries, then it is likely to be true for emerging or less developed markets. This study on Malaysia market provides a case of international portfolio diversification gain for an emerging country. As Malaysia recently faced a currency turmoil and volatile share price movement, this study evaluates if there is still a portfolio diversification gain of investing abroad for Malaysian investors even with significant changes in currency exchange rate and volatile share price movement.

II. Literature Review

Theories

This study focuses on two main subjects namely Modern Portfolio Theory by Harry Markowitz and theory of international portfolio diversification by Bruno Solnik. Markowitz (1952, 1958) conveyed two significant insights with regard to Modern Portfolio Theory. Firstly, he realised that the mathematics could not pick out a single optimal portfolio but rather could only identify a set of efficient portfolios. Secondly, he recognised that the appropriate risk facing an investor was portfolio risk which leads to a fundamental point that the riskiness of a stock should not be measured just by the variance of the stock but also by their covariances.

Markowitz discovered that it is the covariance that determines the risk of a portfolio and not the variance of individual assets in the portfolio. The best portfolio will consist of assets which are perfectly negatively (inversely) correlated. However, the benefits of diversification need not only exist if the assets are perfectly negatively correlated. In fact, as long as the correlation coefficient between two assets is less than 1.0, there will be a reduction in risk by combining both assets in a portfolio. Markowitz proposed that investors should instead consider variances of return along with expected returns, and choose portfolios that offer the highest expected return for a given level of variance. He called this rule the E-V maxim (Markowitz, 1959). In Modern Portfolio Theory, the Markowitz stock portfolio model is optimised by minimising the risk of the portfolio as meas-

ured by the variance of stock prices, subject to a given portfolio return. In short, Modern Portfolio Theory is a way to determine just how many eggs to put in each of several specified baskets.

Markowitz also demonstrated that for a given level of risk, an investor can identify particular combinations of securities that maximise expected return. Markowitz referred to a continuum of such portfolios in dimensions of expected return and standard deviation as the 'efficient frontier'. According to Markowitz's E-V maxim, investors should restrict their choice of portfolio to those that are located along the efficient frontier. The efficient frontier considers a universe of risky investments and explores what might be an optimal portfolio based upon those possible investments. The notion of 'optimal' portfolio can be defined in one of two ways:

- for any level of risk (standard deviation), consider all the portfolios which have that level of risk. From among them all, select the one which has the highest expected return; and
- for any expected return, consider all the portfolios which have that expected return. From among them all, select the one which has the lowest risk (standard deviation).

The first definition produces an optimal portfolio for each possible level of risk while the second definition produces an optimal portfolio for each expected return. However, the two definitions are equivalent as the set of optimal portfolios obtained using one definition is exactly the same set which is obtained from the other. The efficient frontier comprises a series of points, each of which represents a particular allocation of assets across the clusters. Each allocation produces a specific return at a specific level of risk.

In 1956, Harry Markowitz published the 'critical line algorithm' for tracing out the efficient frontier given estimates of expected returns, variances and covariances, for any number of securities subject to various kinds of constraints. There are two restrictions in solving the efficient frontier. Firstly, the sum of the proportions of each assets represented in the portfolio must equal one and secondly, all assets must have positive or zero representation in the portfolio. Returns are varied between the minimum-risk portfolio and the maximum-return portfolio to sketch the portfolio. The formula is given as:

$$\text{Minimize} \quad \sum_{i=1}^n x_i^2 \sigma_i^2 + \sum_{i=1}^n x_i^2 \sigma_i \sigma_{ij} \quad (1)$$

$$\begin{aligned} \text{subject to} \quad & \sum x_i = 1 \\ & R_p = \sum x_i R_i \\ & x_i \geq 0, i = 1, \dots, N \end{aligned}$$

$$\begin{aligned} \text{where} \quad & R_p = \text{total return to the portfolio,} \\ & x_i = \text{fraction of portfolio represented by asset } I, \\ & R_i = \text{return to asset } i, i = 1, \dots, N, \\ & \sigma_i^2 = \text{variance of asset } I, \\ & \sigma_{ij} = \text{covariance of assets } i \text{ and } j, i = 1, \dots, N, j = 1, \dots, N, i \neq j. \end{aligned}$$

Bruno Solnik (1974) made a significant impact on development of international portfolio diversification. He showed that substantial advantages in risk reduction can be attained through portfolio diversification in foreign securities. He also highlighted that there is little evidence that either stock or bond markets have become more volatile world-wide, and correlation between markets remains low. However, correlations do appear to increase when market volatility increases, that is, just when the diversification potential offered by low correlation is most needed. While the biggest advantage for investing internationally is diversification, the biggest disadvantage is the currency risk. However, it is worth noted that although international diversification of equity portfolios represents an exposure to security risk and currency risk, it also offers an opportunity to benefit from security returns and currency returns.

Solnik (1991) studied the correlation coefficients of monthly returns from 1971 to 1989 for 17 countries. The study proves that although the correlation coefficients between stock markets vary over time, they are always far from unity. For investors, this means there is ample room for successful risk diversification. It allows investors to spread risk, since some foreign markets are likely to go up when others go down. This reasoning is actually a variation on the traditional domestic diversification argument, except that it is extended to a larger universe of fairly independent markets. The degree of independence of a stock market is directly linked to the independence of a nation's economy and government policies. Constraints and regulations imposed by national governments, technological specialisation, independent fiscal and monetary policies, and cultural and sociological differences all contribute to the degree of a capital market's independence.

Combining the two main theories together, this study stands behind Markowitz portfolio analysis with an extension to Bruno Solnik's international portfolio diversification. Low international correlation across markets is at the root of global portfolio diversification. By diversifying across national markets with low correlation of returns, investors hope to reduce their total portfolio risk without sacrificing return.

Evidence

The initial application of portfolio theory in an international context to securities was by Grubel (1968) who extended the concept of modern portfolio analysis, pioneered by Markowitz (1952) and Tobin (1958) to global markets. Then, Sharpe (1972) argued that because all stock prices on the same stock exchange tend to move together, the rate of return on any reasonable well diversified portfolio will be highly correlated with that of the market as a whole. Solnik (1974) made a study which shows that increasing the size of a domestic portfolio beyond 20 stocks will only achieve a small incremental reduction in risk but a substantial reduction can be achieved by an international portfolio of the same size.

