International Asset Allocation and Equity Home Bias in Emerging Markets

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Abstract

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This thesis investigates equity home bias from an asset allocation perspective in emerging markets. Firstly, a review of equity home bias in modern finance literature is presented, followed by a discussion of the relative strengths and weaknesses of international asset pricing and optimal allocation models. Secondly, the thesis tests static and conditional Capital Asset Pricing Models (CAPMs) for 23 emerging markets over the period February 1997 - December 2007. The study reveals little support for the static CAPM compared to the conditional version; in which the conditional CAPM seems to explain excess returns' dynamics and implies higher volatility persistence in emerging markets compared to developed markets as documented in the literature. Accordingly, the study employs a modified trivariate generalised autoregressive conditional heteroscedasticity (GARCH) model for the period April 1994 - July 2008, in order to estimate time-varying optimal weights in a portfolio of three assets; namely the return on the domestic index, the return on the US index, and the return on the UK index. The number of assets in the portfolio is increased to reach 13 assets in some markets through the estimation of the Dynamic Conditional Correlation (DCC) model denominated in local currencies and in US Dollars. The three models show that the optimal weights on domestic equities divert substantially from the actual equity holdings as documented in survey reports; in addition to the effect of including more assets in the portfolio, and the influence of exchange rate risk on optimal weights. Lastly, the thesis examines the variables that influence equity domestic holdings through the panel estimation of the feasible Generalised Least Squares (GLS) method in order to control for heteroscedasticity. The study suggests that factors related to information asymmetries, economic risks at home, exchange rate volatility, and markets' inefficiencies are the main factors affecting equity domestic bias in emerging markets.

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Chapter One: Introduction

1.1 Background of the study

The equity home bias is one of the financial puzzles that have attracted considerable attention in the finance literature since at least the 1970s (Levy and Sarnat, 1970; Solnik, 1974). The main idea is that international investors seem to overweight domestic equities, or underweight foreign equities in their investment portfolios. However, Chan, Covrig and Ng (2005) differentiate between domestic bias and foreign bias in mutual fund equity allocation. More specifically, they refer to domestic bias as the case in which investors tend to overweight domestic equities in their investment portfolios, while foreign bias implies that investors have less or more preference for foreign markets. Other studies tend to refer to both biases interchangeably, and rather investigate the factors behind the underweight of foreign equities in international investment portfolios instead of examining why investors seem to have a preference for domestic equities (Fidora, Fratzcher and Thimann, 2006; Baele, Pungulescu and Ter Horst, 2007; Sercu and Vanpee, 2007).

In addition to the differentiation between domestic and foreign bias, it is also important to pay attention to the determination of benchmark weights. The benchmark weights are those against which the actual portfolio holdings are compared, and the extent of equity home bias is then determined. There are different approaches followed in the literature; however, the main ones are the model and data-based approaches. In the model-based approach, the actual equity holdings are compared to the weights extracted from the international Capital Asset Pricing Model (CAPM), which suggests that investors are expected to hold international assets of each country in accordance to its share in the world market (French and Poterba, 1991; Chan, Covrig and Ng, 2005; De Santis, 2006; Fidora, Fratzcher and Thimann, 2006). On the other hand, the data-based approach constructs optimal/benchmark weights according to mean-variance models, through which optimal portfolios are developed in terms of high returns and low variance/risk of returns (Flavin and Wickens, 2006; Baele, Pungulescu and Ter Horst, 2007).

Even though studies differ in their definitions of benchmark weights and their measures of equity home bias, they seem to agree that equity home bias is obvious in developed and emerging markets (French and Poterba, 1991; Tesar and Werner, 1995; Jeske, 2001; De Santis, 2006). For instance, Fidora, Fratzcher and Thimann (2006) explain that developed and emerging markets seem to overweight domestic equities in their equity portfolios, ranging from 70 and 80 per cent in the United Kingdom and individual euro-area markets, to over 90 per cent in emerging markets for the year 2003. Also, Sercu and Vanpee (2007) show that equity home bias in emerging markets is higher than that in developed markets. Furthermore, they reveal that equity home bias decreased over the period 1980-2004, and there seems to be an increasing and modest trend for international diversification in recent years for euro-area markets and the rest of the world, respectively.

The CAPM assumes that the risk premium of a given asset over the market's risk-free rate is directly related to the market's systematic risk known as beta (Lintner, 1965; Solnik, 1974). Additionally, CAPM supposes that unsystematic risk can be reduced through diversification, and that investors are only compensated for the systematic risk (Pettengill, Sundaram and Mathur, 1995). Basically, international portfolio theory as explained by CAPM or consumption-based asset pricing models assumes that investors' optimal portfolios are diversified internationally depending on assets' returns correlations. More specifically, low correlation between international assets can reduce the portfolio's risk (Solnik, 1974; French and Porteba, 1991). Jeske (2001) further explains that the losses from a given stock can be compensated by the gains from another stock through international diversification. Levy and Sarnat (1970) and Lewis (1999) show that the American investor is able to achieve higher returns and reduce portfolio's variance through international diversification compared to the US-only portfolio.

Longin and Solnik (1995) show that conditional correlation in seven major countries is not constant (and rather it increases during turbulent times) during the period 1960-1990, and hence they explain that global factors seem to dominate over domestic ones. Although the rejection of constant correlation hypothesis is to some extent documented in the literature, and international correlation tends to increase over time (Longin and Solnik, 1995; Goetzmann, Li and Rouwenhorst, 2005; Wang and Moore, 2008), still there seem to be unexploited gains from international diversification for investors. For instance, both Cha and Jithendranathan (2009) and Gupta and Donleavy (2009) illustrate that the cross-correlations of the USA and Australia, respectively, with emerging markets are still modest, hence allowing for gains from international diversification.

The integration of international markets, lack of information asymmetries and markets' efficiencies are among the main prerequisites for the success of international CAPM. Hence, the consistency of pricing relationships according to the international CAPM implies the absence of home bias (Lewis, 1999). Therefore, equity home bias to some extent reflects an international portfolio choice problem in that investors seem to forgo international diversification gains (Grubel, 1968; Sercu and Vanpee, 2007, De Santis and Gérard, 2009), additionally 'the persistence of home bias undermines the theoretical case for efficiency of international capital markets', as Bablis and Fitzgerald (2005) explain. Moreover, investment in international markets is assumed to help smooth consumption and risk sharing for households (Lewis, 1999; Coeurdacier, Kollman and Martin, 2010). Hence, the evidence behind the equity home bias poses questions regarding the degree of capital market imperfection, optimality of investment portfolios, and reasons behind such phenomena.

Empirical explanations with regard to the reasons behind equity home bias seem to provide mixed results. For instance, studies relate investors' propensity to hold more domestic assets as they can provide better hedge against home risks like inflation, human capital, economic, political and institutional risks (Mayers, 1973; Bottazzi, Pesenti and Wincoop, 1995; Erb, Campbell and Viskantas, 1996; Faruqee and Yan, 2004; Karlsson and Norden, 2007). Studies also show that costs incurred (including transaction costs, capital controls, information costs, language and distance barriers) can exceed the gains from international equity diversification (Stulz, 1981; Cooper and Kaplanis, 1986; Gehrig, 1993; Kang and Stulz, 1997; Choe, Kho and Stulz, 2001; Jeske, 2001; Portes, Rey and Oh, 2001; Ahearne, Griever and Warnock, 2004; Amadi, 2004; Dvorak, 2005). Additionally, problems may exist resulting from the uncertainty in measuring expected returns and risks, and hence the calculation of equity home bias (Lewis, 1999; Baele, Pungulescu and Ter Horst, 2007). Moreover, the literature also pays attention to the effect of behavioural aspects regarding the effect of familiarity, and social identity on investment decisions (French and Poterba, 1991; Shiller, Kon-Ya and Tsutsui 1996; Fellner and Maciejovsky, 2003).

1.2 Motivation for the study

Coordinated Portfolio Investment Survey (CPIS) published under the International Monetary Fund (IMF) provides year-end geographical breakdown of international portfolio holdings - equity securities and debt securities - while it excludes the official holdings of monetary authorities. The CPIS database started in 1997, but has become increasingly regular since 2001.

Table 1.1 below shows the actual shares of domestic equity holdings to total equity holdings[1] for 17 emerging markets.

The table reveals that there are high shares of domestic equities in portfolio holdings of emerging markets during the period 2001-2007. Additionally there is a slight decrease in the share of domestic equity holdings to total holdings in most markets with the exception of Argentina, Chile, Hungary, Korea, and Turkey. Thus it seems that investors in emerging markets mainly invest in their domestic markets while ignoring possible foreign opportunities and hence possible diversification gains.

[1] Domestic equity holdings are calculated as the market capitalisation in a given country with the subtraction of foreign equity liabilities, while total equity holdings are computed through the summation of both domestic equity holdings and foreign equity assets.

Table 1.1: Actual shares of domestic equity holdings to total holdings in emerging markets during 2001-2007.

December	2001	2002	2003	2004	2005	2006	2007
Argentina	0.818	0.691	0.815	0.820	0.826	0.805	0.777
Brazil	0.981	0.977	0.986	0.820	0.993	0.993	0.994
Chile	0.931	0.912	0.886	0.878	0.850	0.790	0.756
Colombia	0.898	0.902	0.947	0.977	0.980	0.972	0.974
Mexico			0.995	0.978	0.981	0.978	0.987
Egypt	0.979	0.983	0.947	0.935	0.988	0.990	0.991
South Africa	0.715	0.781	0.858	0.901	0.889	0.907	0.914
Hungary	0.964	0.971	0.973	0.935	0.906	0.818	0.772
Poland	0.995	0.993	0.993	0.988	0.979	0.961	0.938
Russia	0.996	0.999	0.999	0.999	0.998	0.998	0.988
Turkey	0.999	0.999	0.999	0.999	0.999	0.999	0.547
India				0.999	0.999	0.999	0.999
Indonesia	0.999	0.996	0.999	0.999	0.999	0.997	0.997
Pakistan		0.999	0.999	0.996	0.992	0.994	0.995
Malaysia	0.988	0.984	0.994	0.994	0.990	0.982	0.966
Korea	0.991	0.989	0.984	0.967	0.974	0.944	0.891
Philippines	0.994	0.993	0.992	0.993	0.997	0.998	0.998

Source: Calculated by the researcher. Data on market capitalisation are obtained from the World Federation of Exchanges (www.world-exchanges.org) and data on international equity holdings are available from IMF, CPIS report (www.imf.org)

Markowitz (1952) shows that an undiversified portfolio could be superior to a diversified one if one security provides an extremely high return and lower variance than the rest of the securities. Nevertheless, the literature demonstrates that returns on emerging markets' indexes tend to exhibit different characteristics from developed markets in terms of returns and risks in the sense that emerging markets' returns are higher and more volatile than the returns on developing markets (Buckberg, 1995; Harvey, 1995a). Given the high volatility of emerging markets' returns, and their low cross-correlations with the rest of the world (Harvey, 1995a, b), it seems that investors in emerging markets would be able to decrease the variances on their optimal portfolios through international diversification.

Hence, equity home bias seems to be more acute in emerging markets compared to developed markets, since domestic equity holdings constitute around 80 per cent of the total equity holdings in emerging markets during the period 2001-2007. Sercu and Vanpee (2007) suggest that the high percentage of domestic equities in the portfolios of emerging markets implies 'that either domestic investors of those countries bear a substantial amount of unrewarded country-specific risk, or international investors are unwilling to cash in an expected return for a risk that, to them, is diversified away'.

As briefly explained, domestic equity bias to some extent reflects international asset misallocation, and can indicate the extent to which international markets are segmented or integrated in the world market. One way to examine this assumption is to test for international CAPM, and to investigate the relationship between emerging markets' equity returns and the return on the world market portfolio. The result of this investigation would assess whether these emerging markets are integrated or segmented from the world market. If markets' returns are not integrated into the world market return, then these emerging markets could be segmented into domestic markets. As a result, investors might not hold foreign equities, and hence equity home bias could be partially expected.

Additionally, Levy and Sarnat (1970) explain that portfolio construction based on the theoretical models mainly depends on the correlations between different asset returns. More specifically, lower correlations between asset returns enhance portfolios' performance through decreasing the risks. This might imply that, if the cross-correlations between emerging markets and the rest of the world are low, then it is expected that the gains from diversification are to be high and hence domestic investors would be willing to hold foreign equities. Therefore, the thesis determines the optimal weights from holding a diversified international portfolio using trivariate generalised autoregressive conditional heteroscedasticity (GARCH) and dynamic conditional correlation models in order to examine how the optimal weights change at each period as a result of the time-varying variance-covariance matrix, and conditional cross-correlations. The lack of comparative empirical examination of optimal asset allocation and possible gains from international diversification for emerging markets has motivated this study. Detailed attention in this thesis is given to the construction of optimal portfolios while introducing large number of assets in customised portfolios for emerging markets.

According to international portfolio theory, the integration of international markets, the assumption of perfect markets and the modest correlation between markets would rule out the existence of equity home bias. So far, the analyses assume that the behaviour of emerging market returns can be explained by an efficient investment environment, which assumes the absence of capital restrictions and information asymmetries, and also excludes the effect of economic and institutional risks on investment decisions. However, actual domestic equity holdings as published by the CPIS remain potentially dominant in investment portfolios of emerging markets compared to what is assumed according to the international CAPM or the mean-variance approach. The present thesis defines domestic equity bias, introduces these investment asymmetries and tests whether they influence investors' decisions towards having more preference for domestic equities through panel data estimation for emerging markets under study. The study investigates the factors behind such a high percentage of domestic equities to total equities in emerging markets by introducing factors related to the nature of emerging markets like capital controls, integration of these markets, and other economic and institutional risks.

1.3 Objectives of the study

The literature related to equity home bias mainly concentrates on investigating the reasons behind the phenomenon in developed markets. With the exception of few studies, the determination of optimal weights against which the portfolio actual weights are compared constitutes a relatively small share in the literature and is only examined in developed markets. However, the literature lacks an empirical investigation of the optimal portfolio allocation, examination of potential international diversification gains and understanding of equity home bias in emerging markets, in which the present thesis attempts to fill these gaps. Specifically, this study's main objectives include:

a. Identifying the extent to which emerging markets are integrated in the world market through the calculation of time-varying betas from the conditional capital asset pricing model;

b. Relying on the mean-variance approach to estimate the optimal weights and estimating the possible gains from international diversified portfolios for investors in emerging markets; and

c. Defining equity domestic bias in emerging markets, and investigating the reasons behind it with the use of the estimates derived in (a) and (b) along with other variables which are assumed relevant to the nature of emerging markets.

1.4 Main contributions of the thesis

The thesis makes an empirical contribution to modern finance literature by assessing the degree of time-varying integration, and calculating optimal weights whilst investigating the benefits of international diversification from an asset allocation perspective, in addition to defining and providing explanations for the domestic equity bias puzzle in emerging markets.

Firstly, the study examines conditional CAPM within a relatively large sample of emerging markets. Most studies apply conditional CAPM on developed markets, and since the share of emerging markets' capitalisation in the world has increased dramatically in recent years, this would give rise to their importance in the world market. Conditional CAPM has found to be successful in testing developed markets (Bollerslev, Engle and Wooldridge, 1988; Hall, Miles and Taylor, 1990; Ng, 1991; Hansson and Hordahl, 1998). However, since emerging markets have embarked on the capital liberalisation process during the 1990s, there seems no consensus in the literature on the appropriate asset pricing model for emerging markets.

Secondly, studies that apply the mean-variance approach to asset allocation tend to consider the variation in the conditional covariance matrix of asset returns in the portfolio while maintaining constant vector of expected asset returns. On the other hand, the present thesis investigates trivariate GARCH while allowing for both expected returns and conditional variances of assets to change over time by allowing more dynamics in the mean equation of returns. Furthermore, the thesis extends the analysis by including more assets in the optimal portfolios for investors in emerging markets. The construction of customised portfolios for investors in emerging markets with a large number of assets offered for each market has not been employed in the literature. In addition, the inclusion of assets taking into consideration survey reports to investigate whether preference for these assets according to actual data could be justified with the use of mean-variance approach, has not been tested in the current literature either. Additionally, potential diversification gains are examined in order to assess the benefits from international portfolio diversification for emerging markets.

Thirdly, the thesis investigates the variables that influence investors' tendency to overweight domestic equities in emerging markets. The present study uses the share of actual equity holdings to total equity holdings in a given market as a dependent variable, which is different from that which is currently employed in the literature[2] in which the measure used serves the analysis in three main ways. Firstly, it directly tests the variables that affect domestic equity holdings without restricting a unit coefficient on the optimal weights. Secondly, it excludes the likelihood of explaining more of the variation in the optimal/benchmark weights instead of the variation in the actual equity holdings. Thirdly, it allows us to include the optimal weights as an explanatory variable and hence provide indication for markets' efficiencies in our sample.

The thesis shows that the variables that result in a perfect capital market do not significantly influence equity domestic bias in emerging markets, hence giving rise to the effect of other variables regarding market inefficiencies like exchange rate volatility, information asymmetries and capital controls.

[2] The literature tends to use the difference between actual and optimal weights of domestic equities as a measure of equity home bias.

1.5 Structure of the thesis

Chapter two discusses the main theoretical and empirical background that relates to equity home bias. Chapter three tests conditional CAPM by examining a bivariate GARCH model for 23 emerging markets in order to identify the extent to which emerging markets are becoming integrated into the world market through the estimation of conditional betas. An estimation of the time-varying optimal weights of an international diversified portfolio then follows, and the extent of gains from the international diversified portfolios are investigated in chapter four. Chapter five defines domestic equity bias, and examines the factors behind the phenomenon in 17 emerging markets through panel estimation. Chapter six concludes the main findings of the thesis.

Chapter Two: Review of Literature

This chapter aims at introducing the main concepts, while discussing the development of the equity home bias in the finance literature, and providing some insight into the relative strengths and weaknesses of international asset pricing and optimal portfolio allocation models.

2.1 International Asset Pricing Models: Theory and Evidence in Emerging Markets

2.1.1 Unconditional and Multifactor CAPM

The literature on theoretical and empirical examination of the CAPM is to some extent broad. Herewith is a summary of relevant model, with special attention to CAPM models applied to emerging countries.

The process of selecting a portfolio in modern finance literature was first introduced by Markowitz (1952). He assumes that investors prefer a combination of assets which provide high expected returns, and low returns' variances, in addition of being risk averse[3]. Tobin (1958), and Hicks (1962) further extend Markowitz's model by introducing liquid asset (such as cash or Treasury bills) into the portfolio along the continuum of risky assets. Sharpe (1964) constructs market equilibrium of asset's price taking into consideration various components of its risk. More specifically, Lintner (1965) specifies that the

[3] Investors' utility function is assumed to be strictly increasing and concave.

minimum expected return on a given asset i is an increasing function of the risk-free rate, the market price of risk, the variance on asset i, the covariance between asset i and the rest of the assets available in the market, and total covariance of all the assets available in the current market.

The paper by Fama and Macbeth (1973) is considered to be one of the main references and earlier studies to investigate the CAPM of Sharpe-Lintner . The model is specified as:

$$E(\tilde{R}_i) = E(\tilde{R}_f) + \left[E(\tilde{R}_m) - E(\tilde{R}_f)\right]\hat{\beta}_i \tag{2.1}$$

where $E(\tilde{R}_i)$ is the expected return on security i or the expected return on equity index of country i, $E(\tilde{R}_f)$ is the expected return on the risk-free asset in the market portfolio (m), $E(\tilde{R}_m)$ is the realised return on the market portfolio, and $\hat{\beta}_i$ is the estimated beta of asset i which mainly indicates the sensitivity of security i to the change in the market index, and equals to $\sigma_{i,m} / \sigma_m^2$

The empirical tests of equation (2.1) usually follow two steps. Firstly, realised returns are used instead of expected ones.

$$R_{it} - R_{ft} = \hat{\alpha}_i + \hat{\beta}_i (R_{mt} - R_{ft}) + \varepsilon_{it} \tag{2.2}$$

where R_{it} and R_{mt} are the realised return on asset i and the market portfolio, respectively at time t, $\hat{\beta}_i$ is the estimated beta on asset i and ε_{it} is the random error term. Secondly, the estimated $\hat{\beta}_i$ is used to calculate the following cross-sectional regression:

$$\overline{R}_{it} = \gamma_0 + \gamma_1 \hat{\beta}_i + u_{it} \tag{2.3}$$

where $\overline{R}_{it}$ is the mean of excess return, $\widehat{\beta}_i$ is estimated from equation (2.2), and the average values of the coefficients γ_0 and γ_1 are calculated, and tested to see whether they are significantly different from zero. If γ_0 is significantly larger than zero, this would imply that excess returns on security i perform better than the normal risk-return expected in the market, and vice versa if γ_0 is significantly smaller than zero. On the other hand, in order to validate CAPM, γ_0 is expected to be equal to zero, implying that investing in security i would result in the same performance of the market. Moreover, γ_1 is assumed to be significantly different from zero and is expected to be equal to the market premium.

Since CAPM assumes that investors live for only one period, and have homogeneous expectations, Merton (1973) develops another class of consumption-based CAPM which is further extended by Lucas (1978), Breeden (1979), and Cox, Ingersoll and Roll (1985). The model relies on multi-period utility functions and hence aggregate consumption is used instead of market portfolio. The main idea behind using consumption estimates is that they are more likely to convey variability in true consumption than the market portfolio[4].

Other approaches to estimating the CAPM include multifactor variables. Under this approach, other variables are included to predict the required rate of return. Basu (1977) reports the significant effect of the price-earnings ratio on the future performance of a security. More specifically, he explains that firms with low price-earnings ratio tend to have higher returns compared to firms with high price-earnings ratio. Fama and French's (1992, 1995, 1996) three-factor model is another pioneering study that includes other variables to

[4] Another alternative to CAPM is Ross (1976)'s Arbitrage Pricing Theory (APT). APT assumes that asset return is a linear combination of number of common factors instead of CAPM's market portfolio's beta.

the beta coefficient of CAPM. They include book-to-market equity, size and the beta estimated by the initial CAPM. Similarly, Carhart (1997) introduces another factor to Fama and French's (1995) model by including momentum risk in stock returns. Other variables used by other studies include earning volatility, and other economic variables such as economic growth, country credit risk rating and inflation[5].

Pettengill, Sundaram and Mathur (1995) propose a different methodology to estimate the relationship between betas and returns, as they argue that negative realised risk premiums are likely to be observed in some periods. They propose a conditional aspect to the Fama and Macbeth (1973) model, conditional on whether the risk premium is positive or negative. They argue that high beta shocks are likely to be more sensitive to negative realised risk premiums

$$R_{it} = \hat{\gamma}_{0t} + \hat{\gamma}_{1t} D\hat{\beta}_i + \hat{\gamma}_{2t}(1-D)\hat{\beta}_i + e_{it} \tag{2.4}$$

D is the dummy variable, which equals one if the realised premium is positive and zero if negative. The model requires the existence of certain conditions in order to be tested: the average risk premium should be positive, and the distribution of the up market periods and the down market periods should be symmetric. The latter can be tested using a two-population t test. The null hypothesis that $\bar{\gamma}_1 - \bar{\gamma}_2 = 0$ can be tested against the alternative that $\bar{\gamma}_1 - \bar{\gamma}_2 \neq 0$.

The examination of CAPM from the international perspective is mainly introduced by Solnik (1974), and further extended by Sercu (1980), Stulz (1981), and Adler and Dumas (1983). For instance, Solnik (1974) assumes that stock prices are affected by both

[5] See Bruner and Chan (2002) for review of different models used.

domestic and international factors, and heterogeneous expectations are included in the analysis for investors who invest abroad. Sercu (1980) develops Solnik's model, by maintaining the same assumptions regarding the mean-variance portfolio construction, while the decomposition of bond-stock fund within the portfolio depend on the nationality of investors through the exchange rate. Adler and Dumas (1983), as will be explained in detail later, show that the single-factor CAPM is only valid if the international capital markets are integrated, and hence the absence of any deviation from the Purchasing Power Parity (PPP).

Most studies which examine the CAPM (either unconditional or multifactor) on emerging markets during the eighties and early nineties conclude that the beta provides little or no explanation for the cross section market returns. In other words, the relation between market beta and average return is rather flat (Fama and French, 1992). Harvey (1995b) examines the asset pricing model on 17 emerging countries in which the expected returns are a function of global and local information variables. Harvey (1995a) investigates whether the betas are significantly different from zero in 20 emerging countries during the period 1979-1992 by examining the unconditional and two-factor CAPM. By analysing the unconditional CAPM, Harvey reveals that betas are not significantly different from zero in 19 countries (the beta is higher than one in only one market, Portugal). Two out of 20 countries have betas higher than one based on the two-factor model. Besides, the world market portfolio is significant in only seven countries which Harvey explains, are likely to be the most integrated in the world economy. Also, Harvey (1999b) rejects the CAPM prediction that beta is the only risk measurement that can explain variations in expected returns. Sandoval and Saens (2004) test the unconditional versus the Pettengill, Sundaram and Mathur (1995) version of the CAPM in Argentina, Brazil, Chile and Mexico for the period January 1995-December 2002. They also use other risk factors documented in the literature such as size, book-to-market ratio and momentum. The study mainly uses weekly returns in US dollar, stock market indexes, government bonds rates and US Treasury bills rates. Pettengill, Sundaram and Mathur (1995) multi-factor version of CAPM outperforms the unconditional version in the sense that the Argentinean, Brazilian and Chilean stock markets react more to down than to up markets. Additionally, Zhang and Wihlborg (2004) analyse the unconditional CAPM and Pettengill, Sundaram and Mathur (1995) version of CAPM on six European emerging countries[6] for the period 1995:01-2002:01, and find that the International CAPM of Pettengill Sundaram and Mathur (1995) performs well in only two markets; namely Czech Republic and Russia. The paper uses the return on market index as a proxy for the return on the market portfolio, and the short term Treasury bill is used as proxy for the risk-free rate. For returns on the market, the Morgan Stanley World index is used as proxy for the returns on the market portfolio.

Esrada and Serra (2005) examine three models on 30 emerging markets during 1982-2001. The first relates the expected rate of return to systematic risks (local and global betas) and total risk (standard deviation of returns), while the second model includes other factors like the price-to-book ratio and size. The last model includes downside betas (local and global) and downside standard deviation of returns. The paper finds a significant relationship between the return from one side, and the size and the standard deviation of returns from the other side. Moreover, Michadilidis et al (2006) investigate 100 stock returns in the Athens Stock Exchange (ASE). The ASE composite share index is used as

[6] The countries investigated are: Cyprus, Czech Republic, Greece, Hungary, Poland, Russia and Turkey.

proxy for the market portfolio and the three-month Treasury bill is used as a proxy for the risk-free rate. The study uses weekly returns for the period 1998-2002. The paper concludes that the risk is not associated with a higher return. However, the linear structure of the CAPM is supported by the paper findings. Also, Gursoy and Rejepova (2007) test the CAPM in Turkey using 20 portfolios through the period 1995-2004. The paper runs regression of weekly risk premium of the stock against weekly risk premiums of the Istanbul Stock Exchange (ISE) 100 index over the given period. The US three-month Treasury bill is employed as a proxy for the risk-free rate. The paper concludes that beta is a significant measure of risk premium, and that high-beta stocks perform better in up-market conditions, and vice versa.

As explained earlier, the unconditional CAPM assumes that beta is the only risk measure that determines the expected return, which implies that an international investor only cares about the mean-variance framework which constitutes the first and second moments. However, evidence of non-normality of returns violates this CAPM basic assumption since it gives rise to jumps or discontinuities in returns. This, in turn, might affect the ability to diversify away idiosyncratic risk (Beim and Calomiris, 2001), and might also affect the investors' risk averseness since investors could become more risk averse in severe events (Gheeraert, 2006). Emerging markets' returns seem to have diverted from normality during the period 1976-1995 (Harvey, 1995a, b) which might partially explain the failure of beta to explain cross returns during this period. However, recent studies and calculations have shown that emerging market returns are becoming increasingly normal, which could be one of the reasons behind the better prediction of the CAPM in recent periods. Another assumption of CAPM is the one related to efficient markets. De Moore (2005) explains that investors tend to overreact to bad (or good) news such that inefficient markets could violate CAPM assumptions.

One of the strict assumptions of the CAPM in applying the model in an international finance framework is capital markets are perfect, and hence perfect integration of capital markets. Emerging markets' returns still exhibit low correlation with the world market. Lower cross-correlations were significantly found for these markets through the period 1976-1995 (Bekaert and Harvey, 1995; Harvey, 1995a; Goetzmann and Jorion, 1999). Additionally, the majority of emerging countries had capital restrictions on equity flows until the mid nineties while the CAPM assumes no transaction costs and integration in the world market[7]. Testing the international CAPM for the period prior to 1995 would probably reflect low or insignificant beta estimation. Emerging markets are somehow segmented from the world market which might be a partial reason behind the failure of the unconditional CAPM applied to these emerging markets. In addition, other factors rather than the beta might seem more significant, giving rise to two or more factor CAPM estimations, by the inclusion of variables more related to local markets such as local events and local market variance. For instance, Chari and Henry (2001) find support for the hypothesis that expected returns of individual stocks mainly depend on their local betas before markets' liberalisation, while the effect of global beta follow afterwards. This might explain the better estimation found as a result of allowing some degree of segmentation to change over time for the CAPM especially at times when low correlation with the world market persists (Baekert and Harvey, 1995; De Santis and Imrohoroglu, 1997).

[7] Capital market reforms in emerging countries started around 1988, and according to Bekaert and Harvey (2003) liberalisation dates; Brazil, Colombia, Pakistan, Philippines, and Taiwan financial markets were liberalised in 1991, while Chile, Korea, India and Jordan experienced financial liberalisation from 1992-1995.

Another underlying assumption of the unconditional CAPM model is the positive linear relationship between the expected return on a given stock and its systematic risk which implies constant beta over time. Given that studies show the existence of heteroscedasticity of error variances in unconditional CAPM estimation (Schwert and Seguin, 1990; Brooks, Faff and McKenzie , 2002), it would be rather difficult to assume that both the risk and beta are constants over time. GARCH models account for cross-sectional correlations in residuals and the conditional heteroscedasticity (Ng, 1991). Additionally, Jagannathan and Wang (1996) argue that the evidences against the unconditional CAPM might not necessary prevail in the conditional CAPM since it allows the risk premiums and betas to vary over time, and in this case, CAPM holds period by period. In other words, it allows the update of investors' information in making portfolio decisions. Hence, incorporating conditional information into the static CAPM to allow for the time-variation in beta and assuming multivariate normality of returns might partially enhance the performance of CAPM.

2.1.2 Conditional CAPM

Campbell (1996) incorporates conditional information into the CAPM model through the use of a general intertemporal asset pricing model and the inclusion of variation in expected stock returns and human capital. Hence he allows the risk aversion coefficient to exceed the standard rate of three. The stock market return remains a significant factor in explaining the cross variation in expected excess returns even when he employs a five-factor version of the intertemporal model. Other factors he considers include past labour income growth, dividend yield, and interest rate variables. Also Ferson and Harvey (1999) loaded lagged instruments into Fama and French's (1993) three-factor CAPM model in order to estimate time-varying betas. Their results improve when they regress conditional expected returns on lagged instruments including the difference between the one-month lagged returns of a three-month and a one-month Treasury bill, dividend yield of the Standard and Poors (S&P) 500, and the lagged value of a one-month Treasury bill yield compared to the unconditional version of Fama and French (1993). A Similar approach is investigated by Lettau and Ludvigson (2001) in which they model the parameters presented in Fama and French (1993) as time-varying and scaled them by a proxy for log consumption-wealth ratio. They find that their scaled consumption-based CAPM model performs better than the static CAPM of Fama and French (1993) in terms of explaining value-premium, and minimising residual size of the model. Similarly, Dahlquist and Sallstrom (2002) test conditional CAPM by using market excess return scaled by excess dividend yield on the world market. However, the paper concludes that international asset pricing models with exchange risk perform better than the conditional CAPM in terms of minimising pricing errors and the explanatory power of the model.

On the other hand, the introduction of the ARCH model by Engle (1982) allows the conditional covariance matrix between the market return and the world return to vary according to its own past values and past squared disturbances. Therefore, it has become increasingly possible to better investigate asset returns' second moments, or risk, rather than assuming constant risk (variance) during the period under study. The ARCH coefficients imply that a large shock in period $(t-1)$ results in a large conditional variance in the next period (t) subject to the structure of the conditional expectation function (Patterson, 2000). Bollerslev (1986) generalised Engle's (1982) ARCH process by allowing more flexible lag structure in the conditional variance equation and allowing the conditional variance to depend on its past values.

Accordingly, multivariate GARCH models have been increasingly used in the finance literature. The models allow for the estimation of time-varying conditional cross-moments. Unlike the estimation of unconditional CAPM, conditional CAPM relies on the maximisation of a likelihood function. Bollerslev and Wooldrige (1992) show that the assumption of error normality can be justified since the quasi-maximum likelihood can still be consistent if the conditional mean and conditional variance are specified correctly. Moreover, Bauwens, Laurent and Rombouts (2006) explain that usually the unconditional distribution tends to have fatter tails than those that result from conditional distribution.

The conditional CAPM mainly extends the static or the unconditional CAPM in equation (2.1) by updating investors' available information at the end of time $t-1$ when calculating returns at time t (Hall, Miles and Taylor, 1990)

$$E(R_{it}|\Omega_{t-1}) - R_{ft-1} = \beta_{it}\left\{E(R_{mt}|\Omega_{t-1}) - R_{ft-1}\right\} \tag{2.5}$$

$$\text{Where } \beta_{it} = \frac{\operatorname{cov}(R_{it}, R_{mt}|\Omega_{t-1})}{\operatorname{var}(R_{mt}|\Omega_{t-1})} \tag{2.6}$$

in which Ω_{t-1} is the information set available at time $t-1$.

Earlier application of conditional CAPM using multivariate GARCH includes the study by Bollerslev, Engle and Wooldridge (1988) in which they investigate the time-varying covariance matrix of three assets' returns namely, US bonds, bills and stocks during the period 1959-1984. They conclude that conditional covariance seems to vary significantly over time, and they relate the change in consumption and lagged excess holding yields to the change in excess returns.

Also, Hall, Miles and Taylor (1990) apply the multivariate GARCH to four industries in the London Stock Exchange, and find that conditional variances and covariances are significantly time-varying. They also show that the GARCH weights for recent history are small, which might indicate that agents tend to have long memories. Ng (1991) examines all common stocks traded of the New York Stock Exchange during the period 1926-1987. The paper uses two methods in order to construct portfolios either according to ranked beta or firm size. The likelihood estimates from the beta-ranked portfolios do not reject the conditional asset pricing approach while the likelihood estimates for the size-ranked portfolios seem to reject the conditional model . On the other hand, Braun, Nelson and Sunier (1995) estimate time-varying betas for twelve main industries of the New York Stock Exchange through the application of a bivariate exponential GARCH model to differentiate between the effect of bad news and good news on returns' volatilities. The paper shows that even though there is evidence of time-varying beta, it is still weaker than time-varying volatility.

Hansson and Hordahl (1998) test the conditional CAPM on the Swedish Stock Exchange by constructing three different value-weighted portfolios: beta, size and industry structure. Estimates reveal that the ARCH coefficients seem large compared to earlier studies, indicating the importance of past innovations while the GARCH coefficients tend to be smaller compared to those presented in previous studies. The paper also documents that the price of risk is positive, significant and varies across portfolios. Also, Minovic (2007) applies bivariate and trivariate GARCH models of various representations like the variant of Berndt, Engle, Kraft, and Kroner (BEKK), Diagonal VEC and Conditional Correlation (CCC) representations to investigate whether selected securities follow the Belgrade Stock Exchange index (BELEX15). Concerning the bivariate estimates, the study explains that the results of the three models exhibit similar results regarding variances, but different results regarding covariances. However, the trivariate estimation shows that the BEKK and DVEC results appear similar regarding conditional covariances, while the CCC model tends to behave differently.

