

## THE COMPONENTS OF SYSTEMATIC RISK AND THEIR DETERMINANTS IN THE MALAYSIAN EQUITY MARKET

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### ABSTRACT

*We examine the country components of world systematic risk in the context of Bursa Malaysia. World systematic risk is divided into the US, developed markets, regional markets, major trading partners, and the rest of the world. We tested market and 9 firm-characteristic-sorted portfolios, based on size, value and liquidity. Using monthly data for the 1988–2010 period, our analyses show that the US and regional factors are the most important sources of systematic risk. Tracing the time-varying betas of the US and regional factors, we find that they are driven by economic risk and financial risk, respectively.*

**Keywords:** systematic risk, time-varying beta, country risk, Malaysia, equity

### INTRODUCTION

Over the last several decades, Asian firms have significantly increased their international investments as the Malaysian economy has successfully integrated into the global production system. Despite the interruption of the 1997 Asian financial crisis, the performance of Malaysian firms has been outstanding compared with their counterparts in developed countries and other parts of the developing world (World Investment Report, 2006). As Asian emerging markets have developed and become increasingly integrated into the world economy, implicit and explicit investment barriers have been significantly reduced, causing firm exposure to systematic risk to increase, with increased instability over time. As Malaysia is a small and open emerging market, Malaysian firms offer a unique opportunity to study the dynamics of systematic risk exposure of firms in Asian emerging countries. According to the World Investment Report because 1995, Malaysian firms have been among the most active international investors in emerging markets, behind only firms from China and Russia in terms of value.<sup>1</sup> Indeed, outward FDI from Malaysia has exceeded its inward flows since 2006

(ASEAN Investment Report, 2012). Moreover, Malaysian equity markets have undergone dynamic changes over the years. As statistics from the World Federation of Exchanges show, before the 1997 Asian crisis, Malaysia's equity market was third behind Japan and Hong Kong in terms of market capitalisation, although it has dropped to 8th place since the beginning of the new millennium. The Malaysian economy also experienced a long period of capital controls and fixed exchange rates from 1998 to 2005. Thus, it would also be interesting to observe how firm systematic risk behaves under a fixed currency regime.

The financial markets of Malaysia have limited depth and liquidity and are not fully integrated into the world markets. Under these conditions, systematic risk exposure of listed firms on Bursa Malaysia (known as Kuala Lumpur Stock Exchange before April 2004) cannot be fully captured by the standard asset pricing model, developed for developed market exchanges. A partial segmented asset pricing model that allows for decomposition of different sources of systematic risk is thus more appropriate. This paper aims to examine which factors represent the main sources of systematic risk for Malaysian listed firms and the main drivers of such risk.

To date, the Capital Asset Pricing Model (CAPM) remains one of the most popular models in asset pricing. Within the primary framework of the CAPM, the firm is posited to be driven by common systematic risk. Although this is not empirically realistic, this single index setting has been quite popular, as it reduces a large multivariate process to one of lower dimension.<sup>2</sup> To cater to the limitations of the single-factor model, many types of multifactor models have been proposed in the literature. Much focus has been placed on macroeconomic variables, such as the exchange rate (see Adler & Dumas, 1983; Dumas & Solnik, 1995; Lin, 2011), interest rates (see Flannery & James, 1984; Flannery, Hameed and Harjes, 1997), and multiple global economic fundamentals (see Ferson & Harvey, 1993; 1994). On the other hand, more microeconomically oriented studies have focused on fundamental firm characteristics, including size and value (see Fama-French, 1996), momentum (see Jegadeesh & Titman, 1993), liquidity (see Amihud & Mendelson, 1986) and idiosyncratic risk (see Bali & Cakici, 2010). An international version of the CAPM and some of its variations has also been proposed; see, for example, the International CAPM (ICAPM) of Stehle (1977) and the international version of the firm factors of Fama and French (1998). In an international setting, another line of research has focused on multi-country models. A multi-country model basically decomposes world systematic risk into various sub-systematic risks. For example, Brooks and Del Negro (2005) decompose systematic risk into regional, country and industry components; Bekaert, Harvey and Ng (2005) and Bekaert, Hodrick and Zhang (2009) decompose systematic risk into world and regional components; while

Heaney and Hooper (1999), Adler and Qi (2003) and Hooy and Goh (2010) decompose systematic risk into world and economic or trading bloc components.

Our study is divided into two sections. In the first section, we follow the multi-country approach to decomposing world systematic risk for Malaysia into five sub-groupings, i.e., the US market, developed markets, regional markets, major trading partners, and the rest-of-the-world. This decomposition enables us to determine which component of systematic risk has had the strongest influence on Malaysian firms. Our empirical evidence for the Malaysian market portfolio shows that the US and the regional factors are the most important sources of systematic risk for Malaysian firms, consistent with the findings of most multi-country analysis in the literature. In the second section, we examine the time-varying betas of the US and regional factors and find that the dynamics of these two sources of systematic risk can be explained by the financial crises that occurred over the last two decades. We then examine possible determinants of the US and regional factors, using country risk ratings to determine whether political, economic or financial risk of the respective factors affects their systematic risk dynamics.

## **DECOMPOSITION OF SYSTEMATIC RISK**

We first examine the systematic risk of the Malaysian market portfolio under a single-factor International Asset Pricing Model, based on Stehle (1977):

$$r_{M,t} = \alpha + \beta_W r_{W,t} + e_{M,t} \quad (1)$$

Where  $r_{M,t} = R_{M,t} - R_{F,t}$  and  $r_{W,t} = R_{W,t} - R_{F,t}$  are the market and world excess returns over the risk free asset (proxied by the US 3-month treasury bill rate) at time period  $t$ . The coefficient  $\beta_W$  is a constant parameter equal to  $[\text{cov}(r_{M,t}, r_{W,t}) / \text{var}(r_{W,t})]$ . Applying Model (1) to the Malaysian market portfolio assumes that the Malaysian market is fully integrated into the world market, such that the return on the Malaysian market portfolio is systematically related to the world market premium. We shall call this setting the World CAPM (WCAPM).

Because the world portfolio is a comprehensive information measure, we decompose systematic risk into five components and examine Malaysian market exposure to these five sub-components. Our decomposition yields the following:

$$r_W = (r_{US}, r_{DM}, r_{RG}, r_{TP}, r_{RW}) \quad (2)$$

where  $r_{US}$ ,  $r_{DM}$ ,  $r_{RG}$ ,  $r_{TP}$ ,  $r_{RW}$  are the portfolio excess returns for the US market, developed markets, regional markets, trading-partner stock markets and the rest-of-the-world markets.

Thus, our general empirical model is given by the following equation:

$$r_{M,t} = \alpha + \beta_1 r_{US,t} + \beta_2 r_{DM,t} + \beta_3 r_{RG,t} + \beta_4 r_{TP,t} + \beta_5 r_{RW,t} + e_{i,t} \quad (3)$$

where  $r_{M,t}$  is the Malaysian market portfolio excess return, and all five explanatory factors are sub-components of the world portfolio excess return. The market index, KLCI, is employed to proxy for the Malaysian market portfolio. We test several different settings, from two factors to five factors, adding one factor at a time to determine whether the factor loadings and their significance levels are sensitive to different settings.