Eun and Resnick (1988) made a study covering a 10-year period from 1973 to 1982, and derived an average correlation of 0.41. Kaplanis and Schaefer (1991) made a similar study that covers a period from February 1978 to June 1987 and found an average correlation of 0.32. Hunter and Coggin (1990) found that international diversification could have reduced investment risk to about 56% of the level that could have been achieved by using only national diversification. Bailey and Stulz (1990) found out that the benefits to U.S. investors of diversifying into Pacific Basin markets are substantial. Price and Ring (1990) suggested that funds need at least 30% in foreign equities to maximise the risk reduction associated with international diversification.

Eaker, Grant, Berry and Woodard (1991) also showed that there are risk reduction opportunities available through international equity investing. Wignall and Shute (1991) argued that adding international investments to a pure U.S. portfolio can lessen volatility and increase returns. Fosberg and Madura (1991) found that approximately 90% of the risk of the individual stocks can be diversified away if investors hold portfolios of as few as 10 stocks. Le (1991) conducted a study on correlation coefficients between the U.S. and foreign markets and found out that the correlation coefficients made a dramatic increase after the October 1987 crash. Madura and Soenen (1992) concluded that gains from international diversification continue to exist regardless of country's perspective. In addition, Odier and Solnik (1993) found that investing internationally offers benefits in terms of portfolio risk reduction and return enhancement, regardless of investor's nationality. Hauser and Marcus (1994) studied the effects of hedging currency exchange rate and found that the hedging of currency risk is an inferior policy because of the negative correlation between the exchange rate and stock returns when measured in the local currencies of emerging markets. Tang (1995) found that the correlation coefficients between stock indices increase in general with an increase in the investment horizon.

Chatrath, Ramchander and Sanjay (1996) studied the benefits from portfolio diversification in the Indian equity market and found that international portfolio diversification generally represents an exposure to currency risk. Solnik, Boucelle and Fur (1996) found that the correlation coefficient of individual foreign stock markets with the U.S. stock market has not increased during the past 10 years. Patel and Sarkar (1998) confirmed the widely held belief that correlation

between the U.S and emerging market returns tend to increase if market declines but this change affects only investors who hold stocks for short time periods (less than one year for Asian stocks). Laster (1998) discovered that raising the equity allocation to foreign stocks from zero to 20% reduces the probability of realizing negative returns over a 5 year period by about a third. It also documents the near certainty of reducing portfolio risk by raising the equity allocation to foreign stocks above conventional levels. Kohers (1998) found that equally weighted portfolios which include some emerging markets that have positive economic forecasts and low correlations with the other countries in a portfolio can provide diversification benefits which are comparable to portfolios with more breadth and more complex weighting schemes.

Espinoza (1998) argued that investing abroad is still superior despite occasional fierce downdrafts. On the issue of currency exchange rate, Solnik (1996) argues that currency fluctuation has never been the major component of total return on a diversified portfolio over a long period of time because the depreciation of one currency is often offset by the appreciation of another. Solnik also confirmed in the study that exchange rates volatility is insignificant in a portfolio. Kwangsoo Ko (1998) conducted a study which found that the effects on exchange rates on monthly seasonality exist but they are not strong enough to significantly influence the international portfolio returns. Addae-Dapaah (1998) also found that the impact of currency volatility on return and risk is statistically insignificant.

Bugar and Maurer (1998) found evidence which supports the benefits from international diversification of stock portfolios from Hungarian as well as German point of view. Garrett and Spyrou (1999) concluded that even though common trends are detected among emerging countries, their impact is very limited and therefore emerging equity markets still offer benefits in terms of diversification, even in the long run. Papadamou and Tsopoglou (1999) study showed that the benefits of international portfolio diversification are higher for investors with clear downward trend of domestic currency, stock, and money markets (like Japanese) for any specified level of risk.

In a more recent study, Schroder (2002) found that investors could mostly increase the performance of their portfolios by investing in international asset and holding only domestic assets is only an inferior solution. A study by Li, Sarkar and Wang (2003) shows that international diversification benefits remain substantial for U.S. equity investors even when they are prohibited from short selling in emerging markets. Driessen and Laeven (2003) found that the benefits of investing abroad are largest for investors in developing countries. They also found that a large part of the diversification benefits disappears when controlling for short-sales constraints and currency effects, even for developing countries.

III. Data and Methodology

Data

In an international portfolio, the effects of currency exchange risks cannot be ignored. As the study focuses on the perspective of Malaysian investors, the exchange rate risks between Malaysia and other selected countries must be taken into account in calculating the expected return and standard deviation of the portfolios. For this, the study used data of weekly closing figures of 20 stock market indices (including KLSE Composite Index of Kuala Lumpur Stock Exchange, Malaysia) which represented the most widely-used stock market index in each country over a 17-year period from January 1987 to December 2003. The 20 countries were selected based on geographical dispersion and availability of data. A list of the selected countries, stock exchanges and stock market indices is presented in Table 1 below.

To consider the currency exchange rate in the study, a set of data on the currency exchange rates between Malaysian Ringgit and currency of the selected countries over a 17-year period from January 1987 to December 2003 are gathered. A list of the countries and currency exchange rate is presented in Table 2 below.