Moreover, the following studies employ multivariate GARCH-in-Mean representation for conditional expected excess returns as proposed by Bollerslev, Engle and Wooldridge (1988). The model allows for the conditional mean return to be a function of conditional volatility. French, Schwert and Stambaugh (1987) use daily returns of S&P portfolio over the period 1928-1984, and find a significant positive relation between the expected excess returns on the S&P and the conditional variance of its return. De Santis and Gerard (1997) employ the representation on the G7 countries in addition to Switzerland. They show that the decline in the US market is contagious at the international level and lead to a significant reduction in international diversification gains apart from the gains for US investors. They also find similar results to earlier studies, in which the GARCH model implies high volatility persistence, while estimates for past innovations are smaller. Similarly, Chan, Karolyi and Stulz (1992) use bivariate GARCH-in-Mean process for conditional expected excess returns on US stocks in order to investigate the effect of foreign indexes[8] on the US stock market portfolio. The paper concludes that there exists a

[8] The foreign indexes investigated are: Nikkei 225 (price-weighted index of the stocks traded in Tokyo stock market), Morgan Stanley Japan and the Morgan Stanley EAFE index (value-weighted index including stocks from Australia, Europe and Far East).

significant relation between the expected excess returns on daily US stocks and the conditional covariance of the S&P 500 with the foreign indexes during the period 1978-1989.

Additionally, Brooks, Faff and McKenzie (2002) use three different approaches for the estimation of a time-varying beta for a set of 17 developed markets using monthly data over the period 1970-1995. They use a bivariate GARCH model, the Schwert and Seguin approach and the Kalman filter method. Marshall, Maulana, and Tang (2009) apply the same methodology as in Brooks, Faff and McKenzie (2002) but they use the dynamic conditional correlation model using daily data sets in emerging markets during the period January 1995 to December 2008. Both papers reveal that countries exhibit time variation in their betas estimation, hence the assumption of constant beta coefficients is rejected. However, as a result of using different data set and different sample periods, they reach different conclusions regarding the efficiency of the three approaches. According to Brooks, Faff and McKenzie (2002), the bivariate GARCH generates the lowest forecast error[9] while Marshall, Maulana, and Tang (2009) find the Kalman filter approach to outperform other methods.

Another line of multivariate studies attempts to show the spillover and interaction between different stock markets. Koutmos and Booth (1995) document price and volatility transmissions between the New York, Tokyo and London stock markets by testing multivariate exponential GARCH. They show that the volatility spillovers are more

[9] Both papers use the smallest mean square error (MSE) as an indicator of the best model in terms of explaining the time variant beta. MSE is estimated as the difference between the observed country return series and the in-sample forecast country returns series according to each model, and it is calculated as $\frac{\sum_{t=1}^{n} \varepsilon_t^2}{n}$

obvious and asymmetric between the three markets compared to the price spillovers. The results indicate the effect of news in one market and its effect on others.

Additionally, Worthington and Higgs (2004) examine the spillover effects of equity returns and volatility among three developed and six emerging markets in East and South-East Asia through the multivariate GARCH model for the period 1988-2000. The analysis show that the mean spillovers from the developed to emerging Asian markets are not homogenous across emerging markets. In addition, the individual volatility seems to be higher than cross-volatility for most markets, giving rise to the importance of domestic variables.

In summary, so far time-varying CAPM has not been investigated in emerging markets apart from Marshall, Maulana, and Tang's (2009) study. Choosing the sample period after the year 1995 might indicate whether these emerging markets are becoming more integrated within the world market or not after the capital liberalisation took place, and shows a preliminary perspective as to the effect of financial contagion, whilst investigating the conditional cross volatility between these emerging markets and the world market. Studies show that the conditional variance of equity markets can be successfully modelled through univariate or multivariate GARCH models. Harvey and Zhou (1993) explain that mutual funds have recently tended to offer country index portfolios, and hence assessing country risks correctly is increasingly important in order to construct efficient portfolios. Hence, investigating the extent of market segmentation/liberalisation through the implementation of conditional CAPM could be helpful since it allows for time-varying betas. As Marshall, Maulana, and Tang (2009) explain, identification of time-varying beta is essential in order to understand not only the dynamic process among risky assets, but also to construct the appropriate weights within portfolios. One of the main reasons why investors diversify their portfolios is to reduce risk in addition to improving the return, since different assets will respond differently to changes in markets (Gupta and Donleavy, 2009).

Further, Longin and Solnik (1995) show that international integration might result in higher markets' correlations. They estimate that cross-correlations of excess returns for Germany, the USA, the UK, Switzerland, Japan, and Canada increased by an average of 0.36 during the period 1960-1990, and hence they reject the hypothesis of constant international correlation. In addition, they demonstrate that correlation increased during turbulence periods, in other words, when the conditional volatility of stock markets is high. This might imply that gains from international portfolio diversification could be declining with increased cross-correlation between markets. Accordingly, multivariate GARCH or conditional correlation models might allow us to construct conditional optimal weights whereby the covariance matrix of returns is rebalanced each period (Flavin and Wickens, 1998), and thus take into account the change in markets' volatilities and international correlation between markets. This implies better insights of the behaviour of efficient portfolios, and the extent of international diversification gains, and hence equity home bias is examined.

2.2 The use of time-varying GARCH models in portfolio asset allocation

"October: This is one of the peculiarly dangerous months to speculate in stocks in. The others are July, January, September, April, November, May, March, June, December, August and February".

Mark Twain, Pudd'nhead Wilson's Calender (1899:108).

Investors who intend to invest in international stocks are expected to consider the expected returns and volatility of returns in their domestic as well as foreign markets. Determination of optimal weights in efficient portfolios diversified internationally mainly follow the data or model approach as mentioned earlier. The model approach assumes that investors all over the world hold the same portfolio of assets in which the share of each country is determined by its share in the world market. This implies that stock markets are efficient and there are no information or transaction costs which could be restrictive assumptions (De Santis, 2006). On the other hand, the data approach follows from a mean-variance perspective and hence estimates of mean and variance of asset returns. The works of Grubel (1968) and Levy and Sarnat (1970) are among the earliest papers to apply mean-variance efficient frontier to asset allocation. Both papers use sample means and fixed covariance matrix of returns. Grubel (1968) investigates the potential gains for the US investor from diversifying his/her portfolio by including 11 industrialised markets. The paper reveals that the inclusion of the 11 assets permits investors to attain higher rates of returns or lower variance on their portfolio compared to the portfolio consisting of Moody's industrial average of common stocks. While Levy and Sarnat (1970) examine the mean rates of returns on common stocks and their standard deviations for 28 countries during the period 1951-1967, and hence construct an internationally diversified portfolio composed of the 28 returns. The paper shows that the share of developing countries such as Venezuela, South Africa, and Mexico in addition to New Zealand, and Japan constituted around 40-60 per cent of the total portfolio. Eun and Resnick (1994) extend the analysis to include Japanese investors in addition to US investors in which investors are allowed to construct optimal portfolios along seven major equities and bonds. The US equities and bonds seem to dominate the optimal stock portfolio and bond portfolio followed by Japanese stocks and bonds.

2.2.1 Multivariate GARCH

Recently, multivariate GARCH models have been used with regard to the modelling of asset returns since they are able to identify volatility clustering in asset returns, and can allow for time-varying covariances of asset returns[10]. Despite this, the use of the estimated conditional covariance matrix of asset returns in international optimal portfolio construction has been to some extent limited. Earlier papers include Cumby, Figlewski, and Hasbrouck (1994) in which they construct internationally diversified portfolios consisting of equities, long-term governmental bonds, and short-term borrowing and lending in the US and Japan during the period July 1977- December 1988. The mean values of returns and the time-varying covariance matrix of returns from the multivariate exponential GARCH (EGARCH) estimation are used in determining the international optimal portfolio. The authors minimize the following utility function:

$$w_t'\Omega_t w_t$$

[10] For a review of different applications of multivariate ARCH models to asset returns models, please refer to Bollerslev et al (1992)

subject to $E(R_{p,t}) = w_t' E(r) = R^*$, and $w_t' 1 = 1$ (2.7)

w_t': stands for time-varying portfolio weights, Ω_t is the conditional covariance matrix of returns from the multivariate exponential GARCH (EGARCH) process, $E(R_{p,t})$ is the expected portfolio of returns in excess of the risk-free rate while R^* is the target expected excess return, and 1 represents a vector of ones.

It is assumed that the return on a given security is r_t and is normally distributed with zero mean and variance equals to σ_t^2. The EGARCH specification for the variance the paper uses can be described as

$$\ln(\sigma_t^2) = a + b\ln(\sigma_{t-1}^2) + cg(z_{t-1})$$

and $$g(z_{t-1}) = dz_{t-1} + |z_{t-1}| - \sqrt{2/\pi}; z_{t-1} = r_{t-1}/\sigma_{t-1} \tag{2.8}$$

The coefficients represent the following: the b coefficient indicates persistence in the deviation from the average constant variance, c measures the instant impact of a large positive or negative return, and d is an asymmetry parameter which tends to be negative if a large negative return leads to an increase in risk prediction relative to the effect of positive return of the same magnitude.

The paper concludes that the gains from international diversification for the US investor are higher than that for the Japanese investor. More specifically, the paper shows that it is optimal for the US investor to invest a large weight of the optimal portfolio in Japanese riskless asset, while hold short Japanese long term bonds and stocks

Simmons (1999) uses simple averages of returns and variance matrix between US equities, US bonds, US money market investment, European stocks and Pacific stocks to obtain the optimal portfolio for the period January 1980-September 1998. In addition, she tests the same set of assets using exponential averages, thus placing more weight on recent observations. The compositions of the optimal portfolio using both methods differ substantially. For instance, the weights on US stocks decrease from 63 per cent (in a slightly risky portfolio) using the first method to zero using the second method.

Pastor (2000) on the other hand uses only prior information about expected returns in constructing optimal portfolio consisting of two assets: the return on the New York Stock Exchange (NYSE) index, and the return on the MSCI 'World-Except-US' during the period January 1926-December 1996. Hence, the model aims at maximising the following expected utility function by choosing w

$$\max_{w} \int u(W_{+1})p(r_{+1}|\Phi)dr_{+1} \tag{2.9}$$

$$\text{where } W_{+1} = W(1 + r_f + (1-\delta)W'r_{+1}) \tag{2.10}$$

w denotes the vector of weights in the portfolio of the investable assets, u stands for investor's utility function, W_{+1} represents investor's next-period wealth, $p(r_{+1}|\Phi)$ is the probability density of the next-period returns on the investible assets in excess of the risk-free rate (r_f), and δ is the proportion of wealth invested in the risk-free asset, and mainly depends on investor's risk aversion.

The analysis shows that the low share of foreign stocks in the optimal portfolio for an American investor is relatively different from the share of US in the world market, or the estimation of mean-variance approach. The authors relate this high share of US equities in the optimal portfolio of US investor to the high confidence in the domestic CAPM.

On the other hand, Flavin and Wickens (1998) assume a constant vector of expected asset excess returns, and rather aim at minimising the risk on the optimal portfolio that consists of four UK assets during the period January 1976- February 1997 using multivariate GARCH. The paper estimates the following specification for the multivariate GARCH model

$$r_{t+1} = a + \beta r_t + \gamma dum87 + \varepsilon_{t+1}$$

where; $\varepsilon_{t+1} | \Psi_t \sim N(0, \Omega_t)$

$$\Omega_t = C'C + \Phi'(\Omega_{t-1} - C'C)\Phi + \Theta'(\varepsilon_T \varepsilon_T' - C'C)\Theta \tag{2.11}$$

r is the vector of annualised monthly excess returns (excess return on UK equities, excess return on the UK government bonds with maturity over 15 years, and the excess return on the UK government bonds with less than five years to maturity); dum87 stands for dummy variable representing the October 1987 stock market crash; Ω_t is the conditional covariance matrix of excess returns, and is a variant BEKK; and $C, \Phi,$ and Θ are restricted to be $n \times n$ symmetric matrices. Their estimates of the multivariate GARCH show that the deviations from the unconditional variance are both predictable and persistent. Also, the paper reveals that the riskiness of the portfolio using the conditional covariance matrix is lower than that proposed by their counterparts using the constant or unconditional covariance matrix.

However, their construction of optimal portfolios using conditional covariance matrix showed that UK equities seem to dominate the optimal portfolio, amounting to an average of 70 per cent of total wealth followed by UK long-term bond (almost 20 per cent) and UK short-term bond (around 10 per cent).

Flavin and Wickens (2000) extend the previous model to construct internationally diversified optimal portfolios from the perspective of US and UK investors, in which investors are allowed to diversify their portfolios between the domestic and foreign equities in addition to domestic long-term bonds. The optimal portfolios are calculated using annualised monthly excess asset returns over the domestic risk-free rate for the period January 1980- March 1997. In their analyses, the short-term deviations of the conditional variance compared to the constant or unconditional variance seem high. They conclude that even though the domestic equity seems to dominate the unrestricted optimal portfolios (amounting to on average of 77 per cent and 64 per cent for the UK and the US investors, respectively), the share of foreign assets remains higher than what witnessed in the survey data, and higher than the domestic bond, indicating the presence of equity home bias.

In addition, Pojarliev and Polasek (2003) construct optimal portfolios consisting of monthly returns on the MSCI North America, MSCI Europe and MSCI Pacific indexes during the period February 1990- September 1999. The study uses the multivariate VAR-GARCH model to forecast a portfolio according to the variance matrix, and another according to means and variance forecasts. The paper shows that the results using multivariate GARCH perform better in terms of forecasting by incorporating more information into the analysis.

In summary; first of all, the use of multivariate GARCH models in portfolio optimal allocation has been to some extent limited to the investigation of developed markets. Secondly, previous studies seem to relate the time-varying change in the optimal portfolio to the change in the variance-covariance matrix while maintaining average rates of returns. Thirdly, the risk-free rate in many emerging markets is considered high, and this might affect the composition of the optimal portfolio. Finally, the use of multivariate bivariate or trivariate GARCH does not take into account the change in cross-correlations between markets, as well as the difficulty that lies in including large number of assets since the maximum likelihood function might not be able to converge.

2.2.2 The use of conditional correlation models in optimal portfolio allocation

The literature identifies the difficulty of estimating a large number of assets through the multivariate GARCH diagonal presentation or the BEKK model due to the large number of resulting unknown parameters. Bollerslev (1990) proposes the constant conditional correlation (CCC) as a remedy for the large number of parameters estimated through the multivariate GARCH. In addition, Engle's research (2000) continues to overcome this difficulty by imposing a common dynamic structure on all elements of the conditional variance matrix which in effect minimised model parameters, in addition to allowing for non-constant correlation in the analysis of multivariate GARCH models (Engle and Sheppard, 2001).

The simple measure of correlation is to use rolling window correlation, which implies giving equal weights to all sample points (Gupta and Donleavy, 2009). With the introduction of GARCH models, Bollerslev (1990) proposes the CCC model in which the model is applied to five nominal European US dollar exchange rates during the period March 1979-August 1985. First, univariate GARCH models are estimated for each asset and then with the use of estimated conditional standard deviations, a correlation matrix is calculated. The CCC model allows for the estimation of large number of assets and ensures that the estimator is positive definite. However, the assumption of constant correlation is rejected by later works.

Longin and Solnik (1995) test CCC on seven major countries during the period 1960-1990, and find that even if the CCC is able to capture time-varying variances, the assumption of constant correlation is rejected as correlation shows an increasing trend over the 30 years of their sample especially in turbulent periods. In addition, Bera and Kim (1996) use an information matrix (IM) in order to test the constancy of the correlation matrix and find strong evidence for rejecting the constant correlation assumption through the application of the matrix on stock markets in the USA, Japan, Germany, the UK, Italy and France.

Moreover, Tse (2000) examines a Lagrange Multiplier (LM) test for the constant correlation assumption of CCC model. When applying the test to real data, the constant correlation assumption is rejected only in stock market returns while supported in spot-futures and foreign exchanges markets. Also Tsui and Yu (1999) test the CCC model using the information matrix test earlier derived by Bera and Kim (1996) on two stock markets in China in which the assumption of constant correlation is rejected. In addition, Gau (2001) applies the LM test of Tse (2000) and reports that the conditional correlations between international index futures' markets are not constant during the period September 1988-May 1999.

On the other hand, Tse and Tsui (1997) introduce a time-varying correlation matrix instead of the constant matrix assumed earlier through the adoption of an autoregressive moving average on the correlation matrix while restricting the conditional variance-covariance to be a vec-diagonal MGARCH. Also, Engle and Sheppard (2001) and Engle (2000) extend a dynamic conditional correlation (DCC) by allowing for the correlation estimator to be time-varying.

Similar to the CCC model, the DCC is estimated in two stages. The first stage calculates univariate GARCH estimates while in the second stage the standardised errors are used in order to obtain the dynamic correlation estimator. However, the DCC allows for the estimation of large correlation matrices while providing a correlation estimate which is time-varying. In addition, the DCC overcomes the heteroscedasticity problem by using standardised residuals of assets.

The usage of the DCC model in constructing optimal weights of an internationally diversified efficient portfolio is to some extent limited. For instance, Cha and Jithendranathan (2009) construct a portfolio of S&P 500 index along with 19 MSCI emerging indexes to examine the benefits from international diversification for US investors during the period January 1996-December 2004. The paper shows that the gains from international diversification in emerging markets increased with the reduction of the maximum restricted investment on emerging markets.

Gupta and Donleavy (2009) aim at identifying the benefits of an Australian investor investing in seven emerging markets for the period February 1988- December 2005. The paper uses the Asymmetric DCC model to find the optimal weights in an efficient portfolio consisting of Australia, Brazil, Chile, Greece, India, Korea, Malaysia and the Philippines. The paper shows that an Australian investor is better off investing in emerging markets as the international diversified portfolio resulted in a higher Sharpe ratio compared to the Australia- held portfolio.

As have been tested through the work of Longin and Solnik (1995), Bera and Kim (1996), Goetzmann, Li and Rouwenhorst (2005), Diamandis (2008), Wang and Moore (2008), and Gupta and Donleavy (2009), the conditional correlation between stock markets has been changing over time, and usually increasing. Gupta and Donleavy (2009) and Cha and Jithendranathan (2009) show that Australian and US investors respectively can benefit from investing in emerging markets.

However, there are other questions still unresolved within the literature regarding the optimal allocation of assets in international framework. For instance, optimal portfolios for investors in emerging markets have not been tested. Would the benefits from international diversification change if domestic investors in emerging markets are offered a portfolio of assets from developed markets, and another portfolio set composed of a mix of assets from emerging and developed markets?. To what extent can the choice of markets by investors as found in survey reports published by the IMF be justified through the calculation of optimal weights for efficient portfolios?. The studies testing the DCC model for asset allocation use expected returns calculated in US Dollars, or local currencies, but do exchange rates' risks tend to give rise to domestic assets in an internationally diversified portfolio?. Estimating efficient portfolios in both domestic and foreign currencies might give an indication as to the extent of change in optimal weights due to the change in exchange rates. To what extent the high risk-free rates in emerging markets contribute in a relative high share in optimal portfolios?

Answers to these questions might help in understanding the equity home bias better. Firstly, determination of the time-varying optimal weights might indicate the extent of market efficiency since in an efficient market the optimal weights on assets are assumed to be equal to actual weights. Secondly, the change in optimal weights due to the exchange rate might imply that exchange rate risk gives rise to investment in the domestic stock market. Thirdly, the calculation of Sharpe ratios resulting from international diversified portfolios and domestic equities-only portfolios could indicate the potential gains/losses for investors in emerging markets in investing abroad. Fourthly, the estimation of time-varying betas according to the international CAPM might help with understanding whether the increased integration of emerging markets affects equity home bias. Fifthly, two of the major factors determining the benefits from international diversification are country risk, and capital controls. Both factors determine to what extent markets can be segmented from the world market (Gupta and Donleavy, 2009). This would imply that domestic investors might tend to invest more in domestic equities in emerging markets instead of investing abroad.

2.3 Equity home bias

The literature on home bias is vast. This section mainly concentrates on the literature relating to equity home bias. It also differentiates between the theoretical framework for home bias and the empirical studies explaining it.

2.3.1 Theoretical background

The theoretical framework on home bias tends to measure and explain the phenomenon mainly from two aspects, either through mean-variance approach, or through consumption-based models.

2.3.1.1 The mean-variance approach

This approach relates home bias to the difference in expected returns or risks between domestic and foreign markets. Adler and Dumas (1983) demonstrate that investors compute the real returns from a given foreign security by converting its nominal return in terms of the national currency and then deflating it through the home price index. In other words, the authors imply that investors would be willing to hold foreign securities after considering the exchange rate risk from holding a foreign security multiplied by the home purchasing power index. Therefore, as a result of inflation risk and deviations from PPP, investors are induced to invest more in their home market.

The model assumes that there are $N+1$ countries, currencies, equity index assets and N risky assets

$$R_i = dY_i / Y_i = \mu_i dt + \sigma_i dz_i \qquad i = 1........N \qquad (2.12)$$

where Y_i is the market value of security i in terms of currency $N+1$; μ_i and σ_i are constants and represent the instantaneous expected nominal rate of return on security i and its standard deviation, and dz_i is the increment to a standard Wiener process.

The model assumes that there are $N+1$ investor types, each with homothetic utility function. The price index P^I of an investor type I expressed in the measurement currency is defined as

$$dP^I / P^I = \pi^I dt + \sigma_\pi^I dz_\pi^I \qquad i = 1 \ldots\ldots N+1 \qquad (2.13)$$

in which they define π^I and σ_π^I as the expected value and the standard deviations of the instantaneous rate of inflation.

They also introduce Ω, an $N \times N$ matrix of covariances $\sigma_{i,\pi}^I$ of the N risky securities returns, and investor I 's measure of rate of inflation. Hence, they compute the optimal portfolio through

$$w^I = \alpha\ \Omega^{-1}(\underline{\mu} - r1) + (1-\alpha\ )\Omega^{-1}\underline{w}^I \qquad (2.14)$$

in which; 1 is an N x1 vector of ones; α is investor I's risk tolerance; $\underline{\mu}$ is the vector of nominal expected returns; Ω is the $N \times N$ matrix of instantaneous covariances of the nominal rates of return on the various securities; r is the nominal interest rate on bank deposits, and $\underline{w}^I$ is the N x1 vector of covariances of the N risky securities returns calculated with investor I's rate of inflation.

In summary, equation (2.14) shows that investor I holds a portfolio of securities based on a portfolio that is generally common among all investors in addition to a portfolio of weight $(1-\alpha)$ which assumes zero risk tolerance ($\alpha = 0$) that mainly hedges inflation risk for investor I.

Cooper and Kaplanis (1994) extend the previous model to allow for investor's risk tolerance to be equal to α instead of zero as assumed in Adler and Dumas (1983).[11] They also integrate proportional deadweight loss ($c_i^I dt$) to the previous model in which they explain that hedging inflation risks is not sufficient to explain equity home bias alone. Hence, investor I's portfolio follows

$$w^I = \alpha\ \Omega^{-1}(\mu - r1 - C^I) + (1-\alpha)\Omega^{-1}\underline{w}^I \tag{2.15}$$

In this case, investor I's portfolio consists of two components. The first component hedges against inflation risk and minimises deadweight costs while the second component is common to all investors. This model assumes that investors holding foreign securities will incur two types of deadweight costs; one related to controls on foreign investment from the home country, and the other relating to costs in foreign markets like withholding taxes. Therefore, home bias occurs when either of these costs is high. Equity home bias is explained through this model based on the idea that the costs from investing abroad are too high to discourage domestic investors from investing abroad (Lewis, 1999). However, the authors use postulated data on the risk aversion coefficient. More specifically, their estimated level of costs is close to proportional to the risk aversion coefficient. The paper shows that relying only on inflation hedging explains little of home bias and that the

[11] An assumption also used in French and Poterba (1991)

introduction of deadweight costs seems an important component of the international equilibrium assuming that investors have low risk aversion coefficients.

Sercu and Vanpee (2008) further amend Cooper and Kaplanis' model by introducing the following main changes. First, they depend on calculated regressors of information costs and international transaction controls instead of relying on postulated values of deadweight costs. Secondly, they compute risk aversion coefficients based on consumption data, and use hedged portfolios based on portfolio holdings data. Thirdly, they rely on estimates of the time-varying covariance matrix resulting from applying Bekaert and Harvey's (1997) time-varying volatility model (2007). Hence, their model can be expressed as follows

$$(y_i^I - y_i^i) = \alpha C_i^I + (1-\alpha)(w_{S_i|X}^i - w_{S_i|X}^I) \tag{2.16}$$

in which I denotes the country of residence as previously defined in the models above; i represents the host country such that y_i^I is the conditional variance of the hedged stock i's return with the return on the portfolio held by investor I; $w_{S_i|X}^I$ is the conditional covariance between the hedged return of stock i with investor I's measure of home price index; and lastly the deadweight costs are defined by a set of instruments like the information asymmetries, and proxies for financial and economic development as well as political risks and corporate governance. The paper concludes that their estimates of implicit costs are considered lower than those estimated by Cooper and Kaplanis (1994). Even though the paper shows that the implicit costs in developing countries remain higher than in developed countries, their estimates of implicit costs in developed countries are to some extent lower compared to previous studies such as that of Cooper and Kaplanis (1994).

2.3.1.2 Consumption-based approach

While the mean-variance approach investigates the risks and costs that might make international investment unworthy, the consumption approach mainly concentrates on the gains from international portfolio diversification that are unexploited as a result of home bias. If the gains from an international diversified portfolio are small and the costs are high, this would explain inconsistent capital mobility (Cole and Obstfeld, 1991; Van Wincoop, 1999). Also Tesar (1995) shows that welfare gains from international risk-sharing calculated through utility models provide evidence of small gains.

Lucas (1978) finds that in a two-country model, investors in each country hold 50 per cent share of the other country's endowment. In equilibrium, investors perfectly diversify their portfolios, and the two countries have equal consumption levels and wealth. In spite of this, Lewis (1996, 1999) shows that correlations of consumption growth rates across countries are quite small, hence international risk sharing is small. The main idea behind this approach as Lewis (1996) explains is to calculate and compare welfare gains from consumption paths under the case of no risk-sharing, and under the case of perfect risk-sharing. The difference in results will then determine whether the gains from international investment are worthy, otherwise equity home bias could be clarified.

The following model is assumed in N closed economies and where stock returns are endogenous[12], and an investor is assumed to consume and buy shares in the domestic market based on the maximisation of the following Epstein-Zin-Weil utility function:

$$V(w_t^j, s_t) = \underset{c_t^j, x_t^j}{Max}[(c_t^j)^{(1-\theta)} + \beta E_t(V(w^j{}_{t+1}, s_{t+1})^{1-\gamma})^{(1-\theta)/(1-\gamma)}]^{(1/(1-\vartheta))}$$

subject to:

$$c^j{}_{t+1} + x^j{}_{t+1} q^j{}_{t+1} = (q^j{}_{t+1} + e^j{}_{t+1}) x_t^j \tag{2.17}$$

in which, s_t is the state of the economy at time t, $w_t^j = k_t^j q_t^j$ is the wealth of country j's investor at time t, θ is the inverse of the intertemporal elasticity of substitution in consumption, γ is the risk aversion coefficient, x_t^j are the shares held of stocks, q_t^j is country's stock price, and e_t^j is country's per capita endowment stream.

The gains from the previous function are computed in which the portfolio is composed of domestic stocks, and compared to gains from a utility function in which the portfolio is composed of the optimal combination of stocks.

In the case of utility function based on maximisation of an optimal portfolio of diversified international stocks, the budget constraint in equation 2.17 becomes

$$c_t^j + \sum_{i=1}^N x_t^{i,j} q_t^i \leq \sum_{i=1}^N x_{i=1}^N x_{t-1}^{i,j} (e_t^i + q_t^i) \tag{2.18}$$

[12] Lewis (1996) shows a case in which stock returns are exogenous as well.

Assuming log-normal distribution of returns, first-order conditions for maximisation of the previous utility functions are calculated, and the maximisation problem is also defined in terms of a world mutual fund paying out the world per capita endowment $\underline{e}_t$. Hence, the welfare gain from diversifying is assumed to be equal to the percentage of permanent consumption that must be deducted from an investor at the optimum to make him indifferent between risk-sharing and otherwise. In other words, if C_o^j is permanent consumption at time 0 for country j, and C_o^{j*} is its permanent consumption under the optimal risk-sharing policy, then the welfare gain δ^j can be defined as follows

$$E_0 U\{C_0^J\} = E_0 U\{(1-\delta^i)C_0^{J*}\} \equiv E_0 U\{(1-\delta^i)(\underline{q}_0^j / \underline{q}_0)\underline{C}_0\} \tag{2.19}$$

Accordingly, the author derived stock prices $\underline{q}^j$ and $\underline{q}$, and hence δ^j follows:

$$\delta^j = 1 - (e_0^j \underline{q}_0 / \underline{e}_0 \underline{q}_0^j) E_0 \{U(\underline{C}_0) / U(C_0^J)\}^{(1/(1-\theta))}$$

$$= 1 - \frac{(e_0^J \underline{q}_0)}{(\underline{e}_0 \underline{q}_0^j)} \frac{(1-\beta \exp[(1-\theta)(\underline{\mu} - 0.5\gamma\underline{\sigma}^2)])}{(1-\beta \exp[(1-\theta)(\mu_j - 0.5\gamma\sigma_j^2])} \tag{2.20}$$

From equation (2.20), the welfare gains depend mainly on the utility under equilibrium in the closed economy relative to the optimal world portfolio, in addition to the ratio of domestic equity to the world equity.

Further, the author calculates welfare gains for the G7 countries using equation (2.20). The results show that welfare gains are higher for larger values of risk aversion coefficients and intertemporal substitution factor; also assuming that consumption mean growth rates differ across countries and over time. However, Cole and Obstfeld (1991) show that the gains from an internationally diversified portfolio are quite small, amounting to 0.15 per cent of the output per year even at high levels of risk aversion coefficients based on United States data.

Lewis (1996, 1999) examines the welfare gains based on consumption data and stock returns data based on the mean-variance approach. Her analysis using stock returns data is based on constructing portfolios of domestic and foreign assets that maximise return and minimise risk, and comparing the performance of these portfolios to domestic-dominated portfolios. She finds that the welfare gains from international risk-sharing based upon stock returns are significantly higher than gains resulting from consumption-based models. The paper concludes that the difference in results between both estimates rely mainly on whether stock returns are treated as exogenous or endogenous, differences in the statistical properties between growth rates of consumption data and stock returns, and the choice of preference coefficients used regarding the risk aversion and intertemporal substitution factors.

However, consumption-based models seem to fail empirically in explaining asset pricing. Possible reasons for that failure include measurement errors present in consumption data sets, and misspecification of the utility function (Campbell and Cochrane, 2000).

2.3.2 Empirical Studies

Empirically, the literature measures equity home bias as the relative difference between actual and optimal foreign portfolio weights. The definition of optimal weights varies among researchers, but as mentioned before, it can be mainly categorised into the use of data-based and model-based approaches (Baele, Pungulescu and Ter Horst, 2007; Sercu and Vanpee, 2007).

The model-based approach relies on the optimal weights computed from the international CAPM, which assumes that there are no transaction costs or barriers to trade, and hence investors are expected to hold the world market portfolio. According to this approach, optimal portfolio weights are defined by the market's share of each country in the world capitalisation (Pesenti and Wincoop, 2002). Adler and Dumas (1983) show that failure of PPP assumption to hold, and the heterogeneity of portfolio choice by individuals tend to make the aggregation of investors into a CAPM untenable. In addition, empirical applications of international CAPM have attracted little support as argued earlier, and hence the reliance on the world portfolio for defining optimal portfolio weights needs be estimated with caution. Additionally, using this approach might imply investigating more of the variation in market capitalisation than the actual change in equity holdings (Sercu and Vanpee, 2007).

On the other hand, the data-based approach mainly depends on the estimation of mean-variance optimisation framework, and the empirical applications range from taking simple average values of the mean and variances of equity returns to the use of DCC models. The development in the data-based approach is mainly to estimate returns' variances with more precision. However, the main argument against the data-based approach remains that mean or realised returns are used instead of expected returns which might lead to volatile investment positions (Merton 1973). Meanwhile, variances and covariances matrices can be estimated with more precision with the use of conditional GARCH models, CCC (Sercu and Vanpee, 2008) and DCC models.

Baele, Pungulescu and Ter Horst (2007) use the previous two approaches for optimal portfolio weights in addition to the Bayesian approach in which they allow for a certain degree of mistrust in the asset pricing model, Multi-Prior correction model of Garlappi et al, and also a combination of the Bayesian approach and the Multi-Prior correction model of Garlappi et al. The authors show that home bias for emerging markets remains high and to a great extent unchanged using the different measures of home bias that they employ.

Other amendments to the data-based approach include those of Sercu and Vanpee (2008), who use the differences between covariances of asset i in the domestic and foreign investor portfolios as their measure of home bias.

On the other hand, the actual foreign weights are commonly determined by the share of foreign equity holdings to the total equity holdings.

Using the difference between actual holdings and optimal (benchmark) weights of foreign/domestic asset as a measure of equity home bias (Chan, Covrig and Ng, 2005; Fidora, Fratzscher and Thimann, 2006; Baele, Pungulescu and Ter Horst, 2007) could result in some drawbacks. For instance, if we assume that

$$HomeBias = Y_{it} - Y_{it}^{*} = \beta X_{it} \tag{2.21}$$

in which Y_{it} is the actual equity holdings to total equity holdings, Y_{it}^{*} is the optimal weights as implied by the data-model approach or the benchmark weights derived from the model-based approach, and X_{it} is the set of explanatory variables explaining the home bias. Then this measure implies a unit coefficient on optimal/benchmark weights (since $Y_{it} = \beta X_{it} + Y_{it}^{*}$); in addition to the probability that we might be explaining more of the variation in the optimal/benchmark weights than the variation in actual equity holdings.

In summary, the different measures used to explain equity home bias fail to an extent to differentiate between domestic and foreign biases apart from Chan, Covrig and Ng (2005). In addition, using the difference between actual and optimal weight of assets as a measure suffers from biases as explained. Further, the effects of different explanatory variables on the domestic equity bias in emerging markets have not reached common conclusions about their significance.

Chapter Three: Testing the Conditional Capital Asset Pricing Model in Emerging Markets

3.1 Introduction

As briefly mentioned, the returns on emerging markets are characterised differently from those on developed countries, which make the implementation of unconditional CAPM difficult in some periods due to the violation of one or more of the CAPM assumptions. Hence, it might be important to analyse the characteristics of returns before testing the CAPM model on emerging countries. For instance, studies show that emerging markets' returns tend to be non-normal (Harvey 1995a,b); or in other words, there might be a need to look beyond the second moment. This would also make the Ordinary Least Squares (OLS) unconditional estimation of CAPM misspecified. The non-normality in returns might be a result of ARCH effects. Therefore the conditional CAPM is expected to provide better estimates. Conditional CAPM mainly relies on the distributional moments of the conditional covariances of returns. Hence, beta's estimate (defined as the ratio of the covariance of given asset return with the market return to the market return's variance) resulting from the conditional CAPM is time-varying and not constant over time as implied by the unconditional CAPM (Hall, Miles and Taylor, 1990).

Most of the emerging countries embarked on gradual capital liberalisation in the 1990s, and hence earlier application of unconditional CAPM in emerging markets would result in flat or little relation with the world market as shown by many studies (Fama and French, 1992; Harvey, 1995b).

The main objectives of this chapter are to examine stock market returns' characteristics and investigate the time-varying conditional covariances and variances in 23 emerging markets in accordance with the world market during the period 1997-2007. Previous empirical studies have mainly concentrated on developed equity markets, and the estimation of CAPM is expected to be enhanced after the liberalisation of emerging markets while allowing for conditional variance-covariance matrix of returns to be time-varying.

Therefore, this chapter is divided into three main sections: The first section identifies the main characteristics of emerging stock market returns and illustrates the unconditional correlation matrix between returns on indexes. The second section tests the unconditional CAPM model on 23 emerging stock markets while the third section investigates conditional CAPM and finally, the conclusion.