The first component is the US factor. The US market is taken as a stand-alone component, given the undisputed role of the US market as the world financial centre over the last several decades. Indeed, mainstream research in almost all finance areas is based on the US market. Because the US market is used to proxy for the world portfolio, in the remainder of the paper, we refer to the one-factor (US) model as the International CAPM (ICAPM).

We take as our second factor the influence of other developed markets. In the literature, some studies use the G7 countries to proxy for the world factor; as we have designated the US as a single factor, we identify five of the remaining G7 countries, namely, Canada, France, Germany, Italy and the UK, together with Spain, Australia and Switzerland, as a group. Spain, Australia and Switzerland are ranked 7th, 11th, and 13th, respectively, in the world ranking of stock markets in terms of size, the highest rankings for developed markets after the G7 countries (World Federation of Exchanges, 2009). Japan (a G7 member) is designated to represent another factor, namely, that of a major Malaysian trading partner, as discussed below. We form a size-weighted portfolio for these 8 markets and refer to this factor as the developed-market (DM) factor.

Our third component is the regional (Asian) factor, covering neighbouring markets that share with Malaysia a similar business and risk profile. In addition to being geographically close, these markets engage in substantial trade and have strong cultural links with Malaysia. On the other hand, these attributes have made these markets competitors with Malaysia to attract foreign capital. If these markets can offer relatively better investment opportunities and incentives, the attractiveness of Malaysia will erode. The list of regional markets

includes other ASEAN countries, i.e., Indonesia, the Philippines, and Thailand, well-known as industrial competitors of Malaysia, and other more advanced East Asia markets such as Hong Kong, South Korea and Taiwan. Singapore and Japan are excluded from this factor because they are included in the trading partner factor. We construct a 6-country portfolio, weighted by the sizes of countries' equity markets, which we call the regional-market factor (RG).

Chen and Zhang (1997), Van Rijckeghem and Weder (2001), and Dumas, Harvey and Ruiz (2003) have highlighted the influence of the real sector on country systematic risk. As Malaysia is a small and open economy, we wish to determine whether the Malaysian stock market has significant exposure to the market performances of her major trading partners. As can be seen in Figure 1, over the last two decades, Malaysia has had more than a 10% annual trade share with her top three counterparts, i.e., Singapore, the US, and Japan. With respect to the others, Malaysia's trade shares have been well below 6%, except for China after 2007, with China emerging as Malaysia's second largest trading partner behind Singapore after 2009. These four countries consistently account for approximately 50% of Malaysia's total trade with more than 200 countries around the world. Because the US effect has been removed as a stand-alone component, we form a trade-weighted average portfolio involving only Singapore, Japan and the Chinese mainland. We shall henceforth call this the trade-partner (TP) factor.

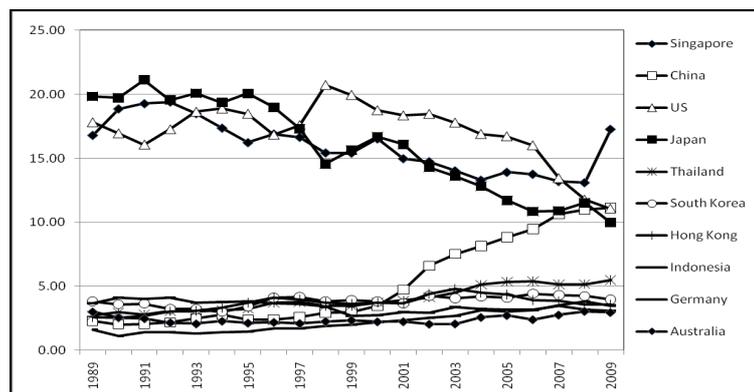


Figure 1. Trade pattern of Malaysia 2010 top 10 trade partners (% of world trade). The monthly data are obtained from Direction of Trade Statistics, International Monetary Fund, IMF (<http://elibrary-data.imf.org/DataExplorer.aspx>).

In addition to the above factors, we have added a buffer component called the rest-of-the-world (RW) factor. This factor contains the remaining stock markets, i.e., those not included among any of the above four factors. As the world portfolio consists of 45 markets (MSCI All Country World Index), this

portfolio covers the remaining 27 markets [45 – 1(US) – 8(DM) – 6(RG) – 3(TP)] listed in the MSCI.

In our analysis, we use monthly data covering the period from January 1988 to June 2010. We collected the total return series (RI) from MSCI, while the market weights (market values) were obtained from DataStream. Trade series were taken from Direction of Trade Statistics of the International Monetary Fund (IMF), and the risk free rate is proxied by the US 3-month Treasury bill rate.

## THE ISSUE OF ORTHOGONALITY

One empirical issue involved in estimating the above model is the orthogonality of the decomposed factors. Given the dominance of the US economy at the global level, the US factor should be highly correlated with the other four factors. This issue is not specifically addressed in previous literature, e.g., studies of Bekaert et al. (2005), Adler and Qi (2003) and Heaney and Hooper (1999). Following Stehle (1977) and Jorion and Schwartz (1986), we orthogonalise each factor from the US portfolio and use the orthogonalised series to replace the original series to avoid multicollinearity.<sup>3</sup> We only consider the US factor, as it is assumed to be the only factor common to all countries. First, we run the following regression to orthogonalise the US factor with respect to all other countries in their respective portfolios:

$$\begin{aligned} r_{i,t}^{DM} &= br_{US,t} + e_{i,t}^{DM} \\ r_{i,t}^{RG} &= br_{US,t} + e_{i,t}^{RG} \\ r_{i,t}^{TP} &= br_{US,t} + e_{i,t}^{TP} \end{aligned}$$

We then used value-weighted methods to form the component portfolios:

$$\begin{aligned} r_{DM,t} &= \sum_i w_{i,t}^{DM} e_{i,t}^{DM} \\ r_{RG,t} &= \sum_i w_{i,t}^{RG} e_{i,t}^{RG} \\ r_{TP,t} &= \sum_i w_{i,t}^{TP} e_{i,t}^{TP} \end{aligned}$$

where  $w_{i,t}^{DM}$  and  $w_{i,t}^{RG}$  are the size-weighted ratios (measured by market capitalisation) of market  $i$  in each portfolio, respectively, and  $w_{i,t}^{TP}$  is the trade-weighted ratio of market  $i$  in Malaysia's total trade. Finally, we regressed the

above orthogonalised portfolios on the world portfolio (MSCI ALL Country Index) and used the residual terms to represent the rest-of-the-world portfolio ( $r_{RW,t} = e_{RW,t}$ ):

$$r_{World,t} = b_1 r_{US,t} + b_2 r_{DM,t} + b_3 r_{RG,t} + b_4 r_{TP,t} + e_{RW,t}$$

Let us examine the explanatory power of the orthogonal factor versus the non-orthogonal factor in explaining Malaysian stock market returns in Table 1. To gain insight into how each factor was influenced by the US factor, we estimated a simple regression of each factor on the Malaysian market portfolio.  $R^2$  values are reported in the "Orthogonal" column. It is clear that the explanatory power of each factor drops significantly after the US influence is removed. The most significant drop in  $R^2$  occurs with the DM factor, from 18.47% to 4.69%. This implies that the developed markets are highly exposed to the US market. After discounting the US effect, the net influence of the orthogonal DM factor is only 4%, while the US market alone can explain approximately 14% of the variation in KLCI. Interestingly, the orthogonal RG factor and TP factor still account for approximately 30% and 20% of the variation in the Malaysian market portfolio, respectively. This implies that the Malaysian market has high exposure to the regional markets as well as to those of its major trading partners. The result is consistent even when GARCH modelling is employed. As a result, we employed the orthogonalised factors in our estimations.