Table 1

List Of Selected Countries, Stock Exchanges And Stock Market Indices

	Countries	Stock Exchanges	Stock Market Indices
1	Malaysia	Kuala Lumpur Stock Exchange	KLSE Composite Index
2	Singapore	Stock Exchange of Singapore	OCBC Index
3	Thailand	Stock Exchange of Thailand	SET Index
4	Philippines	Philippines Stock Exchange	PSE Composite Index
5	Indonesia	Jakarta Stock Exchange	JSX Composite Index
6	Hong Kong	Stock Exchange of Hong Kong	Hang Seng Index
7	Korea	Korea Stock Exchange	Korea Composite Price Index
8	Taiwan	Taiwan Stock Exchange	Composite Stock Price Index
9	China	Shanghai Stock Exchange	Shanghai All Share Index
10	India	Bombay Stock Exchange	Bombay National Index
11	Pakistan	Karachi Stock Exchange	KSE-100 Index
12	Australia	Australian Stock Exchange	All Ordinaries Index
13	New Zealand	New Zealand Stock Exchange	NZSE 40 Capital Index
14	Japan	Tokyo Stock Exchange	Nikkei 225
15	Canada	Toronto Stock Exchange	Toronto Composite Index
16	United States	New York Stock Exchange	Dow Jones Industrial Average
17	United Kingdom	London Stock Exchange	Financial Times 250 Index
18	Germany	Frankfurt Stock Exchange	Dax Index
19	France	Paris Stock Exchange	CAC 40 Index
20	Switzerland	Zurich Stock Exchange	Credit Suisse Index

Table 2

List of Selected Countries and Currency Exchange Rates

	Countries	Currency Exchange Rates
1	Singapore	Ringgit Malaysia VS Singapore Dollar
2	Thailand	Ringgit Malaysia VS Thai Baht
3	Philippines	Ringgit Malaysia VS Philippines Peso
4	Indonesia	Ringgit Malaysia VS Indonesia Rupiah
5	Hong Kong	Ringgit Malaysia VS Hong Kong Dollar
6	Korea	Ringgit Malaysia VS Korean Won
7	Taiwan	Ringgit Malaysia VS Taiwan Dollar
8	China	Ringgit Malaysia VS Renmimbi
9	India	Ringgit Malaysia VS Indian Rupee
	Countries	Currency Exchange Rates
10	Pakistan	Ringgit Malaysia VS Pakistani Rupee
11	Australia	Ringgit Malaysia VS Australian Dollar
12	New Zealand	Ringgit Malaysia VS New Zealand Dollar
13	Japan	Ringgit Malaysia VS Japanese Yen
14	Canada	Ringgit Malaysia VS Canadian Dollar
15	United States	Ringgit Malaysia VS U.S Dollar
16	United Kingdom	Ringgit Malaysia VS Pound Sterling
17	Germany	Ringgit Malaysia VS Deutschemark
18	France	Ringgit Malaysia VS French Franc
19	Switzerland	Ringgit Malaysia VS Swiss Franc

The capital control measure undertaken by Malaysian government in September 1998 resulted in a fixed currency exchange rate pegged at the rate of RM3.80 to \$1.00. The currency exchange rate for selected European countries is adjusted to the Euro-Dollar beginning from January 1999.

Besides the most widely-used stock market index of each country, there is another type of country index which is also widely-used especially by fund managers who invest internationally. The Morgan Stanley Composite Index (MSCI) provides standardisation as all the country indices are dividend-adjusted and quoted in a single currency, the US Dollar. For the purpose of this study, data on the MSCI indices are used to provide an in-depth study of the effects of international portfolio diversification by using a standardised type of indices. This consists of weekly closing figures of 20 stock market indices represented by the MSCI of 20 countries over a 17-year period from January 1987 to December 2003.

To provide a more in-depth study, the 20 countries as in this study are also divided into either developed or emerging countries group in accordance with the classification of International Finance Corporation (IFC). The World Bank defines an emerging country as one having per capita GNP that would place it in the lower or middle-income category. At the end of 1995, an emerging country had an annual per capita GNP less than \$8,955. Although emerging countries are home to about 85% of the world's population, they produce only about 20% of the world's GNP and have only about 11% of the world's stock market capitalisation (World Bank 2000 Report). The classification of countries between Developed and Emerging Countries is shown in Table 3 below.

Table 3

Classification Of Countries Between Developed And Emerging Countries

Developed Countries		Emerging Countries	
1	Singapore	1	Malaysia
2	United States	2	Thailand
3	United Kingdom	3	Philippine
4	Japan	4	Indonesia
5	Hong Kong	5	Korea
6	Australia	6	Taiwan
7	New Zealand	7	India
8	Germany	8	Pakistan
9	France	9	China
10	Switzerland		
11	Canada		

To compare the benefits of investing in an internationally diversified portfolio and a domestically diversified portfolio, data on selected domestic counters are needed. For this, the domestically diversified portfolios are represented by two different sets of domestic portfolios. Firstly, the Domestic-Large Portfolio, comprises the top 20 stocks listed on the KLSE, which consistently are in the list of the top 50 stocks with the largest market capitalisation on each year from 1987 to 2003.

Secondly, the Domestic-Smaller Portfolio, comprises stocks on the KLSE with two constraints. The stocks must be listed on the KLSE throughout the period of the study (from January 1987 to December 2003) and it must exclude those stocks which have been chosen to form Domestic-Large Portfolio. In general, the Domestic-Smaller Portfolio represents smaller companies on the KLSE. In this way the research question on diversification can be investigated for two sets of divergent portfolios to document the differences.

The stocks which are chosen to form the Domestic-Large Portfolio are presented in Table 4 while the stocks which are chosen to form the Domestic-Smaller Portfolio are presented in Table 5.

Table 4

List of Selected Stocks Which Form the Domestic-Large Portfolio

	Name of Stock		Name of Stock
1	British American Tobacco Malaysia Berhad	11	Malayan Banking Berhad
2	Batu Kawan Berhad	12	Malaysia Mining Corporation Berhad
3	ESSO Malaysia Berhad	13	Multi-Purpose Holdings Berhad
4	Genting Berhad	14	PPB Group Berhad
5	Guinness Anchor Berhad	15	Sarawak Enterprise Corporation Berhad
6	Highlands & Lowlands Berhad	16	Shell Refining Company (Malaysia) Berhad
7	Kuala Lumpur Kepong Berhad	17	Sime Darby Berhad
8	Magnum Corporation Berhad	18	Tan Chong Motor Holdings Berhad
9	Malayan United Industries Berhad	19	Tractors Malaysia Holdings Berhad
10	Malaysian Airlines System Berhad	20	United Plantations Berhad