3.2 Main characteristics of emerging stock market returns

3.2.1 Definition of emerging stock market

The literature reflects different "emerging stock market" definitions. The World Bank classifies a country as emerging according to its per capita Gross National Income and its changes over time. According to the Standard & Poor's, an emerging market refers to a "stock market that is in transition in terms of increasing size, activity or level of sophistication". The term is more specifically defined as: the assessment of the stock market's relative level of development, whether the country is located in low/middle income group economy, the placement of any restrictions or control on foreign investors, and the presence of distortion in the capital market regarding the lack of transparency and efficiency. The International Finance Corporation (IFC), a private sector corporation established under the World Bank Group, began to use the term "emerging financial markets" in the early 1980s to track nine stock indexes that they considered promising. Later, the list was expanded to include 31 countries in February 1997 and 53 countries by 2003. The list of emerging countries defined by the IFC now mainly includes all developing countries (Beim and Calomiris, 2001). On the other hand, the Morgan Stanley Capital International (MSCI) Emerging Index included 26 countries by the year 1995: Argentina, Brazil, Chile, China, Colombia, Czech Republic, Egypt, Hungary, India, Indonesia, Israel, Jordan, Korea, Malaysia, Mexico, Morocco, Pakistan, Peru, Philippines, Poland, Russia, South Africa, Taiwan Thailand, Turkey, and Venezuela.

3.2.2 Importance of emerging markets

Emerging market capitalisation increased from around 0.2 trillion USD in 1985 to 0.9 trillion USD in 1992 and further increased to five trillion USD in 2006. Its share in the world capitalisation increased from seven per cent in 1985 to around 14 per cent in 2006 (Harvey, 1995a; Demirguc-Kunt and Levine, 1995; Gheeraert, 2006). Mexico, Taiwan and Korea were considered the largest emerging markets in terms of total capitalisation in 1992 (Bekaert and Harvey, 1995).

Figure 3.1 (page 107) shows the percentage share of capitalisation for 23 emerging markets included in the MSCI Emerging Index, divided into regions through the years 2004-2007. On average, the share of emerging markets in South and East Asia constitute almost 50 per cent of the total market capitalisation of emerging markets followed by Latin American countries (around 23 per cent), then the Middle East and Africa, and lastly European emerging countries.

3.2.3. Stock indexes benchmarks

There are primarily three sets of benchmarks for returns on stock market indexes for emerging markets in addition to local data sources. These are the Emerging Markets Database (EMBD) of the International Finance Corporation (IFC), the MSCI, and the ING Barings' Emerging Markets Indexes (BEMI). These indexes share the same feature of using value-weighted portfolio composed of a set of stocks that constitute a substantial share in the market capitalisation for each country (Bekaert et al, 1997). The EMBD provides global and investable indexes (IFCG and IFCI, respectively). The global indexes mainly depend on domestic investors to represent market performance. They do not take into account foreign investment restrictions. The database emerged in December 1980 (backfilled to December 1976[13]) with nine stock markets, and expanded later. The investable index could be considered as a subset of the IFCG index that is "legally and practically available to foreign investors".

The EMBD might suffer from biases related to countries or companies included due to major price interruption as a result of long historical record, and possible wars, economic crisis or change in political regimes that might have occurred during the sample period. Also biases might occur as a result of backfilling for the period 1975-1981 (Goetzmann and Jorion, 1999). In addition, EMBD might have included stock markets as emerging more

[13] Backfilling means that the sample of firms used in 1981 were recorded using price data documented back to December 1976.

recently, which might rather be considered as "developed" stock markets (e.g. Greece) according to Gheeraert (2006). The IFC also uses different selection criteria to select stocks which might result in bias towards "larger and more frequently stocks" (Rouwenhorst, 1999).

On the other hand, the MSCI produces an Emerging Markets Global index (EMG) and an Emerging Markets Free index (EMF) in which the latter resembles the IFCI. Lastly, the ING Barings provides only investable indexes. Bekaert et al (1997) find that the average correlation between the IFC indexes and the BEMI amounts to approximately 96 per cent, while the correlation between MSCI and IFC indexes is around 94 per cent.

The EMBD targets 70-80 per cent of the total market capitalisation based on the largest and most active traded stocks while the MSCI emerging index captures 85 per cent of the free float market capitalisation and differs from the IFC emerging index in that the former does not take into consideration the volume of trading. Instead, it relies more on industries' representation. Further, both indexes exclude strategic public or private shareholdings like governments (Demirguc-Kunt and Levine, 1995; Hacibedel and Bommel, 2007). In contrast, the ING Barings index mainly focuses on liquidity aspects and frequent financial reporting. However, there is no consensus on which benchmark to use for emerging stock market data, although MSCI is the most commonly used (Calverley, Hewin and Grice, 2000).

3.2.4. Distribution of returns and CAPM

This section investigates the main characteristics of emerging markets' monthly returns as compared to findings by previous studies testing returns on emerging stock markets and their relevance to testing CAPM. In doing so, the remaining sections of this chapter refer to the returns on the MSCI indexes for 23 emerging countries[14]. It might be of importance to briefly review how the MSCI index for each country is calculated

$$MSCI_{x,t} = \sum_{i=1}^{N} w_i P_{it} \tag{3.1}$$

in which x stands for the country; N refers to the total number of stocks (constituting 85 per cent of the total market capitalisation) included in the index for country x; P_{it} is the price for each stock in the index (usually available in local currency and USD); and w_i is the weight of each stock in the index measured

$$w_i = \frac{free\,floatadjustedMCAP_i}{\sum_{i=1}^{N} free\,floatadjustedMCAP_i} \tag{3.2}$$

$MCAP_i$ refers to the total market capitalisation. Free float is defined by MSCI as the "total shares outstanding held by strategic investors such as governments, corporations, controlling shareholders and management, and shares subject to foreign ownership restrictions". The free float shares are adjusted by rounding-up shares of a security to the closest five per cent whenever the free float security equals to or exceeds 15 per cent. For instance, a constituent security with a free float of 24 per cent will be rounded up in the index to 25 per cent of its total market capitalisation. A detailed description of the selection criteria and the index methodology can be found in the MSCI methodology book.

Accordingly, continuously compounded returns are calculated as

[14] Namely Argentina, Brazil, Chile, Colombia, Czech Republic, Egypt, Hungary, India, Indonesia, Jordan, Korea, Malaysia, Mexico, Morocco, Pakistan, Peru, Philippines, Poland, Russia, South Africa, Thailand, Turkey, and Venezuela.

$$\widehat{R}_{it} = \ln(\widehat{I}_{it}) - \ln(\widehat{I}_{it-1}) \tag{3.3}$$

in which $\widehat{I}_t$ is the MSCI index in month t for country i. Harvey (1995b) explains that due to the high volatility in emerging markets, arithmetic and continuously compounded returns differ. For instance, Harvey (1995a) reports that the annual arithmetic mean return for Argentina was 71.8 per cent, while the geometric mean return was 26.9 per cent. A less severe difference is found in the Asian Index. Mateus (2004) also calculates the arithmetic return for Cyprus during the period 1992-2002 (which amounts to 0.13 per cent) and the geometric return (-0.83 per cent). The difference between both returns declines to 0.24 per cent in Hungary. Benninga (2000) illustrates that continuously compounded returns provide the appropriate return measure since they allow better distribution of returns, and that they are usually smaller than discretely compounded returns or arithmetic return. Henry and Kannan (2006) demonstrate that the arithmetic average of continuously compounded returns provides a better metric than arithmetic returns.

Regarding the distribution of emerging market returns, the literature mainly identifies four main characteristics: high expected returns associated with high volatility; non-normality of returns; and predictable returns to an extent. In addition to that, there seems to be low correlation between emerging markets and the world index.

The period considered here under this thesis is partially a turbulent period which is characterised by the occurrence of financial crises: the Asian financial crisis in 1997; the Russian financial crisis that dominated the year 1998 and its contagion reached other countries like Brazil and Argentina around 2001; and the Turkish liquidity crisis in the year 2000/2001 (Mateus, 2004). Bruner et al (2003) explain that contagion is "the spread of financial market turmoil from one country to the next causing financial markets to move downward in a synchronized fashion". It does not necessarily mean having high correlation between equity indexes in different countries during a crisis period. Higher correlations can occur during periods of high volatility (Forbes and Rigobon, 2000).

Table 3.1C (page 98) provides summary statistics of monthly returns in emerging markets denominated in USD through the period 1997-2007; while Tables 3.1A (page 96) and 3.1B (page 97) present summary statistics of returns on emerging market indexes and MSCI World index[15] before 2001 and after 2001, respectively in order to shed light on the effects of the financial crises on emerging market returns.

Risk and continuously compounded returns in US dollars are expressed in per cent per annum for each market. Returns are denominated in US Dollars to allow for comparisons between emerging markets.

3.2.4.1 Mean returns on emerging markets

The main contrasting feature between Table 3.1A (page 96) and Table 3.1B (page 97) is that most of the emerging markets under study show negative returns during the period 1997-2001 (Similar to Bruner et al (2003) and Mateus (2004)) in contrast to the period 2002-2007. In particular, severe negative returns dominated Indonesia, Philippines, Thailand and Malaysia. Negative market returns imply that an investor who had chosen a buy-and-hold strategy would have lost money during this period.

[15] The MSCI World index is a market-capitalisation weighted index consisting of 23 developed equity indexes, including the United States and United Kingdom (Harvey, 1995a). It is also argued that the MSCI World index is highly correlated with the United State equity index.

Higher positive mean returns started to dominate in the period 2002-2007. This period witnessed no major financial crisis or contagion in emerging markets as described by Taylor (2007). Also the mean returns on all emerging indexes are higher than the mean return on the world index during this period[16] .

Returns on emerging markets seem to have decreased during the period 1997-2007 compared to earlier periods investigated in previous studies, which could be partially attributed to the negative returns during the financial crisis period. For instance, Harvey (1995b) and Bekaert and Harvey (1997) show that the annual mean US return ranges from 11.4 per cent for Indonesia to 71.8 per cent in Argentina during the period 1976-1992. Beim and Calomiris (2001) explain that emerging financial markets seem to differ from developed markets in the sense that the former tend to range between states of very high returns and states of very low returns due to successful and failed institutional experiments regarding bank regulation, foreign exchange policies and other related political and economic reforms.

Bekaert and Harvey (2003) present a model which suggests that when an emerging market moves from a segmented to an integrated state, expected returns decrease. The results might also seem consistent with those of Bekaert et al (1997) which show that the mean return on emerging markets tended to decline in the 1990s compared to the 1980s. More precisely, Bekaert et al (1997) show that the mean returns on four emerging countries declined from more than 65 per cent in 1980s to less than 25 per cent returns in the 1990s[17].

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[16] Similar findings are also found in Bekaert and Harvey, 1995; Harvey (1995:a,b); Garcia and Ghysels, 1998; Goetzmann and Jorion, 1999; Rouwenhorst, 1999

[17] Most of the capital liberalisation in emerging countries occurred in the early 1990s (Bekaert et al, 1997)

3.2.4.2 Volatility in emerging markets

The literature on emerging stock markets gives special attention to the study of volatility as a key ingredient to asset pricing. Volatility of market returns is sometimes taken as an indicator of the "vulnerability of financial markets and the economy". Volatility can be defined by the standard deviation of market returns, which represents the second moment characteristics of market returns (Poon and Granger, 2003).

There exists a debate on whether volatility in equity prices in emerging prices has resulted from financial liberalisation of these stock markets or not (Bekaert and Harvey, 1997; De Santis and Imrohoroglu, 1997; Aggarwal, Inclan and Leal, 1999; Kim and Singal, 2000; Kearney and Lucey, 2004).

In regard to volatility of market returns, Tables 3.1A (page 96) and 3.1B (page 97) show that the standard deviation values seem to be relatively high during the period 1997-2001 compared to the period 2002-2007 among most emerging countries with the exception of Argentina, the Czech Republic and Jordan. The increased volatility might be attributed to contagion in financial markets during that period. In contrast to Harvey (1995a), and De Santis and Improhoroglu (1997), the high volatility of returns does not seem to be accompanied by high return. For instance in Table 3.3C (page 98), Czech Republic, Turkey, Indonesia and Thailand have the highest standard deviation; while Egypt, Colombia and Peru have the highest mean returns.

During the overall period and the sub-periods studied, the standard deviations of all emerging market returns exceed that of the return on the world index. This result seems consistent with studies that show that volatility tends to be higher in emerging stock markets than in developed markets (De Santis and Imrohoroglu, 1997; Soydemir, 2005). For instance, Harvey (1995b) reports that the standard deviation of USD returns on emerging countries amounts to 24.9 per cent annually in the sample countries under study compared to 13.9 per cent for the MSCI world composite index in the year 1992. Bekaert and Harvey (1997) test volatility of USD returns in 20 emerging countries for the years 1976-1992 and find that annual volatility exceeds 33 per cent in 12 emerging countries and 30 per cent in Colombia, Indonesia and Korea.

Harvey (1995a) ascribes the high volatility in emerging markets to: "lack of diversification in the country index (Schwert, 1989; Roll, 1992); high risk exposures to volatile economic factors (Liew, 1995; Erb, Harvey and Viskantas, 1996); time-variation in the risk exposures; and incomplete integration in the world capital markets (Demirguc-Kunt and Levine, 1996)". On a sample of the 10 largest emerging countries, Aggarwal, Inclan and Leal (1999) relate the high volatility in emerging markets to local events within each country rather than to global events. For instance, Argentina's high standard of deviation (146 per cent) was associated with a period of hyperinflation, Mexico and Brazil's high volatile period coincided with anti-inflation policy implementation, and India's volatile period was during the balance of payments crisis. The contribution of local events in the volatility to emerging market returns can be seen as another indication of segmentation of these markets from the world market (Drobetz, Sturmer and Zimmermann, 2002).

Existing empirical evidence suggests that emerging markets' integration into the world market might lower expected returns, increase the correlation between emerging markets and world market returns and have unclear effects on returns volatility (Bekaert and Harvey, 2003). Mateus (2004) shows that market returns in 11 EU accession countries were low and volatility was declining through the period 1997-2002.

Since the standard deviation can be a misleading measure of risk (Beim Calomiris, 2001), it might be worth looking at Figure 3.2 (page 108) which shows that there are certain periods that reflect higher volatility of market returns (and hence riskier) than others. Some periods of higher volatility are also followed by periods of long-lasting lower volatility, a phenomenon referred to in the literature as "volatility clustering". In this case, it might be difficult to assume that the variance is constant over the whole sample, and hence ARCH effects are likely to be present (Brooks, 2002; Dimitrios and Hall, 2007).

So far, the positive relationship between return and volatility assumed by the CAPM seems to be violated in most of the countries under study. The negative correlation between changes in stock returns and volatility is referred to as leverage effects. The following section attempts to investigate the normality of returns to test whether higher moments seem relevant to the analysis of returns.

3.2.4.3 Normality of returns

Previous studies explore the importance of investigating returns beyond a two-moment framework; there is a lot of significance in looking at higher order moments of returns such that skewness and kurtosis. Jarque-Bera (JB), Kolmogorov-Smirnov and Wald tests are the most common tests for determining the normality of return distribution. The JB test identifies whether or not the coefficient of skewness and coefficient of excess kurtosis are equal to zero. The null hypothesis of a normal distribution is rejected according to the probability of the JB statistics. If the returns are normally distributed, then their means and variances are sufficient to describe their distribution, otherwise tests for higher moments might be required.

Evidence reflects that investors are likely to have preferences for the third and fourth distributional moments (Aggrawal and Schatzberg, 1997). Investor utility function shows that investors will probably prefer skewness and be averse to kurtosis (Scott and Horvath, 1980). Thus testing for skewness and kurtosis provides a better picture of the probability distribution of risk, which might be crucial for the CAPM examination.

In contrast to Aggrawal, Inclan and Leal (1999) and De Santis and Improhoroglu (1997), emerging markets returns tend to be mostly negatively skewed during the whole period under study as can be noted from Tables 3.1A (page 96) and 3.1C (page 98). However, the number of countries with negative skewness returns tend to decline in sub-periods. According to Adcock and Shutes (2005), skewness of returns tend to be lower during a small interval of time. The negative skewness coefficient might not be surprising given that most emerging countries had negative market returns as a result of financial crisis suffered during the period 1997-2001 and possible "contagion", as mentioned earlier (Drobetzet Sturmer and Zimmermann, 2002).

On the other hand, emerging market returns tend to be leptokurtic. The kurtosis coefficients vary among the sample countries: most countries range from 4-6 during 1997-2007, while the highest values are reached in Turkey and Peru[18]. This indicates that the unconditional distribution of returns has a heavier tail compared to the normal distribution.

[18] Similar findings can be found in De Santis and Improhoroglu, 1997.

Bekaert and Harvey (1997) illustrate that the skewness coefficient seems to have shrunk in the 1990s compared to the 1980s in most of the emerging countries investigated. Furthermore, the change in kurtosis coefficient is considered minor.

Table 3.1C (page 98) shows that the normality distribution of the returns in emerging countries during the period 1997-2007 is violated in almost all countries at 10 per cent significance level with the exception of Egypt[19], while during the sub-periods shown in Tables 3.1A (page 96) and 3.1B (page 97), the normality of returns cannot be rejected in most countries under study, due to the short sample period. These characteristics tend to contradict the assumptions of CAPM in the sense that the returns tend to divert from normality, suggesting that higher moments might seem important in evaluating the mean-variance approach of the unconditional CAPM.

3.2.4.4 Predictability of returns

Autocorrelation and partial autocorrelation functions help to determine the pattern in which an observation of a given series depends on its lagged observations (e.g. to what extent present market's return predicts future return). It is argued that whether or not market returns follow a random walk process has implications on the appropriate asset pricing model. The random walk model would imply that the market is efficient, meaning that stock returns exhibit unpredictable behaviour, and that they reflect available information (Karemera, Ojah and Cole, 1999).

Most of the literature on emerging market returns agrees that emerging markets' returns can be predictable to some extent. The degree of predictability in developed

[19] See also; Bekaert and Harvey, 1997; Aggarwal, Inclan and Leal, 1999; Drobetzet Sturmer and Zimmermann, 2002.

countries is found to be low and more dependent on economic instrument variables (Drobetz, Sturmer and Zimmermann, 2002). The predictability of returns can be measured by identifying the first-order correlation coefficients (ρ_1), in which ρ_1 is expected to be equal to zero if market returns vary randomly. If ρ_1 is positive, this would imply that positive departures in returns from the mean are likely to be followed by positive departures in returns from the mean; negative autocorrelation is usually seen as an indication of price reversals (Brown, 1979).

Table 3.1C (page 98) shows that the majority of the markets exhibit positive serial correlation, and higher serial correlation than the return on the MSCI world index during the whole period under study. In contrast, nearly more than half the sample of countries under study have negative first order correlation during the period 1997-2001 which gives rise to the probability of price reversal during financial crisis (Table 3.1A (page 96)). On the other hand, Table 3.1B (page 97) reveals that positive serial correlations dominate emerging markets during the period 2002-2007.

Autocorrelation coefficients of market returns are found to be positively correlated in most studies on emerging markets, which might imply that shocks in the volatility process might have a long-term effect (Poon and Granger, 2003). Besides, there is some consensus in the literature that the first-order autocorrelation coefficients for emerging countries seem to be higher than that found in developed markets (Claessens and Gooptu, 1993; Harvey, 1995a; Mateus, 2004). For example, the serial correlation for the Latin America stock index amounts to 25 per cent compared to three per cent on the MSCI World index. 12 out of 20 emerging countries have first-order serial correlation above 10 per cent. The results shown in Tables 3.1A (page 96) and 3.1C (page 98) show lower serial correlation than what has been documented in previous studies. The decline in predictability of market returns might mean more frequent trading and an improvement in market efficiency due to increased integration with the world market (Harvey, 1995a; Kim and Signol, 2000; Mateus, 2004). In addition, many emerging market returns are becoming more characterised by mean reversion like some developed markets.

Reasons behind the observed autocorrelation vary across studies. Harvey (1995a) explains that it might be as a result of infrequent trading of the index stock, and as the size of the stock market increases, infrequent trading of stocks seems to decline. Other factors for the higher percentage of serial correlation include slow adjustment to new announcements, market inefficiencies (Bekaert and Harvey, 2003), non-synchronous price quotes (Lo and Mackinlay, 1990) and limited information set used by investors (Cohen et al, 1980).

In summary, the presence of high serial correlations coefficients in emerging markets is taken as an indicator of weak market efficiency in emerging countries (Harvey 1995b; Bekaert et al, 1997).

3.2.4.5 Unconditional correlation between emerging equity returns and the MSCI World return

Table 3.2 (page 99) presents the unconditional correlation coefficients among the returns for emerging countries, and the world market. Jordan and Morocco have the lowest insignificant correlations with the return on other emerging markets and the return on the World Index. Most correlations range from 0.25 to 0.55. Most of the European emerging countries show correlations around 0.50 with the return on the World Index, and around 0.30 with other emerging countries.

Brazil, Chile and Mexico returns are highly correlated with the return on the World Index, ranging on average around 0.65, while the correlations of returns on Argentina, Colombia, Peru and Venezuela with the return on the World index range around 0.30 [20].

Philippines, Thailand and Korea have the highest correlations among South, East and South-East Asia ranging around 0.40 with the MSCI World Index (see also Soydemir, 2005).

Regarding the Middle East and Africa, South Africa has the highest correlation with the return on World index (58 per cent) followed by Egypt (26 per cent). The result might seem consistent with Collins and Abrahamson's (2006) study which shows that the cost of equity in five African emerging countries is declining with the exception of Morocco.

The highest cross-correlation is noted between Brazil and Chile (74 per cent), followed by Brazil and Mexico (70 per cent).

Thus, emerging countries exhibit moderate correlation among each other and the world market. There seems to be an increase in correlations between emerging countries and the world market compared to calculated correlations obtained by previous studies (Kim and Singal, 2000; Bekaert and Harvey, 2003; Mateus, 2004; Esrada and Serra, 2005). For instance, Harvey (1995b) shows that in a sample of 18 emerging markets, the cross-country correlations between emerging markets are low and negative over the period

[20] Marshall, Maulana and Tang (2009) also show that Latin America markets have the highest unconditional correlation with the MSCI World index, using daily dataset for the period January 1995 until December 2003.

1986:03-1992:06. On average, cross-country correlation of emerging countries amounts to 12 per cent compared to 41 per cent in 17 developed markets. This increase in cross-correlation and correlation with the return on world index presented in Table 3.2 (page 99), which might reflect more integration in the world market unless the increase is temporary and only resulting from "potential bubble in the global technology stocks" (Bekaert and Harvey, 2003; Carrieri, Errunza and Sarkissian, 2004). It also implies that most emerging stock markets are still developing, and their fully integration with the world market is still in the process.

Even though returns' correlation between emerging and developed markets can be an indicator of how integrated or segmented an emerging market is, it might seem not sufficient. The results on returns' correlation might need to be taken cautiously. Bekaert and Harvey (1995) show that the correlation between emerging market return and the world return can be low or negative while the emerging market is perfectly integrated into world markets as a result of differences in industry mix between both markets in addition to low liquidity and the important role of local factors (Mateus, 2004). On the other hand, the presence of investment regulations on foreign participation might give the impression that emerging markets are segmented from the world market, while this is not the case in Korea and Taiwan, for example, because the international investors are still able to access these markets through USD and non-USD country funds.

Collins and Abrahamson (2006) offer another recent contribution to the literature related to the effect of financial liberalisation in emerging countries on increased integration in world market. The paper uses changes in the cost of equity (by comparing the percentage change in the cost of equity during the period 1995-1999 to 1999-2002) as an indicator of the changes that occur in sector growth as a result of integration. The cost of equity is measured on a sector-by-sector basis in six African emerging countries. The measure depends on volatility in sectors' share price and global market performance. Sectors which are more integrated with the world market are expected to be less volatile, and hence imply low cost of equity. Collins and Abrahamson (2006) reveals a declining cost of equity in the majority of countries through the period 1999-2002 (except Morocco) and the lowest cost of equity is found in Egypt. The authors relate the declining cost of equity not only to integration but rather to the structure of the market in these countries. The analysis shows that the cost of equity seems to decline the most in the largest sectors in each market. For instance, Zimbabwe's largest sector (i.e. Financials constitute 81 per cent of market capitalisation) has one of the lowest cost of equity. The industrial weight seems to differ considerably compared to developed countries. For example, the Financials constitute only 25 per cent in the United Kingdom.

In conclusion, the summary of statistics for the returns on emerging market indexes shows that the returns tend to be leptokurtic, and that signs of volatility clustering and leverage effects might exist. Moreover integration of these emerging markets in the world market seems modest during the period 1997-2007, although increasing in comparison to previous periods. The characteristics seem to contradict some of the basic assumptions of CAPM. One would assume that using multivariate GARCH model might enhance the results of CAPM, compared to the unconditional CAPM since it accounts for volatility clustering and leptokurtosis shown in the returns on emerging market indexes.

3.3 Testing the unconditional CAPM in Emerging Countries

This section tests whether 23 emerging markets that constitute most of the MSCI Emerging Index allocate their money according to the simple prediction of the unconditional CAPM using monthly data over the period 1997-2007.

3.3.1 The Dataset

The dataset consists of monthly data over the period January 1997- September 2007. Monthly returns are used instead of weekly data to avoid possible biases as the result of infrequent trading. Harvey (1995b) explains that on average, emerging markets have higher turnover compared to the average turnover in the United States, United Kingdom and Japan. The MSCI total return index in USD is used to compute returns for each market. The MSCI total return index includes price, performance and dividend payments[21]. The short term US Treasury bill rate is employed as a proxy for the risk-free return. The return on the MSCI world index in USD is used as a proxy for returns on the market portfolio. The data are extracted from DataStream, and International Financial Statistics (IFS) of IMF.

3.3.2 Estimation of unconditional CAPM in emerging markets

Prior to the estimation of the unconditional CAPM using OLS, the time series properties (stationary) of excess returns are examined. Augmented Dickey-Fuller (ADF) test is employed in order to test the stationarity of excess returns on market indexes and the market premium. The null hypothesis of unit root is rejected on all the excess returns

[21] The MSCI total return indexes are defined by the Morgan Stanley organisation as a measure for market performance, including price performance and income from dividend payments.

examined as well as in the market premium at 1 per cent significance level as reported in Table 3.3 (page 101). The ADF tests are estimated using a constant and no trend. The unconditional CAPM estimation usually follows Fama and MacBeth's (1973) two-pass approach mentioned in chapter two. Firstly, the beta is estimated for individual markets for the period January 1997- December 2007 as follows

$$R_{it} - R_{ft} = \hat{\alpha}_i + \hat{\beta}_i (R_{mt} - R_{ft}) + \varepsilon_{it} \tag{3.4}$$

in which, R_{it} is the return on equity index of market i; R_{ft} is the return on the US Treasury bill rate; R_{mt} is the return on the MSCI world index; β_i is the estimated beta of equity index of country i; and ε_{it} is the random error term.

Secondly, the betas estimated for each market are used to calculate the following cross-sectional regression

$$\overline{R}_{it} = \gamma_0 + \gamma_1 \hat{\beta} + u_{it} \tag{3.5}$$

where $\overline{R}_{it}$ represents the mean of excess returns for each market (return on equity index in excess of the risk-free rate), and $\hat{\beta}_i$ is estimated from equation (3.4). The average values of the coefficients γ_0 and γ_1 are then calculated, and tested to assess whether they are significantly different from zero. According to CAPM assumptions, γ_0 is expected to be equal to zero while γ_1 is assumed to be significantly different from zero and is expected to be equal to the market premium.

The monthly excess returns on market indexes are regressed on a constant and the excess returns on World market index for 23 emerging markets. The excess return is calculated as the difference between the market return and the US Treasury bill rate.

Beta estimates are presented in Table 3.1C (page 98). The coefficient estimates on all betas are significantly different from zero mostly at 1 per cent level except for Egypt, and they range from 0.27 in Morocco to 2.10 in Turkey[22]. Turkey has both the highest beta and standard deviation which might be attributed to the high volatility of exchange rates during this period.

A cross-sectional regression is then calculated in order to estimate equation (3.5). The results are shown below (in which the number in parentheses denotes p-value)

γ_0	**-0.026** **(0.000)**
γ_1	**3.39E-05** **(0.990)**
R-squared	**0.000**
F-statistic	**0.0001** **(0.990)**

The table above shows the mean of the monthly coefficients of the intercept (γ_0) and the slope (γ_1). The Newy and West t-statistics is used in order to account for possible effects of heteroscedasticity. It can be shown that γ_0 is significantly different from zero

[22] Also Marshall, Maulana and Tang (2009) show that the unconditional betas' coefficients are positive and significantly different from zero in emerging markets; with the exception of Pakistan, during the period January 1995-December 2003.

while the null hypothesis that γ_1=0 cannot be rejected at 10 per cent significant level. In addition to that, γ_1 is expected to be equal the mean of market premium (-0.030) which is not the case.

To conclude, the results show that the positive relationship between the mean of excess return and the beta is rejected; also there is almost a flat and insignificant relationship between the means of excess returns and their betas.

Understanding the characteristics of returns provides an explanation for the failure of unconditional CAPM as noted in previous studies, and also the assumption that the beta is constant during this period might have contributed to the failure of the unconditional CAPM estimated. The next section examines the conditional CAPM, in which the betas are allowed to vary over time and also take into account possible volatility clustering in the data.

3.4 Conditional CAPM in Emerging Countries

This section allows the betas for emerging markets to be time-varying. It aims to investigate whether conditional CAPM would model excess returns on emerging markets better than the unconditional CAPM. The literature review shows that the conditional CAPM is mainly investigated in developed markets with the exception of Marshall, Maulana and Tang (2009). However, this study differs from Marshall, Maulana and Tang (2009) in the methodology and the data set used. They use daily data for emerging markets during the period January 1995-December 2008; while this study employs monthly data for the period January 1997-December 2007, allowing for the effect of financial liberalisation in the emerging markets under study. Marshall, Maulana and Tang (2009) use bivariate GARCH with VECH parameterisation, Schwert and Seguin (1990) model, Kalman filter, and DCC model to estimate time-varying betas. However, this study applies bivariate GARCH with BEKK parameterisation in order to estimate the time-varying covariance matrix with regard to the world market.

3.4.1 Estimation of conditional CAPM in emerging markets

According to the bivariate GARCH model with the BEKK representation, the conditional covariance is assumed to depend on its own lagged covariance and the cross-product of past forecast errors (Bollerslev, Engle and Wooldridge, 1988). The model extends the static CAPM on the information available in the last period, which as expressed in Hall, Miles and Taylor (1990) below

$$E(R_{it}|\Omega_{t-1}) - r_{ft-1} = \beta_i\{E(R_{mt}|\Omega_{t-1}) - r_{ft-1}\}$$

where; $$\beta_{it} = \frac{Cov(R_{it}, R_{mt}|\Omega_{t-1})}{Var(R_{mt}|\Omega_{t-1})} \tag{3.6}$$

in which, R_{it}, R_{mt}, and r_{ft-1} are the return on a country i's MSCI index, return on the MSCI World index, and the last period US Treasury bill, respectively. Ω_{t-1} represents the information set available at time $t-1$.

One way to overcome the difficulty of finding the expected excess return on countries' indexes is to assume that the market price of risk is constant during the period under study. Thus the market price of risk can be defined as:

$$\lambda = \frac{E(R_{mt}|\Omega_{t-1}) - r_{ft-1}}{Var(R_{mt}|\Omega_{t-1})} \tag{3.7}$$

Hence, we can express R_{it} and R_{mt} as

$$\begin{aligned} R_{it} &= r_{ft-1} + \lambda \operatorname{cov}(R_{it}, R_{mt}|\Omega_{t-1}) + \varepsilon_{it} \\ R_{mt} &= r_{ft-1} + \lambda \operatorname{var}(R_{mt}|\Omega_{t-1}) + w_t \end{aligned} \tag{3.8}$$

where,

$$\varepsilon_{it} = R_{it} - E(R_{it}|\Omega_{t-1}) \tag{3.9}$$

and $\quad w_t = R_{mt} - E(R_{mt}|\Omega_{t-1})$

ε_{it} and w_t are the innovations on the returns on country's index and the return on the MSCI World index, respectively.

In other words, equations (3.8) and (3.9) express the conditional second moments in which

$$\operatorname{var}(R_{mt}|\Omega_{t-1}) = E(w_t^2|\Omega_{t-1}) \tag{3.10}$$

and $\quad \operatorname{cov}(R_{it}, R_{mt}|\Omega_{t-1}) = E(\varepsilon_{it} w_t|\Omega_{t-1})$

This conditional CAPM can be expressed by bivariate GARCH model:

$$R_t = \mu + \lambda H_t e + v_t \tag{3.11}$$

where; R_t = $(R_{it} - r_{ft-1}, R_{mt} - r_{ft-1})'$, the constant mean of R_t is the vector μ of dimension $N \times 1$ while H_t represents the conditional variance-covariance matrix of $N \times N$ dimension, and $v_t = (\varepsilon_{it}, w_t)'$

One of the representations for multivariate GARCH conditional covariance is the BEKK parameterisation which can be written as

$$H_t = C'C + A'e_{t-1}e'_{t-1}A + B'H_{t-1}B \tag{3.12}$$

in which C is an $N \times N$ lower triangular matrix with intercept parameters. In this case, A and B are constrained to be diagonal matrices of $N \times N$ dimension. The diagonal representation assumes that the conditional variances and covariances between the excess return on a country's index and the world market are functions of lagged values of squared errors and lagged squared residuals. Elements of matrix A represent the effect of past innovation in a given market and the world market while elements in the symmetric matrix B indicate the persistence of conditional volatility in a given market and on the world market. The diagonal constraint also reduces the number of parameters to a total of nine in the case of the bivariate GARCH. Moreover, the BEKK representation imposes positive definiteness on the matrices A and B due to the quadratic nature of terms on the right hand side of equation (3.12) (Brooks, 2002). Equation (3.12) can be expressed in matrices format as follows

$$H_t = C'C + \begin{bmatrix} a_{11}^* & a_{12}^* \\ a_{21}^* & a_{22}^* \end{bmatrix} \begin{bmatrix} \varepsilon_{1,t-1}^2 & \varepsilon_{1,t-1}\varepsilon_{2,t-1} \\ \varepsilon_{2,t-1}\varepsilon_{1,t-1} & \varepsilon_{2,t-1}^2 \end{bmatrix} \begin{bmatrix} a_{11}^* & a_{12}^* \\ a_{21}^* & a_{22}^* \end{bmatrix}'$$

$$+\begin{bmatrix} b_{11}^{*} & b_{12}^{*} \\ b_{21}^{*} & b_{22}^{*} \end{bmatrix} \begin{bmatrix} h_{11,t-1} & h_{12,t-1} \\ h_{21,t-1} & h_{22,t-1} \end{bmatrix} \begin{bmatrix} b_{11}^{*} & b_{12}^{*} \\ b_{21}^{*} & b_{22}^{*} \end{bmatrix}' \tag{3.13}$$

Or

$$\begin{aligned} h_{11t} &= c_{11} + a_{11}^{*2} \varepsilon^{2}{}_{1,t-1} + b_{11}^{*2} h_{11,t-1} \\ h_{12t} &= c_{12} + a_{11}^{*} a_{22}^{*} \varepsilon_{1,t-1} \varepsilon_{2,t-1} + b_{11}^{*} b_{22}^{*} h_{12,t-1} \\ h_{22,t} &= c_{13} + a_{22}^{*2} \varepsilon_{2,t-1}^{2} + b_{22}^{*2} h_{22,t-1} \end{aligned} \tag{3.14}$$

Equation (3.11) is estimated using the maximum likelihood method assuming that the random errors are normally distributed. The log-likelihood for a sample for T observations and N assets can be expressed as follows:

$$\ln(\Theta) = -\frac{TN}{2} LN(2\pi) - \frac{1}{2} \sum_{t=1}^{T} \{\ln|H_t(\Theta)| + \varepsilon_t{}'(\Theta) H_t^{-1}(\Theta) \varepsilon_t(\Theta)\} \tag{3.15}$$

where Θ is the vector estimated which contains the conditional mean and variance equations. The BHHH (Berndt, Hall, Hall and Hausman) algorithm is used to maximize the log-likelihood function.