Table 1  
Explanatory power ( $R^2$ ) of non-orthogonal versus orthogonal factors (in %)

	OLS			GARCH		
	Non-orthogonal	Orthogonal	Changes	Non-orthogonal	Orthogonal	Changes
US	14.20			13.37		
DM	18.47	4.69	-74.61	17.82	4.14	-76.78
RG	42.33	29.88	-29.40	40.86	28.18	-31.04
TP	32.92	21.92	-33.40	31.78	18.53	-41.69

## EMPIRICAL ESTIMATES OF THE DECOMPOSITION MODEL

Table 2 reports the summary of the descriptive statistics and the correlation structure of our series. We observe that the Malaysian market portfolio is quite volatile compared with the other series; given that the other series are all for internationally weighted portfolios, some diversification effect applies, reducing their volatility. Excluding the RW portfolio, the DM portfolio is the most stable

portfolio, while the RG portfolio is the most volatile. As these portfolios represent developed and emerging markets, respectively, this is consistent with expectations of the behaviour of volatility. The RW factor does not offer much in the way of diversification opportunities to international investors compared with the East Asian countries in the RG portfolio. The Malaysian market portfolio also exhibits high leptokurtosis, and thus, a GARCH model could be helpful in modelling.

Table 2  
Descriptive statistics and correlation matrix

	Malaysia	World	US	DM	RG	TP	RW
Panel A: Descriptive statistics							
Mean	0.6595	0.5401	0.7135	0.0878	-0.1012	-0.0984	-0.0549
Maximum	40.5781	11.2401	10.8189	7.6034	24.0116	13.2369	2.4317
Minimum	-35.9522	-22.0530	-18.7554	-8.4720	-27.2879	-13.1918	-2.5558
Stdev	8.5086	4.5458	4.3396	2.9595	5.8584	4.5590	0.6204
Skewness	-0.2589	-0.9189	-0.8101	-0.1971	-0.0408	-0.0504	0.1842
Kurtosis	7.0284	5.3876	4.6512	3.2346	5.4713	3.2926	5.3251
Normality	184.8937	101.7530	59.9827	2.3586	61.9056	0.8378	48.4885
	(0.0000)*	(0.0000)*	(0.0000)*	(0.3075)	(0.0000)*	(0.6578)	(0.0000)*
Observation	269	269	269	269	243	210	210
Panel B: Correlation matrix							
Malaysia	1.0000						
World	0.4475	1.0000					
US	0.3535	0.9310	1.0000				
DM	0.2389	0.3439	0.0439	1.0000			
RG	0.5864	0.2513	0.0724	0.3424	1.0000		
TP	0.4650	0.2893	0.0332	0.3989	0.7092	1.0000	
RW	-0.0175	0.1468	0.0115	0.0061	0.0017	-0.0019	1.0000

Note: Figures in parentheses are probabilities; Stdev is the standard deviation; the normality test is the Jarque-Bera test. \* denote significance at the 1% level.

Next, we turn to the estimation of the decomposed model, with different value-weighted component portfolios. As shown in Table 3, we first test a one-factor model, using the world portfolio; we then test another one-factor model, using the US portfolio. The adjusted  $R^2$  of the WCAPM is approximately 21%. With the US factor, the adjusted  $R^2$  drops to only 13%. However, when the RW factor is added, the adjusted  $R^2$  of the model rebounds to 21%, the same level as with the WCAPM. When more factors are added, the adjusted  $R^2$  values obtained

are actually higher than for the WCAPM. This result is as expected when the added orthogonalised factors (from the US) are included in the WCAPM.

When we add the DM factor,  $R^2$  remains 21%, but the adjusted  $R^2$  drops to 19%. Clearly, the orthogonal DM factor does not add any value. Interestingly, when we include the RG factor, both  $R^2$  and adjusted  $R^2$  increase to 40%, and the DM and RW factors become statistically insignificant. The coefficient of the RG factor (0.6114) is also higher than the US factor (0.5874). When the TP factor is added, the coefficient of the RG factor rises still more (0.6596), and the coefficient of the US factor drops (0.5555), but only the US and RG factors are statistically significant, with adjusted  $R^2$  rising to 42.70%. We thus conclude that in the world portfolio, only the US and regional factors are important.

We further examine whether our decomposition approach is affected by different characteristics of firms. Among the list of important firm characteristic reported in the asset pricing literature, we give priority to three popular characteristics; size (market value), value (book-to-market) and liquidity (trading volume). We construct three equal weighted portfolios based on each of the three firm characteristics. In total, we have nine characteristic-sorted portfolios. Our sorting procedure is as follow: first, we rank all firms based on firm characteristic values; we then divide them into three groups at the 33.3% and 66.67% percentiles of the total cumulative characteristics values and form nine stock return portfolios, using an equal weighted method. This means that each of the groups might not have the same number of firms. We take this approach instead of equally dividing the firms into three groups. We then repeat the above procedure for every 5-year window. The number of firms for each of the 5-year rebalanced characteristic-sorted portfolios over our 20-year sample period is tabulated in Table 4. The summary of the descriptive statistics of these nine portfolios is reported in Table 5. In essence, the average returns of these portfolios are not consistent with their characteristics, except for the value portfolio where the portfolio returns drop as the portfolio value increases. For size and liquidity, we observe that the medium portfolios offer the highest returns, followed by the large and liquid portfolios, respectively. However, the standard deviation of the portfolios is fairly consistent across characteristics; smaller size, higher value, and more liquid portfolios are all more volatile. One interesting observation in Table 5 is that size portfolios and value portfolios are highly correlated, but liquidity portfolios have a very low correlation with both size and value portfolios.