Table 5

List of Selected Stocks Which Form the Domestic-Smaller Portfolio

	Name of Stock		Name of Stock
1	Aluminium Company of Malaysia Berhad	11	Lafarge Malayan Cement Berhad
2	Bandar Raya Developments Berhad	12	Malayawata Steel Berhad
3	Boustead Holdings Berhad	13	Mulpha International Berhad
4	Carlsberg Brewery Malaysia Berhad	14	Oriental Holdings Berhad
5	Chemical Company of Malaysia Bhd	15	RHB Capital Berhad
6	Guthrie Holdings Berhad	16	SCB Developments Berhad
7	Hong Leong Industries Berhad	17	Selangor Properties Berhad
8	Hume Industries Malaysia Berhad	18	SESB Berhad
9	IOI Corporation Berhad	19	Tasek Corporation Berhad
10	Kulim Malaysia Berhad	20	UMW Holdings Berhad

All data are gathered from database managed by Datastream Limited. The 17-year period is used as it provides a comprehensive analysis of the international portfolio diversification gain under different stock market conditions. As the study also analyses the effects of international portfolio diversification at different periods of pre-, during- and post-crisis, the 17-year period is selected as it covers six major stock market crises namely the 1987 stock market crash, the Gulf Crisis, the South East Asia Financial Crisis, the September 11, the Invasion of Iraq and the SARS Outbreak. Based on this, the whole 17-year period is then divided into additional thirteen sub-periods which are identified in this study as in Table 6 below.

Table 6

Period And Sub-Periods Of Study

Period	Name of Period	Date Started and Ended
1	2	3
Period 1	17 Years from January 1987 to December 2003	January 02, 1987 to December 31, 2003
Period 2	Pre Crash 1987	January 02, 1987 to October 09, 1987
Period 3	During Crash 1987	October 16, 1987 to December 25, 1987
Period 4	Post Crash 1987	January 01, 1988 to July 27, 1990

Table 6 (continuous)

1	2	3
Period 5	During Gulf Crisis	August 03, 1990 to March 01, 1991
Period 6	Post Gulf Crisis	March 08, 1991 to June 27, 1997
Period 7	During Asian Financial Crisis	July 04, 1997 to December 25, 1998
Period 8	Post Asian Financial Crisis	January 01, 1999 to September 07, 2001
Period 9	During September 11	September 14, 2001 to December 28, 2001
Period 10	Post September 11	January 04, 2002 to March 14, 2003
Period 11	During Invasion of Iraq	March 21, 2003 to April 18, 2003
Period 12	Post Invasion of Iraq	April 25, 2003 to December 31, 2003
Period 13	During SARS Outbreak	March 14, 2003 to June 27, 2003
Period 14	Post SARS Outbreak	July 04, 2003 to December 31, 2003

Methodology

The main concern of the study is to create a portfolio of stock market indices that maximises return at a given level of risk, or minimises risk at a given level of return. The expected return on the portfolio is given by the weighted average returns of the stock market indices for each country. This is shown as below:

$$R_p = \sum_{i=1}^n W_i R_i, \quad (2)$$

where

$$\begin{aligned} \sum W_i &= 1 \\ R_p &= \text{the expected return on portfolio } p, \\ W_i &= \text{the proportion of stock market indices of the country in the total portfolio,} \end{aligned}$$

folio,

$$\begin{aligned} R_i &= \text{the expected return on stock market index } I, \\ N &= \text{the number of stock market indices in the portfolio.} \end{aligned}$$

The portfolio risk is represented by the weighted average of the variability and the correlation coefficient of the returns from the sampled stock market indices. For this, the mean-variance model is used to identify an optimal allocation of portfolio in several stock market indices. The basic principle behind the search for an optimal allocation is the Markowitz Efficient Frontier Model as stated below;

$$\sigma_p^2 = W_i^2 \sigma_j^2 + 2 \sum_{i=1}^n \sum_{j=1}^n W_i W_j \sigma_i \sigma_j \sigma_{ij} \quad (3)$$

$$\text{and } W_i \geq 0 \quad \sum W_i = 1,$$

where

$$\begin{aligned} \sigma_p^2 &= \text{the portfolio variance,} \\ \sigma_i \sigma_j &= \text{the standard deviation of stock market index } i \text{ and } j, \text{ respectively,} \\ \sigma_{ij} &= \text{the correlation coefficient of stock market index } i \text{ and } j, \text{ respectively,} \\ W_i W_j &= \text{the proportion of stock market index } i \text{ and } j, \text{ respectively, in the portfolio.} \end{aligned}$$

The constraint $W_i \geq 0$ implies that short-selling is not allowed while the constraint $\sum W_i = 1$ ensures that the portfolio is fully invested.

For the purpose of this study, a new computer programme called the Efficient Frontier Calculator has been developed. The programme is able to calculate the weights of assets in an optimal portfolio and plot the efficient frontiers. Besides calculating the weights of assets in an opti-

mal portfolio, users of the programme are also able to know the standard deviation of an optimal portfolio at different level of expected returns.

The Efficient Frontier Calculator was developed by using Microsoft Visual Basic 6.0. Advanced ActiveX Components such as the MSGraph and MSFlexgrids were implemented to provide a much user-friendly interface. This program also employs the latest Microsoft OLE Automation technology by incorporating the Excel control. The Excel control was used to enable collaboration with the Solver toolkit which is only available in Excel installations. The calculation of the weights of assets in an optimal portfolio is done by Solver. Due to the usage of Solver, this programme requires the installation of the Microsoft Excel plus Solver toolkit in the destination computer prior to its own installation. For the benefit of the users, the program also provides saving options, printing options, customisation of solver variables and 'cut & paste' options. All these options make operations much easier and efficient.

With the formation of an optimal portfolio using the Markowitz mean-variance model, the study proceeded with several divisions of studies which are differentiated in data used in the studies and the constraint pre-set on the minimum level of an asset. Results of these studies are presented in the form of efficient frontiers for each study which are calculated and graphically constructed using the Efficient Frontier Calculator programme. In each graph, there are two sets of efficient frontier plotted to provide a visual evaluation of the superiority of the efficient frontier sets.