Table 3.4 (page 102) presents the estimates of the likelihood estimation for the bivariate models for the emerging markets under study during the period 1997-2007.

The coefficients C_{11}, C_{12} and C_{13} mainly specify the long-run matrix. They are mostly insignificant at all conventional significance levels. This might give rise to the importance of the short-run volatilities. Regarding the ARCH parameters of estimated coefficients in matrix A, they are mostly significant at 10 per cent level except for a few markets. a_{11} indicates the significance of the lagged excess returns shocks ($\varepsilon_{1,t-1}^{2}$) which is found to be significant in East and South Asian markets with the exception of India, and also in most Latin American markets in addition to the Morocco and South Africa coefficients. This may suggest that volatility in excess market returns is affected by innovations in the previous period. The highest values for the coefficient a_{11} are reported for Korea, Russia and South Africa.

On the other hand, a_{22} shows the effect of lagged market premium shocks $(\varepsilon_{2,t-1}^2)$ which is found to be significant at 10 per cent significance level in most countries with the exception of Malaysia, and India in East and South Asia and Turkey in Europe. Meanwhile, the highest values for the coefficient a_{22} are obtained for Brazil, Turkey, Poland and Morocco.

The effect of lagged cross term $\varepsilon_{1,t-1}\varepsilon_{2,t-1}$ is not obvious since it depends on the cross multiplication of a_{11} and a_{22}. With respect to the magnitudes of a_{11} and a_{22}, they hover around 0.25, which are larger than estimates from previous studies (for instance Engle and Rodrigues, 1989; Hall, Miles and Taylor, 1990; Hansson and Hordahl, 1998; Marshall, Maulana and Tang, 2009).

The GARCH parameters are given by the diagonal elements of matrix $B'B$, which show the effect of past values of conditional variance. Table 3.4 (page 102) shows that b_{11}, which indicates the effect of lagged conditional variance of excess return ($h_{11,t-1}$) is statistically significant at 10 per cent level in most markets with the exception of Peru, India, Hungary, and Poland. The highest coefficients values (around 0.98) are reported for Chile, the Philippines and Turkey. b_{22} coefficients are to be found even more significant with the exception of only India. The magnitude of b_{11} and b_{22} vary from 0.85-0.96, which is considered higher than estimates obtained by Engle and Rodrigues (1989), Ng (1991), and Hansson and Hordahl (1998), but similar estimates are found in Hall, Miles and Taylor (1990). Higher coefficients magnitudes might be a result of higher volatility in these emerging markets similar to Marshall, Maulana, and Tang (2009) compared to estimations on more developed markets.

Figure 3.4 (page 112) shows the conditional time-varying variances and covariances. In all the emerging markets studied, the conditional variances of the excess returns on emerging indexes exceed the conditional variance on the market premium throughout the sample period with the exception of Jordan.

3.4.1.1 Results for Latin America

Studies show that the Russian crisis, and also the Asian crisis had spillover effects on the Latin America financial markets. As can be noted from Figures 3.3 (page 110) and 3.4 (page 112), Argentina, Brazil, and Venezuela have the highest levels of conditional variances and time-varying betas during late 1998.

The conditional variance on Argentina's excess return started to increase by the year 2001, but reached its peak by the year 2002 (approximately equals to 0.036). The Argentinean crisis dates back to 30 November 2001 in which the Argentinean president De La Rua limited the cash withdrawal from banks to $1000 followed by the Peso devaluation.

Brazil witnessed two main crises during the period under study: 1998-1999, and 2001-2002. Figures 3.3 (page 110) and 3.4 (page 112) indicate that the excess return on the Brazil index and its beta reached their highest during these two periods. With Brazil's devaluation crisis in early 1999, Figure 3.4 (page 112) shows how the excess return on Brazil's index remains highly volatile during 1999. The high conditional covariance could be partially attributed to the high unconditional correlation coefficient between Brazil and the world index (as can be seen in Section 3.1.4).

It is also worth mentioning that the conditional variances remain high during and after the crisis, as in the case of Argentina, Brazil, Chile and Colombia, while the conditional variances for Mexico, Peru and Venezuela excess returns decline almost a year after the crisis.

Latin American markets seem to exhibit higher a_{11} and a_{22} coefficients values followed by South Asia, Middle East and Africa, and lastly emerging European markets. As noted section 3.2.4.5, most Latin American markets exhibit high unconditional correlation coefficients with the world index and the emerging index. This might give rise to the relation between the increased integration of emerging markets and the effect of short-run shocks on these markets.

3.4.1.2 Results for South and East Asia

Most markets, with the exception of India, seem to reach the peak of their conditional variances through the years 1998-1999. The Indian Rupee did not suffer major depreciation during the Asian Crisis. According to Dua and Sinha (2007) "India was relatively isolated". This might seem consistent with the bivariate estimation for India in which almost all the coefficients are insignificantly different from zero.

The patterns in the Philippines, Thailand, Malaysia, and Indonesia seem similar where the conditional variances started to decline by the year 2001. Dua and Sinha (2007) explain that the Asian crisis spread quickly from Thailand to Malaysia, the Philippines, and Indonesia, which could explain the similar structure in conditional variances of their excess returns. According to Gong, Lee, and Chen (2004), Thailand first experiences the crisis in 1998, which might partially explain the highest beta estimate (of 2.7) for Thailand during this year. Korea's conditional variance seems remarkable. It reached a high of 0.11 in 1998 and dropped the following year to 0.03. Gong, Lee, and Chen (2004) explain that "Korea was severely affected by the crisis.., but the crisis was over quickly". South Korea was significantly hit during the Asian crisis as a result of widespread companies' bankruptcies leading to the fall of its stock index and thus capital outflow (Dua and Sinha, 2007). The spiral downwards of Korea's stock index during the Asian crisis might partially explain the high value of its a_{11} coefficient.

Another notable observation from Figures 3.3 (page 110) and 4.4 (page 112) is that Korea, Thailand and Indonesia have the highest betas and the highest conditional variances as well. According to Calverley, Hewin and Grice (2000), the three markets were the most affected by the Asian crisis in 1998. The result might seem consistent with the unconditional correlation coefficients calculated in section 3.2.4.5, in which Thailand and Korea reported the highest correlations among South-East Asia of around 0.4 with the MSCI World Index.

Malaysia suffered from a strong speculative attack on its Ringgit which resulted in its depreciation by January 1998. Poon (1999) explains that devaluation of the Ringgit was followed by fall in the Malaysian stock market index as a result of contagion effect from Thailand.

3.4.1.3 Results for Emerging Europe

Gelos and Sahay (2001) show that the Asian crisis had substantial spillover effects on the Czech Republic, Hungary, Poland and Russia as reflected in the increase in these markets' excess returns' conditional variances, and conditional betas during 1998.

The effect of the Russian crisis on the Russian stock market can be noted through the high beta during the year 1998/1999. The conditional beta of around 6 during this period is considered the highest among emerging markets during the period under study.

Further, the Russian crisis had a financial spillover on other financial markets, with Eastern European markets being partially affected in addition to some markets in Latin America. Hungary was immediately affected, but its stock market retained more stability by the year 1999. Figure 3.4 (page 112) shows the jump in Hungary's beta to 1.8 by mid 1998, and the increase in its excess return conditional variance to 0.015. The figures might also indicate the short-lived effect of the crisis on its excess return, in which the conditional variance and beta decline by the year 1999.

The spillover effect of the Russian crisis on the markets of Poland and the Czech Republic stock markets might seem less obvious partially due to less foreign exposure in these two markets prior the crisis (Calverley, Hewin and Grice, 2000).

As can be seen from Figure 3.4 (page 112), the conditional variance on the Czech excess return reaches around 0.011 in the year 1997, and stock market volatility increased before 1997 prior to the Czech crisis in May 1997. According to Gelos and Sahay (2001), the Czech crisis had a limited effect on other emerging European markets.

The estimated unconditional correlation coefficient of Turkey's index with the world is equal to 55 per cent. Gazioglu (2003) estimates that the foreign investors share in the Istanbul Stock Exchange amounts to almost 50 per cent in 2003, and shows that it increases the vulnerability of the stock market. The bivariate estimation shows that a_{22} and b_{22} coefficients are considered high among the markets under study. This might indicate the high effect of shocks and conditional variance of the market premium on Turkey's excess return. The conditional variance for Turkey's excess return seems to have risen during 1998, and late 1999, and reached its peak by the year 2001. During 2001, Turkey suffered a decline of almost one-third of its foreign reserves in order to maintain the exchange rate of its Lira which later depreciated by almost 50 per cent by 2001. The country later experienced banking crisis, debt crisis and credit crunch. Shachmurove (2003) shows that the Turkish stock market remained volatile during the early months of 2003 as a result of mixed signals from some economic indicators. The fluctuations in Turkey's excess return variance might indicate that domestic factors impose an effect.

3.4.1.4 Results for Middle East and Africa

As can be seen from Figure 3.4 (page 112), the conditional variance for Egypt's excess return shows a high of 0.012 by the year 1999, which can be the result of the Asian crisis and domestic terrorist attacks in the South of Egypt. After September 11, 2001 the exchange rate was significantly affected, and the monetary authorities announced a change to the floating regime which resulted in the depreciation of the exchange rate of the Egyptian Pound of about 30 per cent. The conditional variance on Egypt's excess return reached its peak in 2005, which might be due to other domestic terrorist attacks, and a change of Prime Minister as well as some other ministers, which could have affected the stock market expectations. This led to a decline in the stock market index.

The conditional variance in Jordan's excess return shows an interesting trend. Before 2003/2004, the conditional variance on market premium seems to have exceeded the conditional variance on Jordan's excess return, whereas after 2003/2004, the trend changed dramatically. Jordan managed to maintain a fixed exchange rate vis-à-vis the US Dollar during the whole period under study, and comprehensive reform of the stock market was introduced in 1999. Starting in 2003, the volatility in the Amman stock exchange (ASE) increased, partially due to an escalation in Palestinian territories and the United States war on Iraq (Shachmurove, 2003).

Conditional variance in South Africa excess return has witnessed one of the highest levels among the markets under study. South Africa is considered one of the sophisticated financial markets and quite exposed to the world market (with unconditional correlation coefficient of 60 per cent with the world index). South Africa's stock exchange was severely affected by the Asian financial crisis, whereby equity prices declined, and the Rand depreciated against the US Dollar by 14 per cent.

According to Collins and Biekpe (2003), the contagion of the emerging global crisis affected the largest and most traded markets in Africa; namely South Africa and Egypt. This conclusion supports the dramatic change in conditional variances on South Africa's and Egypt's excess returns.

In Summary, during the Asian crisis, the conditional variances on emerging markets' excess returns increased in almost all countries (Figure 3.4 (page 112)). Also the time-varying beta coefficients show a rise in most of the markets under study. This might indicate that the covariances between excess market returns and the market premium during the crisis were relatively high with the exception of Malaysia, Morocco and Jordan. This could be attributed to the low insignificant unconditional correlation coefficients between Morocco and Jordan and the return on the MSCI World index and also the return on emerging index (See section 3.2.4.5).

The fluctuations in these emerging excess returns can be partially attributed to the volatility in exchange rates since excess returns are denominated in US Dollars. As has been briefly highlighted, at least half of the countries under study experienced major devaluation in their currencies during the period under study. Identifying the change in volatility of emerging markets' returns due to the usage of local currencies instead of the US Dollar will be dealt with in the next chapter.

3.4.2 Diagnosis Test

For diagnostic checking, this section examines serial correlation in standardised residuals ($\varepsilon_t h_t^{-\frac{1}{2}}$) for excess returns and the market premium estimated from the BEKK model. The Ljung box statistics of up to the 12th-order serial correlation are reported in Tables 3.5A (page 105) and 3.5C (page 106). The standardised residuals and squared standardised residual for the excess returns indicate no significant order dependence up to the 12th lag for most of the markets at 10 per cent significance level with the exception of Argentina, Philippines, Indonesia, India, and Czech Republic. On the other hand, the normality of the squared standardized residuals for excess returns cannot be rejected at 10 per cent significance level except for Russia and South Africa for high order serial correlations[23].

Meanwhile, the standardized residual and squared standardised residual ($\varepsilon_t^2 h_t^{-1}$) on the market premium are consistent with the normality assumption in all markets as can be seen in Tables 3.5B (page 105) and 3.5D (page 106), in which the null hypothesis of normality distributed residuals cannot be rejected at any conventional significance level.

The results from Tables 3.5A (page 105) and 3.5C (page 106) indicate that the residuals, and squared standardised residuals from the bivariate estimates follow normality in most of the markets with few exceptions. The estimates seem to imply a good description of excess returns in these emerging markets, and also seem to provide insights into the effect of international financial crises and domestic imbalances on excess returns.

3.5 Conclusion

This chapter investigates the characteristics of returns and the behaviour of conditional volatility in emerging markets by testing both the static and time-varying CAPM. The examination of returns' characteristics extends the findings of relevant literature, in which emerging markets' returns seem to be higher than the return on the world index and more volatile, in addition to showing signs of leptokurtic and predictability during the period 1997-2007. The analysis of the bivariate GARCH estimation shows that

[23] The rejection of normality of the squared standardised residuals for excess returns on the Russian and South African indexes might require the estimation of higher order bivariate GARCH model, but since the estimation of the bivariate GARCH model for the 23 markets is complicated enough, the study chooses to maintain the same model for all the markets since the normality of standardised and squared standardised residuals was not rejected for most of the markets under study. Also, in order to obtain comparable results among the markets under study.

the conditional ARCH and GARCH coefficients seem significant in most of the markets, and more significant than the constant long-run effects. The coefficients' values seem higher than those estimated in earlier studies for developed markets, which might indicate higher conditional volatility in these markets. Given the increased level of integration of these emerging markets into the world market, one would expect that investors will show a tendency to diversify their portfolios.

In addition, it has been shown that the conditional variances of emerging markets returns seem time-varying and their covariances with the world index are not constant. In the absence of transaction costs, time-varying optimal weights of international equities might need to be calculated (Flavin and Wickens, 2000).

The next chapter examines the effect of time-varying variances and covariances on the optimal portfolio selection with particular reference to periods of financial crisis, and increased integration in the world market.

Appendix A

Table 3.1: Characteristics of emerging stock markets returns denominated in US Dollar.

The coefficients of skewness and excess kurtosis follow the conventional t-statistics. Jarque-Bera statistic (JB) is used to test for the null hypothesis of normal distribution, and its p-value, and ρ_1, ρ_2, ρ_3 and ρ_4 are the 1st,2nd,3rd and 4th-order correlation coefficients

Table 3.1A Feb 1997-Dec 2001	Mean (%)	St.Dev (%)	Skew	Kur	JB	P.Value	ρ_1	ρ_2	ρ_3	ρ_4
Argentina	-1.07	11.14	-0.69	4.95	13.94	0.00	-0.13	-0.03	-0.01	0.03
Brazil	-0.02	13.21	-0.78	4.69	12.97	0.00	0.01	-0.20	-0.09	0.04
Chile	-0.30	8.37	-1.18	6.15	37.92	0.00	-0.06	-0.09	-0.06	0.14
Colombia	-0.95	11.58	0.04	3.30	0.24	0.89	0.11	-0.21	-0.09	0.02
Mexico	0.82	10.71	-1.00	5.01	19.75	0.00	-0.15	-0.07	0.13	-0.10
Peru	-0.01	8.85	-1.56	9.04	113.6	0.00	-0.02	0.01	-0.20	0.07
Venezuela	-0.58	14.35	-0.31	5.56	17.09	0.00	-0.20	0.04	0.02	-0.01
Philippines	-2.89	12.08	0.42	4.31	5.95	0.05	0.25	-0.07	-0.16	-0.09
Thailand	-2.69	17.6	0.03	2.84	0.08	0.96	-0.08	0.15	-0.12	-0.20
Korea	0.15	16.96	0.31	3.51	1.55	0.46	0.09	-0.07	0.03	-0.11
Malaysia	-1.67	14.69	0.30	3.56	1.64	0.44	0.15	0.21	-0.05	0.00
Indonesia	-3.69	20.42	0.01	3.30	0.23	0.89	0.19	-0.24	-0.06	0.22
India	0.06	9.65	-0.17	2.01	2.68	0.26	-0.02	0.08	-0.09	-0.12
Pakistan	-0.82	14.54	-0.29	4.39	5.54	0.06	-0.11	0.09	-0.10	0.05
Czech	-0.49	10.48	-0.15	3.27	0.39	0.82	-0.09	-0.13	-0.16	-0.18
Hungary	0.45	12.08	-0.99	6.18	34.65	0.00	-0.06	-0.26	0.12	-0.04
Poland	-0.69	12.00	-0.51	4.11	5.60	0.06	-0.07	-0.17	-0.04	-0.18
Russia	0.36	23.99	-0.96	5.27	21.80	0.000	0.15	-0.21	0.11	0.23*
Turkey	0.14	20.32	0.06	3.61	0.96	0.62	0.00	-0.14	0.12	0.07
Egypt	-0.75	9.45	0.91	4.14	11.29	0.00	0.15	0.05	-0.01	0.04
Jordan	0.03	3.80	0.23	2.66	0.81	0.67	0.37*	-0.03*	0.07*	0.09
Morocco	-0.01	5.41	0.59	3.33	3.64	0.16	0.07	-0.05	0.05	-0.02
South Africa	-0.50	9.70	-0.87	4.79	15.20	0.00	-0.01	-0.07	-0.08	-0.19
World	0.44	4.89	-0.62	3.13	3.78	0.15	-0.01	-0.12	0.06	-0.01

Characteristics of emerging stock markets returns denominated in US Dollar.

The coefficients of skewness and excess kurtosis follow the conventional t-statistics. Jarque-Bera statistic (JB) is used to test for the null hypothesis of normal distribution, and its p-value, and ρ_1, ρ_2, ρ_3 and ρ_4 are the 1st,2nd,3rd and 4th-order correlation coefficients

Table 3.1B Jan 2002-Dec 2007	Mean (%)	St.Dev (%)	Skew	Kur	JB	P.Value	ρ_1	ρ_2	ρ_3	ρ_4
Argentina	2.25	11.43	-0.42	4.72	10.97	0.004	0.07	0.06	-0.02	-0.02
Brazil	3.02	9.95	-0.87	4.51	15.86	0.000	-0.09	0.21	-0.01	-0.01
Chile	1.87	5.53	-0.18	3.51	1.184	0.55	0.08	0.16	0.00	0.09
Colombia	3.76	7.92	-0.55	3.72	5.25	0.07	0.22	0.03	-0.18	-0.25
Mexico	2.05	5.70	-0.39	2.85	1.90	0.386	0.08	0.17	-0.10	-0.15
Peru	3.54	7.77	-0.66	3.76	6.93	0.031	-0.18	-0.04	0.12	-0.01
Venezuela	1.36	14.21	-0.05	7.00	48.18	0.000	-0.16	-0.12	0.19	-0.20
Philippines	1.85	6.33	0.27	2.56	1.48	0.48	0.05	0.09	0.07	0.21
Thailand	1.98	8.31	0.23	4.17	5.53	0.06	-0.20	-0.03	0.16	-0.09
Korea	2.12	6.72	-0.60	3.02	4.25	0.12	0.00	-0.01	0.20	-0.30
Malaysia	1.42	4.21	0.13	2.85	0.27	0.88	0.12	-0.02	-0.01	0.05
Indonesia	3.56	8.38	-0.41	3.27	2.19	0.33	0.07	-0.12	0.01	0.08
India	2.86	7.20	-0.55	3.41	4.13	0.127	0.09	0.02	-0.05	-0.11
Pakistan	3.09	8.24	0.12	3.17	0.27	0.874	-0.03	-0.04	-0.12	-0.10
Czech	2.56	12.35	-0.50	3.88	5.37	0.068	-0.06	0.04	0.02	-0.06
Hungary	3.72	5.66	0.19	2.49	1.21	0.55	0.05	-0.11	-0.24	-0.09
Poland	2.51	7.42	-0.04	2.67	0.35	0.84	0.03	-0.28	-0.06	-0.07
Russia	2.23	7.75	-0.36	2.55	2.16	0.34	-0.11	-0.13	-0.01	-0.14
Turkey	2.82	7.85	-0.24	2.60	1.15	0.56	-0.03	-0.04	-0.13	0.08
Egypt	4.04	8.60	0.01	3.31	0.28	0.87	0.15	-0.12	0.12	0.13
Jordan	1.83	6.24	-0.38	4.62	9.69	0.007	0.23*	0.17*	0.11	0.22*
Morocco	2.14	5.30	0.85	6.51	45.63	0.000	-0.01	-0.03	0.07	-0.11
South Africa	2.22	7.07	-0.81	3.57	8.78	0.010	0.03	-0.11	-0.07	-0.09
World	0.85	3.32	-0.87	4.38	14.80	0.001	0.13	0.09	0.05	-0.13

Characteristics of emerging stock markets returns denominated in US Dollar.

The coefficients of skewness and excess kurtosis follow the conventional t-statistics. Jarque-Bera statistic (JB) is used to test for the null hypothesis of normal distribution, and its p-value, and ρ_1, ρ_2, ρ_3 and ρ_4 are the 1st,2nd,3rd and 4th-order correlation coefficients

Table 3.1C Feb 1997-Dec 2007	Mean (%)	St.Dev (%)	Skew	Kur	JB	Beta	P.Value	ρ_1	ρ_2	ρ_3	ρ_4
Argentina	0.69	11.40	-0.46	4.79	22.61	1.24	0.000	-0.01	0.04	-0.05	0.08
Brazil	1.56	11.60	-0.92	5.10	42.56	1.95	0.000	-0.01	-0.01	-0.03	0.05
Chile	0.90	7.01	-1.12	6.99	114.54	1.11	0.000	0.02	0.02	-0.01	0.17
Colombia	1.64	9.98	-0.37	3.62	5.10	0.87	0.08	0.21	-0.06	-0.09	-0.13
Mexico	1.50	8.32	-1.14	6.73	104.73	1.43	0.000	-0.09	0.00	0.07	0.09
Peru	1.69	8.49	-1.15	7.09	119.97	0.87	0.000	-0.03	0.05	0.01	-0.11
Venezuela	0.49	14.25	-0.17	6.35	61.84	1.09	0.000	-0.17	-0.04	0.13	-0.11
Philippines	-0.28	9.63	-0.01	5.02	22.27	1.16	0.000	0.26	0.03	-0.07	0.02
Thailand	0.04	13.08	-0.35	4.53	15.56	1.70	0.000	-0.04	0.16	-0.04	-0.16
Korea	1.23	12.41	0.11	5.45	33.17	1.63	0.000	0.09	-0.04	0.07	-0.13
Malaysia	0.13	10.34	-0.05	6.24	57.30	0.85	0.000	0.17	0.21	-0.03	0.03
Indonesia	0.30	15.41	-0.54	4.98	27.65	1.65	0.000	0.22	-0.15	-0.01	0.22
India	1.60	8.47	-0.44	2.60	5.06	0.94	0.08	0.05	0.08	-0.04	0.68
Pakistan	1.33	11.63	-0.49	5.55	40.84	0.70	0.000	-0.05	0.08	-0.03	0.02
Czech	1.47	16.41	-0.17	4.43	11.74	2.10	0.003	0.00	-0.09	0.07	0.01
Hungary	1.83	8.42	-0.50	4.30	14.71	0.78	0.001	0.01	-0.04	-0.11	-0.09
Poland	1.58	9.81	-0.98	7.21	117.73	1.47	0.000	-0.02	-0.24*	0.08*	-0.04
Russia	0.92	9.96	-0.67	4.68	25.33	1.42	0.000	-0.05	-0.13	0.01	-0.16
Turkey	2.73	16.9	-1.43	9.77	293.07	2.06	0.000	0.14	-0.17*	0.08*	0.21*
Egypt	1.88	9.27	0.36	3.21	3.10	0.79	0.21	0.22	0.06	0.14	0.17
Jordan	1.02	5.34	-0.08	4.90	19.87	0.42	0.000	0.28*	0.14*	0.13*	0.21*
Morocco	1.18	5.44	0.67	4.95	30.47	0.27	0.000	0.07	0.01	0.12	-0.01
South Africa	0.99	8.43	-0.99	5.08	45.18	1.29	0.000	0.03	-0.06	-0.04	-0.13
World	0.67	4.09	-0.78	3.94	18.01		0.000	0.04	-0.05	0.05	-0.03

Note: *indicates significance at 1 per cent level.

Table 3.2: Unconditional correlation coefficients between monthly country index returns for the period Jan 1997-Dec 2007

	Arg	Brz	Chl	Col	Mex	Peru	Venz	Egy	Jor	Mor	Phl	Thai	Kor	Mal	Indo	Ind	Pak	Tur	Czh	Hun	Pol	Rus	Sou	World
Arg	1.00																							
Brz	0.55	1.00																						
Chl	0.59	0.74	1.00																					
Col	0.33	0.39	0.40	1.00																				
Mex	0.55	0.71	0.64	0.32	1.00																			
Peru	0.47	0.62	0.62	0.39	0.47	1.00																		
Venz	0.28	0.32	0.32	0.24	0.39	0.21	1.00																	
Egy	0.28	0.27	0.36	0.27	0.27	0.23	0.13	1.00																
Jor	-0.05	0.08	0.17	0.22	0.10	0.09	-0.09	0.30	1.00															
Mor	0.11	0.11	0.07	-0.01	-0.02	0.11	-0.12	0.19	0.07	1.00														
Phl	0.36	0.41	0.50	0.24	0.44	0.34	0.28	0.28	0.08	-0.02	1.00													
Thai	0.34	0.45	0.45	0.23	0.43	0.32	0.20	0.26	0.10	0.08	0.64	1.00												
Kor	0.23	0.37	0.40	0.24	0.37	0.22	0.16	0.22	0.12	0.04	0.41	0.65	1.00											
Mal	0.25	0.32	0.45	0.23	0.31	0.30	0.25	0.23	0.11	-0.01	0.43	0.47	0.31	1.00										
Indo	0.22	0.39	0.50	0.34	0.38	0.36	0.20	0.24	0.13	0.02	0.55	0.52	0.42	0.47	1.00									
Ind	0.35	0.46	0.46	0.17	0.42	0.39	0.16	0.38	0.12	0.19	0.23	0.29	0.30	0.39	0.34	1.00								
Pak	0.21	0.36	0.26	0.32	0.25	0.23	0.05	0.21	0.14	-0.02	0.08	0.24	0.15	0.35	0.20	0.42	1.00							
Tur	0.39	0.51	0.49	0.44	0.52	0.37	0.21	0.36	0.14	0.00	0.23	0.22	0.25	0.14	0.22	0.31	0.31	1.00						

	Arg	Brz	Chl	Col	Mex	Peru	Venz	Egy	Jor	Mor	Phl	Thai	Kor	Mal	Indo	Ind	Pak	Tur	Czh	Hun	Pol	Rus	Sou	World
Czh	0.36	0.44	0.43	0.31	0.38	0.36	0.26	0.26	0.01	0.04	0.19	0.21	0.27	0.30	0.27	0.36	0.28	0.41	1.00					
Hun	0.43	0.55	0.55	0.35	0.54	0.45	0.27	0.33	0.07	0.00	0.28	0.26	0.31	0.30	0.33	0.37	0.32	0.50	0.67	1.00				
Pol	0.37	0.52	0.53	0.21	0.53	0.39	0.20	0.35	0.04	0.04	0.35	0.40	0.47	0.37	0.27	0.46	0.25	0.38	0.62	0.67	1.00			
Rus	0.41	0.61	0.65	0.44	0.60	0.49	0.23	0.06	0.10	-0.04	0.38	0.37	0.31	0.28	0.55	0.27	0.29	0.55	0.40	0.53	0.44	1.00		
Sou	0.41	0.61	0.61	0.31	0.62	0.55	0.28	0.34	0.14	0.21	0.46	0.57	0.47	0.29	0.40	0.45	0.21	0.39	0.42	0.49	0.60	0.54	1.00	
World	0.44	0.72	0.62	0.26	0.72	0.37	0.30	0.26	0.12	0.11	0.45	0.49	0.52	0.28	0.39	0.42	0.17	0.55	0.36	0.59	0.58	0.51	0.60	1.00

Table 3.3: Unit root tests of excess returns on countries indexes, and the market premium.

Country	ADF test statistic
Argentine	-11.00
Brazil	-11.04
Chile	-10.04
Colombia	-8.50
Mexico	-11.75
Peru	-10.66
Venzuela	-13.19
Egypt	-8.58
Jordan	-6.99
Morocco	-9.61
Philippiness	-8.29
Thailand	-11.07
Korea	-9.84
Malaysia	-9.10
Indonesia	-8.15
India	-10.09
Pakistan	-11.21
Turkey	-11.33
Czech	-10.03
Hungary	-10.93
Poland	-11.30
Russia	-8.86
South Africa	-10.17
Market premium	-9.55

Test critical value at 1% level: -3.48

Table 3.4: Estimation results for BEKK bivariate GARCH [the number in parentheses denotes p-value]

	μ_1	μ_2	C_{11}	C_{12}	C_{13}	a_{11}	a_{22}	b_{11}	b_{22}	Log Likelihood	AIC
Argentine	-0.02	-0.03	0.05	0.007	3.34E-05	0.33	0.29	0.87	0.95	349.720	-5.242
	(0.030)	(0.000)	(0.075)	(0.030)	(1.000)	(0.014)	(0.000)	(0.000)	(0.000)		
Brazil	-0.02	-0.03	0.05	0.03	0.000	0.28	0.35	0.88	0.60	374.050	-5.616
	(0.155)	(0.000)	(0.027)	(0.055)	(1.000)	(0.004)	(0.004)	(0.000)	(0.021)		
Chile	-0.03	-0.03	0.01	0.01	-6.92E-06	0.13	0.29	0.98	0.94	423.80	-6.381
	(0.000)	(0.000)	(0.364)	(0.266)	(1.000)	(0.12)	(0.001)	(0.000)	(0.000)		
Colombia	-0.02	-0.03	0.02	0.01	0.01	0.33	0.25	0.93	0.950	349.567	-5.239
	(0.123)	(0.000)	(0.131)	(0.088)	(0.260)	(0.002)	(0.016)	(0.000)	(0.000)		
Mexico	-0.02	-0.03	0.01	0.01	0.01	0.26	0.30	0.95	0.94	424.409	-6.391
	(0.009)	(0.000)	(0.046)	(0.151)	(0.043)	(0.000)	(0.000)	(0.000)	(0.000)		
Peru	-0.02	-0.03	0.068	0.01	4.39E-05	0.31	0.28	0.53	0.94	372.229	-5.588
	(0.021)	(0.000)	(0.000)	(0.56)	(1.000)	(0.045)	(0.027)	(0.11)	(0.000)		
Venezuela	-0.030	-0.028	0.076	0.004	0.004	0.269	0.194	0.811	0.969	299.011	-4.462
	(0.042)	(0.000)	(0.161)	(0.278)	(0.719)	(0.083)	(0.023)	(0.003)	(0.000)		
Philippines	-0.02	-0.03	0.01	0.01	0.00	0.16	0.27	0.98	0.95	370.693	-5.56
	(0.003)	(0.000)	(0.729)	(0.642)	(0.980)	(0.001)	(0.000)	(0.000)	(0.000)		

	μ_1	μ_2	C_{11}	C_{12}	C_{13}	a_{11}	a_{22}	b_{11}	b_{22}	Log Likelihood	AIC
Thailand	**-0.02**	**-0.03**	**0.01**	**0.01**	**0.01**	**0.26**	**0.21**	**0.95**	**0.96**	**343.433**	**-5.145**
	(0.021)	**(0.000)**	**(0.132)**	**(0.441)**	**(0.141)**	**(0.000)**	**(0.002)**	**(0.000)**	**(0.000)**		
Korea	**-0.01**	**-0.03**	**0.03**	**0.009**	**-9.27E-06**	**0.49**	**0.24**	**0.83**	**0.95**	**364.737**	**-5.473**
	(0.144)	**(0.000)**	**(0.001)**	**(0.000)**	**(1.000)**	**(0.000)**	**(0.008)**	**(0.000)**	**(0.000)**		
Malaysia	**-0.02**	**-0.03**	**0.02**	**0.013**	**-2.26E-05**	**0.34**	**-0.09**	**0.91**	**0.95**	**387.488**	**-5.823**
	(0.000)	**(0.000)**	**(0.011)**	**(0.413)**	**(1.000)**	**(0.000)**	**(0.312)**	**(0.000)**	**(0.000)**		
Indonesia	**-0.01**	**-0.03**	**0.01**	**0.01**	**0.01**	**0.20**	**0.26**	**0.97**	**0.95**	**318.484**	**-4.761**
	(0.259)	**(0.000)**	**(0.170)**	**(0.402)**	**(0.173)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**		
India	**-0.02**	**-0.03**	**0.06**	**0.01**	**4.48E-06**	**0.16**	**0.24**	**0.71**	**0.95**	**375.429**	**-5.637**
	(0.021)	**(0.000)**	**(0.214)**	**(0.280)**	**(1.000)**	**(0.332)**	**(0.17)**	**(0.199)**	**(0.236)**		
Pakistan	**-0.02**	**-0.03**	**0.05**	**0.01**	**4.34E-05**	**-0.28**	**0.20**	**0.88**	**0.97**	**326.844**	**-4.889**
	(0.163)	**(0.000)**	**(0.039)**	**(0.014)**	**(1.000)**	**(0.022)**	**(0.058)**	**(0.000)**	**(0.000)**		
Turkey	**-0.02**	**-0.03**	**0.03**	**0.03**	**1.21E-06**	**0.10**	**0.34**	**0.98**	**0.80**	**296.202**	**-4.418**
	(0.259)	**(0.000)**	**(0.681)**	**(0.704)**	**(1.000)**	**(0.228)**	**(0.222)**	**(0.000)**	**(0.017)**		
Czech	**-0.01**	**-0.03**	**0.01**	**0.01**	**0.00**	**0.271**	**0.21**	**0.96**	**0.96**	**379.130**	**-5.694**
	(0.290)	**(0.000)**	**(0.215)**	**(0.278)**	**(0.622)**	**(0.001)**	**(0.009)**	**(0.000)**	**(0.000)**		
Hungary	**-0.02**	**-0.03**	**0.07**	**0.01**	**7.63E-07**	**0.17**	**0.26**	**0.58**	**0.92**	**375.124**	**-5.633**
	(0.074)	**(0.000)**	**(0.119)**	**(0.316)**	**(1.000)**	**(0.347)**	**(0.054)**	**(0.425)**	**(0.000)**		

	μ_1	μ_2	C_{11}	C_{12}	C_{13}	a_{11}	a_{22}	b_{11}	b_{22}	Log Likelihood	AIC
Poland	-0.03	-0.03	0.04	0.03	-5.60E-05	0.10	0.57	0.90	0.57	369.784	-5.551
	(0.002)	(0.000)	(0.607)	(0.496)	(1.000)	(0.247)	(0.000)	(0.027)	(0.002)		
Russia	-0.01	-0.03	0.02	0.01	0.003	0.417	0.246	0.90	0.96	324.656	-4.856
	(0.482)	(0.000)	(0.038)	0.112)	(0.673)	(0.000)	(0.000)	(0.000)	(0.000)		
Egypt	-0.019	-0.029	0.055	0.005	0.003	0.273	0.215	0.763	0.964	356.519	-5.346
	(0.037)	(0.000)	(0.169)	(0.282)	(0.865)	(0.103)	(0.017)	(0.032)	(0.000)		
Jordan	-0.02	-0.03	0.03	0.00	0.01	0.20	0.26	0.86	0.95	417.661	-6.287
	(0.000)	(0.000)	(0.124)	(0.238)	(0.479)	(0.181)	(0.013)	(0.000)	(0.000)		
Morocco	-0.03	-0.03	0.01	0.02	0.01	0.30	0.34	0.96	0.82	416.808	-6.274
	(0.000)	(0.000)	(0.460)	(0.537)	(0.487)	(0.000)	(0.019)	(0.000)	(0.000)		
South Africa	-0.02	-0.03	0.05	0.01	-3.27E-05	0.42	0.29	0.71	0.92	397.190	-5.972
	(0.010)	(0.000)	(0.007)	(0.007)	(1.000)	(0.000)	(0.009)	(0.000)	(0.000)		

Note: According to the BEKK representation, the quadratic form implies that all the coefficients in the variance equation will be multiplied by itself in order to ensure that all the coefficients are positive.