Table 3  
*Decomposition pricing of Bursa Malaysia aggregate market index*

	World CAPM <sup>1</sup>	International CAPM	2-factor International CAPM	3-factor International CAPM	4-factor International CAPM	5-factor International CAPM
Constant	0.6078 (0.0644)*	0.6531 (0.0775)*	0.8819 (0.0056)***	0.9642 (0.0039)***	0.5070 (0.0983)*	0.0468 (0.8904)
US	0.7340 (0.0000)***	0.6188 (0.0000)***	0.6156 (0.0000)***	0.6192 (0.0000)***	0.5880 (0.0000)***	0.5672 (0.0000)***
DM				0.5709 (0.0000)***	0.1333 (0.2567)	0.0790 (0.5311)
RG					0.6093 (0.0000)***	0.6656 (0.0000)***
TP						0.1094 (0.3369)
RW			0.9407 (0.0000)***	0.7609 (0.0011)***	0.1335 (0.5777)	-1.1673 (0.0035)***
Constant Variance	2.3017 (0.0080)****	2.9759 (0.0086)***	2.1072 (0.0195)**	2.0232 (0.0233)**	1.4629 (0.0796)*	1.4707 (0.0786)*
ARCH	0.2288 (0.0000)***	0.2095 (0.0003)***	0.2470 (0.0000)***	0.2429 (0.0000)***	0.1933 (0.0001)***	0.2613 (0.0001)***
GARCH	0.7258 (0.0000)***	0.7344 (0.0000)***	0.7159 (0.0000)***	0.7217 (0.0000)***	0.7685 (0.0000)***	0.7163 (0.0000)***
R <sup>2</sup>	0.2061	0.1337	0.2127	0.2121	0.4117	0.4315
Adj R <sup>2</sup>	0.2032	0.1305	0.2068	0.2032	0.4018	0.4176
LogL	-864.5228	-881.0087	-863.0953	-862.9173	-755.5255	-649.9449
AIC	6.4649	6.5874	6.4617	6.4678	6.2842	6.2757
SBC	6.5317	6.6542	6.5419	6.5613	6.3992	6.4191
Q(12)	12.4030 (0.4140)*	11.4100 (0.4940)	13.5680 (0.3290)	14.2230 (0.2870)	19.0600 (0.0870)*	17.4020 (0.1350)
Q(24)	31.4020 (0.1430)*	33.2510 (0.0990)*	32.3400 (0.1190)	33.1120 (0.1020)	33.2730 (0.0980)*	28.2830 (0.2480)
Q <sup>2</sup> (12)	12.9170 (0.3750)*	11.8860 (0.4550)	10.9490 (0.5330)	9.6835 (0.6440)	16.1870 (0.1830)	13.3290 (0.3460)
Q <sup>2</sup> (24)	23.0850 (0.5150)*	24.1030 (0.4560)	20.1630 (0.6870)	18.8270 (0.7610)	23.2380 (0.5060)	16.5930 (0.8650)

Note: <sup>1</sup>For the World CAPM, instead of the US factor, the MSCI All-Country world portfolio is used. \*, \*\*, \*\*\* denote significance at the 10%, 5% and 1% levels, respectively. LogL is the log-likelihood functions value, while AIC and SC denote the Akaike and Schwarz values, respectively. Q(12), Q(24), Q<sup>2</sup>(12) and Q<sup>2</sup>(24) are the Box Pierce portmanteau test statistics applied to the standardised residuals and squared standardised residuals for lag 12 (1 year) and lag 24 (2 years). Figures in parentheses are probabilities.

Using these characteristic-sorted portfolios as an alternative to  $r_{M,t}$  in Equation (3), the following equation is estimated:

$$r_{p,t} = \alpha + \beta_1 r_{US,t} + \beta_2 r_{DM,t} + \beta_3 r_{RG,t} + \beta_4 r_{TP,t} + \beta_5 r_{RW,t} + e_{i,t} \quad (4)$$

where  $r_{p,t}$  refers to the nine characteristic-sorted portfolios. Note that in the above model, we do not introduce a country factor into the model, as Brooks and Del Negro (2005) have shown that country factors can be explained by regional factors.

Table 4  
Number of firms and range of values in characteristic-sorted portfolios

Panel A	1991–1995	1996–2000	2001–2005	2006–2010
<i>Size (market value)</i>				
Small	208	374	582	643
Medium	43	28	22	22
Big	10	5	7	8
<i>Value (book to market)</i>				
Low	89	216	412	438
Medium	30	74	131	176
High	26	43	69	87
<i>Liquidity (trading volume)</i>				
Illiquid	194	403	540	542
Medium	28	19	27	41
Liquid	7	7	5	14

We proceed to test the model on the nine characteristic-sorted portfolios and report the estimation results in Table 6. The estimation results turn out to be consistent with the estimate of the market portfolio, except for the three liquidity portfolios. Two similar observations arise for the size- and value-sorted portfolios: first, only the US factor and the RG factor are highly significant; second, the coefficient for the RG factor is higher than that for the US factor. In addition, we observe some interesting patterns in the coefficients. Although the size and value portfolios are highly correlated, the coefficients for the US and RG factors clearly decrease with size but increase with the book-to-market value. Note that the returns of the larger firms and undervalued firms are less sensitive to international and regional market movements than the returns of firms that are smaller and overvalued. For the liquidity portfolios, the only statistically significant factor is the US factor, and the medium portfolio has the highest exposure, followed by the illiquid portfolio. The liquid portfolio appears to be relatively insensitive to the US factors.

Table 5  
Descriptive statistics and correlation matrix of the tested portfolios

Panel A Descriptive	Market	By Size					By Value					By Liquidity				
		small	medium	big	low	medium	high	illiquid	medium	liquid						
Mean	0.5154	-0.0077	1.1766	0.9689	0.4128	-0.3948	-0.8515	0.1292	0.5857	0.3182						
Maximum	40.5781	42.5565	36.0570	30.1742	38.5114	45.7640	46.2644	43.4093	47.2187	36.6472						
Minimum	-35.9522	-42.9509	-28.7550	-27.4367	-39.3425	-36.6880	-39.1413	-43.6491	-34.6210	-33.8494						
Stdev	8.6968	10.6297	8.6433	7.8616	9.6084	10.4371	11.3020	10.4377	10.7638	10.8941						
Skewness	-0.2022	0.1513	0.1260	0.2003	0.1044	0.3418	0.4224	0.0938	0.2104	0.2194						
Kurtosis	7.2064	6.5261	6.5157	5.6557	6.7332	6.3392	6.0211	6.8037	5.8960	4.3372						
Normality	174.1090	122.1203	121.1316	70.3307	136.3088	113.2699	95.9451	141.4084	83.4951	19.3099						
	(0.0000)*	(0.0000)*	(0.0000)*	(0.0000)*	(0.0000)*	(0.0000)*	(0.0000)*	(0.0000)*	(0.0000)*	(0.0001)*						
Panel B Correlation																
Market	1.0000															
Size (small)	0.8037	1.0000														
Size (average)	0.8881	0.8974	1.0000													
Size (big)	0.8610	0.7472	0.8685	1.0000												
Value (low)	0.8352	0.9928	0.9218	0.7857	1.0000											
Value (medium)	0.8019	0.9864	0.8917	0.7471	0.9807	1.0000										
Value (high)	0.7862	0.9809	0.8815	0.7353	0.9723	0.9793	1.0000									
Liquidity (illiquid)	0.0920	0.1034	0.0742	0.1207	0.1078	0.0971	0.0678	1.0000								
Liquidity (normal)	0.0807	0.0834	0.0614	0.1216	0.0882	0.0797	0.0554	0.9377	1.0000							
Liquidity (liquid)	0.1130	0.0975	0.0884	0.1355	0.1005	0.0946	0.0735	0.8859	0.9128	1.0000						

Note: Figures in parentheses are probabilities. Stdev is standard deviation. The normality test is the Jarque-Bera test. \* denotes significance at the 1% level.