In the universe of expected return and standard deviation, it is known and accepted that the more 'north-west' a portfolio is, the more superior it is. This is easy to understand as a portfolio, which is located more 'north-west' will have higher expected return and lower standard deviation than a portfolio which is not as 'north-west' as the earlier portfolio. The more 'south-east' a portfolio is in the universe of expected return and standard deviation, the more inferior it is. Also, those that are below the frontier are inefficient objects for investment choice. For a given subset of securities, no superior portfolio exists above the frontier. These are standard results of the theory in practice.

On some results, visual evaluation is sufficient to tell which set of efficient frontier is more superior. However, this is not the case for all results. In some other results, it is difficult to tell the superiority level of each of the efficient frontier sets. It is even more difficult for users to compare multiple or more than two sets of efficient frontier by just visually evaluating them. As such, visual evaluation can turn into an art form rather than a mathematical evaluation. An efficient frontier curve in the eye of an individual may be different in the eye of another individual.

To provide an alternative to a visual evaluation of the superiority of efficient frontiers, this study introduced the Efficient Frontier Index. It is a quantitative measure developed to provide a guide to the superiority of efficient frontiers for ease of comparison. It provides an indication of the superiority of a set of optimal portfolios by indicating a value to an efficient frontier. The formulation of Efficient Frontier Index is as below:

$$EF\ Index = \left(\sum_{i=1}^n \frac{R_i}{\sigma_i} \right) \left(\sum_{i=1}^n \frac{R_i - R_{lowest}}{\sigma_i - \sigma_{lowest}} \right), \quad (4)$$

where

R_i = all points of Expected Return on a set of optimal portfolios.

σ_i = all points of Standard Deviation on a set of optimal portfolios.

R_{lowest} = the lowest Expected Return at a point where the optimal Standard Deviation is also the lowest.

σ_{lowest} = the lowest point of Standard Deviation on a set of optimal portfolios.

A set of efficient frontier which has a higher value of EF Index can be regarded as more superior than a set of efficient frontier with a lower value of EF Index.

IV. Research Findings and Discussion

Figure 1 below provides a visual evaluation of the superiority of five different portfolios, three of which represent internationally diversified portfolios and two of which represent purely domestic portfolios. The efficient frontiers are plotted by using the Efficient Frontier Calculator program.

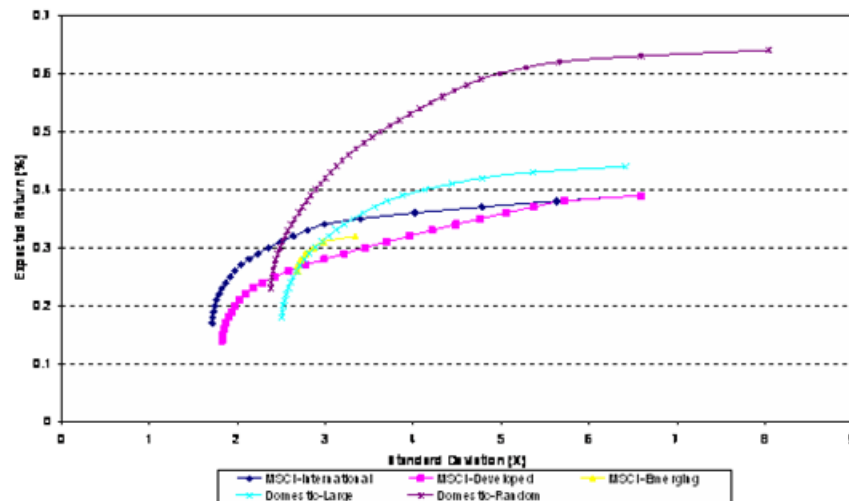


Fig. 1. Efficient Frontiers for MSCI Developed Countries, MSCI Emerging Countries, Domestic-Large and Domestic-Random Portfolios – January 1987 to December 2003

The internationally diversified portfolios are MSCI-International (comprises all 20 selected MSCI countries indices), MSCI-Developed (comprises 11 MSCI developed countries indices) and MSCI-Emerging (comprises 9 MSCI emerging countries indices). The purely domestic portfolios are Domestic-Large (comprises 20 large market capitalisation stocks on the KLSE) and Domestic-Smaller (comprises 20 smaller market capitalisation stocks on the KLSE). The data used are for the whole period of study of 17 years from 1987 to 2003 (Period 1).

Efficient frontiers are also plotted for all the five portfolios for all the thirteen sub-periods of the study using the Efficient Frontier Calculator program. Nonetheless, the charts are not presented in this study as it is difficult to ascertain the ranking of superiority through visual evaluation alone. From Figure 1, visually, it may be seen that MSCI-International and Domestic-Smaller portfolios both are more superior than the other three portfolios as both are quite clearly being positioned more 'north-west' in the universe of expected return and standard deviation.

However, in many cases, there are crossing of efficient frontiers and the steepness of the efficient frontiers also vary, which make it difficult to evaluate their relative superiority. Thus, the study provides a quantitative measure of the superiority of efficient frontiers through the computation of Efficient Frontier Index which is presented in Table 7 with the results for Efficient Frontier Index. This enables readers to make meaningful comparisons among efficient frontiers either within the same period, between different periods or any other comparisons.

Table 7

Efficient Frontier Index of MSCI International, MSCI Developed Countries, MSCI Emerging Countries, Domestic-Large and Domestic-Smaller Portfolios – Ranked Within Each Periods