Table 3.5: The Ljung-Box Statistics of Scaled Residuals

3.5A: The Ljung-Box statistics of scaled residuals of the excess return on markets' indexes [number in parentheses denotes p-value].

	Arg	Brz	Chl	Col	Mex	Peru	Venz	Egy	Mor	Jor	Phl	Thai	Kor	Mal	Indo	Ind	Pak	Tur	Czh	Hun	Pol	Rus	Sou
ρ_1	0.55	0.53	0.42	0.06	0.25	0.21	0.01	0.45	0.84	0.03	0.02	1.18	1.01	0.01	0.24	0.23	0.65	1.94	0.13	0.19	1.13	0.06	0.03
	(0.46)	(0.47)	(0.52)	(0.80)	(0.62)	(0.65)	(0.91)	(0.50)	(0.36)	(0.85)	(0.90)	(0.28)	(0.31)	(0.94)	(0.62)	(0.63)	(0.42)	(0.16)	(0.72)	(0.66)	(0.29)	(0.80)	(0.85)
ρ_4	2.54	0.95	2.09	4.08	2.48	1.24	3.97	4.60	1.99	1.93	5.62	8.05	5.52	4.47	6.20	2.56	2.31	3.04	3.08	1.34	3.65	8.75	6.83
	(0.64)	(0.92)	(0.72)	(0.40)	(0.65)	(0.87)	(0.41)	(0.33)	(0.74)	(0.75)	(0.23)	(0.09)	(0.24)	(0.35)	(0.19)	(0.63)	(0.68)	(0.55)	(0.54)	(0.86)	(0.46)	(0.07)	(0.15)
ρ_{12}	18.92	13.54	10.63	7.18	17.39	3.87	6.80	16.03	4.82	7.11	22.61	9.96	8.19	9.47	19.24	20.16	10.09	11.26	18.76	3.48	15.31	13.80	11.32
	(0.09)	(0.33)	(0.56)	(0.85)	(0.14)	(0.99)	(0.87)	(0.19)	(0.96)	(0.85)	(0.03)	(0.62)	(0.77)	(0.66)	(0.08)	(0.06)	(0.61)	(0.51)	(0.10)	(0.99)	(0.23)	(0.31)	(0.50)

3.5B: The Ljung-Box statistics of scaled residuals of the market premium [number in parentheses denotes p-value].

	Arg	Brz	Chl	Col	Mex	Peru	Venz	Egy	Mor	Jor	Phl	Thai	Kor	Mal	Indo	Ind	Pak	Tur	Czh	Hun	Pol	Rus	Sou
ρ_1	0.29	0.03	0.25	0.18	0.30	0.19	0.07	0.13	0.29	0.08	0.30	0.07	0.11	0.29	0.23	0.10	0.08	0.01	0.09	0.09	0.52	0.26	0.20
	(0.59)	(0.87)	(0.62)	(0.67)	(0.58)	(0.66)	(0.79)	(0.72)	(0.59)	(0.78)	(0.59)	(0.79)	(0.75)	(0.59)	(0.63)	(0.75)	(0.77)	(0.94)	(0.77)	(0.76)	(0.47)	(0.61)	(0.65)
ρ_4	1.02	0.62	0.96	0.93	0.99	0.80	0.81	0.88	1.08	0.64	0.91	0.73	0.70	1.72	0.88	0.89	0.79	0.58	0.89	0.69	1.01	0.91	0.76
	(0.91)	(0.96)	(0.92)	(0.92)	(0.91)	(0.94)	(0.94)	(0.93)	(0.90)	(0.96)	(0.92)	(0.95)	(0.95)	(0.79)	(0.93)	(0.93)	(0.94)	(0.97)	(0.93)	(0.95)	(0.91)	(0.92)	(0.94)
ρ_{12}	6.52	6.86	5.94	5.83	6.41	6.72	6.38	5.97	5.88	5.15	6.61	6.38	6.49	10.30	6.42	5.99	6.43	6.27	6.03	5.65	4.75	6.77	6.36
	(0.89)	(0.87)	(0.92)	(0.92)	(0.89)	(0.88)	(0.90)	(0.92)	(0.92)	(0.95)	(0.88)	(0.90)	(0.89)	(0.59)	(0.89)	(0.92)	(0.89)	(0.90)	(0.91)	(0.93)	(0.97)	(0.87)	(0.90)

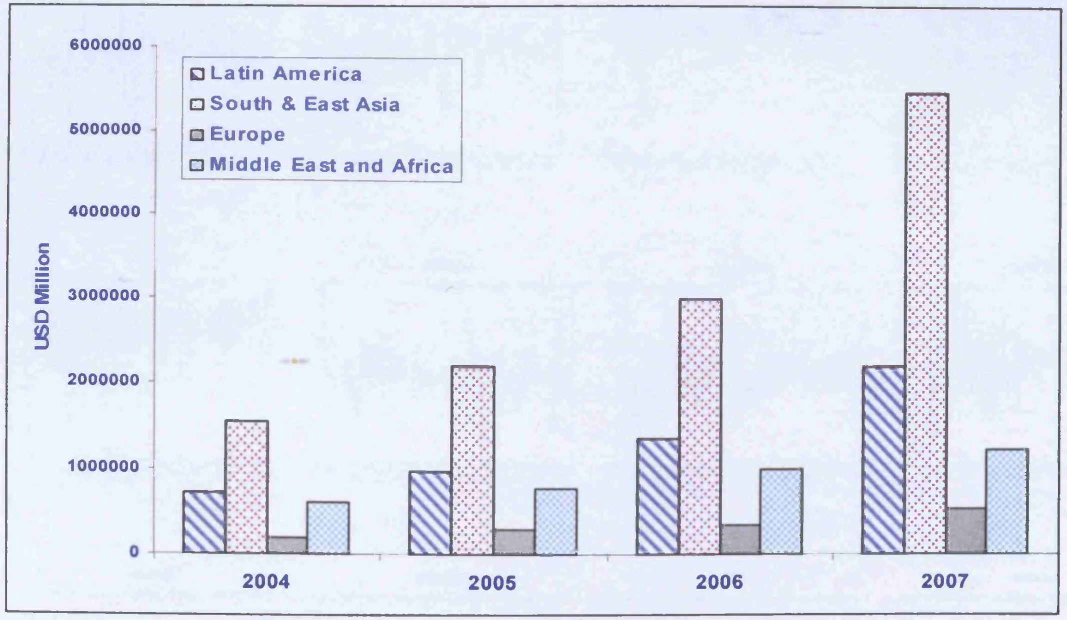
3.5C: The Ljung-Box statistics of squared standardized residuals of the excess return on markets' indexes [number in parentheses denotes p-value].

	Arg	Brz	Chl	Col	Mex	Peru	Venz	Egy	Mor	Jor	Phl	Thai	Kor	Mal	Indo	Ind	Pak	Tur	Czh	Hun	Pol	Rus	Sou
ρ_1	0.20	0.06	0.04	0.15	0.04	0.02	0.15	0.00	0.07	0.02	0.00	0.21	0.04	0.00	0.01	0.04	0.00	0.30	0.07	0.02	0.07	0.09	0.43
	(0.66)	(0.81)	(0.85)	(0.70)	(0.85)	(0.89)	(0.70)	(0.98)	(0.79)	(0.88)	(0.97)	(0.65)	(0.84)	(0.98)	(0.94)	(0.84)	(0.97)	(0.59)	(0.80)	(0.89)	(0.79)	(0.76)	(0.51)
ρ_4	0.53	0.097	0.05	1.61	0.20	0.05	1.06	1.79	0.19	1.54	2.36	5.06	0.12	0.29	2.83	1.07	0.11	0.45	0.38	0.06	0.19	15.08	20.63
	(0.97)	(0.99)	(1.00)	(0.81)	(0.99)	(1.00)	(0.90)	(0.78)	(0.99)	(0.82)	(0.67)	(0.28)	(1.00)	(0.99)	(0.59)	(0.90)	(1.00)	(0.98)	(0.98)	(1.00)	(1.00)	(0.01)	(0.00)
ρ_{12}	5.31	3.31	0.71	5.45	1.96	0.17	4.94	7.44	0.60	4.54	14.96	5.77	0.34	0.95	4.90	11.04	1.19	4.31	2.75	0.19	1.68	17.02	22.07
	(0.95)	(0.99)	(1.00)	(0.94)	(0.99)	(1.00)	(0.96)	(0.83)	(1.00)	(0.97)	(0.24)	(0.93)	(1.00)	(1.00)	(0.96)	(0.53)	(1.00)	(0.98)	(1.00)	(1.00)	(1.00)	(0.15)	(0.04)

3.5D: The Ljung-Box statistics of squared standardized residuals of the market premium [number in parentheses denotes p-value].

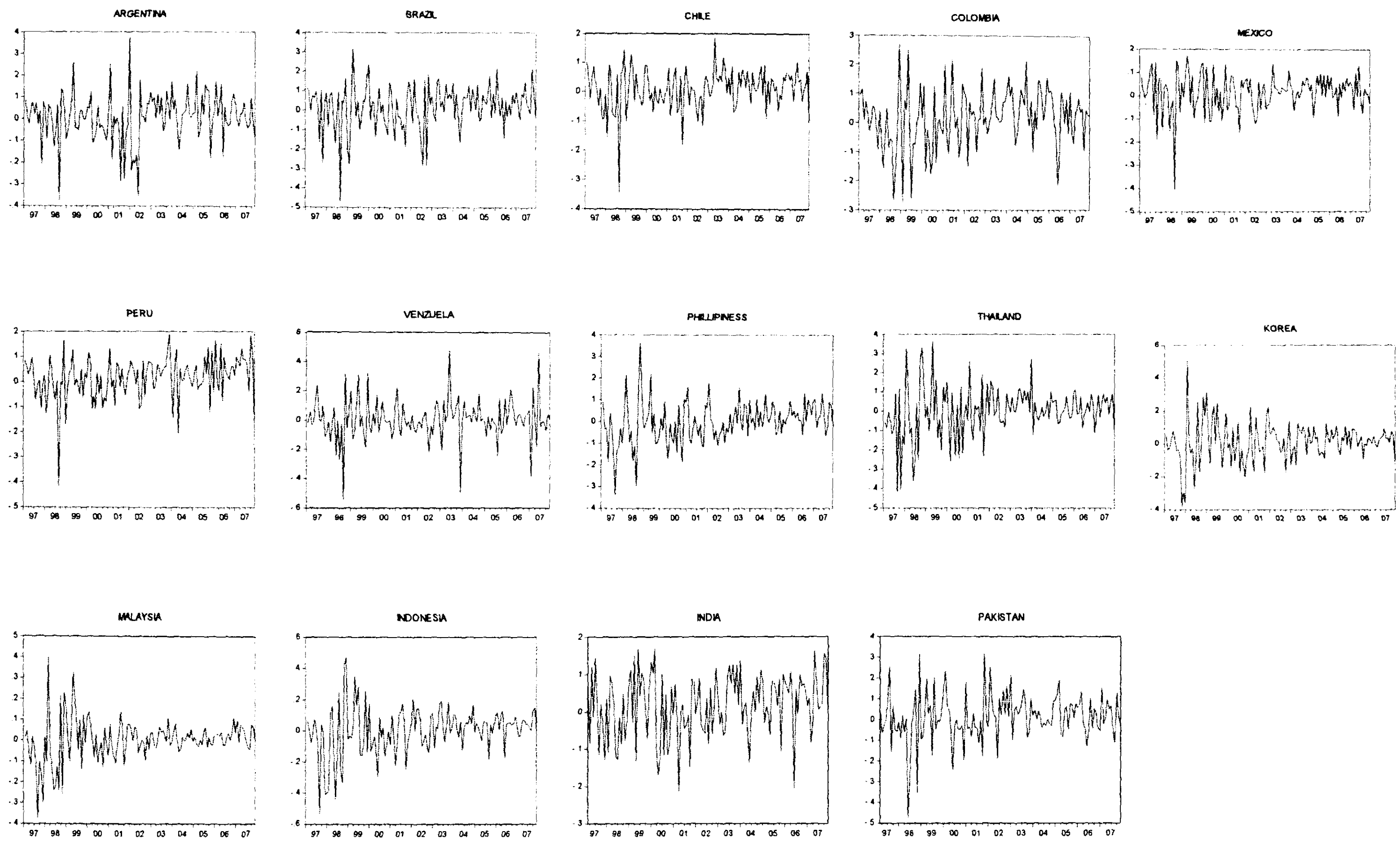
	Arg	Brz	Chl	Col	Mex	Peru	Venz	Egy	Mor	Jor	Phl	Thai	Kor	Mal	Indo	Ind	Pak	Tur	Czh	Hun	Pol	Rus	Sou
ρ_1	0.05	0.07	0.04	0.05	0.04	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.03	0.05	0.05	0.05	0.06	0.05	0.05	0.06	0.05	0.05
	(0.83)	(0.80)	(0.83)	(0.83)	(0.83)	(0.83)	(0.82)	(0.83)	(0.83)	(0.82)	(0.83)	(0.82)	(0.82)	(0.87)	(0.83)	(0.82)	(0.82)	(0.81)	(0.82)	(0.82)	(0.81)	(0.83)	(0.83)
ρ_4	0.14	0.20	0.14	0.15	0.15	0.15	0.15	0.15	0.14	0.18	0.15	0.15	0.16	0.17	0.15	0.15	0.15	0.19	0.15	0.16	0.20	0.15	0.16
	(0.99)	(0.99)	(0.99)	(0.99)	(0.99)	(1.00)	(1.00)	(1.00)	(1.00)	(1.00)	(1.00)	(0.99)	(1.00)	(1.00)	(1.00)	(1.00)	(1.00)	(1.00)	(1.00)	(1.00)	(1.00)	(1.00)	(0.99)
ρ_{12}	1.11	0.99	0.95	0.95	1.08	1.26	1.01	0.94	0.88	0.82	1.16	1.07	1.15	1.25	1.10	1.02	1.07	0.99	0.98	0.94	0.69	1.18	1.15
	(1.00)	(1.00)	(1.00)	(1.00)	(1.00)	(1.00)	(1.00)	(1.00)	(1.00)	(1.00)	(1.00)	(1.00)	(1.00)	(1.00)	(1.00)	(1.00)	(1.00)	(1.00)	(1.00)	(1.00)	(1.00)	(1.00)	(1.00)

Figure 3.1: Market Capitalisation in Emerging regions through the years 2004-2007



Source: ***Based on data from World Exchange Federation and Standard and Poor's***

Figure 3.2: Emerging stock markets returns denominated in US Dollar (Feb 1997- Dec 2007).



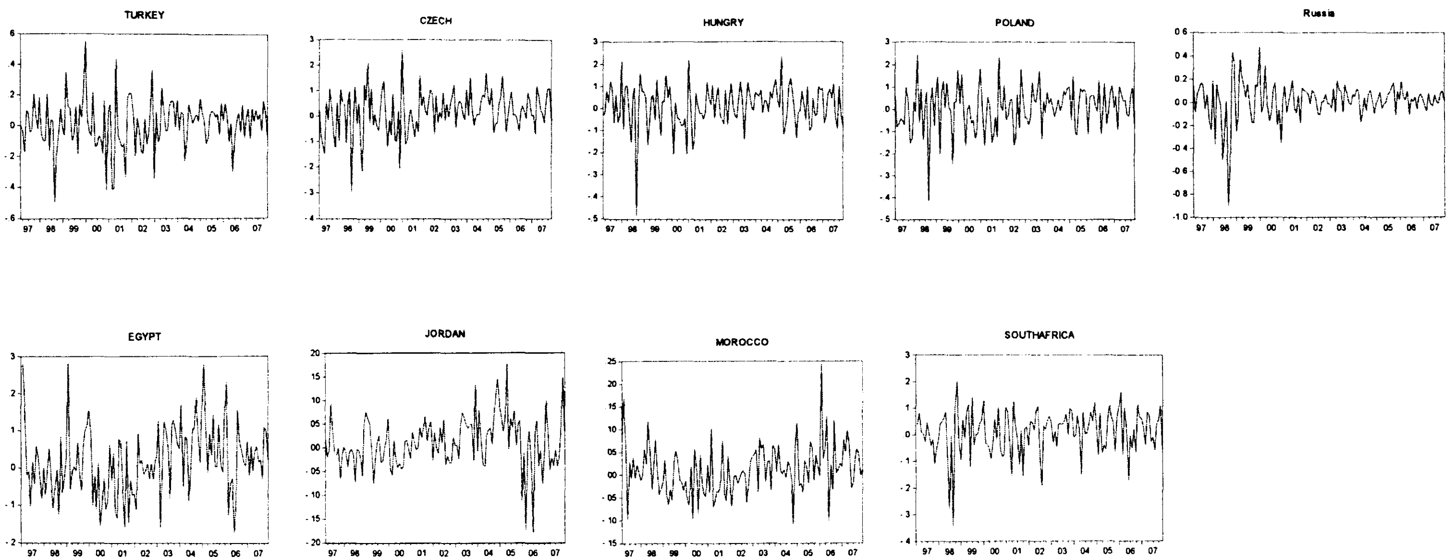
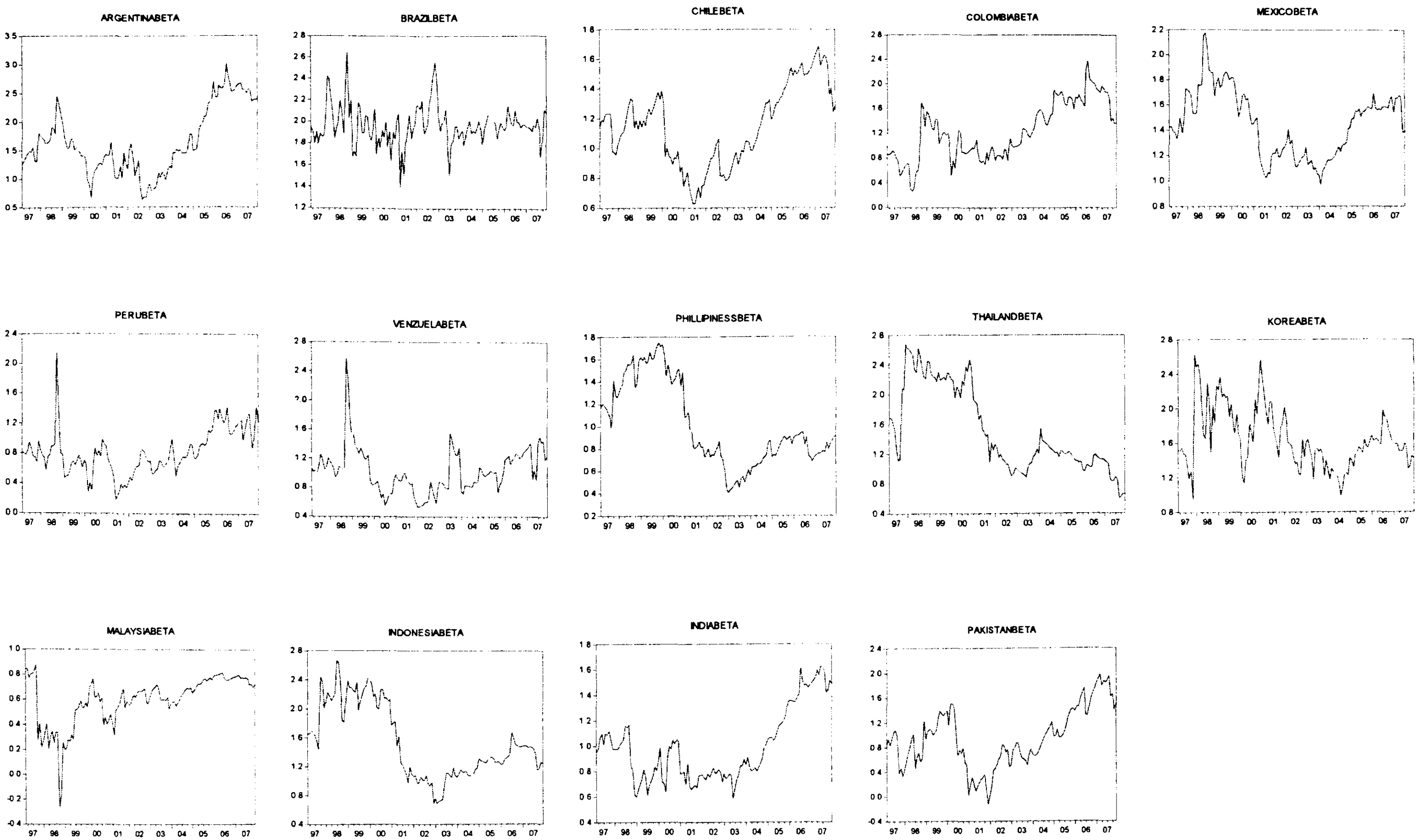

TURKEY
CZECH
HUNGRY
POLAND
Russia
EGYPT
JORDAN
MOROCCO
SOUTHAFRICA

Figure 3.3: Time-Varying Beta based on the bivariate GARCH estimations



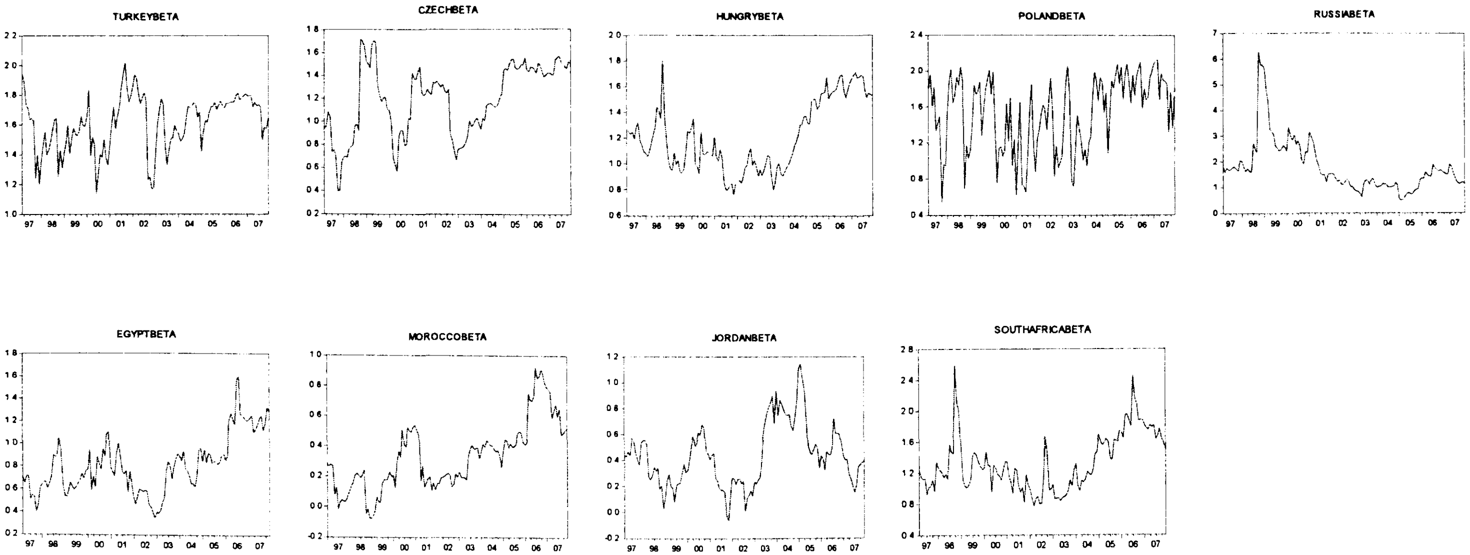
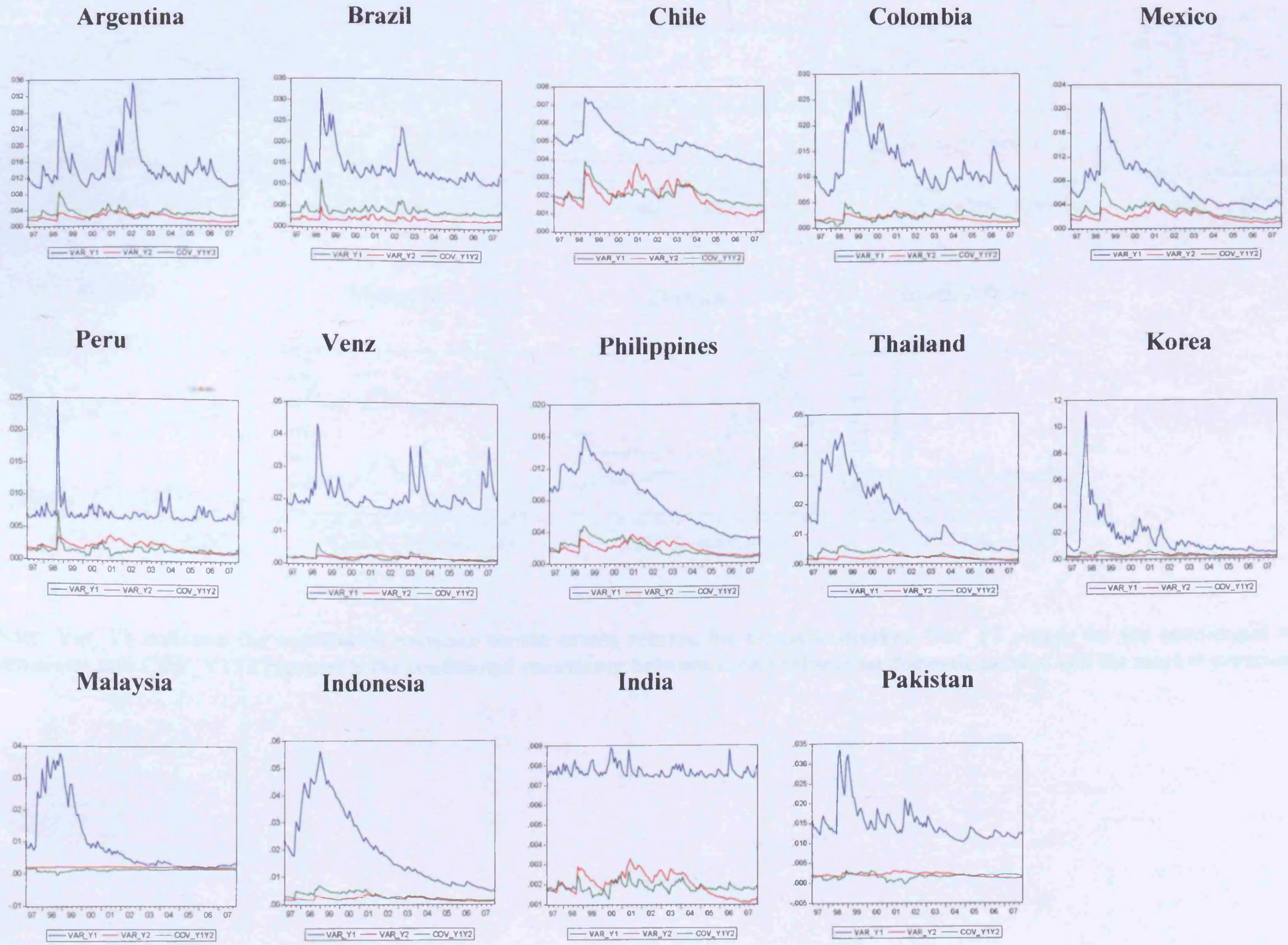
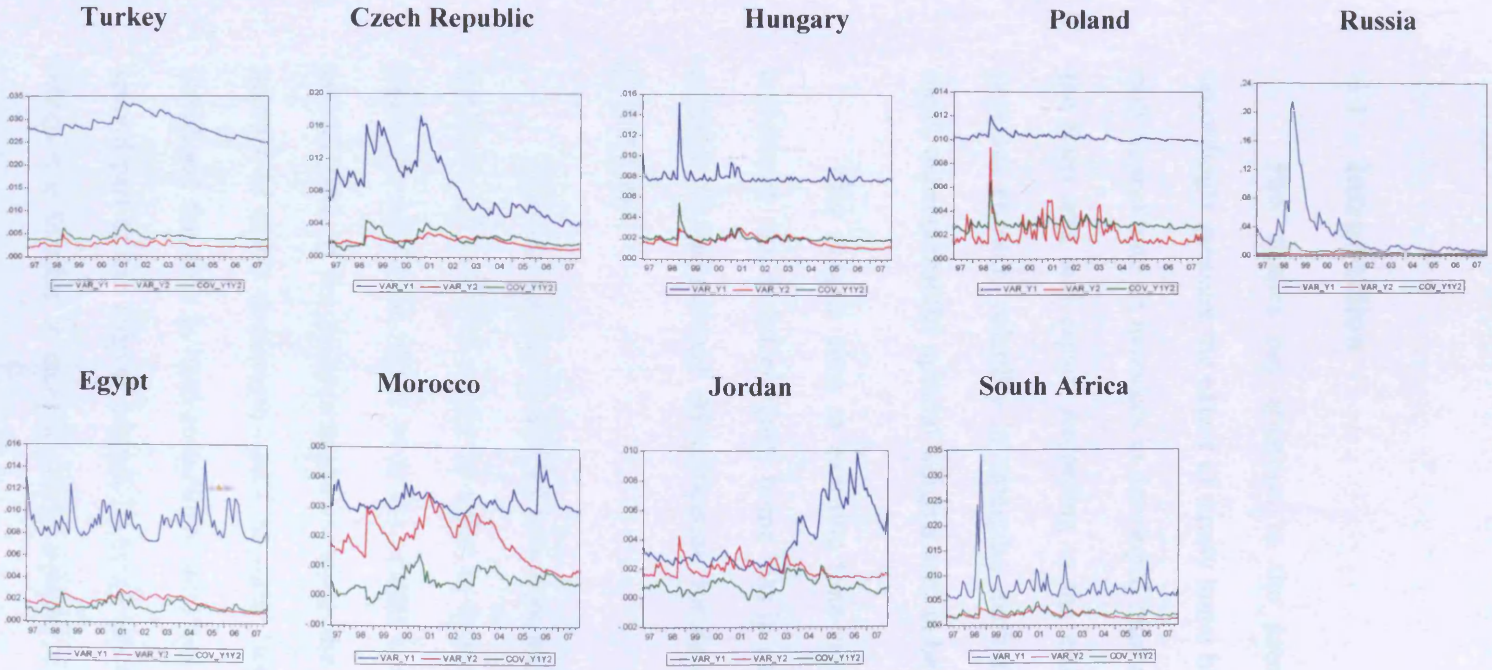

TURKEYBETA
CZECHBETA
HUNGRYBETA
POLANDBETA
RUSSIABETA
EGYPTBETA
MOROCCOBETA
JORDANBETA
SOUTHAFRICABETA

Figure 3.4: Time-varying Covariances/variances based on the bivariate GARCH estimations.





Note: Var_Y1 indicates the conditional variance on the excess returns for domestic market; Var_Y2 stands for the conditional variance on market premium; and COV_Y1Y2 represents the conditional covariance between excess returns on domestic market and the market premium.

Chapter Four: Time-varying optimal weights for international asset allocation in Emerging Markets

4.1 Introduction

Few studies pay attention to the determination of the optimal weights, and accordingly measure the extent of equity home bias accurately. Moreover, previous studies only concentrate on investors in developed markets, more specifically in the USA, the UK, the Euro area and Japan. According to the estimation of the conditional CAPM in the previous chapter, volatility in emerging market returns are time-varying, and hence the thesis expects that the optimal weights need to be updated each period.

This chapter aims to examine time-varying weights in the optimal portfolio to understand the extent of equity home bias in emerging markets. In addition, the potential gains from international diversification for domestic investors in emerging markets are investigated.

Thus this chapter is divided into three main parts. The first part considers the use of the trivariate GARCH model in order to estimate the time-varying variance-covariance matrix in which the output from this model is used to estimate optimal weights in each period. One of the disadvantages in using the multivariate GARCH model is that the number of assets considered could be quite limited since convergence of the maximum likelihood function is hard to achieve with too many estimated parameters. Hence, the second part of the chapter intends to apply the dynamic conditional correlation model in which it is feasible to include a large number of assets. Testing both models would also allow the examination of the difference in optimal weights as a result of including more assets, whereas investigating the effect of conditional correlation and whether it tends to increase/decrease during financial crises. The third part re-estimates the DCC model in part two using indexes denominated in US Dollar in order to investigate the effect of exchange rate on the construction of optimal weights.

The objectives of parts two and three are threefold

1- To test whether the time-varying optimal weights would differ from the results in obtained from the trivariate GARCH estimation by introducing more assets to the portfolio;

2- To investigate whether the share of domestic equities in optimal portfolios would change if the returns were denominated in US Dollar instead of local currencies, hence introducing the effect of exchange rate risk on investment decisions; and

3- To construct the correlation matrix for emerging market returns since its effect is a major component in portfolio construction. The finance literature defines that the gains from international diversification seem to be higher in cases of low correlation (Levy and Sarnat, 1970; Solnik, 1974).

4.2 The use of the Multivariate GARCH Model in international asset allocation

Following the mean-variance approach to asset allocation, this section uses trivariate GARCH model in order to identify the time-varying covariance matrix of returns, and hence construct conditional optimal weights for efficient portfolios that are re-balanced allow the examination of the difference in optimal weights as a result of including more assets, whereas investigating the effect of conditional correlation and whether it tends to increase/decrease during financial crises. The third part re-estimates the DCC model in part two using indexes denominated in US Dollar in order to investigate the effect of exchange rate on the construction of optimal weights.

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1- To test whether the time-varying optimal weights would differ from the results in obtained from the trivariate GARCH estimation by introducing more assets to the portfolio;

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However, this thesis considers the effect of both the expected returns and conditional variances in order to construct efficient portfolios for investors in emerging markets. It uses the expected returns whenever the lags of return are significant, otherwise the mean values are used. Hence, optimal portfolio weights are computed in each period depending on the estimates of expected returns, variances and covariances between the assets' returns.

Investors are assumed to optimise a portfolio consisting of three assets mainly - the return on domestic index, the US, and the UK indexes. The analysis is conducted from the perspective of a domestic investor, in which the returns on the three assets are dominated in the local currency of each market under study. The continuously compounded returns on MSCI indexes for 22 emerging markets are used along the returns on MSCI USA and MSCI UK indexes. The data used are monthly and the sample differs between some markets depending on the availability of data - in general the data ranges from 1994M04 to 2008M07. The total monthly returns are used to account for dividend payments, and are extracted from DataStream. All series are stationary as the null hypothesis of unit root is rejected on all the returns examined at 1 per cent significance level (See Table 4.1 (page 168)).