## ESTIMATING THE TIME-VARYING US AND REGIONAL SYSTEMATIC RISKS AND THEIR DETERMINANTS

### The Two-Factor Model

In the final section, we present evidence that only two components of the world portfolio, the US factor and the regional factors, are statistically significant in explaining the Malaysian market portfolio and firm-characteristic portfolios sorted by firm size, firm value and firm liquidity. This is consistent with the country-decomposition literature. In this section, we take the further step of tracing the dynamics of each of these two factors in driving Malaysian stock market performance. We aim to track the time-varying dynamics of the factor loadings and their relative influences. For this purpose, we estimate a 2-factor version of Equation (3):

$$r_{MY,t} = \alpha + \beta_{US,t}r_{US,t} + \beta_{RG,t}r_{RG,t} + e_t \quad (5)$$

The parameter estimates for the above 2-factor model in the static version are:

$$\begin{aligned} r_{MY,t} &= \alpha + 0.5970(r_{US,t}) + 0.6631(r_{RG,t}) \\ R^2 &= 0.4138 \quad Adj R^2 = 0.4089 \end{aligned}$$

Note that with two factors, the explanatory power of the model has achieved 40%, very close to the 5-factor model reported in Table 3. This shows that the other 3 factors (DM, TP and RW) do not add significant explanatory power to variations in Malaysian equities, justifying our focus on the 2-factor model.

It is possible that the factor loadings vary over different phases of the business cycle (see Bos and Newbold, 1984; Riddick, 1992; Brooks, Faff and Lee, 1992; Faff, Lee and Fry, 1992; and, more recently, Koutmos and Knif, 2002, and Yao and Gao, 2004, for evidence of time varying systematic risk). Over the last two decades, there were some episodes of financial turbulence in the world stock market. The 1997 Asian financial crisis, the 2001 collapse of the dotcom bubble, and the 2007/08 subprime crisis are amongst the most notable episodes of turbulence. Moreover, the Malaysian economy underwent some structural changes during this period. From January to December 1994, Malaysia implemented a short period of monetary and capital controls, aiming to restrict short-term capital inflows amid rising inflationary pressures. In September 1998, Malaysia implemented broader based capital controls to prevent capital outflows, de-internationalised ringgit exchange rates, and pegged the ringgit at

USD3.8/RM to offset the growing threat of the 1997 Asian financial crisis. The ringgit was only de-pegged in July 2005. An examination of time-varying loadings allows us to determine whether exposure of Malaysian firms to the US factor and the regional factor show any pattern of exposure to these structural changes.

### Time-Varying Systematic Risk in a 2-Factor Model

We specify time-varying parameters in the form of conditional betas, following the equations in Roll (1977, p. 167). We adopt the equations and reset them to estimate the time-varying betas in our 2-factor model in equation (4), using the following setting:

$$\hat{\beta}_{US,t} = \frac{\text{cov}(r_{MYt}, r_{US,t} | \Omega_{t-1}) \text{var}(r_{RG,t} | \Omega_{t-1}) - \text{cov}(r_{MYt}, r_{RG,t} | \Omega_{t-1}) \text{cov}(r_{US,t}, r_{RG,t} | \Omega_{t-1})}{\text{var}(r_{US,t} | \Omega_{t-1}) \text{var}(r_{RG,t} | \Omega_{t-1}) - \text{cov}(r_{US,t}, r_{RG,t} | \Omega_{t-1})} \quad (6)$$

$$\hat{\beta}_{RG,t} = \frac{\text{cov}(r_{MYt}, r_{RG,t} | \Omega_{t-1}) \text{var}(r_{US,t} | \Omega_{t-1}) - \text{cov}(r_{MYt}, r_{US,t} | \Omega_{t-1}) \text{cov}(r_{US,t}, r_{RG,t} | \Omega_{t-1})}{\text{var}(r_{US,t} | \Omega_{t-1}) \text{var}(r_{RG,t} | \Omega_{t-1}) - \text{cov}(r_{US,t}, r_{RG,t} | \Omega_{t-1})} \quad (7)$$

where  $\hat{\beta}_{US,t}$  and  $\hat{\beta}_{RG,t}$  measure exposure to the systematic world factor and the systematic regional factor, respectively. Based on Equations (6) and (7), dynamic time-varying factor loadings can be obtained once we have the conditional variance-covariance series, which can be formulated in a multivariate model setting. We employ the CCC-GARCH multivariate model for this purpose.<sup>4</sup>

In Figure 2, we do not observe total dominance of the regional factor over the US factor, although the two factors move together very closely. In general, the regional beta was dominant in the Malaysian stock market during the boom period until capital controls were imposed in September 1998. This is the period of the so-called Asian miracle, which resulted from liberalisation in the early 1990s.<sup>5</sup> The US factor, which was quite significant before and during the ERM crisis and during the early months of the 1997 Asian financial crisis, started to become dominant in the Malaysian stock market portfolio with the pegging of the RM to the USD from September 1998 to July 2005. However, beginning with the de-pegging of the RM in July 2005, the dominance of the US factor became ambiguous. In fact, the US factor appears to have lost its influence on the Malaysian market since late 2003.<sup>6</sup> The inception of the US subprime mortgage crisis in early 2008 again found the US factor becoming dominant over the Malaysian market.<sup>7</sup>

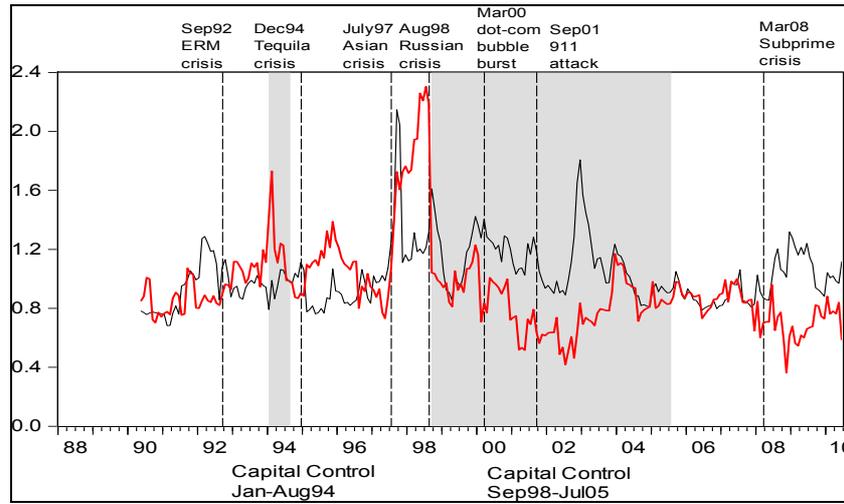


Figure 2. Plotting of the time-varying betas for the market portfolios. Plotting is from April 1990 to June 2010. The back line is US systematic risk, while the red bolded line is RG systematic risk.