Period/ Ranking – 1=Highest 5=Lowest	Name of Period/Types of Portfolio	Lowest E(R)	Lowest SD	Number of Effi- cient Portfolios	Summation of each E(R)/each SD	Summation of each E(R) mines Lowest E(R)	Summation of each SD mines Lowest SD	Summa- tion of each (E)/(F)	EF Index – Sum- mation of each (G) × (D)
		(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)
1	2	3	4	5	6	7	8	9	10
Period 1	17 Years from January 1987 to December 2003								
1	Domestic- Smaller	0.23	2.38	42	5.29	8.61	47.42	17.04	2.07
2	MSCI Inter- national	0.17	1.71	23	2.58	2.53	22.68	10.11	1.17
3	MSCI Emerging	0.26	2.68	7	0.71	0.21	1.25	11.44	1.15
4	Domestic- Large	0.18	2.51	27	2.54	3.51	21.93	12.16	1.08
5	MSCI Devel- oped	0.14	1.82	26	2.28	3.50	81.29	1.03	0.09
Period 2	Pre Crash 1987								
1	MSCI Inter- national	0.54	0.53	247	301.01	303.81	268.72	677.87	852.10
2	MSCI Emerging	0.56	0.59	304	313.36	460.56	539.61	545.73	606.03
3	Domestic- Large	0.76	1.89	218	123.32	236.53	330.84	408.54	217.65
4	MSCI Devel- oped	0.72	1.08	329	212.35	539.56	2,796.00	249.63	160.12
5	Domestic- Smaller	0.78	1.82	188	87.23	175.78	414.10	165.90	79.34
Period 3	During Crash 1987								
1	MSCI Inter- national	0.03	0.54	26	3.32	3.25	23.13	80.51	10.50
2	MSCI Emerging	0.06	0.54	23	3.09	2.53	22.98	47.39	7.80
3	Domestic- Large	(0.31)	0.90	16	(4.02)	1.20	0.82	65.91	(18.68)
4	MSCI Devel- oped	(2.30)	5.17	397	(31.80)	786.06	712.12	699.58	(133.73)
5	Domestic- Smaller	(1.47)	3.84	161	(26.98)	128.80	63.47	709.49	(185.12)
Period 4	Post Crash 1987								
1	MSCI Inter- national	0.48	1.05	136	59.83	91.80	284.61	155.68	77.68
2	Domestic- Smaller	0.41	1.44	192	92.88	283.20	544.94	138.83	70.84
3	MSCI Emerging	0.66	1.53	118	47.54	69.03	236.03	100.45	45.42
4	Domestic- Large	0.16	1.36	143	45.85	101.53	180.69	168.77	43.28
5	MSCI Devel- oped	0.35	1.32	28	7.68	3.78	25.77	37.47	11.22
Period 5	During Gulf Crisis								
1	Domestic- Large	(0.05)	2.89	129	16.32	82.56	168.90	222.94	10.51

Table 7 (continuous)

1	2	3	4	5	6	7	8	9	10
2	MSCI International	(0.09)	0.82	85	10.66	35.70	127.28	78.73	3.84
3	MSCI Developed	(0.04)	1.57	38	2.76	7.03	10.30	77.40	2.35
4	MSCI Emerging	(0.04)	1.29	80	8.03	31.60	143.96	48.08	1.89
5	Domestic-Smaller	(0.20)	2.08	100	6.64	49.50	139.84	87.97	0.56
Period 6	Post Gulf Crisis								
1	MSCI International	0.22	1.03	49	9.53	11.76	98.38	36.82	8.73
2	MSCI Developed	0.21	1.13	50	8.59	12.25	102.99	27.69	5.56
3	MSCI Emerging	0.22	1.55	22	3.79	2.31	7.69	27.73	4.49
4	Domestic-Large	0.11	1.93	56	6.87	15.40	75.47	38.84	3.97
5	Domestic-Smaller	0.30	2.04	34	4.93	5.61	49.98	15.22	2.43
Period 7	During Asian Financial Crisis								
1	MSCI International	0.01	1.90	45	4.83	9.90	7.73	116.30	8.61
2	MSCI Developed	0.23	2.10	23	3.50	2.53	2.84	62.10	8.52
3	Domestic-Smaller	(0.28)	2.90	63	(0.52)	19.53	143.54	26.28	(1.24)
4	Domestic-Large	(0.28)	3.87	71	0.08	24.85	167.48	46.69	(2.06)
5	MSCI Emerging	(0.63)	2.81	69	(5.25)	23.46	219.42	21.60	(3.45)

For Period 1 (17-year period from 1987 to 2003), the results show that Domestic-Smaller portfolio provides the highest Efficient Frontier Index of 2.07 points. This is followed by MSCI International portfolio with an Efficient Frontier Index of 1.17 points, MSCI Emerging portfolio of 1.15 points, Domestic-Large portfolio of 1.08 points and lastly MSCI Developed Countries portfolio recorded the lowest Efficient Frontier Index of 0.09 points.

The results for Period 1 above show that, over a long term period of 17 years from 1987 to 2003, a portfolio of selected smaller market capitalisation stocks on the KLSE is the most superior investment asset since it provides the highest risk-return trade-off among portfolios of international assets and a portfolio of large market capitalisation stocks on the KLSE. This is in contrast to many earlier studies which supported that in the longer term, internationally diversified portfolio is always more superior than a purely domestic portfolio. The results suggest that in the long term, there are smaller stocks on the KLSE which are correlated at low values with each other as compared to assets of international market portfolios or a portfolio of larger stocks on the KLSE.

The low correlation coefficients among the selected smaller market capitalisation stocks on the KLSE are the basis for the superiority of the efficient frontiers constructed from the Domestic-Smaller portfolio. This suggests that for a long-term investment period, Malaysian investors are able to construct a superior efficient portfolio by selecting smaller stocks on the KLSE which are lowly correlated to each other and combining this with a portfolio consisting of international assets.

Although the Domestic-Smaller portfolio is the most superior portfolio in the long-term period, this is not the case for all sub-periods. The results from Table 7 show that for the first three sub-periods, namely Pre-Crash 1987 (Period 2), During Crash 1987 (Period 3) and Post-Crash 1987 (Period 4), the MSCI International portfolio is the superior portfolio among the five portfolios. That is, the KLSE failed to yield normal returns in the period and the two periods surrounding

the crash. This makes the KLSE a very risky market, particularly since it has a history of crashes. For both periods of Pre-Crash 1987 and During Crash 1987, the second best portfolio is the MSCI Emerging market portfolio. In fact, the Domestic-Smaller portfolio is the inferior portfolio for the period Pre-Crash 1987, suggesting that in the period of Pre-Crash 1987, the best investment strategy would have been to invest in an internationally diversified portfolio.