4.2.1 Econometric Model

A trivariate GARCH model is used to compute time-varying covariance matrix of equity returns. The general model estimated can be written as follows

$$R_t = \mu + \Pi r_{t-1} + \phi r_{t-2} + \Theta r_{t-3} + e_t$$

$$\text{where } \; e_t | \Omega_{t-1} \sim N(0, H_t) \tag{4.1}$$

$R_t = (R_{It}, R_{USt}, R_{UKt})$, in which R_{It} is the return on domestic MSCI index, R_{USt} is the return on the MSCI US index, and R_{UKt} is the return on the MSCI UK index. The constant mean of R_t is the vector μ of dimension $N \times 1$. The first, second and third lagged values of returns (denoted as r_{t-1}, r_{t-2} and r_{t-3} respectively) are included for some of the markets depending on their significance, Ω_{t-1} represents the information set available at time $t-1$, and H_t refers to the conditional variance-covariance matrix. The diagonal BEKK representation is used in which the conditional variance-covariance matrix between the three asset returns are functions of the lagged values of squared errors and lagged squared residuals. The BEKK representation can be expressed as

$$H_t = C'C + A' e_{t-1} e'_{t-1} A + B' H_{t-1} B \tag{4.2}$$

or alternatively

$$H_t = C'C + \begin{bmatrix} a^*_{11} & a^*_{12} & a^*_{13} \\ a^*_{21} & a^*_{22} & a^*_{23} \\ a^*_{31} & a^*_{32} & a^*_{33} \end{bmatrix}' \begin{bmatrix} e^2_{1,t-1} & e_{1,t-1}e_{2,t-1} & e_{1,t-1}e_{3,t-1} \\ e_{2,t-1}e_{2,t-1} & e^2_{2,t-1} & e_{2,t-1}e_{3,t-1} \\ e_{3,t-1}e_{3,t-1} & e_{3,t-1}e_{2,t-1} & e^2_{3,t-1} \end{bmatrix} \begin{bmatrix} a^*_{11} & a^*_{12} & a^*_{13} \\ a^*_{21} & a^*_{22} & a^*_{23} \\ a^*_{31} & a^*_{32} & a^*_{33} \end{bmatrix}$$

$$+ \begin{bmatrix} b^*_{11} & b^*_{12} & b^*_{13} \\ b^*_{21} & b^*_{22} & b^*_{23} \\ b^*_{31} & b^*_{32} & b^*_{33} \end{bmatrix}' H_{t-1} \begin{bmatrix} b^*_{11} & b^*_{12} & b^*_{13} \\ b^*_{21} & b^*_{22} & b^*_{23} \\ b^*_{31} & b^*_{32} & b^*_{33} \end{bmatrix}$$

The matrix $C'C$ represents the constant, while matrices A and B identify the short-term deviations from the constant variance. As can be inferred from the general form of equation (4.1), a number of lags for the returns on equity are included, which is not assumed in relevant literature. The reason for this inclusion is that the number of lags is found to be significant, and the model provides lower AIC values in some markets. Hence expected values of returns are used instead of mean values for some markets.

The model is estimated by maximising the following log likelihood function

$$L_T = -\frac{1}{2} m \log(2\pi) - \frac{1}{2}\log(|H_t|) - \frac{1}{2} e_t' H_t^{-1} e_t \tag{4.3}$$

where m stands for the number of mean equations. The maximization of the likelihood function is achieved using the BHHH algorithm in EVIEWS while the estimation of the optimal portfolio weights is done in MATLAB. The results of the trivariate estimation are shown in Table 4.2 (page 169).

4.2.2 Empirical results

4.2.2.1 Results for Latin America markets

The vector of the constant mean μ is statistically significant at 10 per cent level in most of the markets under study. The first lag of returns on the domestic index, and the second lag of returns on US and UK indexes statistically significance in Brazil and Colombia at 10 per cent.

With regard to the variance equation, most of the elements that constitute the matrix $C'C$ are statistically insignificant at conventional significance levels. On the other hand, elements of short-run volatilities represented by the matrices A and B are statistically significant in most of the markets with the exception of the insignificant a_{11} in Brazil and Venezuela, and a_{33} in Colombia, and b_{22} in Mexico at 10 per cent. The magnitude of short-term shocks in the return on the US index (a_{22}) is higher that of the shocks in the returns on the domestic (a_{11}) and UK (a_{33}) indexes in Colombia, Mexico and Peru.

On the other hand, the magnitude of past values of the conditional variance for the return on the domestic index (as represented by b_{11} coefficients) tends to be higher than the past values of the conditional variance on the US and the UK indexes with the exception of Chile. As can also be noted, the coefficients of the B matrix are higher in magnitude than the A matrix.

Figure 4.1 (page 202) shows the expected returns and conditional variances that are extracted from the trivariate output. The expected returns are expressed as

$$R_t = \mu + \prod r_{t-1} + \phi r_{t-2} + \Theta r_{t-3} + e_t \tag{4.4}$$

Returns are regressed on their means and their first, second and third lagged values (denoted as r_{t-1}, r_{t-2} and r_{t-3} respectively). Only significant values are included in this equation. For example, mean values are used as proxy for the expected returns if all the lagged values are insignificant[24].

Flavin and Wickens (2000) find that the conditional variances on the domestic market are usually lower than those for foreign markets, and they explain that the fluctuation in the exchange rate tends to result in that. In contrast to that, Figure 4.1 (page 206) shows that the conditional variances for the returns on Chile, Colombia, Peru and

[24] Mean values of the return on assets were also used as proxy for their expected values in Cumby, Figlewski and Hasbrouck (1994), and Flavin and Wickens (2000)

Venezuela indexes are higher than conditional variances of returns on USA and UK indexes. Venezuela's figure is particularly interesting in that the conditional variances are significantly higher than the conditional variances on the returns on the USA and the UK indexes. On average, the returns on domestic indexes tend to be higher than the returns on the USA and the UK indexes during the period under study in most markets. As referred to in the previous chapter, the returns on emerging markets' indexes are usually higher than those of developed markets.

In addition, the conditional variances for returns on the USA index are on average higher than those of the returns on UK indexes, apart from Argentina, and Venezuela estimations. However, the expected returns seem to be oscillating similarly with the exception of Chile and Peru.

4.2.2.2 Results for Middle East and African market

In addition to the mean values of returns, the first lag of returns is statistically significant in Egypt, and on domestic indexes in Jordan, and Morocco at 1 per cent significant level. Moreover, the third lag of returns on the Egyptian index is also significant at 1 per cent significant level.

Regarding the variance equation, the elements of the matrix $C'C$ seem to be insignificant in most of the markets with the exception of South Africa at 1 per cent significant level.

In addition to the previous markets investigated, the elements of short-run volatilities imply that the matrices A and B are significant in most of the markets at 10 per cent significant level. Few exceptions include- insignificant a_{11} in Egypt and Morocco, in addition to insignificant b_{11} in Morocco. The magnitude of the short-term shocks in the USA return seem to dominate in Egypt and Jordan while the short-term shocks in the return on UK can be found to be more significant in South Africa and Morocco.

The past values of the conditional variance on the return of the USA index represented by the coefficients b_{22} are found to be significant at 1 per cent significant level and higher in magnitude than the past values of the conditional variance on the domestic and the UK indexes in South Africa and Morocco. On the other hand, b_{11} which resembles the past values of the conditional variance on the domestic return seems to be significant at 1 per cent significant level and amounts to 0.998 in Egypt.

Referring to Figure 4.1 (page 202), the expected returns and conditional variances seem to differ from the previous markets. The conditional variances of the return on the domestic index are higher than the conditional variances of the returns on the USA and UK indexes only in Egypt, and from mid-2004 in Jordan. However, the conditional variance of the return on the UK index is higher in Morocco and South Africa.

4.2.2.3 Results for Emerging European markets:

The estimated equation (4.4) includes a number of significant lags in the estimation for emerging European markets. In particular, the first lag of returns on the USA and the UK indexes are statistically significant in Turkey at 10 per cent significant level. In addition, the second lag of returns on the USA and the UK indexes are significant in most of the markets at 10 per cent significance level. The second lag of returns on the domestic index is significant in Hungary and Poland.

With respect to the variance equation, the elements that resemble the matrix $C'C$ are insignificant in most of emerging European markets at conventional significance levels. However, the long-run effect of the domestic return and USA return variances in Turkey are significant at 10 per cent significance level.

Similar to the previous markets examined, the elements of short-run volatilities indicate that the matrices A and B are highly significant at 1 per cent significance level in most of the markets. The magnitude of the short-term shocks in the domestic return seem to dominate in Poland and Turkey, while the short-term shocks in the return on the UK can be found to be highly significant in Hungary at 1 per cent.

Another similarity between the three markets investigated so far is that the magnitudes of past values of the conditional variance on the return of the domestic index represented by the coefficients b_{11} are higher in magnitude than the past values of the conditional variance on the US and UK indexes in most markets. The coefficients of the B matrix range from 0.87 in Turkey to 0.98 in Hungary, which remain higher in magnitude than the A matrix.

Figure 4.1 (page 206) shows that the conditional variances of the return on domestic indexes remain higher than the conditional variances of the returns on the USA and the UK indexes in emerging European markets. On the other hand, the expected returns on domestic indexes outperform the return on USA and UK indexes with regard to the Czech Republic and Hungary.

4.2.2.4 Results for East and South Asia markets

The vector of constant mean μ is significant in most of the markets under study at 10 per cent level with the exception of insignificant mean values for the returns on the Philippines and Thailand indexes. The first lag of returns on the domestic indexes is significant in Korea while the second lag of returns on the USA index is only significant in the Philippines at 10 per cent significance level. However, the third lag of returns seems insignificant in all the markets in East and South Asia at conventional significance levels.

Regarding the variance equation, the elements that resemble the unconditional matrix $C'C$ seem to be significant in Malaysia, Korea and Thailand at 10 per cent significance level. Moreover, the constant term of the Pakistan returns, and the UK return variances in Indonesia and Philippines are significant at 5 per cent.

An examination of the elements of short-run volatilities shows that the matrices A and B are highly significant in most of the markets at 5 per cent significance level, indicating considerable ARCH and GARCH effects respectively. Few exceptions include insignificant a_{11} and a_{33} in India, and insignificant b_{11} in Pakistan at conventional levels. In contrast to Latin American markets, the magnitude of short-term shocks in the return on UK index (a_{33}) are higher that of the shocks in the returns on the domestic (a_{11}) and US (a_{22}) indexes mainly in Malaysia, Korea, Philippines and Thailand.

Similar to Latin American markets, the magnitude of past values of the conditional variance on the return of domestic index as expressed by the coefficients b_{11} is higher than the past values of the conditional variance on the US and UK indexes except for Pakistan.

In addition, the coefficients of the B matrix remain higher in magnitude than for the A matrix.

Another similarity between the markets in Latin America and South and East Asia are noted in Figure 4.1 (page 202). The conditional variances of the returns on domestic indexes are on average higher than the conditional variances of the returns on the USA and the UK indexes with the exception of Indonesia. The gap between the conditional variances of returns on the domestic index and the conditional variances of returns on the USA and UK indexes is particularly obvious in India, Pakistan, Philippines and Thailand.

On the other hand, in the markets in which mean values are taken as proxy for the expected returns, the return on the UK index outperforms returns on the domestic and USA indexes, specifically in Pakistan, Indonesia, Malaysia and Thailand. In that sense, it could be expected that UK equities might dominate investors' portfolios in these markets.

In summary, most of the diagonal elements of the A and B matrices seem to be significant in most of the markets, indicating that the short-term volatility matters, and hence markets might be characterised by volatility clustering.

4.2.3 Diagnostic test for the trivariate GARCH model

The squared scaled residuals for the three returns on assets are tested for serial correlation (see Table 4.3 (page 173)). The null hypothesis for the Ljung-Box Q(k) test assumes that there is no autocorrelation up to order k. The results show that the Ljung-Box test statistics for serial correlation in the squared residuals for domestic returns do not exhibit serial correlation in most of the markets with the exception of higher orders in Colombia and Korea (for the 3^{rd}, 4^{th} and 12^{th} orders). On the other hand, partial serial correlation can be found in the squared scaled residuals of US return; more specifically in Malaysia, Korea, Philippines, Poland and Turkey. In addition, serial correlation of squared scaled residuals of UK returns can be seen in Indonesia, Korea, Philippines, Turkey and South Africa. However, according to the trivariate GARCH estimation, the assumption that the covariance matrix of returns is constant over the period under study in most of the markets is rejected. This is shown also in Cumby, Figlewski and Hasbrouck (1994) and Flavin and Wickens (2000). Hence, portfolio weights need to be adjusted each month to account for this variation in the variance-covariance matrix between the three underlying assets.

4.2.4 Time-Varying optimal weights according to the trivariate GARCH model

In this section, the time-varying mean-variance output from the trivariate model is applied to asset allocation in order to compute optimal weights for each asset, namely the return on domestic index, the USA, and the UK indexes in the optimal portfolio. As mentioned earlier, all the returns and risk are measured in the 'home currency'.

Firstly, the two-fund theorem is used in order to compute the efficient frontier for each month. The efficient frontier aims at minimising the portfolio standard deviation, given the portfolio return calculated, which can be represented by

$$\min \sigma_p^2 = w'H_t w \tag{4.5}$$

where $w' = (w_1, w_2, w_3)$ are the weights for each asset and H_t is the (3x3) covariance matrix. In addition, two constraints are introduced: the expected return on the portfolio $(ER_p = \sum_{i=1}^{3} w_i ER_i)$, and the total of all weights in the portfolio equal to 1 $(\sum_{i=1}^{3} w_i = 1)$.

Both the expected returns on three assets and the covariance matrix are extracted from the trivariate estimation in sub-section (4.2.1) for each month. This implies that changes in the efficient frontier can be as a result of the change in expected returns, the covariance matrix or both.

Secondly, the optimal risky portfolio on the efficient frontier for each month is computed through the introduction of the domestic risk-free rate, and the coefficient of risk aversion[25]. The domestic risk-free rates are represented by the Treasury bill rates; if not available, the deposits rates or discount rates are used instead. The coefficient of risk aversion is assumed to be equal to three in most of the markets[26]. The optimal portfolio and hence the optimal weights for each of the three assets is computed by the point of tangency of the Capital Market Line with the mean-variance efficient frontier at each month[27]. The time-varying weights in the optimal portfolio can be seen in Figure 4.2 (page 210) and Table 4.4 (page 176) reviews the mean values of the optimal weights.

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[25] Borrowing is not allowed in this model.

[26] For some months in the sampled markets, the optimal portfolio is not computed unless the risk aversion coefficient is increased. On average, the coefficient of risk aversion is increased to reach 15 in some months for some markets.

[27] Capital Market line is defined as the transformation line which is tangent to the efficient frontier, while the transformation line expresses the linear relationship between the expected return and the risk on a portfolio that consists of the risk-free rate and a bundle of the three assets (Cuthbertson, and Nitzsche; 2004).

4.2.4.1 Results for Latin America

Domestic equity seems to dominate the optimal portfolio in Brazil, Colombia, and Mexico. On average, the domestic equities share reaches a high of 66 per cent in Brazil, and a low of approximately 44 per cent in Mexico.

The share of the nominal annual risk-free rate in Brazil and Colombia reached around 40 per cent during 1998 and the early nineties, respectively. This has resulted in a considerable share of the risk-free asset in the optimal portfolio amounting to almost 22 per cent for Brazil, and 26 per cent for Colombia. The nominal annual risk-free rate in Venezuela amounted to 60 per cent in 1998, ranged around 40 per cent during 1997 and until mid 2003, and then further declined to around 28 per cent from mid 2003 till mid 2007. Accordingly, this might explain the high share of the risk-free rate asset (amounting to almost 80 per cent) since the return on the risk-free rate tend to be higher than the return on the three assets during most of the period under study (Refer to Figure 4.2 (page 210) and Table 4.4 (page 176)).

On the other hand, it seems optimal for domestic investors in Chile and Peru to invest in UK equities (See Figure 4.2 (page 210)). The mean values for UK equities in the optimal portfolio for Chile and Peru amounted to 60 and 54 per cent, respectively while the weights of domestic equities ranged around 32 and 46 per cent, respectively.

Lastly, the share of domestic equity and investment in risk-free assets constitute almost the same share as the share of US equity in the optimal portfolio for Argentina (both amounting to around 40 per cent).

4.2.4.2 Results for Middle East and Africa:

Domestic equities seem to dominate the optimal portfolio for Egypt. Its share amounts to 58 per cent of the total wealth, followed by 40 per cent of UK equities. However, the share of UK equities equals almost 75 and 80 per cent in Jordan and Morocco, respectively. On the other hand, it might be optimal for domestic investors in South Africa to invest on average, 80 per cent of their wealth in US equities (Figure 4.2 (page 210)).

4.2.4.3 Results of Emerging European Markets

The share of UK equity seems to dominate the optimal portfolio in all the markets except for the Czech Republic. However, the domestic equity tends to dominate the optimal portfolio for the Czech Republic amounting to 72 per cent.

The share of UK equity in the optimal portfolio for Hungary, Poland and Turkey ranges around 40 per cent of the total portfolio while the range of US equity fluctuates between 1 per cent in Hungary and approximately 20 per cent in Poland.

Similarly with reference to Venezuela, the risk-free rate in the three markets mentioned above is considered relatively high compared to other markets. The nominal annual risk-rate in Hungary ranged from 33 per cent in 1995 to eight per cent in 2006, while it fluctuated from 30 per cent in 1994 to eight per cent in Poland, and it swung between 80 per cent in 1994 to 25 per cent in 2008 for Turkey. As a result, the weight of the risk-free assets in the optimal portfolio for these markets ranges from 13 per cent in Hungary to 37 per cent in Turkey.

4.2.4.4 Results of East and South Asia

Unlike the Latin American markets but similar to emerging European market, the UK equity share tends to dominate all the markets (Figure 4.2 (page 210)). The mean shares for UK equities range from 31 per cent in India to 85 per cent in Pakistan. On the other hand, the share of US equity in the optimal portfolio fluctuates between zero per cent in Pakistan and 44 per cent in the Philippines. The considerable share of UK equities in the optimal portfolio for East and South Asian markets can be partially attributed to the relatively high expected returns on the UK equities compared to the expected returns on domestic indexes and the US equities in most of these markets in addition to the low conditional variance on the return on UK equity compared to the conditional variances on the returns of most of the markets in East and South Asia (Figure 4.1 (page 202)).

In summary, the results of the trivariate GARCH imply that investors' location might exert an influence on their portfolio selection, a result also demonstrated by Flavin and Wickens (2006). Domestic equities seem to dominate most markets in Latin American, the Czech Republic in Emerging Europe, and Egypt in Africa. However, UK equities seem to dominate Chile and Peru in Latin America, all markets in South and East Asia and Emerging Europe in addition to Morocco and Jordan. The structure of optimal weights seems to be quite different from what would be assumed by international CAPM. During the period under study, the share of US market capitalisation amounts to 40-55 per cent of the world market capitalisation, while the share of UK market capitalisation ranged around 10 per cent.

Additionally, seven markets out of 22 witnessed some sort of continuous increase in the expected return of the optimal portfolio compared to the expected returns on domestic indexes during the periods under study. However, the variance on the optimal portfolio seems to be higher than the conditional variance on domestic returns for almost 15 markets. This might have been a result of exchange rate volatility included in the US and the UK returns, which might have affected the variance on the optimal portfolio. This might also justify the high risk aversion coefficients assumed during some periods for the markets under study. An investigation of the expected returns and conditional variances on both domestic indexes and optimal portfolios through the estimation of Sharpe ratios follows next in order to gain insights into the possible gains from international diversification for emerging markets.

4.2.5 Sharpe Ratio of optimal portfolios constructed with the trivariate GARCH estimation denominated in local currency

Figure 4.3 (page 214) indicates in more details the possible gains from international diversification for emerging markets. For instance, the figure shows Sharpe ratios for the optimal portfolios versus domestic equities. On average, the Sharpe ratios for Argentina, Brazil and Peru is higher than on the optimal portfolio is with the exception of the years 1999 and 2002 in Brazil and Argentina, respectively. Chile and Mexico show similar trend; the Sharpe ratios for the optimal portfolios seem to outperform those on the domestic equities till 2002, and then show reversing trend. While Sharpe ratios on the domestic equities of Colombia and Venezuela are found negative almost throughout the period under study. This might imply that benefits from international diversification could prevail mostly in Colombia and Venezuela.

Figure 4.3 (page 214) implies low Sharpe ratios on the optimal portfolios in South Africa, since the expected return on the optimal portfolio tends to outperform the expected return on domestic indexes. Moreover the variance on the optimal portfolio remains a lot higher than the conditional variances on domestic returns. Sharpe ratios on domestic equities in Egypt, Jordan and Morocco tend to have more positive values after the year 2002.

The expected return on the optimal portfolio is higher than the expected return on the domestic indexes in Poland and Turkey. However, portfolio variance remains higher than the conditional variance on the domestic return for all the markets, which resulted in mostly positive/zero Sharpe ratios for the optimal portfolios in the markets for emerging Europe. On the other hand, Sharpe ratios on the Czech equities tend to outperform the Sharpe ratios on the optimal portfolios with the exception of the period in early 1999 and 2001.

Regarding South and East Asia market, even though the expected return on the optimal portfolio seems to be higher than the expected return on domestic equities in five out of the seven sample markets in South and East Asia, the variance on the optimal portfolio is higher than the variance on the expected returns on domestic indexes in all the markets, which resulted in positive/zero Sharpe ratios for the optimal portfolios in all markets with the exception of negative Sharpe ratios for the optimal portfolio in Indonesia in 1998. Negative Sharpe ratios on domestic equities seem to dominate Pakistan, Indonesia, Korea, Philippines and Thailand during 1998/1999.

The estimated Sharpe ratios on the optimal portfolios show that most specifically investors in Colombia, Venezuela, India, Philippines and Turkey could benefit from international diversification.

4.2.6 Portfolio International diversification from the International Investment Position

To what extent do the optimal weights calculated differ from the actual equity holdings by domestic investors in these markets? The CPIS started to construct regular annual figures for the geographic breakdown of cross-border equity holdings since 2001. The report can be useful in giving an indication of whether emerging markets in the last seven years seem to follow the optimal weights regarding the return on the US and the UK indexes. Investors in emerging markets tend to hold larger proportion of their equity in domestic equities than would be supported by the optimal weights calculated. Table 4.5 (page 177) shows the share of US and UK equities in the international investment position of some of the emerging markets[28]. The table implies that the share of US and UK equities in the domestic market capitalisation is in general relatively small, ranging between zero to 0.5 per cent. A few exceptions include: the share of the US equities to Argentine market capitalisation which reached almost 35 per cent in 2002; the share of the US equities to Chilean market capitalisation which increased in recent years to reach more than 12 per cent; and lastly, the share of UK equities to South Africa market capitalisation which amounted to 12 per cent in 2001 and decreased to four per cent in 2007.

As can be seen in Table 4.5 (page 177), the investment of these emerging markets in the US and the UK equities remains modest between 2001 and 2007. From the analysis conducted, there seems to be more gains for domestic investors in emerging markets especially in South and East Asia, and Emerging Europe to diversify their portfolios by increasing their investment in the UK equities. It can also be seen from Tables 4.4 (page

[28] Due to data inavailability, the researcher is not able to report the geographical breakdown of the international investment position for the 22 markets examined here.

176) and 4.5 (page 177) that the home bias towards UK equities is more acute than home bias towards the US equities.

In order to extend the number of assets available for the domestic investor in the construction of the optimal portfolio, it would be difficult to use multivariate GARCH models. The difficulty lies in the fact that, as the number of parameters increase, the convergence of the likelihood function might be difficult. Hence, the next section investigates larger number of assets through the use of the dynamic conditional correlation model.

4.3 The use of Dynamic conditional correlation model

The finance literature explains that equity home bias in emerging markets is higher than in developed markets partly because emerging markets exhibit low correlations with developed markets (Bekaert and Harvey, 1995), and hence the gains from international diversification seem to be unexploited. Moreover, Longin and Solnik (1995) among others apply constant conditional correlation model and reject the assumption that international correlation among developed markets is constant over time[29]. They also explain that international integration seems to result in higher markets' correlation. The question that poses itself is to what extent this increase in international correlation decreases the gains from international diversification for investors in emerging markets, and partly justify equity home bias.

[29] Refer to the literature review in first chapter.

Due to the empirical evidence that conditional correlation is time-varying, and the difficulty of applying the multivariate GARCH to many assets, the use of dynamic conditional correlation (DCC) model emerged.

Since emerging markets show low correlation with the rest of the world, recent studies have investigated the gains from international diversification for investors in developed markets investing in emerging markets. However, the present thesis is mainly concerned with the gains from international diversification for investors in emerging markets. Identifying the gains from international diversification could help understand the extent of equity home bias in these markets.

This section employs the DCC model in order to estimate the conditional covariance matrix between asset returns which will be used to compute the time-varying optimal weights for a wide range of assets in the portfolio accordingly.

Therefore, it would be important to investigate whether conditional correlations for these emerging market returns are constant throughout the period under study. Also taking correlation into consideration, this section examines the extent to which this would alter the results found in section 4.2 in addition to testing whether correlations for emerging markets tend to increase/decrease during turbulence times.

4.3.1 Econometric Model

The DCC-GARCH model is estimated in two stages

$$r_t = \mu + \Pi r_{t-1} + \varepsilon_t$$

$$\varepsilon_t | \Omega_{t-1} \sim N(0, H_t) \tag{4.6}$$

$$H_t \equiv D_t R_t D_t \qquad (4.7)$$

where r_t is the $k \times 1$ vector of asset returns, ε_t is a $k \times 1$ vector of asset returns innovation with zero mean conditional on information available at time t-1[30]. H_t is a $k \times k$ matrix and determines the conditional variance-covariance matrix. D_t is a diagonal $k \times k$ matrix composed of conditional standard deviations while R_t is a $k \times k$ matrix which defines the time-varying correlation matrix.

In the first stage, estimates of mean equations of each asset return are calculated, and a univariate GARCH model of asset returns conditional variances are estimated as follows

$$h_{it} = w_i + \sum_{p=1}^{P_i} \alpha_{ip} \varepsilon_{it-p}^2 + \sum_{q=1}^{Q_i} \beta_{iq} h_{it-q} \qquad (4.8)$$

Imposing the usual GARCH restrictions for non-negativity ($\alpha_{ip} \succ 0$; $\beta_{iq} \succ 0$), and stationarity ($\sum_{p=1}^{P_i} \alpha_{ip} + \sum_{q=1}^{Q_i} \beta_{iq} \prec 1$). It follows that imposing these conditions, H_t will be positive definite for all periods. The estimates from the univariate GARCH conditional variance equation are then used to compute D_t, where D_t=diag($h_{iit}^{1/2}$.....$h_{kkt}^{1/2}$) and h_{iit} is the conditional variance of each asset.

In the second stage, the standardised innovations (h_{iit}....h_{kkt}) obtained from the first stage are used to define R_t :

[30] The first lag of return (r_{t-1}) is introduced to the mean equation in the original DCC model, in which it was found significant in many markets.

$$D_t = diag(h_{iit}^{\frac{1}{2}} \ldots\ldots h_{kkt}^{\frac{1}{2}}) \qquad (4.9)$$

in which the time-varying conditional correlation matrix is computed as

$$R_t = (diagQ_t^{-1/2})Q_t(diagQ_t^{-1/2}) \qquad (4.10)$$

where,

$$Q_t = (1-a-b)\overline{Q} + a\eta_{t-1}\eta_{t-1}' + bQ_{t-1} \qquad (4.11)$$

Q_t is a $k \times k$ symmetric and positive definite matrix, $\overline{Q}$ is the unconditional covariance of the standardised residuals from the first stage, and η_{it} is the standardised innovations in which residuals are scaled by their standard deviation estimated in the first stage ($\frac{\varepsilon_{it}}{\sqrt{h_{iit}}}$). Again the non-negativity and stationarity restrictions are imposed for the model to be mean reverting. In the first stage, a quasi-likelihood function is computed which is mainly the sum of individual log-likelihoods GARCH models of each series.

Hence, the conditional variance-covariance matrix is in a way computed from the conditional correlation matrix. The DCC differs from the CCC in the way the conditional correlation matrix is computed, in which a natural extension of the GARCH model in equation (4.11) provides more dynamics for the DCC model (Engle, 2000).

In the second step, the following likelihood function is estimated taking into consideration the parameters estimated in the first stage likelihood (Engle and Sheppard, 2001)

$$L = -\frac{1}{2}\sum_{t=1}^{T}(k\log(2\pi) + 2\log|D_t| + \log(|R_t|) + \eta_t' R_t^{-1}\eta_t) \quad (4.12)$$

4.3.2 Data

The DCC model is estimated using monthly indexes dominated in local currencies and in US Dollars. The monthly indexes are represented by the MSCI indexes (I_{it}), and are obtained from DataStream[31]. The DCC model is applied to 17 emerging markets[32], and due to data availability the sample period covered for Latin American and South and East Asia is from 1994:03-2008:12. However, the sample period covered for Emerging Europe and Africa is 1995:03-2008:12.

The time-varying variance-covariance matrices resulting from the DCC estimations using local currencies and US Dollar denominated indexes are later used to calculate the time-varying optimal weights.

For efficient portfolio construction from the DCC estimation using US dollar-denominated indexes, the US three-month Treasury bill rate is used as a proxy for the risk-free rate. On the other hand, the domestic Treasury bill rate, or the deposit rate, is used as proxies for the risk-free rate in order to compute the time-varying optimal portfolios in addition to the variance-covariance matrices from the DCC estimations denominated in

[31] The monthly returns on a continuously compounded basis are computed in which ($r_{it} = \log I_{it} - \log I_{it-1}$)

[32] In comparison to the trivariate GARCH estimations done in the first section, five markets are excluded from the DCC estimations; Peru, Venezuela, Czech Republic, Jordan, and Morocco, while Russia is included. The exclusion is mainly due to data unavailability on these markets' investment flows in the Coordinated Portfolio Investment Survey (CPIS) of the IMF.

local currencies[33]. No borrowing is allowed in both DCC estimations, and the risk aversion coefficient is assumed to be equal to three.[34]

In order to construct an efficient portfolio for domestic investors in each market, three main criteria are taken into consideration when choosing the equity portfolio. Investors for each market are offered an equity portfolio consisting of

1) Returns on equity indexes of the same region. For example, Argentinean investors are assumed to construct a portfolio consisting of other emerging equities in our sample of Latin America;

2) Returns on American, British and Japanese indexes are included. The share of these three equities collectively in the world market capitalisation is over 60 per cent during the period under study (World Federation of Exchanges); and

3) Other equities are included for some markets. The inclusion is based on the CPIS report in which investors seem to highly invest in some markets. For example, Argentinean investors tend to invest in Spain as shown by Argentina's investment position in the report. The main purpose of this inclusion is to test the optimal weight of these equities according to the DCC estimation, and hence gain insight into whether investors' decisions to invest in these markets as empirically found in the survey report could be justified.

The number of equities assumed for portfolio construction varies from eight equities in Mexico and South Africa to 13 equities in Hungary. The choice of equities mentioned above has not been tested in the literature which might help to provide a better insight

[33] The money market rates in the cases of Brazil and Turkey, while in Indonesia and Korea, the discount rates are used as proxies for the risk-free rate.

[34] Similar to Part (1), for some months in the sampled markets, the optimal portfolio is not computed unless the risk aversion coefficient is increased. On average, the coefficient of risk aversion is increased to reach 21 in some months for some markets.

relating to the portfolio allocation for emerging markets, in which domestic investors are offered a wider range of equities in the portfolio including other emerging markets, main developed stock markets, and other markets which seem significant for domestic investors according to CPIS survey report. In addition, the analysis is expected to provide better understanding for the equity home bias puzzle.

The stationarity of market returns under study is checked by applying the Augmented Dickey Fuller (ADF) test on the returns denominated in US dollar. The null hypothesis of unit root is rejected on all the returns examined at 1 per cent significance level. The results are found in Table 4.6 (page 179).

The conditional variance-covariance matrix from the DCC estimation along the expected returns is used in the time-varying efficient portfolios. It follows that the expected returns follow this general form

$$r_t = \mu + \Pi r_{t-1} + e_t \tag{4.14}$$

The returns are regressed on their means and their first lag values (r_{t-1}). Only significant values are included in this equation. In other words, mean values are used as a proxy for the expected returns if the first lag is found to be insignificant.

The maximisation of the quasi-maximum likelihood function of the DCC model is achieved using the BHHH algorithm in RATS, while the estimation of the optimal portfolio weights is done in MATLAB.

4.3.3 Empirical results of DCC estimation denominated in local currency

In order to test whether the time-varying optimal weights would differ from the results found in section 4.2 by introducing more equities for the domestic investor, a DCC estimation is conducted using returns on indexes denominated in local currency and the result for Argentina is found in Table 4.7 (page 181)[35]. However, the estimation results for the DCC estimation denominated in local currency can be briefly summarised as follows

4.3.3.1 Results for Latin America

The mean equation (4.14) shows that the constant term is statistically significant at 5 per cent for all the markets in Latin America with the exception of the constant term on the return on the Japanese index. The first lag is statistically significant on most returns in Argentina, Brazil and Chile at 10 per cent.

Regarding the variance equation, the constant term is statistically insignificant at 10 per cent significance level in Brazil and Chile. However more significant constant terms are found mainly in Argentina. The insignificance of the constant terms in the variance equation might give rise to the effect of short term volatility. The ARCH coefficients are found to be mostly statistically significant at 10 per cent with the exception of Brazil in which all the ARCH coefficients are insignificant at conventional significance levels. On the other hand, the GARCH coefficients are all significant in Argentina, and mostly significant in the rest of the markets at 1 per cent.

The a and b coefficients in equation (4.11) that mostly capture the ARCH and GARCH coefficients in the conditional correlation equation are statistically significant at 1

[35] Table 4.7(page 179) in appendix B shows the result for Argentina as an example. The rest of estimation results for the DCC model (denominated in local currency and US Dollar) can be provided upon request.

per cent in Argentina, Brazil, while statistically significant at 10 per cent in Mexico. This indicates that conditional correlations for these markets are to some extent time-varying and persistent.

4.3.3.2 *Results for Africa*

The constant in the mean equation (4.14) is mostly statistically significant in Egypt and South Africa at 10 per cent, while the constants in the variance equation are found to be statistically insignificant at conventional levels in most of the markets with few exceptions. In contrast to the Latin America markets, the ARCH coefficients are statistically insignificant at 10 per cent level in Egypt and most markets in the South Africa estimation, while the GARCH coefficients in the variance equation are more significant at 5 per cent level.

In addition, the ARCH and GARCH coefficients in the conditional correlation equation (4.11) are found to be statistically significant at 10 per cent in both markets, which might imply high persistent levels in the conditional correlation.

4.3.3.3 *Results for Emerging Europe*

With respect to the mean equation (4.14), the constants are mostly significant in Hungary Turkey and Russia, while few significant constants are found in Poland and Russia at 10 per cent.

Regarding the variance equation (4.8), the constant term is mostly insignificant in emerging Europe markets at 10 per cent level. Similar to the variance equation for the African markets, the ARCH coefficients are statistically insignificant at conventional levels with few exceptions especially in the case of Turkey. On the other hand, the GARCH coefficients are found mostly significant at 10 per cent level.

Regarding the conditional correlation, the ARCH and GARCH coefficients are found significant at 10 per cent in Hungary and Russia while the GARCH coefficients are insignificant in Poland and Turkey.

4.3.3.4 Results for South and East Asia

The constants in the mean equations (4.14) are mostly statistically significant only in Pakistan and Indonesia while mostly insignificant in the rest of the markets at conventional levels. Similar to the previous markets, the constant term in the variance equation (4.8) is statistically insignificant in most of the markets at conventional levels. Similar to the results for Latin American markets, the ARCH coefficients of the variance equation are statistically significant at 10 per cent level, whilst the GARCH coefficients are mostly statistically significant at 5 per cent level with few exceptions.

On the other hand, the ARCH and GARCH coefficients in the conditional correlation equation are found to be statistically insignificant only in India and Pakistan at 10 per cent level. The ARCH and GARCH coefficients are significant in the rest of the markets at 10 per cent level with the exception of insignificant GARCH coefficients in Malaysia and the Philippines.

4.3.4 Diagnostic test for the DCC model denominated in local currency

Table 4.8 (page 184) reports the diagnostic test for the DCC model denominated in local currency, in which the Ljung-box Q-statistics for autocorrelations test up to the 1st and 12th lags are calculated for both the standardised residuals and squared standardised residuals for all markets. The results show no statistical significant autocorrelation for both the standardised residuals and the squared standardised residuals for either lags in Latin American and African markets. Turkey's estimation shows that the Ljung-box Q-statistics exhibit significant autocorrelation in the standardised residuals for the American, British, Japanese, and German returns at 1 per cent significance level. As can be seen from the results regarding South and East Asia, significant autocorrelation at 1 per cent level can be found in the standardised residuals of the Malaysian and British returns in some markets. Also, the autocorrelation in the squared standardised residuals are found significant in Pakistan, and domestic returns in the Philippines estimation at 1 per cent significance level. The diagnostic test might imply that conditional correlation tends to change throughout the period under study and that the assumption of constant correlation cannot be supported by most of the markets under study and that the DCC model seems to capture the dynamics of conditional covariances and correlations.