We also estimated the time-varying betas of the 2-factor model for the nine characteristic-sorted portfolios. Graphs are presented in Figure 3. Generally, the patterns of the graphs in Figure 3 are all quite consistent with the market portfolio plotted in Figure 2: First, the regional factor dominates over the US factor after the September 1992 ECM crisis through the September 1998 fixed exchange rate regime; second, the US factor becomes dominant over the USD pegging regime as well as after the inception of the US subprime mortgage crisis in March 2008. Unlike the market portfolio, we observe that the rise of the regional factor in the period from mid-2005 (USD de-pegging) to early 2008 occurs in the medium size portfolio only. In addition, the medium size portfolio exhibits the highest response to the regional factor during the first capital control period in 1994. This result implies that such firms might be more exposed to the regional factor than other firms, leading to an increase in the impact of the regional factor on the market portfolio, as depicted in Figure 2.

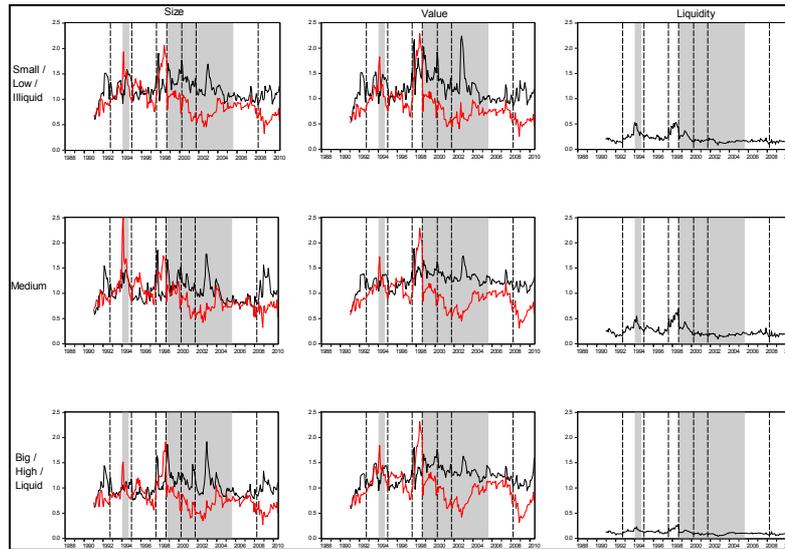


Figure 3. Plotting of the time-varying betas for the characteristic-sorted portfolios. Plotting is from April 1990 to June 2010. The back line is US systematic risk, while the red bolded line is RG systematic risk.

### The Determinants of Time-Varying Systematic Risks

Our purpose in tracing the time-varying US and regional components of systematic risk faced by Malaysian firms is to examine possible driving forces behind these exposures. Since the establishment of the concept of systematic risk by Sharpe (1964) and others, many scholars have attempted to explain the determinants of systematic risk. Early literature in this vein focused on the role of market versus accounting variables in explaining systematic risk exposure; see, for example, Beaver and Manegold (1975) and Bowman (1979). The accounting fundamentals that explain firm static systematic risk are found to be financial leverage, earnings variability, growth, and cyclical factors; see the survey of Ryan (1997). Most of these fundamentals are also found to drive the conditional beta in an international dataset (see Ferson and Harvey, 1997). However, unlike the accounting literature, there is no consensus in the macroeconomic literature regarding systematic risk determinants; see, for example, Robichek and Cohn (1974), Bos and Newbold (1984) and Abell and Krueger (1989). More recent work, addressing the issue from a country risk perspective rather than a systematic risk perspective, focuses on the unanticipated component of macroeconomic factors (the unanticipated component in ARIMA modelling of the variables) as a possible explanation of time-varying country (systematic) risk. Gangemi, Brooks and Faff (2000), for example, relate the conditional betas from

the WCAPM as a measure of time-varying country risk of the Australian market to a list of business cycle variables, but their results show that only exchange rate surprises are statistically significant. Goldberg and Veitch (2002) also document that exchange rate surprises in Brazil and Mexico matter for variations in Argentina's conditional beta. Verma and Soydemir (2006) extend the analysis to four Latin markets, reporting a consistent result; they find that local exchange rate surprises affect Brazil and Mexico, and money supply surprises affect all four markets except Argentina, while external surprises in the G7's real interest rate and inflation also affect the conditional betas of all four Latin markets. More recently, Marshall, Maulana and Tang (2009), examining the same issue using a panel analysis of 20 emerging markets, find that local interest rates, local inflation and US interest rates are significant determinants of time-varying betas.

As highlighted in the literature, the world beta, estimated using the WCAPM applied to a country portfolio, is a measure of country risk. In this study, as we have decomposed Malaysia's world systematic risk into two country components, we shall relate the two country components of systematic risk or so-called country risk to the rating of country risk reported by the International Country Risk Guide (ICRG). Erb, Harvey and Viskanta (1996a; 1996b) show that the ICRG country risk indexes are correlated with beta, future equity returns and equity valuation measures, while Diamonte, Liew and Stevens (1996) and Bilson, Brailsford and Hooper (2002) find that ICRG can explain return variation in emerging markets very well. Moreover, Oetzel et al. (2001), comparing four different country risk measures (Investor, Euromoney, ICRG and PRS), conclude that ICRG performed the best in predicting actual realised risks reflected in currency instability, a proxy for the financial crisis. Here, we would like to examine how well the relevant ICRG rating can explain the time-varying US and regional systematic risk (country risk) that we have extracted.

In Table 7, we tabulate the three ICRG indexes and their sub-components for Malaysia, the US and the RG factor (average over the six countries), namely, the political risk index (PR), economic risk index (ER), and financial risk index (FR). For political risk, it is clear that the US has the lowest risk among the three except with respect to External Conflict (due to involvement in several external wars). For Economic Risk, the US is riskier in Real GDP Growth (developed nations have relatively slow growth) and the Current Account as a Percentage of GDP (the US has had a deficit profile for over a decade). With respect to Financial Risk, the US clearly differs from its emerging economy counterparts, as the US has lower scores in all five items except Foreign Debt as a Percentage of GDP. Relative to Malaysia and the US, the regional RG factor scores lower in several Political Risk indicators as well as Annual Inflation under Economic Risk and Exchange Rate Stability under Financial Risk.