It is interesting to note that for the period of During Crash 1987, only MSCI International and MSCI Emerging portfolios provided positive figures in their Efficient Frontier Index. The other three portfolios recorded negative Efficient Frontier Index for the period while the MSCI Emerging Portfolio is the most inferior with an Efficient Frontier Index of -185.12 points. This suggests that if a stock market crash almost similar to the 1987 stock market crash happens again, the best investment strategy for Malaysian investors is to have a position in international markets or emerging markets plus avoid investing in markets of developed countries.

During the Gulf Crisis (Period 5), the results from Table 7 show that Domestic-Large portfolio is the most superior portfolio for the sub-period. All the internationally diversified portfolios are ranked from the second spot to the fourth spot while the most inferior portfolio for the period is the Domestic-Smaller portfolio. This shows that both the domestic-based portfolios are very much diverse to each other that they can be as far apart as being the most superior and most inferior portfolios in a crisis period. On the other hand, during the Post-Gulf Crisis (Period 6), it is clearly evidenced that internationally diversified portfolios are more superior to domestic-based portfolios. The top three portfolios during this period are the internationally diversified portfolios, followed by the domestic-based portfolios.

As stocks markets in emerging Asian countries suffered significantly during the Asian Financial Crisis (Period 7), it is not surprising that the results from Table 7 for that period show that the MSCI International and MSCI Developed portfolios are the superior ones: recall similar results for the 1987 crash. It is also not surprising to note that the MSCI Emerging portfolio and both the domestic-based portfolios recorded negative Efficient Frontier Index values for the period. As the KLSE recovered from the Asian Financial Crisis, the results for the period of Post Asian Financial Crisis (Period 8) show that the Domestic-Smaller portfolio is the most superior portfolio for Malaysian investors during the period. Nonetheless, the results also show that some Asian stock markets took a longer time to recover as the MSCI Emerging portfolio still recorded a negative Efficient Frontier Index of -0.77 points for the period.

The event of September 11 (Period 9) affected stocks markets globally but in general, those in developed countries were badly affected than those in emerging countries. As such, Domestic-Smaller portfolio is the most superior portfolio as opposed to MSCI Developed portfolio which is the most inferior portfolio for the period. MSCI Emerging portfolio is at the second spot, followed by MSCI International portfolio and Domestic-Large portfolio. Interestingly, the rankings of all the five portfolios for the periods of During September 11 (Period 9) and Post September 11 (Period 10) are exactly the same, suggesting that there is no significant difference on the superiority of the portfolios, during and post September 11. That means that crises in developed markets make domestic positioning more valuable.

The biggest surprise from the results presented in Table 7 is for Period 11 (During Invasion of Iraq). In contrast to the results for Period 5 (During Gulf Crisis) where all the portfolios produced low Efficient Frontier Index, the Efficient Frontier Index of the portfolios in the period of During Invasion of Iraq is the highest for all the five portfolios among all the period and sub-periods. The Domestic-Smaller portfolio for Period 11 (During Invasion of Iraq) recorded the highest Efficient Frontier Index among the portfolios for all periods and sub-periods at 14,647.05 points.

If the Domestic-Smaller portfolio is the most superior portfolio in the period During Invasion of Iraq, it is the opposite in the period of Post Invasion of Iraq (Period 12) as it turns to be the most inferior portfolio for the period. In other words, the world markets recovered, and performed well above, and a position in such markets would have been superior to one in domestic market. MSCI International becomes the most superior portfolio for the period although its Efficient Frontier Index for the period of 390.43 is very much lower than any of the portfolios in the period of During Invasion of Iraq.

In the period of During SARS Outbreak (Period 13), MSCI International portfolio turns out to be the most superior portfolio among the five portfolios, followed by MSCI Emerging Countries, Domestic-Smaller, Domestic-Large and lastly the MSCI Developed Countries portfolio as the most inferior portfolio for the period. The sequence does not change much for the period of Post SARS Outbreak (Period 14) where MSCI Emerging Countries portfolio becomes the portfolio with the highest Efficient Frontier Index for the period, followed by MSCI International, Domestic-Smaller, MSCI Developed Countries and lastly the Domestic-Large portfolio.

The Efficient Frontier Calculator is relatively flexible that it is able to produce results with constraint imposed on the weight of individual assets in the portfolio. For the purpose of this study, efficient frontiers of MSCI International are produced with variable minimum weight constraint imposed on Malaysia, one of the countries in the MSCI International portfolio. A total of ten different efficient frontiers are formed with the variable minimum weight constraint imposed on Malaysia ranging from 0% to 10% with an interval of 10%. This is presented in Figure 2 as below:

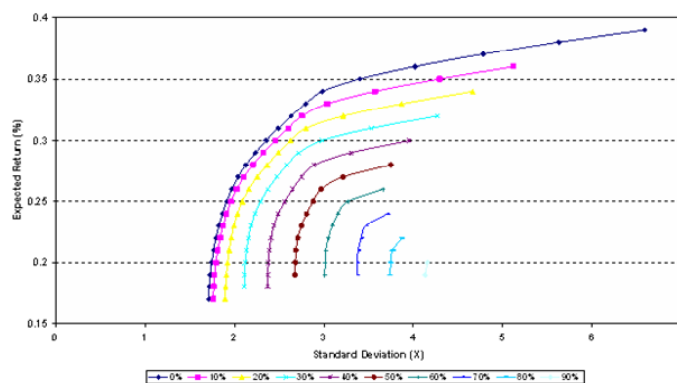


Fig. 2. Efficient Frontiers for MSCI International – 17 Years from January 1987 to December 2003 with Variable Minimum Weightage Constraint for Malaysia Ranging from 0% to 90%

The figure shows that unconstrained efficient frontier is more superior to constrained efficient frontiers. As the level of minimum weight constraint increases, the efficient frontiers formed become more and more inferior (moving towards 'south-east'). In the financial market operations, many restrictions are imposed on fund managers and one of them is to have a limit on the maximum exposure in a single asset to ensure safety to invested funds. The result of this analysis shows that any constraint imposed on a portfolio will only result in a more inferior efficient frontier as compared to those with no restriction(s).