As a result of the diagnostic test and the results of the DCC estimation, the conditional correlations of these emerging markets could be considered time-varying, and hence the variance-covariance matrices. The optimal portfolios are constructed using the two-fund theorem as previously explained in section 4.2. The time-varying weights for the optimal portfolios are provided in Figure 4.4 (page 217), while Table 4.9 (page 194) reviews the mean values of the optimal weights. Taking into consideration the same time period investigated in the first section, the mean values for optimal weights seem to differ substantially from those resulting from the trivariate GARCH estimations.

4.3.5 Time-Varying optimal weights based to the DCC model denominated in local currency

4.3.5.1 Results for Latin America

Argentine's average domestic equities share in the optimal portfolio decreased from 40 per cent to almost 1 per cent with the DCC estimation denominated in local currency. However, the US equities still maintain a large portion in the portfolio (around 40 per cent). The share of UK equities increased to around 23 per cent and Colombia's share reached 18 per cent while Chile and Spain's shares constitute around 6 per cent each.

On average, Brazil's domestic equities declined from almost 66 per cent in the trivariate GARCH estimation to 21 per cent in the DCC estimation. On the other hand, the US equities increased to reach almost 20 per cent. It is worth noticing that the estimation of conditional variances according to the DCC model as seen in Figure 4.5a (page 222) is different from the estimation of conditional variances according to the trivariate GARCH model in Figure 4.1 (page 202) in which the conditional variances according to the DCC model seem to take into account the effect of the Asian crises on all the returns. Moreover, the risk-free asset's average share in the portfolio decreased to reach around 4 per cent. Similarly, Portugal's equities amounted to 16 per cent, and Argentine and Colombia's average share reached 25 per cent.

A similar trend can be found in Chile in which domestic equities' average share in the portfolio declined significantly from 32 per cent to almost 2 per cent according to the DCC estimation. The UK's share shrank from the trivariate GARCH estimation and instead higher weights are given to Ireland (almost 40 per cent) and Colombia (almost 38 per cent).

Also, Colombia's domestic equities decreased from 58 per cent in the trivariate GARCH estimation to 27 per cent. The US equity's share remain almost unchanged while the average shares of the risk-free asset and Brazil's equities increased substantially in the portfolio to reach 33 per cent and 14 per cent, respectively. The high share of the risk-free rate in the portfolio especially during the period 1994-1998 can be attributed to the high annual nominal deposit rate during this period which reached almost 35 per cent in late 1994 and around 36 per cent in late 1998.

Similar trends are observed in Mexico where the domestic equity's share declined from almost 44 per cent in the trivariate GARCH estimation to around 5 per cent in the DCC estimation. The shares of US equity and the risk-free asset increased while the UK equity's share declined giving rise to the shares of the Brazilian and Colombian equities.

In summary, the domestic equities' share in the optimal portfolio declined substantially in all Latin American markets with the estimation of the DCC model. Colombian equity's share constitutes a substantial share in the optimal portfolios of Latin American markets. The increased share of Colombian equity in most markets can be attributed to the relatively high returns and low conditional variances, as can be seen from Brazil's estimation in Figure 4.5a (page 222). The average share of Brazilian equities seems to represent considerable share in Chile, Colombia and Mexico. Moreover, the inclusion of Spain, Portugal and Ireland in the portfolios for the Argentinean, Brazilian and Chilean investors proved to constitute a considerable share of the optimal portfolios.

4.3.5.2 Results for Africa

In the case of Egypt, the domestic equities slightly decreased from almost 58 per cent in the trivariate GARCH estimation to almost 49 per cent. However, the UK equity's share declined substantially from 40 per cent in the trivariate GARCH estimation to zero per cent according to the DCC estimation; and instead the share of Jordanian and Swiss equities constitute almost 24 and 21 per cent, respectively. The result of estimation might be explained by looking at Figure 4.5c (page 224), in which the returns on the Egyptian MSCI index tend to outperform other returns on indexes in the portfolio, followed by the returns on Jordanian and Swiss MSCI indexes. On the other hand, the conditional variances on the returns of the Swiss index seem to be the lowest, followed by the returns on British, Jordanian, and Egyptian indexes.

On the other hand, the share of US equity's share in the optimal portfolios offered to investors in South Africa decreased substantially and is mainly replaced by Egyptian equities (74 per cent). In addition, the share of French and German equity reached 15 and 6 per cent, respectively during the period under study according to the DCC estimation.

As can be seen from the results for Egypt and South Africa, a similar trend to those found in Latin America markets are found, in which domestic equities' share in the optimal portfolio decline. In addition, the Egyptian equity tends to constitute a substantial share in both markets similar to Colombian equity in Latin American markets. Further, the share of other equities included in the portfolios in accordance with the CPIS report seem to constitute a considerable share of the portfolios, like the Jordanian and Swiss equities in Egypt's case and German and French equities in the case of South Africa.

4.3.5.3 Results for Emerging Europe

According to Hungary's estimation, the average share of domestic equity declines substantially from 40 per cent in the trivariate GARCH to 1 per cent in the DCC estimation. Also the average share of UK equity shrinks from 44 per cent to zero per cent in the DCC estimation. On the other hand, the average share of the risk-free asset and Czech equity constitute almost 29 per cent and 69 per cent, respectively. Similar to Brazil, Colombia, and Mexico, the risk-free asset in the Hungarian case seems to dominate the portfolio especially during the period 1995-1998 in which the nominal monthly rate ranges around 20 per cent.

Poland's results show that under both estimations of trivariate GARCH and DCC model, the domestic equities tend to constitute a small portion of the optimal portfolio during the period under study. However, the results tend to be quite similar to the ones found in the Hungarian case in which the share of UK equity declines substantially from 44 per cent in the trivariate GARCH to almost 1 per cent according to DCC estimations. The shrinkage of UK equity is mainly replaced by high share of Czech equity (43 per cent) and risk-free asset (54 per cent).

Turkey's estimation reveals a similar trend to those found in Hungary and Poland: domestic equity's share decreased from 19 per cent in the trivariate GARCH to almost 1 per cent in the DCC estimation. Also the UK equity's share declines substantially, while giving rise to the Czech equity (27 per cent) and the risk-free asset (57 per cent).

Emerging European markets share some features with the previous markets regarding the decline of the domestic equities in the optimal portfolios during the period under study. The rise in the share of Czech Republic equity resembles the increased share of Colombia and Egypt in Latin American and African markets, respectively. On the other hand, the inclusion of other equities in the portfolio according to the investment portfolio position of the CPIS report do not seem to constitute any significant share in the optimal portfolios of emerging European markets in contrast to previous markets.

4.3.5.4 Results for South and East Asia

The results found in South and East Asian markets differ from those found for previous markets. The domestic equities share in the optimal portfolio according to the DCC estimation decreased relative to those found in the trivariate GARCH estimation in India, Pakistan, Indonesia, and Korea while domestic equities' shares increase in Malaysia, and remain unchanged for Philippines (zero per cent).

The average share of US equity in the optimal portfolios increased relative to the results from the trivariate GARCH in all East and South Asian markets with the exception of Korea. The increased share of US equities can be explained through Pakistan's estimation in Figure 4.5g (page 228), in which the returns on the US MSCI index seem to outperform returns on other indexes while the conditional variances on the returns on the US MSCI index appear to be modest. The results of conditional variances estimated with the DCC model seem to differ from those calculated with the trivariate GARCH model in which Figure 4.1 (page 202) shows that the conditional variances on the returns on UK index are found to be the lowest. This result could explain the decrease in the share of UK equities in some markets. Higher weights are given to the risk-free asset in comparison with the results from the trivariate GARCH especially in India, Pakistan and Korea. The rise in the shares of US equity and the risk-free asset in the optimal portfolios was mainly at the expense of the share of UK equity.

Similar to the results in Emerging Europe, the optimal weights of the markets included according to the CPIS report did not seem to justify why investors tend to invest in these markets.

In conclusion, the optimal weights resulting from the DCC model seems to differ substantially by the inclusion of more assets in the portfolio. According to the DCC estimation denominated in local currency, the share of the domestic equity declines in all the markets under study except in Malaysia, and remains unchanged in the Philippines. The decline in the share of domestic equities after the inclusion of more assets in the portfolio is supported by Flavin and Wickens (2000).

Colombian equity seems to constitute a substantial share in the portfolios of Latin America, a similar feature found for Egyptian equity in African markets, Czech Republic equity in Emerging European markets, and American equity in South and Asian markets. The high share of UK equity in the portfolio of most markets observed according to the trivariate GARCH shrinks in most markets with the estimation of the DCC model, which is partially explained by the difference in the structure of the conditional variance-covariance matrices estimated by both models. Equations (4.2) and (4.7) show the differences in structure in the conditional variance-covariance matrix (H_t) under both models that is used as input for optimal portfolios; in which the trivariate GARCH model relies on the BEKK representation, while the DCC model considers the effects of conditional volatility in each market and the time-varying correlation matrix. Nevertheless, the results indicated by both the trivariate GARCH and DCC estimation still raise the question on whether the differences in the results are attributed to the influence of the different structure in the conditional variance-covariance matrices or the change in the number of assets in the portfolio.

The inclusion of equities according to markets' investment portfolio positions as reported by the CPIS report tends to constitute significant shares in the optimal portfolios of Latin America, Africa and Indonesia in South and East Asian markets.

Another way of comparing optimal portfolios constructed through the trivariate GARCH estimation and the DCC estimation is to examine the performance of portfolios in terms of the Sharpe ratio.

4.3.6 Sharpe Ratio of optimal portfolios constructed with the DCC estimation denominated in local currency

Figure 4.6 (page 230) shows the Sharpe ratios for the optimal portfolios constructed according to the DCC model denominated in local currency versus Sharpe ratios for domestic equities. As can be seen from the figure, Sharpe ratios are mostly negative for domestic equities in Argentina, Hungary, Turkey, Pakistan, Indonesia and the Philippines. Negative Sharpe ratios might imply that the risk-free rate outperforms the domestic return. Another feature that can be noticed from the figure is that negative Sharpe ratios dominated domestic equities in Chile, Colombia, Mexico, Poland, Russia, Turkey, India, Pakistan and Indonesia until 2001, and then improved and turned positive. The risk-free rates in these markets remained quite high until 2000 especially in Mexico, Poland, Russia and Turkey and then started to decrease. In addition, the conditional variances on the returns in these markets decreased after 2000 compared to the period prior to that, which could provide a partial explanation for the change in Sharpe ratios.

On the other hand, Sharpe ratios for the optimal portfolios are found mostly positive for the period under study in Argentina, Brazil, Chile, Korea and Philippines, which might indicate that investors in these markets might benefit from internationally diversifying their portfolios. However, in the case of Egypt, South Africa and Malaysia, the Sharpe ratios for domestic equities tend to oscillate through the period under study, but on average they seem to outperform portfolios' Sharpe ratios.

The following part of the discussion intends to investigate the extent to which results would change following the use of equity indexes denominated in US dollar. Equity indexes denominated in US dollar is used in the literature[36] in constructing international diversified portfolios. However, the analysis mainly aims at testing the effect of exchange rate volatility on the investment decision for investors, and to the extent to which this would alter the results reported in the previous section.

4.3.7 Empirical results of DCC estimation denominated in US Dollar

Below is a summary of the main findings regarding the estimation results of the DCC model denominated in US dollars.

4.3.7.1 Results for Latin America

The results from the mean equation (4.14) show that the constant term is statistically significant at 1 per cent for all markets in Argentina and Mexico estimations and significant at 10 per cent for Brazil, Chile and Colombia estimations with the exception of mean return on Japan's index. However, the first lag is not as statistically significant as the constant term at 10 per cent.

On the other hand, the constant term in the variance equation (4.8) is found to be insignificant in most of the markets with few exceptions, implying that the short term

[36] For Example refer to: Yin Feng Gau, 2001; Gupta R. 2006; Olusi O and Abdul-Majid H, 2008.

volatility matters more. The ARCH coefficients are mostly significant in Argentina, Chile, Colombia and Mexico at 10 per cent. However, the ARCH coefficients of the return on Chile's index (in Chile's estimation), and the return on Colombia's index (in Colombia's estimation) in addition to the return on Japan's index in both estimations is insignificant at 10 per cent level.

The GARCH coefficients in the variance equation (equation 4.8) are mostly significant at 10 per cent level for most markets in all estimations, which might suggest high persistence to shocks in the conditional volatility.

In addition to persistent conditional volatility as seen by the significance of ARCH and GARCH coefficients in the variance equation, the coefficients (a), and (b) in equation (4.11) are also significant in which they capture the ARCH and GARCH effects in the conditional correlation equation. The coefficient (a) is highly significant at a 1 per cent level in Argentina, Brazil and Mexico. This implies that the short term shocks in the conditional correlation seem to be quite significant. In addition, both (a) and (b) coefficients are statistically significant in Chile (at 5 per cent) and Colombia (at 10 per cent).

4.3.7.2 Results for Africa

The results for Egypt and South Africa show a similar pattern. There seems to be few significant coefficients regarding the constants and the first lags at 10 per cent level in the mean equation (4.14). On the other hand, the constant coefficients in the conditional variance equation (4.8) are all insignificance except for South Africa in both markets. However, the ARCH coefficients in the variance equation are mostly significant at ten per cent level, whilst the GARCH coefficients are significance with few exceptions at five per cent level. The magnitudes of the GARCH coefficients are also higher on average than the magnitudes of the ARCH coefficients. The conditional volatility seems highly persistent which is similar to the results found in Latin America.

Regarding equation (4.11), only (a) coefficient was found significant in Egypt, while both coefficients are significant at 5 per cent level in South Africa.

4.3.7.3 Results for Emerging Europe

The estimations for Hungary show that the constant term in the mean equation is significant at 1 per cent level in all the markets. However, the first lags of returns are mostly insignificant with the exception of the first lag on the USA returns. Regarding the variance equation (4.8), the constant is statistically insignificant in most markets, while the ARCH and GARCH coefficients seem statistically significant at 10 per cent level with few exceptions.

On the other hand, the results for Poland, Russia and Turkey are quite similar. The constant term in the mean equation (4.14) is mostly significant while the first lag returns are on average statistically insignificant. With regard to the variance equation (4.8), the constant is found mostly statistically insignificant with few exceptions, which implies that the short term shocks seem to matter more. The ARCH coefficients are statistically insignificant at 10 per cent with few exceptions. However, the GARCH coefficients tend to be statistically significant at 10 per cent with the exception of Turkey and UK in the case of Poland and Turkey, and UK, France and Switzerland in the case of Russia.

With respect to the (a) and (b) coefficients in the conditional correlation equation (4.11), both coefficients are found statistically significant in Hungary, Poland and Turkey at

10 per cent level, while only the coefficient (a) is significant in the case of Russia at 1 per cent level.

4.3.7.4 Results for South and East Asia

India and Pakistan's estimation results are similar and so are those of Malaysia and Korea since both groups have the same number of assets in the portfolio available for domestic investors, hence the same expected returns and covariance matrices are estimated[37].

The first lags in Pakistan's estimation are more statistically significant than the constant term in the mean equation (4.14) at 10 per cent. In the variance equation (4.8), similar to those of Indonesia, Malaysia, Korea and the Philippines, most of the constant coefficients are statistically insignificant with few exceptions. The ARCH coefficients are mostly significant in Pakistan's estimation. However, they are mostly statistically insignificant for the estimations of Indonesia, Malaysia, Korea and the Philippines at 10 per cent significance level. On the other hand, the GARCH effects are statistically significant for most of the markets in South and East Asia with few exceptions such as India, Pakistan, and Australia in Malaysian and Korean estimations.

Unlike the previous markets, the coefficients of the conditional correlation in equation (4.11) are statistically insignificant in the case of Pakistan and Indonesia. However, the ARCH effects tend to dominate in Malaysia, Korea, and the Philippines.

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[37] Hence, the attached CD shows the results for only Pakistan and Malaysia.

4.3.8 Diagnostic test for the DCC model denominated in US Dollar

Table 4.10 (page 197) reports the diagnostic test for the DCC model, in which the Ljung-box Q-statistics for testing autocorrelations up to the 1^{st} and 12^{th} lags are calculated for both the standardised residuals and squared standardised residuals. The results show no statistical significant autocorrelation for both the standardised residuals and the squared standardised residuals for either lags. The diagnostic test implies that conditional correlation seems to vary through the period under study and that the assumption of constant correlation cannot be supported by the markets under study.

4.3.9 Time-Varying optimal weights according to the DCC model denominated in US Dollar

Figure 4.7 (page 232) shows the time-varying optimal weights taking into consideration the variance-covariance matrix from the DCC model denominated in US dollar, while Table 4.11 (page 199) shows the mean values for these optimal weights. Table 4.9 (page 194) shows the mean values for the time-varying optimal weights according to the DCC model denominated in local currency taking into consideration the same sample period of the DCC model denominated in US Dollar.

The results in Figure 4.7 (page 232), Tables 4.11 (page 199) and 4.9 (page 194) reveal the following main results:

4.3.9.1 Results for Latin America

The share of domestic equity further decreases compared to the estimation of the DCC in local currency. The shares of the US and the UK equities decline compared to the results of the DCC in local currency, giving rise to the share of Colombia (43 per cent) and Spain (almost 40 per cent). The share of Brazil also doubled to reach almost 5 per cent.

Brazil's results are quite similar to the Argentinean case. The shares of domestic and US equities decline, while the share of Colombian equities on average increases to reach almost 95 per cent of the optimal portfolio during the period under study. The shares of Spanish and Portuguese stocks diminish substantially from 2 per cent and 15 per cent to 0.2 per cent and 1 per cent, respectively when considering the variance-covariance matrix resulting from the DCC model denominated in US Dollar.

Chile's results have not changed much with the estimation of the DCC denominated in US Dollar. However, the share of Colombia, the UK and Ireland slightly increased, while the share of the risk-free asset represented by the US Treasury bill rate amounts to only four per cent on average during the period under study.

The estimation results for Colombia shows that in contrast to the results of the other markets, the share of domestic equity (almost 38 per cent) under the DCC model denominated in US dollar seems higher than its share (almost 26 per cent) under the DCC model denominated in local currencies.

Similar to Argentina, Brazil and Chile results, the shares of domestic equity, US equities and the risk-free asset declined in Mexico with the estimation of the DCC model using indexes denominated in US dollar. In addition to the shares of the Colombian equities, Brazilian equities increased to reach almost 54 per cent and 28 per cent, respectively.

According to the estimation of the DCC model using US dollar indexes on Latin America markets, the share of Colombia remains substantially higher, and the shares of domestic equities and US equities decline in all markets with the exception of Colombia. The high share of Colombian equity in the portfolios according to the DCC model denominated in local currency and in US dollar might be attributed to the relatively high returns offered by Colombian equities whether denominated in US dollar or other currencies and the relatively low conditional variances as can be seen from Brazil's estimation figures of expected returns and conditional variances in Figure 4.5b (page 223).

4.3.9.2 Results for Africa

Similar results to those found in Latin America can be seen in Egypt and South Africa. The shares of domestic equities declined to an average of 41 per cent and 0.1 per cent, respectively when the DCC model is estimated in US Dollars.

Another common characteristic between optimal portfolios weights for Egypt and South Africa is that Egyptian equities seem to dominate with considerable weight in the portfolio amounting to 40 per cent for Egypt and 35 per cent for South Africa with the estimation of the DCC in US Dollars, compared to 45 per cent for Egypt and 74 per cent for South Africa according to the estimation of the DCC model in local currency.

Regarding Egypt's results, the average share of US and UK equities decreased while the average share of Jordanian and Swiss equities remain considerably higher amounting to an average of almost 27 per cent and 17 per cent, respectively. Figure 4.5c (page 224) shows that returns on the Jordanian and Swiss indexes seem relatively high while maintaining low conditional variances.

For South Africa, the share of Egyptian equities decreased to more than half with the estimation of the DCC in US dollar to reach almost 35 per cent. The decline in the average share of Egyptian equities in the portfolio estimation for Egypt and South Africa can be attributed to the high conditional variances on the returns on Egypt MSCI index denominated in US Dollar as can be seen in Figure 4.5d (page 225) which might be due to additional volatility of the exchange rate. The average share of German equities decreased from almost 15 per cent to zero per cent in the DCC estimation in US Dollar, and more weights were given to Irish equities (almost 40 per cent).

4.3.9.3 Results for Emerging Europe

The estimates for Hungary reveal that the average share of Czech Republic equity declined from almost 65 per cent according to the DCC model denominated in local currency to almost 7 per cent in the DCC model in US dollar. Higher weights are given to the risk-free asset amounting to almost 53 per cent. The share of US and UK equities also increased to 4 per cent and 8 per cent, respectively according to the DCC model denominated in US Dollar.

In contrast to Hungary's result, the average share of Czech equities seems to constitute a higher share in Poland, Russia and Turkey with the estimation of the DCC in US dollar amounting to almost 56 per cent, 51 per cent and 59 per cent, respectively. The increase of Czech equities increased at the expense of the risk-free asset represented by the US Treasury bill rate. The considerable share of Czech equities in the portfolio can be explained using Figure 4.5f (page 227), in which the expected returns on the Czech MSCI index seem to be higher than all returns from the rest of the markets with the exception of Japanese returns during certain periods. This could explain another notable change from the

DCC estimation in local currency which is attributable to the average share of Japan's equities, in which its share increased in all markets in emerging Europe. Also, the conditional variances on return on the Czech MSCI index seem to be among the lowest returns in the portfolio.

The extent to which Czech equities tend to dominate the portfolios in Poland, Turkey and Russia can be examined by looking at Figures 4.5e (page 226), and 4.5f (page 227) in which the expected returns on the Czech MSCI index denominated in US Dollar tend to outperform other returns in the portfolio while maintaining relatively low conditional variances. Similar results are found with regard to Colombian equities in Latin America.

4.3.9.4 Results for South and East Asia

Similar to the results for other markets, the average share of domestic equities decreased in India and Malaysia in the DCC model estimation denominated in US Dollars. The average share of US equities also decreased in all the markets except Korea.

India and Pakistan results show that the share of the UK equities and the risk-free asset also declined with the estimation of the DCC denominated in US Dollars, while the average shares of Indonesia and the Philippines increased to reach almost 39 per cent and approximately 17 per cent, respectively.

Similarly, Indonesia's results show that the average shares of UK equities, and the risk-free asset declines. However, the share of Indonesia's domestic equities and those of the Philippines increased in comparison to the results found in the estimation of the DCC model denominated in US Dollars.

Malaysia's domestic equities decreased to zero per cent with the estimation of the model DCC denominated in US Dollars compared to almost 26 per cent with the estimation of DCC model in local currency.

The average shares of Korea and the Philippines's domestic equities increases to almost 24 per cent and 8 per cent, respectively compared to 0.1 per cent and zero per cent in the estimation of the DCC model denominated in local currency. The average share of the risk-free asset represented by the US Treasury bill also declined substantially in both markets according to the DCC model denominated in US Dollar.

In summary, the share of domestic equities further decreases in most markets according to the DCC model estimation denominated in US dollars compared to the results of DCC estimation in local currencies with the exception of Colombia, Korea and Philippines. The share of the risk-free asset represented by the US Treasury bill rate also declines in most markets with the estimation of DCC denominated in US dollars except for Hungary.

The shares of Colombian equities in Latin America portfolios, Egyptian equities in African portfolios, Czech equities in Emerging European portfolios and American equities in South and East Asian portfolios decreased in the DCC model estimation denominated in US Dollars, but still maintain considerable share in the portfolios. The decline is mainly caused by the additional volatility in the conditional variances due to exchange rate risk. However, the substantial shares of these equities are mainly attributed to their relatively high returns and relatively low conditional variances whether denominated in US dollars or other currencies.

4.3.10 Sharpe Ratio of optimal portfolios constructed with the DCC estimation denominated in US dollar

Figure 4.8 (page 236) shows the Sharpe ratios for the optimal portfolios calculated according to the DCC model denominated in US dollar versus Sharpe ratios for domestic equities. The figure shows that the Sharpe ratios for Argentina, South Africa and Malaysia are mostly negative through the period under study. For the rest of the markets, positive Sharpe ratios tend to largely dominate during 2000 until mid-2004 and during 2007/2008.

On the other hand, Sharpe ratios for the optimal portfolio seem mostly positive for all markets under study, which implies that if investors chose to invest abroad in US Dollars, there seems to be benefits from international diversification.

4.4 Conditional correlation

The conditional cross-correlations are calculated for each market under study with the rest of the markets in their portfolios. This section briefly highlights some of the key elements found in the results[38]. For example, in Argentine's case, the cross-correlation with Brazil and Mexico reached a high of almost 0.95 during 1997/1998 and late 2008, while Chile's conditional cross-correlation with the USA was 0.9 during both periods. On the other hand, Mexico's conditional cross-correlations reached a maximum of 0.80 during 1998 and 2008 with Argentina, Brazil, Chile, and the USA. Diamandis (2008) also shows that the conditional correlation of Latin American markets and the US market increased

[38] The full set of calculations can be provided upon request.

during mid-1998 when the Asian and Russian crises took place. However, his conditional correlation estimates using weekly data are lower than our estimates.

Figure 4.9 (page 238) reveals the results of cross conditional correlation of some markets investigated in each region. Colombia's cross-correlations show a substantial increase during 1997/1998 and late 2008 with all the markets in the portfolio. The cross-correlation of Colombia with Chile reached a high of 0.58 in 1998 and 2008. However, the cross-correlation of Colombia with the rest of the markets in Latin America is still considered the lowest in our sample, in which the correlations did not exceed 0.60 during the period under study, which could be another explanation for why the Colombian equities tend to dominate the portfolios of Latin American markets. Similar interpretation is provided by Gupta and Donleavy (2009) in which Chilean equities dominated the portfolio for Australian investors due to low conditional correlation using the Asymmetric DCC GARCH model. On the contrary, Olusi O and Abdul-Majid (2010) explain that low correlation between MENA markets and the euro zone is not reflected in diversification benefits.

On the other hand, the cross-correlations for the rest of the markets in Latin America ranged on average around 0.80, and reached 0.9 during the financial crisis at the end of 2008.

With respect to Egypt and South Africa, the results for South Africa in Figure 4.9 (page 238) show that the lowest cross-correlations are observed with Egypt and Ireland. However, cross-correlations seem to have increased in all markets by the end of 2008. The low cross-correlation between South Africa and Egypt could be an additional reason behind the high share of Egyptian equities in the portfolio of South Africa.

On average, the cross-correlations of Egypt and South Africa with the rest of the markets in the portfolio tend to range around 0.4 and 0.5 respectively with the exception of an increase to 0.5 and 0.7, respectively during late 2008.

Emerging European markets seem to show a similar trend. The entire conditional cross-correlations increased during 1998 with the exception of the cross-correlation with Japan in the case of Hungary and Poland. Moreover, the conditional cross-correlations show a rise late 2008 in all the markets except for Ireland in Hungary's estimation. The conditional cross-correlations seem to be lower than those found in Latin America, but remain higher compared to Egypt and South Africa. Few exceptions include: Poland-Hungary cross-correlation which reached a high of 0.80 during 1998 and 2008; Hungary-France cross-correlation which amounted to almost 0.68 in 2008; Russia-Hungary which equalled 0.75 during 2008, and Russia-UK cross-correlation which equals to 0.65 in late 2008. Figure 4.9 (page 238) shows the estimation of the conditional cross-correlation of Turkey with the rest of the markets in the portfolio.

Cross-correlations between Turkey and the rest of the markets tend to increase during 1998 and late 2008. However, the conditional correlations did not exceed 0.5 with Japan and 0.6 with the Czech Republic. Similarly, Wang and Moore (2008) show that the conditional correlation between Czech Republic, Poland and Hungary with the Euro zone area reaches its peak during the Asian crisis in 1997/1998.

The cross-correlations between South and East Asian markets and the US, the UK, and Japan seem to be on average lower than what is witnessed in the previous regions discussed, which ranged around 0.45. India and Pakistan's cross-correlations constitute the lowest conditional correlations with the rest of the markets in the portfolio. Hyde, Bredin and Nquyen (2007) find similar result regarding Pakistan's conditional correlation with other Asia-Pacific, European and US indexes using the asymmetric DCC model. Indonesia's cross-correlations tend to be below 0.5 with the exception of its cross-correlations with Thailand and the Philippines. On the other hand, Indonesia's conditional cross-correlations with the US, the UK, and Japan increased substantially in late 2008 reaching 0.46 and 0.42 with USA and UK, respectively. The highest cross-correlation for the Philippines is found with Indonesia (0.63), Malaysia (0.55), and Thailand (0.63) during 1997/1998.

Figure 4.9 (page 238) presents the cross-correlations for Malaysia[39] which shows a substantial increase in 1997 with the exception of the cross-correlations with Pakistan and India. The mean of cross-correlation between Malaysia and the USA is 0.39 which is higher than what is estimated by Hyde, Bredin and Nquyen (2007) for the period 1991-2006. This could be partly due to the difference in sample size and their use of the asymmetric DCC model. Similar to results in the same region, cross-correlations range below 0.5 except for Indonesia.

In summary, the cross-correlations of our sampled markets with the rest of the markets in their portfolios seem to increase during the Asian crisis in 1997/1998 with the exception of estimations for India and Pakistan. However, all cross-correlations show an increasing trend by the end of 2008, in which cross-correlations increased to higher levels than those estimated during 1997/1998.

[39] Also exact results can be deducted on Korea.

4.5 Conclusion

This chapter investigated the time-varying optimal weights for emerging markets' investors. Investors are assumed to hold a portfolio consisting of the US, the UK, and domestic equities in addition to the risk-free asset through the estimation of the trivariate GARCH model. The analysis is extended by including more assets in the portfolio through the estimation of the DCC model. The rationale for including more assets is to examine the extent to which the optimal weights on an internationally diversified portfolio would change by including more assets in the optimal portfolios, and hence to better understand 'equity home bias'.

The results reveal important aspects which have not been explored in the current literature on international finance that tends to concentrate mainly on developed markets.

First, the share of risk-free assets constitutes a considerable share in the optimal portfolios under both models denominated in local currencies. This result might not be surprising taking into consideration the high nominal Treasury bill, deposit or discount rates that emerging markets seem to offer especially during periods of high inflation, as in the case of Mexico, Poland and Turkey.

Secondly, including more assets in the portfolio seems to alter the results of the trivariate GARCH, in which the share of domestic equities declines in most markets with few exceptions, while more weights are given to other emerging equities mainly Colombian equities in Latin America, Egyptian equities in Africa and Czech equities in Emerging European markets, where the share of US equities increases in South and East Asia. On the other hand, the share of UK equities declined in most of the markets, a result which might be attributed to the change in the structure of conditional variances in the DCC estimation from the trivariate GARCH model.

Thirdly, comparing the results under the DCC estimation denominated in local currency with those from the DCC denominated in US dollars reveals changes in the optimal weights. However, the Colombian equities, Egyptian equities, Czech equities and US equities still constitute considerable shares in the portfolios of Latin America, Africa, Emerging Europe, and South and East Asia, respectively. High expected returns, relatively low conditional variances and low conditional correlations with the rest of the markets are the main reasons behind this result.

Fourthly, conditional cross- correlations of Latin American markets with the rest of the markets in their portfolios seem to be the highest, ranging around 0.80 with the exception of Colombia, and reaching around 0.9 during the stock market crisis in October 2008. Conditional cross-correlations for emerging European markets with the rest of the markets are second highest, amounting to around 0.50-0.80. African markets' conditional cross-correlations tend to range around 0.40-0.50 during the period under study, and increased to reach 0.70 during the late 2008. Lastly, India's and Pakistan's insignificant ARCH and GARCH coefficients of their conditional correlations are reflected in the low cross-correlations with the rest of the markets ranging around 0.20-0.40 during the period under study. Most importantly, all conditional cross-correlations show an increasing trend by the end of 2008, in which cross-correlations increased to higher levels than those estimated during the Asian crisis of 1997/1998.

Fifthly, the gains from international diversification increases with the inclusion of more assets in the portfolio according to Sharpe ratios estimation under the trivariate GARCH and the DCC models.

On the other hand, results found here provide support for evidence in the literature, in which both models show that the constant variances are found statistically insignificant in most markets with very few exceptions, while the GARCH effects are more statistically significant than the ARCH effects in the conditional variances for most of the markets. Also, regarding the conditional correlation coefficients, under the estimation of DCC denominated in local currencies, ARCH and GARCH effects are found significant with the exception of India and Pakistan, which imply high persistent levels in the conditional correlation which are quite dynamic and time-varying. Additionally, the results show that conditional correlations tend to increase during times of crisis, and that the recent financial crisis of 2008/2009 reveals higher cross-correlations between these markets and the rest of the world compared to the Asian crisis of 1997/1998.

Appendix B

Table 4.1: Unit root tests of returns on markets indexes used for the trivariate GARCH.