Table 7  
Average ICRG monthly risk indexes and their components for 1990–2010

Factor	Malaysia	Regional	US
<i>Political Risk</i>			
1. Government stability	9.5742	8.3649	9.2527
2. Socioeconomic conditions	8.3049	6.9625	8.7363
3. Investment profile	8.2830	8.6873	10.7473
4. Internal conflict	10.5440	9.5531	10.5769
5. External conflict	10.5220	9.9440	8.4396
6. Corruption	2.9313	2.7253	4.2253
7. Military in politics	5.0000	3.7289	5.0000
8. Religious tensions	4.0000	4.3672	5.5907
9. Law and order	3.9066	3.9332	5.4588
10. Ethnic tensions	4.2143	4.5009	4.9780
11. Democratic accountability	3.4396	4.4359	5.8434
12. Bureaucracy quality	2.9560	2.7262	4.0000
<i>Economic Risk</i>			
1. GDP per head	2.3868	2.4614	4.7203
2. Real GDP growth	7.9418	7.5318	7.3670
3. Annual inflation rate	9.1978	8.7564	9.4478
4. Budget balance	5.9555	6.7342	6.5951
5. Current account as a percentage of GDP	13.1830	12.1936	10.1736
<i>Financial Risk</i>			
1. Foreign debt as a percentage of GDP	6.3901	6.7262	7.7720
2. Foreign debt service as a percentage of exports of goods and services	9.6648	8.9066	7.6016
3. Current account as a percentage of exports of goods and services	12.6593	12.4661	9.4615
4. Net international liquidity as months of import cover	2.9259	2.7426	1.0130
5. Exchange rate stability	9.1703	8.9016	9.1648

Note: Higher scores in every index reflect lower risk. The scores of each sub-component reflect the contribution (weight) of each sub-component in formulating the three indexes.

We relate both the systematic risks to the logarithm of the composite level of political risk, economic risk and financial risk, as shown in the following equations:

$$\hat{\beta}_{RG,t} = \alpha + \hat{\beta}_{RG,t-1} + \delta_1 \log(\text{Pol}R_{RG,t}) + \delta_2 \log(\text{Econ}R_{US,t}) + \delta_3 \log(\text{Fin}R_{US,t}) + e_{i,t} \quad (8)$$

$$\hat{\beta}_{RG,t} = \alpha + \hat{\beta}_{RG,t-1} + \delta_1 \log(\text{Pol}R_{RG,t}) + \delta_2 \log(\text{Econ}R_{RG,t}) + \delta_3 \log(\text{Fin}R_{RG,t}) + e_{i,t} \quad (9)$$

Table 8  
Determinants of US systematic risk by market, size, value and liquidity sorted firm portfolio

Industry	Aggregate	By Size			By Value			By Liquidity		
		Small	Average	Big	Low	Medium	High	Illiquid	Normal	Liquid
Constant mean	-0.9349 (0.0343)**	-2.4403 (0.0029)***	-1.1655 (0.0429)**	-0.6289 (0.3841)	-2.4032 (0.0006)***	-1.6131 (0.0021)***	-2.5416 (0.0001)**	-0.0519 (0.8532)	0.0107 (0.9588)	-0.1288 (0.5050)
Lag Dependent	0.8444 (0.0000)***	0.7635 (0.0000)***	0.8631 (0.0000)***	0.7410 (0.0000)***	0.7748 (0.0000)***	0.7513 (0.0000)***	0.7505 (0.0000)***	0.8839 (0.0000)***	0.8520 (0.0000)***	0.7947 (0.0000)***
log(PoIR)	0.1208 (0.3218)	0.3697 (0.0427)**	0.0967 (0.5335)	0.0827 (0.5875)	0.3932 (0.0170)**	0.2707 (0.0109)**	0.3902 (0.0022)***	-0.0592 (0.4466)	0.0028 (0.9512)	0.0740 (0.1464)
log(EcomR)	0.1815 (0.0732)*	0.3121 (0.0024)***	0.2211 (0.0784)*	0.1362 (0.0614)*	0.2913 (0.0011)***	0.2625 (0.0080)***	0.3633 (0.0043)***	0.0993 (0.0223)**	0.0095 (0.8099)	-0.0351 (0.4356)
log(FinR)	-0.0284 (0.3564)	-0.0110 (0.8087)	0.0230 (0.5844)	0.0104 (0.7468)	-0.0356 (0.3011)	-0.0607 (0.1193)	-0.0517 (0.3007)	-0.0079 (0.5115)	-0.0079 (0.4463)	-0.0055 (0.6056)
Constant Variance	0.0012 (0.0311)**	0.0032 (0.0239)**	0.0024 (0.0045)***	0.0086 (0.0039)***	0.0016 (0.0537)*	0.0013 (0.1183)	0.0019 (0.0509)*	0.0001 (0.0118)**	0.0001 (0.0587)*	0.0001 (0.1983)
ARCH	0.1668 (0.0223)**	0.4168 (0.1529)	0.3002 (0.0758)*	0.3833 (0.0927)*	0.2011 (0.1168)	0.1812 (0.0249)**	0.2062 (0.0164)**	0.6281 (0.0396)**	0.2768 (0.1211)	0.2379 (0.3075)
Asymmetric	-0.2959 (0.0041)***	-0.3859 (0.2821)	-0.4334 (0.0420)**	-0.4488 (0.0420)**	-0.3348 (0.0756)*	-0.2564 (0.0059)***	-0.2915 (0.0107)**	-0.3035 (0.5213)	-0.2231 (0.4432)	-0.2512 (0.3096)
GARCH	0.8227 (0.0000)***	0.4912 (0.0009)***	0.7188 (0.0000)***	0.1230 (0.5674)	0.7797 (0.0000)***	0.7196 (0.0000)***	0.7495 (0.0000)***	0.5716 (0.0000)***	0.7647 (0.0000)***	0.7658 (0.0000)***
R <sup>2</sup>	0.6824	0.7211	0.6775	0.6625	0.7152	0.7152	0.7079	0.6909	0.6958	0.6554
Q(12)	0.1200 (0.2000)	0.0790 (0.1370)	0.0780 (0.3530)	0.0750 (0.2360)	0.1110 (0.0540)*	0.0160 (0.1000)*	0.0630 (0.4530)	0.0580 (0.0480)**	0.0380 (0.0820)*	0.0400 (0.3800)
Q(24)	0.0450 (0.3750)	0.0310 (0.2450)	0.0400 (0.4810)	-0.0090 (0.4350)	0.0500 (0.1940)	0.0250 (0.4140)	0.0210 (0.5510)	-0.0580 (0.4300)	-0.0420 (0.2450)	0.0330 (0.6510)
Q2(12)	0.1740 (0.3240)	0.0310 (0.9590)	0.0680 (0.9790)	0.0090 (0.9950)	0.0170 (0.9280)	0.0460 (0.5090)	0.0100 (0.7380)	-0.0100 (0.8980)	-0.0040 (0.9170)	-0.0350 (0.9170)
Q2(24)	0.0560 (0.8160)	0.0300 (0.9990)	0.0340 (1.0000)	-0.0120 (1.0000)	0.0340 (0.9990)	0.0680 (0.8730)	-0.0020 (0.9390)	-0.0080 (0.9910)	-0.0280 (0.8900)	-0.0310 (0.9930)

Note: The model is the Threshold-GARCH(1,1,1) setting with an asymmetric term in the variance equation. Figures in parentheses are probabilities. \*\*\*, \*\*, \* denote significance at the 10%, 5% and 1% levels, respectively. AIC and SC denote the Akaike and Schwarz values, respectively. Q(12), Q(24), Q<sup>2</sup>(12) and Q<sup>2</sup>(24) are the Box Pierce portmanteau test statistics applied to the standardised residuals and squared standardised residuals for lag 12 (1 year) and lag 24 (2 years).