There are several factors that affect the valuation of Efficient Frontier Index. First, the position of each point of the optimal portfolios is plotted in the universe of expected return and standard deviation. An optimal portfolio which is located in a position where it has a high expected return at a low standard deviation will have a more positive impact on the level of Efficient Frontier Index than an optimal portfolio which is located in a position where it has a lower expected return at a higher standard deviation. The positions of each expected return and each standard deviation will also determine the 'steepness' of the efficient frontier. As for the Domestic-Smaller portfolio in the period of During Invasion of Iraq (Period 11), its lowest expected return (Column A in Table 7) is as high as 0.74% while its lowest standard deviation (Column B in Table 7) is as low as 0.20. Compared to the portfolio which recorded the lowest Efficient Frontier Index in Table 7, the MSCI Developed Countries portfolio for Period 3 (during Crash 1987), its lowest expected return is as low as -1.47% while its lowest standard deviation is as high as 3.84.

Second, the summation of each expected return of the optimal portfolios divided by each of the standard deviation of the optimal portfolios (Column D in Table 7) may also provide an indication of the superiority of an efficient frontier. Table 7 shows that the summation of each expected return of the optimal portfolios divided by each of the standard deviation of the optimal

portfolios for Domestic-Smaller portfolio in Period 11 was the highest among all the results at 1,569.61 while at the same time, those of the MSCI Developed Countries portfolio for Period 3 was the second lowest among all the results at -26.98.

Third, the superiority of an efficient frontier may also be affected by the number of optimal portfolios which form the efficient frontier (Column C of Table 7). The number of optimal portfolios which form the efficient frontier of the Domestic-Smaller portfolio for Period 11 was the second highest at 338 optimal portfolios as compared to only 161 optimal portfolios which form the efficient frontier of the MSCI Developed Countries portfolio for Period 3.

V. Conclusion

The results from Table 7 show mixed outcomes on the most superior efficient frontier for all the periods and sub-periods. Internationally diversified portfolios are the most superior portfolios in eight of the sub-periods while domestic-based portfolios are most superior ones in six of the period/sub-periods including the main period of 17-years from January 1987 to December 2003. It is interesting to note that the results also show a general change in the superiority of portfolios over time during the period of the study. From January 1987 to December 1998 (from Period 2 to Period 7), in general internationally diversified portfolios are more superior to domestic-based portfolios. However, this seems to change after the Asian Financial Crisis as from this period until the period of Invasion of Iraq (from January 1999 to April 2003), in general, domestic-based portfolios are superior to internationally diversified portfolios.

Undeniably, the findings are not in full support of international portfolio diversification to Malaysian investors when the Efficient Frontier Index of domestic-based portfolios proved to be more superior to those of internationally diversified portfolios under certain market conditions. The results proved that an internationally diversified portfolio needs not necessarily be more superior to one domestic-based portfolio in any stock market or economic conditions. In some crisis periods and even non-crisis periods, domestic-based portfolios proved to be superior to internationally diversified portfolios.

The study also found a general change in the superiority of portfolios over time during the period of the study. From January 1987 to December 1998 (from Period 2 to Period 7), in general internationally diversified portfolios are superior to a domestic-based portfolios. However, this seems to change after the Asian Financial Crisis as from this period until the period of Invasion of Iraq (from January 1999 to April 2003), in general, domestic-based portfolios are superior to internationally diversified portfolios.

The study also analyses the effect of imposing investment restrictions to a portfolio. The results show that as the minimum weight constraint for Malaysia increases, the value of Efficient Frontier Index of the portfolio decreases. This means that there is an inverse relationship between level of investment constraints or restrictions imposed on a portfolio and the superiority of the portfolio. Efficient frontiers of a portfolio with no or less constraints or restrictions will always be more 'north-east' than efficient frontiers of a portfolio with constraints or restrictions.

Given the findings which are not in full support of international portfolio diversification, the basic question on practical point of view is "Can Malaysian investors form a domestic-based portfolio which is superior to an internationally diversified portfolio?" The study shows that it depends on two main aspects: the selection of domestic stocks in the portfolio and the stock market or economic condition of the investment period. On the first aspect, as evidenced in this study, it is possible to construct a purely domestic portfolio which is superior to an internationally diversified portfolio under conditions of strengthening currency, worsening market conditions and away from large market capitalisation stocks. The main determinant for the superiority of the domestic-based portfolio is the correlation among stocks in the portfolio.

Naturally, the lower the correlation among stocks in the portfolio is, the more superior the portfolio is. In contrast to the general belief, the results show that the average correlation coefficients of domestic-based portfolios are generally lower than those of internationally diversified portfolios. This means that the selected domestic stocks are less correlated to each other as compared to equity markets of the selected countries. Furthermore, the results also show that selected

smaller market capitalisation stocks on the KLSE are less correlated with each other compared to large market capitalisation stocks on the KLSE.

On the second aspect, the results show that the other determinant of whether a domestic-based portfolio is superior to an internationally diversified portfolio is the stocks market or economic condition(s) of the investment period. In this aspect, the results are not very consistent. For the crisis periods, a domestic-based portfolio is the superior portfolio during the Gulf Crisis, September 11 and Invasion of Iraq while an internationally diversified portfolio is the most superior portfolio during the Stock Market Crash 1987, the Asian Financial Crisis and the SARS Outbreak.

For the non-crisis periods, a domestic-based portfolio is the most superior portfolio during the period of Post Asian Financial Crisis and Post September 11 and while an internationally diversified portfolio is the most superior portfolio during the period of Pre Stock Market Crash 1987, Post Stock Market Crash 1987, Post Gulf Crisis, Post Invasion of Iraq and Post SARS Outbreak. Malaysian investors thus may construct a superior portfolio by matching the assets which are lowly correlated to each other under certain stock market or economic condition(s) rather than generalise the stock selection throughout the investment periods.

The findings above may be summarised as suggesting that it is feasible for Malaysian investors to construct a purely domestic portfolio which is more superior to an internationally diversified portfolio under certain conditions peculiar to this market. To do this, investors must select stocks in the KLSE which are lowly correlated to each other during certain stock market or economic conditions. The study shows that the KLSE is not short of stocks which are lowly correlated to each other. In the context of portfolio diversification, this is good. If the stocks on the KLSE are highly correlated to each other, it will be difficult to construct a portfolio which is superior for risk reduction purposes.

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