The estimates for Models (8) and (9) are reported in Table 8 and Table 9, respectively. Note that we have estimated the country risk exposure for both the aggregate market portfolio and the 9 firm portfolios in both tables.

We make two observations on the modelling before turning to the estimates of the country risk ratings. First, the persistency of the mean and variance for both systematic risks is well captured by the autoregressive and GARCH terms in the mean and variance processes, respectively. For US systematic risk, we find that a Threshold GARCH (TGARCH) model can well describe the variance process, where the variance parameters are highly significant, and the asymmetric term is significant with a leverage effect (the asymmetric coefficient is negative). For RG systematic risk, a GARCH(1,1) model is sufficiently well fitted, and the GARCH process (sum of ARCH and GARCH) is not explosive, except for the illiquid portfolio. Both models pass the diagnostic Q and  $Q^2$  tests except in several cases, but the latter results are not highly statistically significant. Second, the explanatory power of both models is reasonably high. The adjusted  $R^2$  for the model of RG systematic risk is approximately 76% on average. For the US systematic risk model, the adjusted  $R^2$  is only approximately 69% but with wider variations across different firm portfolios.

Our results show, consistently across all portfolio regressions except those for the normal and liquid portfolios, that systematic risk arising from exposure to the US market is significantly associated with US Economic Risk. The high-value and small-size portfolios have the highest associations with Economic Risk in the respective characteristic-sorted portfolios, while the illiquid portfolio exhibits a very small sensitivity to the US factor. Political Risk is not significant at the aggregate level but is significant with respect to the three value portfolios and the small-size portfolio, with high-value and low-value portfolios having very high exposure to Political Risk. Financial Risk is not statistically significant with respect to US systematic risk.

On the other hand, RG systematic risk is shown to be associated only with the region's average Financial Risk, with the largest and most statistically significant association for the average-size portfolio, followed by the large-size portfolio. RG systematic risk for both the normal and liquid portfolios also shows significant exposure to Financial Risk, although the coefficients are relatively small.

Note that the estimated coefficients for the country risk indexes are all positive. Given that a higher country risk rating implies a lower country risk level, the positive coefficients indicate that lower US economic risk and lower regional financial risk will induce increased systematic risk exposure to the US and

regional factors, respectively. At first glance, this may seem counterintuitive. One possible explanation is that the Malaysian stock market tends to be more inward-looking (hence exhibit lower systematic risk) when political, financial and/or economic risks of US and regional markets are rising. When external market conditions are improving, the Malaysian stock market becomes less insulated and more exposed. We can say that the Malaysian market is, in a sense, becoming more globally integrated, as the  $R^2$  of the 2-factor WCAPM model can be used to draw inferences regarding market integration (see Pukthuanthong & Roll, 2009).

## **CONCLUSION**

This paper has two main objectives. First, we addressed the country-grouping decomposition of world systematic risk of the Malaysian stock market. We decomposed the world portfolio into 5 sub-groupings: US market, developed markets, regional markets, major trading partners, and the rest of the world. We sought to determine which of these five sub-groupings of the world portfolio contributes to world systematic risk of the Malaysian market portfolio. We also tested firm characteristic-sorted portfolios based on size, value and liquidity. The results show that only the US and regional factors are statistically significant in explaining the Malaysian market portfolio and firm characteristic-sorted portfolios.

We then proceeded to trace the time-varying behaviour of the betas of these two factors, using a 2-factor model setting in a trivariate-GARCH modelling framework. We find that these two time-varying betas match international financial crises and economic regimes in Malaysia over the last two decades. We then related them to country risk ratings provided by ICRG. After modelling the high degree of mean and variance persistency in these time-varying betas, our results show that US economic risk can explain US systematic risk especially well for high value and small size Malaysian firms, while regional financial risk can explain regional systematic risk of large and average size firms. Political risk only affects small size firms or firms with extreme book-to-market values.

Our findings lead to several conclusions. First, pricing of firms listed on Bursa Malaysia to world systematic risk is mainly driven by US and regional factors. Additionally, our 2-factor model has greater explanatory power than the WCAPM. Second, if we refer to explanatory power as a yardstick of market integration (see Pukthuanthong and Roll, 2009), we can conclude that the Malaysian market/firm is still a good candidate for a global country diversification strategy, as the explanatory power of the model is still far from perfect. Third, exposure to these two factors is time-varying with respect to

different regimes of the Malaysian economy, and approximately 70% of this variation is significantly driven by the US economic climate and regional (Asia) financial uncertainty. For the fund manager, such outcomes suggest that a country diversification strategy must be time-varying as well and that the two indicators noted above can serve as guides to portfolio restructuring.

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## **NOTES**

1. Firms from India have only aggressively invested in overseas markets over the last few years, with India's outward FDI surpassing that of Malaysia in 2006. Another emerging Asian country that has had a higher outward FDI than Malaysia is Indonesia but only over 2 years, 2004 and 2005. See statistics in the World Investment Report for 1995–2012 for details.
2. See Roll's (1977) critiques.
3. Stehle (1977) and Jorion and Schwartz (1986) construct an orthogonal world/global factor in their ICAPM model. The only difference is that we do not include a constant in the first pass regression to retain the individual mean in the orthogonalised series. This allows us to calculate the value-weighted portfolios in the next stage, using orthogonalised series with a different intercept.
4. Following Bollerslev, Engle and Wooldridge (1988), the variance-covariance matrix of the CCC multivariate model of stock returns series is assumed to follow a quadratic form as follows:  $H_t = C'C + A'\Xi_{t-1}\Xi'_{t-1}A + B'H_{t-1}B$ ; where  $C$  is the  $3 \times 3$  lower triangular matrix of constants, and  $A$  and  $B$  are  $3 \times 3$  diagonal matrices of coefficients. The restriction,  $h_{ij,t}^2 = \rho_{ij,t} \sqrt{h_{ii,t}^2 h_{jj,t}^2}$ , is imposed, where  $\rho_{ij}$  is the conditional correlation of variables  $i$  and  $j$ , with  $i \neq j$ , while  $h_{ij}^2$  is the  $(i, j)$  element in  $H_t$ .
5. The economy of the four dragons, i.e., NIC-4, comprised of Hong Kong, Singapore, South Korea, and Taiwan, picked up in the mid 1980s; while the four tigers of Indonesia, Malaysia, the Philippines and Thailand started to industrialise their economies and liberalise their financial markets in the late 1980s.
6. With the end of the US dot-com crisis and developed market recession (as a result of the dot-com crisis) in 2003 and the strong rebound of the East Asian emerging markets, there was strong speculation that the ringgit was undervalued against the USD. The market thus expected a revaluation or de-pegging to occur beginning in 2004.

7. The effect of the subprime mortgage crisis was felt when Bursa Malaysia suspended trading for one hour after a sharp 10% fall in the composite index on 10 March 2008.

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