Country	Augmented Dickey-Fuller (ADF)	Critical value at 1% level
Argentina	-12.20142	-3.473382
Brazil	-11.76432	-3.487046
Chile	-13.12791	-3.468749
Colombia	-11.12954	-3.471454
Czech Republic	-12.53080	-3.474265
Egypt	-10.40131	-3.474567
Hungary	-12.09956	-3.474567
India	-12.41668	-3.470934
Indonesia	-10.76373	-3.468980
Jordan	-9.331886	-3.473967
Korea	-10.79053	-3.470679
Malaysia	-11.34065	-3.468980
Mexico	-13.76434	-3.469691
Morocco	-10.11281	-3.487550
Pakistan	-13.79892	-3.468980
Peru	-12.57366	-3.469214
Philippines	-11.35407	-3.469451
Poland	-14.15137	-3.470427
South Africa	-13.01749	-3.468521
Turkey	-12.18167	-3.470427
Thailand	-9.253456	-3.519050
Venezuela	-11.17160	-3.485586

Table 4.2: Estimation of the trivariate GARCH. $R_t = \mu_t + \Pi r_{t-1} + \phi r_{t-2} + \Theta r_{t-3} + e_t$ [**The number in parenthesis is the p-value**]

Latin America	Argentina	Brazil	Chile	Colombia	Mexico	Peru	Venezuela
μ_1	0.019449	0.031085	0.009049	0.018415	0.018246	0.018122	0.020155
	(0.0218)	(0.0000)	(0.0358)	(0.0022)	(0.0010)	(0.0051)	(0.0000)
μ_2	0.008582	-0.00150	0.006495	0.010629	0.014280	0.009276	0.021933
	(0.0670)	(0.7102)	(0.0251)	(0.0022)	(0.0000)	(0.0021)	(0.0102)
μ_3		0.010297	0.008809	0.011167	0.010092	0.012333	0.021965
		(0.1991)	(0.0049)	(0.0005)	(0.0026)	(0.0000)	(0.0001)
Π_1		-0.075712		0.175617			-0.037943
		(0.3871)		(0.0757)			(0.0003)
Π_2		-0.311847		0.022981			
		(0.0499)		(0.7889)			
Π_3	0.286406	0.131742		0.034774	0.222449		
	(0.0209)	(0.3902)		(0.6714)	(0.0230)		
ϕ_1		0.016601		-0.079290			
		(0.8398)		(0.3175)			
φ_2	0.282777	-0.189088		0.128406			
	(0.0239)	(0.0800)		(0.0995)			
ϕ_3		-0.227920		(0.147019			
		(0.0001)		(0.0964)			
Θ_1		-0.135584					
		(0.1048)					
Θ_2		-0.094535					
		(0.3456)					
Θ_3		0.059074					
		(0.6993)					
C_{11}	0.019930	0.013278	0.017951	0.021277	0.032652	0.017801	0.006547
	(0.1470)	(0.3945)	(0.0318)	(0.0863)	(0.0019)	(0.0059)	(0.9536)
C_{12}	0.045282	0.026210	0.002140	0.004867	0.027226	0.009221	0.012765
	(0.4737)	(0.5060)	(0.1699)	(0.4113)	(0.0588)	(0.4240)	(0.9503)
C_{13}	-9.57E-05	-0.013970	-8.35E-06	1.25E-06	0.002293	1.57E-05	-7.59E-06
	(1.0000)	(0.6961)	(1.0000)	(1.0000)	(0.9996)	(1.0000)	(1.0000)
a_{11}	0.232285	-0.131399	0.282124	0.225532	0.454559	-0.149616	-0.001032
	(0.0000)	(0.1463)	(0.0252)	(0.0115)	(0.0010)	(0.1143)	(0.9950)
a_{22}	0.357736	0.527331	0.256206	0.234642	0.787561	0.346530	0.144951
	(0.0699)	(0.0000)	(0.0002)	(0.0008)	(0.0000)	(0.0001)	(0.0019)
a_{33}	-0.488677	0.555485	0.123263	0.188397	0.630466	0.340260	0.164322
	(0.1300)	(0.0001)	(0.1105)	(0.1278)	(0.0000)	(0.0017)	(0.0008)
b_{11}	0.957979	0.975264	0.905385	0.941942	0.791284	0.914983	1.000342
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.000)	(0.0000)	(0.0000)
b_{22}	0.857182	0.485841	0.945285	0.937524	-0.177199	0.863538	0.980660
	(0.0000)	(0.0368)	(0.0000)	(0.0000)	(0.2143)	(0.0000)	(0.0000)
b_{33}	0.039072	0.594774	0.981092	0.836054	-0.371318	0.586874	0.972790
	(0.9296)	(0.0232)	(0.0000)	(0.0000)	(0.0011)	(0.0485)	(0.0000)

Middle East & Africa	South Africa	Egypt	Jordan	Morocco
μ_1	0.12938 (0.0051)	0.013783 (0.0000)		
μ_2	0.015508 (0.0001)		0.008333 (0.0034)	0.004923 (0.2261)
μ_3	0.007452 (0.0158)		0.010221 (0.0004)	0.007415 (0.0269)
Π_1		0.156075 (0.0001)	0.273327 (0.0013)	0.186381 (0.0017)
Π_2		0.009023 (0.0053)		
Π_3		0.010959 (0.0005)		
ϕ_1				0.082203 (0.3994)
φ_2				
ϕ_3				
Θ_1		0.120533 (0.0023)		
Θ_2				
Θ_3				
C_{11}	0.021010 (0.0207)	-0.003951 (0.9871)	0.009359 (0.0641)	0.038209 (0.8881)
C_{12}	0.009290 (0.0292)	-0.004694 (0.9862)	0.001638 (0.3794)	0.003522 (0.4435)
C_{13}	0.013973 (0.0000)	1.21E-06 (1.0000)	0.002293 (0.8381)	1.23E-05 (1.0000)
a_{11}	0.281664 (0.0001)	0.040663 (0.6731)	0.23438 (0.0050)	0.023652 (0.9354)
a_{22}	0.187139 (0.0080)	0.259638 (0.0074)	0.282868 (0.0003)	0.312101 (0.0010)
a_{33}	0.584249 (0.0000)	0.167578 (0.1051)	0.144047 (0.0678)	0.454588 (0.0002)
b_{11}	0.895828 (0.0000)	0.998026 (0.0000)	0.954591 (0.0000)	0.631729 (0.9256)
b_{22}	0.953584 (0.0000)	0.943461 (0.0000)	0.936634 (0.0000)	0.882767 (0.0000)
b_{33}	0.761242 (0.0000)	0.968998 (0.0000)	0.972993 (0.0000)	0.668955 (0.0031)

Emerging Europe	Czech Republic	Hungary	Poland	Turkey
μ_1	0.018822 (0.0069)	0.016060 (0.0051)		0.027539 (0.0076)
μ_2		0.007123 (0.1117)	0.007248 (0.0528)	0.015591 (0.0019)
μ_3	0.005557 (0.0935)	0.009093 (0.0095)	0.006916 (0.0216)	0.016521 (0.0012)
Π_1				
Π_2				0.212142 (0.0110)
Π_3				0.122086 (0.1132)
ϕ_1		-0.146253 (0.0000)	-0.059327 (0.0000)	
φ_2	0.118346 (0.1485)		0.170882 (0.0348)	0.251901 (0.0009)
ϕ_3	0.142455 (0.0731)	0.214663 (0.0143)	0.249189 (0.0011)	0.392257 (0.0000)
Θ_1	-0.133919 (0.1270)			
Θ_2				
Θ_3				
C_{11}	0.014675 (0.0802)	0.008759 (0.3447)	-0.006074 (0.5708)	0.021785 (0.0262)
C_{12}	0.006610 (0.0798)	0.014487 (0.4664)	-0.011585 (0.5518)	0.011198 (0.1089)
C_{13}	-2.80E-05 (1.0000)	1.30E-05 (1.0000)	1.78E-06 (1.0000)	-1.44E-05 (1.0000)
a_{11}	0.181668 (0.0019)	0.141278 (0.0159)	0.194117 (0.0003)	0.219710 (0.0000)
a_{22}	0.226687 (0.0001)	0.185708 (0.0035)	0.178497 (0.0000)	0.090844 (0.0000)
a_{33}	0.388400 (0.0000)	0.090781 (0.1348)	0.188268 (0.0000)	0.105882 (0.0000)
b_{11}	0.959585 (0.0000)	0.980315 (0.0000)	0.974247 (0.0000)	0.957590 (0.0000)
b_{22}	0.946463 (0.0000)	0.936053 (0.0000)	0.956809 (0.0000)	0.926394 (0.0000)
b_{33}	0.889186 (0.0000)	0.901499 (0.0000)	0.900707 (0.0000)	0.867268 (0.0000)

South & East Asia	India	Pakistan	Indonesia	Malaysia	Korea	Philippines	Thailand
μ_1		0.012566	0.015342	0.009725	0.010646	0.003658	-0.009842
		(0.1158)	(0.0704)	(0.0360)	(0.0944)	(0.5653)	(0.3867)
μ_2	0.008630	0.011982	0.015021	0.007441	0.006232	0.007115	0.015720
	(0.0067)	(0.0000)	(0.0000)	(0.0031)	(0.0190)	(0.0260)	(0.0072)
μ_3	0.012811	0.014816	0.016157	0.010853	0.008102	0.009542	0.006820
	(0.0000)	(0.0000)	(0.0000)	(0.0003)	(0.0094)	(0.0070)	(0.2605)
Π_1					0.160475		
					(0.0809)		
Π_2							
Π_3							
ϕ_1	0.202484						
	(0.0066)						
φ_2						0.135400	
						(0.0642)	
ϕ_3							
Θ_1							
Θ_2							
Θ_3							
C_{11}	0.023235	0.102677	0.009813	0.012637	0.015501	0.15716	0.039989
	(0.6918)	(0.0000)	(0.2978)	(0.0006)	(0.0287)	(0.2471)	(0.0341)
C_{12}	0.004502	0.002203	0.002293	0.003688	0.014133	0.005476	0.018759
	(0.6608)	(0.5233)	(0.3916)	(0.0782)	(0.0887)	(0.4292)	(0.0617)
C_{13}	7.82E-06	5.38E-06	0.011116	0.007709	0.012365	0.009346	0.014374)
	(1.0000)	(1.0000)	(0.0000)	(0.0001)	(0.0002)	(0.0112)	(0.0030)
a_{11}	-0.098673	-0.231150	0.233183	0.332904	0.348289	0.162490	0.255962
	(0.5717)	(0.0377)	(0.0001)	(0.0000)	(0.0000)	(0.0199)	(0.0318)
a_{22}	0.266229	0.388468	0.535078	0.348868	0.391928	0.272270	0.478967
	(0.0192)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0001)	(0.0000)
a_{33}	0.221264	0.261420	0.494912	0.352925	0.477537	0.282970	0.602799
	(0.2297)	(0.0400)	(0.0000)	(0.0000)	(0.0000)	(0.0001)	(0.0003)
b_{11}	0.951531	-0.040592	0.945694	0.929978	0.926276	0.966906	0.935504
	(0.0001)	(0.9740)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
b_{22}	0.917268	0.836139	0.820268	0.924393	0.844449	0.915337	0.834289
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
b_{33}	0.760513	0.559843	0.830138	0.918185	0.751233	0.839989	0.708996
	(0.0398)	(0.0612)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)

Table 4.3: The Ljung-Box statistics of squared scaled residuals of domestic returns.

[the number in parentheses denotes p-value]

	ρ_1	ρ_2	ρ_3	ρ_4	ρ_{12}
Argentina	-0.004 (0.958)	0.012 (0.987)	0.063 (0.886)	-0.012 (0.995)	-0.032 (0.986)
Brazil	-0.012 (0.894)	-0.012 (0.982)	0.029 (0.987)	0.004 (0.998)	-0.003 (1.000)
Chile	-0.012 (0.876)	-0.011 (0.978)	0.001 (0.998)	-0.007 (1.000)	-0.009 (1.000)
Colombia	-0.076 (0.320)	0.112 (0.211)	0.341 (0.000)	-0.078 (0.000)	-0.040 (0.000)
Mexico	-0.007 (0.932)	-0.018 (0.970)	0.015 (0.992)	-0.016 (0.997)	-0.007 (1.000)
Peru	-0.016 (0.835)	-0.014 (0.963)	0.015 (0.990)	0.009 (0.998)	-0.016 (1.000)
Venezuela	-0.013 (0.883)	-0.014 (0.977)	-0.005 (0.997)	-0.002 (1.000)	-0.004 (1.000)
India	-0.021 (0.784)	0.014 (0.947)	-0.027 (0.973)	-0.013 (0.993)	0.041 (0.033)
Pakistan	0.009 (0.911)	-0.022 (0.953)	-0.016 (0.987)	-0.004 (0.998)	-0.020 (0.764)
Indonesia	0.000 (0.998)	-0.012 (0.987)	0.036 (0.969)	-0.012 (0.991)	0.225 (0.633)
Malaysia	-0.011 (0.887)	0.033 (0.901)	0.010 (0.973)	0.048 (0.960)	0.045 (1.000)
Korea	-0.008 (0.922)	-0.019 (0.965)	0.345 (0.000)	-0.011 (0.000)	-0.009 (0.062)
Philippines	-0.010 (0.892)	0.082 (0.553)	-0.035 (0.705)	0.087 (0.605)	0.255 (0.185)
Thailand	0.132 (0.242)	-0.007 (0.503)	0.054 (0.657)	-0.044 (0.779)	-0.059 (0.435)
Czech Republic	-0.012 (0.879)	-0.019 (0.960)	-0.002 (0.994)	-0.023 (0.997)	-0.021 (1.000)
Hungary	-0.019 (0.813)	-0.200 (0.944)	-0.015 (0.985)	-0.019 (0.995)	0.087 (1.000)
Poland	-0.042 (0.583)	-0.046 (0.722)	0.001 (0.884)	-0.034 (0.931)	-0.003 (0.918)
Turkey	-0.022 (0.781)	-0.042 (0.827)	-0.037 (0.893)	-0.014 (0.958)	-0.024 (0.999)
Egypt	0.076 (0.947)	-0.037 (0.581)	-0.049 (0.691)	-0.022 (0.820)	0.003 (0.962)
Jordan	-0.038 (0.636)	0.031 (0.830)	-0.063 (0.801)	0.059 (0.818)	0.017 (0.931)
Morocco	-0.023 (0.802)	-0.017 (0.952)	0.004 (0.992)	0.123 (0.743)	-0.007 (0.998)
South Africa	-0.014 (0.853)	0.028 (0.920)	0.014 (0.997)	-0.014 (0.993)	-0.015 (1.000)

The Ljung-Box statistics of squared scaled residuals of US return

[the number in parentheses denotes p-value]

	ρ_1	ρ_2	ρ_3	ρ_4	ρ_{12}
Argentina	-0.007	-0.007	-0.0007	-0.007	-0.007
	(0.932)	(0.993)	(0.999)	(1.000)	(1.000)
Brazil	-0.008	-0.008	-0.009	-0.009	-0.009
	(0.991)	(0.999)	(1.000)	(1.000)	(1.000)
Chile	-0.007	-0.014	0.048	-0.020	0.019
	(0.928)	(0.978)	(0.930)	(0.971)	(1.000)
Colombia	0.108	-0.002	-0.031	-0.062	0.029
	(0.159)	(0.371)	(0.542)	(0.589)	(0.792)
Mexico	-0.007	-0.008	-0.004	-0.008	-0.001
	(0.929)	(0.991)	(0.999)	(1.000)	(1.000)
Peru	-0.034	0.067	0.052	-0.045	0.008
	(0.652)	(0.611)	(0.694)	(0.771)	(0.981)
Venezuela	-0.009	-0.016	-0.017	-0.002	-0.018
	(0.921)	(0.979)	(0.995)	(0.999)	(0.998)
India	-0.025	-0.014	-0.001	-0.013	-0.014
	(0.746)	(0.935)	(0.987)	(0.997)	(0.785)
Pakistan	0.025	0.076	-0.007	-0.048	0.013
	(0.740)	(0.572)	(0.771)	(0.821)	(0.999)
Indonesia	0.084	0.054	0.164	0.007	0.036
	(0.269)	(0.421)	(0.092)	(0.169)	(0.094)
Malaysia	-0.021	0.260	-0.019	-0.014	-0.015
	(0.785)	(0.003)	(0.008)	(0.018)	(0.379)
Korea	0.199	-0.012	-0.013	-0.005	-0.001
	(0.010)	(0.037)	(0.086)	(0.158)	(0.875)
Philippines	-0.020	0.238	0.009	-0.013	-0.019
	(0.791)	(0.007)	(0.020)	(0.042)	(0.553)
Thailand	-0.012	-0.020	-0.019	-0.017	0.001
	(0.912)	(0.978)	(0.995)	(0.999)	(1.000)
Czech Republic	0.045	0.093	0.027	-0.048	-0.043
	(0.578)	(0.441)	(0.625)	(0.715)	(0.959)
Hungary	-0.004	0.075	0.036	-0.016	-0.038
	(0.963)	(0.649)	(0.785)	(0.893)	(0.347)
Poland	0.040	0.162	0.052	0.032	-0.037
	(0.604)	(0.096)	(0.162)	(0.257)	(0.186)
Turkey	0.328	0.162	0.013	0.025	0.040
	(0.000)	(0.000)	(0.000)	(0.000)	(0.008)
Egypt	-0.021	-0.010	0.006	-0.018	-0.016
	(0.796)	(0.960)	(0.993)	(0.996)	(1.000)
Jordan	-0.014	-0.003	-0.009	-0.016	-0.009
	(0.859)	(0.984)	(0.997)	(0.999)	(1.000)
Morocco	-0.019	0.083	0.010	0.007	-0.001
	(0.838)	(0.649)	(0.830)	(0.927)	(0.723)
South Africa	-0.004	0.140	-0.031	0.001	0.031
	(0.959)	(0.176)	(0.302)	(0.456)	(0.976)

The Ljung-Box statistics of squared scaled residuals of UK return

[the number in parentheses denotes p-value]

	ρ_1	ρ_2	ρ_3	ρ_4	ρ_{12}
Argentina	-0.004 (0.958)	0.012 (0.987)	0.063 (0.886)	-0.012 (0.995)	-0.032 (0.986)
Brazil	-0.009 (0.922)	-0.009 (0.991)	-0.009 (0.999)	-0.009 (1.000)	-0.001 (1.000)
Chile	-0.003 (0.971)	-0.018 (0.971)	0.019 (0.989)	-0.028 (0.992)	-0.015 (1.000)
Colombia	0.006 (0.939)	-0.031 (0.917)	-0.027 (0.960)	0.004 (0.990)	-0.021 (0.988)
Mexico	-0.009 (0.905)	-0.009 (0.986)	0.018 (0.993)	-0.009 (0.999)	-0.002 (1.000)
Peru	-0.015 (0.845)	0.033 (0.894)	-0.030 (0.944)	-0.029 (0.970)	-0.028 (0.968)
Venezuela	-0.007 (0.937)	-0.018 (0.977)	-0.011 (0.996)	-0.001 (1.000)	-0.017 (1.000)
India	-0.014 (0.855)	0.028 (0.923)	-0.028 (0.961)	-0.029 (0.980)	-0.032 (0.999)
Pakistan	-0.021 (0.781)	0.060 (0.702)	-0.030 (0.834)	-0.033 (0.902)	0.002 (0.727)
Indonesia	0.128 (0.091)	0.047 (0.197)	0.172 (0.038)	0.041 (0.068)	-0.047 (0.109)
Malaysia	0.014 (0.855)	0.118 (0.292)	0.000 (0.483)	-0.009 (0.649)	0.016 (0.470)
Korea	0.396 (0.000)	0.034 (0.000)	0.011 (0.000)	-0.030 (0.000)	-0.027 (0.007)
Philippines	-0.037 (0.627)	0.400 (0.000)	0.108 (0.000)	-0.028 (0.000)	-0.044 (0.001)
Thailand	-0.015 (0.892)	-0.016 (0.981)	-0.018 (0.996)	-0.018 (0.999)	-0.017 (1.000)
Czech Republic	-0.027 (0.740)	0.084 (0.549)	-0.047 (0.672)	0.013 (0.813)	-0.015 (0.932)
Hungary	-0.005 (0.952)	0.052 (0.813)	-0.045 (0.868)	-0.060 (0.866)	-0.084 (0.693)
Poland	-0.035 (0.653)	0.061 (0.664)	-0.026 (0.818)	-0.023 (0.907)	-0.055 (0.355)
Turkey	0.335 (0.000)	-0.041 (0.000)	-0.037 (0.000)	-0.024 (0.001)	0.013 (0.052)
Egypt	-0.024 (0.771)	0.004 (C.958)	-0.010 (0.991)	-0.031 (0.993)	-0.053 (0.843)
Jordan	-0.017 (0.837)	0.038 (0.876)	-0.033 (0.934)	-0.037 (0.959)	-0.033 (0.987)
Morocco	0.049 (0.593)	0.063 (0.684)	-0.049 (0.788)	-0.068 (0.804)	-0.048 (0.257)
South Africa	0.223 (0.003)	0.072 (0.008)	0.007 (0.022)	-0.034 (0.043)	-0.029 (0.426)

Table 4.4: Mean values for optimal weights according to the trivariate GARCH estimation

Country	Domestic index	US index	UK index	Domestic Riskfree
<u>Latin America</u>				
Argentina	0.409869	0.430512	0.120406	0.039216
Brazil	0.658324	0.005482	0.113054	0.22314
Chile	0.322401	0.004888	0.602534	0.070175
Colombia	0.414785	0.117555	0.208623	0.259036
Mexico	0.435389	0.164127	0.2927	0.107784
Peru	0.459524	0	0.540476	0
Venezuela	0.059074	0.060714	0.061062	0.791667
<u>East and South Asia</u>				
India	0.233677	0.289297	0.310362	0.06993
Pakistan	0.029548	0	0.852753	0.117647
Indonesia	0.152635	0.163828	0.630598	0.052941
Malaysia	0.196958	0.000908	0.802135	0
Korea	0.391955	0.014653	0.593391	0
Philippines	0	0.434454	0.488125	0.062992
Thailand	0.03377	0.140387	0.558401	0.136364
<u>Emerging Europe</u>				
Czech	0.721731	0.003509	0.241427	0.03333
Hungary	0.408883	0.014354	0.442534	0.134228
Poland	0.039868	0.195043	0.380943	0.343284
Turkey	0.192703	0.036579	0.404863	0.371951
<u>Middle East and Africa</u>				
Egypt	0.580727	0.000582	0.405269	0.013423
Jordan	0.249101	0.003381	0.747517	0
Morocco	0.196039	0.000397	0.803564	0
South Africa	0.206656	0.793052	0.000291	0.023256

Table 4.5: The share of US and UK equities in the international investment position of emerging markets to domestic market capitalisation (In Percentage).

Latin America	Argentina		Brazil		Chile		Colombia		Mexico	
	US	UK	US	UK	US	UK	US	UK	US	UK
2001	18.661612	0.074886	0.1605476	0.0187932	2.116864	0.067484	0	0	0	0
2002	34.570942	0.368612	0.2373312	0.0606752	2.113281	0.008028	0	0	0	0
2003	17.745537	0.208603	0.3216148	0.0357841	2.826015	0.603371	2.005821	0.133254	0	0.078346
2004	15.854647	0.248807	0.2533703	0.0115031	3.619437	0.867228	1.141821	0	1.271372	0.01105
2005	14.412601	0.275266	0.1584336	0.0048457	4.114469	0.575885	1.43166	0	1.368848	0.002326
2006	13.654362	0.140515	0.1004409	0.0043647	10.24077	0.415666	1.652898	0.001779	1.086574	0.013205
2007	17.392617	0.257611	0.0929567	0.0032124	12.55585	0.547649	1.509288	0.014712	0.573133	0

Africa and Middle East	Egypt		South Africa	
	US	UK	US	UK
2001	0	0	4.615649	12.5724
2002	0	0	3.257985	12.97531
2003	0	0	1.666358	8.685772
2004	0	0.067474	1.329867	6.482339
2005	0	0.047793	6.747405	6.747405
2006	0	0.070591	1.783495	4.83373
2007	0	0.058159	1.376769	4.191603

Emerging Europe	Hungary		Poland		Turkey
	US	UK	US	UK	US
2001	0.800617	0.221858	0.087937	0.026764	0.019088
2002	0.48503	0.130881	0.038129	0	0.017535
2003	0.434595	0.105999	0.076259	0.024264	0.017549
2004	0.469965	0.056537	0.177505	0.034942	0
2005	0.644652	0.089023	0.332257	0.076921	0.008048
2006	1.001562	0.114464	0.323812	0.079705	0.025699
2007	1.289554	0.66673	0.297568	0.132785	0.015703

East and South Asia	India		Indonesia		Malaysia		Korea		Philippines		Thailand	
	US	UK	US	UK	US	UK	US	UK	US	UK	US	UK
2001	0	0	0	0	0.057152	0.020171	0.233455	0.026739	0.446467	0	0.038943	0
2002	0	0	0	0	0.106597	0.031735	0.322511	0.029614	0.549522	0	0.006607	0.013214
2003	0	0	0.0018295	0	0.057775	0.009318	0.322215	0.034535	0.616633	0	0	0
2004	0.00233	0.000259	0.0013652	0	0.050654	0.027529	0.620582	0.08396	0.496468	0.02797	0.025132	0
2005	0.003435	0.000181	0.0024562	0	0.088172	0.069245	0.214064	0.055988	0.234222	0.020092	0.050095	0.038746
2006	0.003419	0	0.00216	0	0.100006	0.080652	0.62083	0.161193	0.139154	0	0.079537	0.063498
2007	0.002639	5.5E-05	0.0033067	0.000472	0.291287	0.086384	2.236454	0.154114	0.086402	0.004854	0.386147	0

Note: -*The geographic breakdown of international investment position was downloaded from the IMF Website, Portfolio Investment: Coordinated Portfolio Investment Survey*

-Domestic market capitalisation was downloaded from the World Federation of Exchanges.

Table 4.6: Unit root tests of returns on markets indexes for the use of DCC estimation

Country	Augmented Dickey-Fuller (ADF)	Critical value at 1% level
Argentine	-12.06502	-3.467205
Brazil	-11.84452	-3.467205
Chile	-12.07607	-3.467205
Colombia	-10.90019	-3.467205
Mexico	-12.01706	-3.467205
USA	-10.63447	-3.467205
UK	-10.07124	-3.467205
Japan	-11.95226	-3.467205
Spain	-12.04741	-3.467205
Portugal	-11.03307	-3.467205
Germany	-11.69015	-3.467205
Ireland	-9.380869	-3.467205
Egypt	-8.834114	-3.469933
South Africa	-11.79204	-3.469933
Italy	-12.12467	-3.469933
Jordan	-8.078348	-3.469933
Switzerland	-10.73920	-3.469933
France	-10.68164	-3.469933
Hungary	-11.96333	-3.469933
Czech Republic	-11.26628	-3.469933
Poland	-13.29317	-3.469933
Russia	-10.68473	-3.469933
Turkey	-12.44335	-3.469933
Austria	-7.900669	-3.469933
Belgium	-8.177545	-3.469933
Netherlands	-11.38214	-3.469933
India	-11.65226	-3.467205

Pakistan	-13.17578	-3.467205
Indonesia	-9.571135	-3.467205
Malaysia	-6.812304	-3.467205
Korea	-11.47840	-3.467205
Philippines	-10.82207	-3.467205
Thailand	-7.581773	-3.467205
Australia	-11.43078	-3.467205
China	-11.79099	-3.467205
Singapore	-11.60944	-3.467205

Table 4.7: DCC Model estimation denominated in local currencies

Result for Argentina

DCC Estimators $Q_t = (1-a-b)\overline{Q} + a\eta_{t-1}\eta'_{t-1} + bQ_{t-1}$

	Variable	Coeff	Std Error	T-Stat	Signif
1	a	0.0239	0.0052	4.6076	0.0000
2.	b	0.9068	0.0244	37.1324	0.0000

Mean Equation $r_t = \mu + \Pi r_{t-1} + \varepsilon_t \qquad \varepsilon_t|\Omega_{t-1} \sim N(0, H_t) \qquad H_t \equiv D_t R_t D_t$

GARCH Equation $h_{it} = w_i + \sum_{p=1}^{P_i} \alpha_{ip}\varepsilon_{it-p}^2 + \sum_{q=1}^{Q_i} \beta_{iq} h_{it-q}$

MV_GARCH, DCC - Estimation by BHHH					
Log Likelihood	2314.99352014				
	Variable	Coeff	Std Error	T-Stat	Signif
1.	$\mu_{\text{arg}\,entina}$	0.0193	0.0094	2.0475	0.0406
2.	Argentina{-1}	-0.1195	0.0727	-1.6446	0.1000
3.	μ_{brazil}	0.0262	0.0099	2.6179	0.0089
4.	Brazil{-1}	-0.0053	0.0685	-0.0768	0.9388
5.	μ_{chile}	0.0188	0.0089	2.2745	0.0229
6.	Chile{-1}	-0.0675	0.0612	-1.1017	0.2706
7.	$\mu_{Colombia}$	0.0224	0.0097	2.3037	0.0212
8.	Colombia{-1}	0 1169	0.0851	1.3747	0.1692
9.	μ_{mexico}	0.0229	0.0106	2.1713	0.0299
10.	Mexico{-1}	-0.1066	0.0730	-1.4592	0.1445
11.	μ_{usa}	0.0155	0.0066	2.3495	0.0189
12.	USA{-1}	-0.1410	0.0677	-2.0849	0.0371

13.	μ_{uk}	0.0156	0.0067	2.3449	0.0190
14.	UK{-1}	-0.1342	0.0657	-2.0444	0.0409
15.	μ_{japan}	0.0082	0.0065	1.2526	0.2103
16.	Japan{-1}	0.0806	0.0749	1.0761	0.2819
17.	μ_{spain}	0.02067	0.0073	2.8302	0.0046
18.	Spain{-1}	-0.1192	0.0649	-1.8351	0.0664
19.	w(Argentina)	0.0015	0.0011	1.3169	0.1878
20.	w(Brazil)	0.0013	0.0008	1.6301	0.1030
21.	w(Chile)	0.0008	0.0005	1.6325	0.1026
22.	w(Colombia)	0.0021	0.0018	1.1933	0.2327
23.	w(Mexico)	0.0015	0.0015	1.0295	0.3032
24.	w(USA)	0.0006	0.0002	2.6784	0.0073
25.	w(UK)	0.0005	0.0002	2.2041	0.0275
26.	w(Japan)	0.0004	0.0002	1.4686	0.1419
27.	w(Spain)	0.0007	0.0004	1.7948	0.0726
28.	α (Argentina)	0.1087	0.0539	2.0165	0.0437
29.	α (Brazil)	0.1088	0.0547	1.9862	0.0470
30.	α (Chile)	0.0827	0.0702	1.1782	0.2386
31.	α (Colombia)	0.1648	0.1341	1.2291	0.2190
32.	α (Mexico)	0.1108	0.0585	1.8947	0.0581
33.	α (USA)	0.1276	0.0466	2.7366	0.0062
34.	α (UK)	0.1244	0.0852	1.4604	0.1441
35.	α (Japan)	0.0856	0.0541	1.5804	0.1139
36.	α (Spain)	0.1211	0.0969	1.2488	0.2117
37.	β (Argentina)	0.7716	0.1267	6.0905	0.0000
38.	β (Brazil)	0.8088	0.0930	8.6967	0.0000
39.	β (Chile)	0.8097	0.1026	7.8941	0.0000

40.	β (Colombia)	0.7128	0.2020	3.5272	0.0004
41.	β (Mexico)	0.7802	0.1438	5.4240	0.0000
42.	β (USA)	0.7747	0.0645	11.9963	0.0000
43.	β (UK)	0.8119	0.0788	10.2989	0.0000
44.	β (Japan)	0.8636	0.0669	12.8945	0.0000
45.	β (Spain)	0.8019	0.1068	7.5085	0.0000

Table 4.8: Ljung-box Q-statistic for the standardised residuals For DCC estimations denominated in local currency.

Q(1), and Q(12) are the Ljung-box Q-statistic for the 1st and 12th orders in levels of the standardised residuals, while $Q^2(1)$ and $Q^2(12)$ are the Ljung-box Q-statistic for the 1st and 12th orders in levels of the squared standardised residuals (*,**, and * resembles significance at 1%, 5% and 10% level respectively)**

Latin America	Argentine	Brazil	Chile	Colombia	Mexico
Argentine Q(1)	0.3866	0.0033	0.0984	0.0425	0.0039
Q(12)	10.873	13.633	8.4875	5.4721	12.565
$Q^2(1)$	0.0009	0.0012	0.0405	0.0157	0.1403
$Q^2(12)$	11.508	8.7274	15.133	13.320	17.869
Brazil Q(1)	0.2264	0.0928	0.1672	0.2347	0.6356
Q(12)	10.683	7.7644	2.7077	2.1138	3.0371
$Q^2(1)$	0.4467	0.4947	0.0866	0.3885	0.4774
$Q^2(12)$	3.6507	5.3331	10.054	8.1451	9.5067
Chile Q(1)	0.3919	0.1227	0.0020	0.7593	0.2325
Q(12)	9.8696	11.161	8.0870	14.343	14.337
$Q^2(1)$	0.3617	1.3829	0.4068	0.9017	1.7969
$Q^2(12)$	3.5253	7.6994	10.303	5.5783	10.812
Colombia Q(1)	0.0273	0.3062	0.1802	3.2747	3.1161
Q(12)	3.2861	6.6451	8.7210	9.4139	15.318
$Q^2(1)$	0.1399	4.6414	1.6872	0.0402	0.3458
$Q^2(12)$	1.9662	6.8336	11.270	30.349	2.9222
Mexico Q(1)	0.0215	0.2504	0.1028	0.7432	0.0854
Q(12)	14.611	14.216	10.860	11.238	7.1990
$Q^2(1)$	0.0650	0.2340	0.0578	0.0854	0.1812
$Q^2(12)$	1.0943	6.0700	2.0575	2.7926	5.2018

USA Q(1)	2.8975	1.3128	0.0843	0.0140	0.0555
Q(12)	7.1031	9.5791	9.0775	28.262	21.479
$Q^2(1)$	0.0650	0.3318	0.0578	0.1357	0.0589
$Q^2(12)$	1.0943	6.7942	2.0575	13.304	1.9467
UK Q(1)	2.8814	1.3504	1.1691	0.1506	0.8373
Q(12)	7.4587	9.0688	11.599	26.055	21.121
$Q^2(1)$	0.0861	0.0297	0.0011	0.5924	0.4965
$Q^2(12)$	0.5587	0.8748	11.142	8.5900	9.9923
Japan Q(1)	3.3213	0.1246	0.2911	1.2145	1.0580
Q(12)	10.592	9.1639	7.5604	15.279	14.950
$Q^2(1)$	0.0435	0.1947	0.6829	0.0007	0.1748
$Q^2(12)$	0.5489	5.9769	8.1335	8.0338	11.189
Spain Q(1)	0.3687	0.1216			
Q(12)	13.470	16.627			
$Q^2(1)$	0.0619	0.0599			
$Q^2(12)$	0.5814	10.738			
Portugal Q(1)		0.1704			
Q(12)		6.6999			
$Q^2(1)$		0.0401			
$Q^2(12)$		2.3016			
Germany Q(1)			0.5884		
Q(12)			9.0393		
$Q^2(1)$			0.0138		
$Q^2(12)$			6.3258		
Ireland Q(1)			0.4018	2.1111	

Q(12)			7.8964	21.866	
$Q^2(1)$			0.0279	0.0333	
$Q^2(12)$			15.628	8.6876	

Africa	**Egypt**	**South Africa**
Egypt Q(1)	0.0141	2.9033
Q(12)	10.695	11.184
$Q^2(1)$	0.1863	0.6318
$Q^2(12)$	9.4391	10.517
South Africa Q(1)	0.1218	1.1433
Q(12)	7.1189	9.8273
$Q^2(1)$	0.0479	0.2415
$Q^2(12)$	3.7778	7.7185
USA Q(1)	0.0158	0.2154
Q(12)	8.2442	7.8422
$Q^2(1)$	0.0117	0.0788
$Q^2(12)$	0.9477	2.9215
UK Q(1)	0.4766	0.3407
Q(12)	11.204	8.7756
$Q^2(1)$	0.9181	0.1405
$Q^2(12)$	12.782	1.7455
Japan Q(1)	0.0811	0.0654
Q(12)	11.013	1.1852
$Q^2(1)$	0.6512	1.0344

$Q^2(12)$	11.900	19.842
Germany Q(1)	0.3786	0.1008
Q(12)	7.9180	5.7977
$Q^2(1)$	0.0482	0.8210
$Q^2(12)$	8.7496	11.471
Italy Q(1)	0.3510	
Q(12)	10.409	
$Q^2(1)$	0.0337	
$Q^2(12)$	6.3512	
Jordan Q(1)	0.0912	
Q(12)	8.5610	
$Q^2(1)$	0.3125	
$Q^2(12)$	8.2655	
Switzerland Q(1)	0.0177	
Q(12)	12.066	
$Q^2(1)$	0.1102	
$Q^2(12)$	9.8171	
France Q(1)		0.0009
Q(12)		7.7387
$Q^2(1)$		0.6588
$Q^2(12)$		8.6907
Ireland Q(1)		2.0838
Q(12)		8.8893
$Q^2(1)$		0.4815
		12.984

$Q^2(12)$		

Emerging Europe	Hungary	Poland	Russia	Turkey
Czech Q(1)	0.4812	0.0006	4.0486	0.0040
Q(12)	13.838	11.987	13.003	12.897
$Q^2(1)$	0.0006	0.0081	0.1122	0.6226
$Q^2(12)$	13.772	12.436	8.8909	17.612
Hungary Q(1)	0.1237	0.1445	1.8568	2.0378
Q(12)	11.292	9.1342	7.7998	10.370
$Q^2(1)$	0.2038	0.0928	0.0052	0.0959
$Q^2(12)$	7.2018	8.4295	2.3055	3.2859
Poland Q(1)	2.6672	4.2026	0.0722	1.4040
Q(12)	17.389	17.332	11.564	7.7431
$Q^2(1)$	0.0086	0.0024	0.0212	0.1646
$Q^2(12)$	8.6291	12.734	7.0062	12.252
Russia Q(1)	2.6635	3.2574	1.4228	3.1861
Q(12)	8.9704	7.6287	4.6143	7.4041
$Q^2(1)$	0.0002	0.0017	0.7946	0.0143
$Q^2(12)$	7.2109	5.8893	6.0184	7.2000
Turkey Q(1)	0.0319	0.0587	0.3111	0.0525
Q(12)	9.2709	8.0807	8.4235	6.8212
$Q^2(1)$	0.1487	0.0427	0.1943	0.1233
$Q^2(12)$	8.5688	11.299	12.699	14.770
USA Q(1)	2.1733	1.9686	3.7916	12.665***
Q(12)	37.053	32.037	27.900	116.25***

$Q^2(1)$	0.7652	1.3653	0.1538	0.4263
$Q^2(12)$	8.1224	10.034	0.4060	11.991
UK Q(1)	3.6184	5.5534	3.3223	12.814***
Q(12)	53.357	52.220	23.218	109.80***
$Q^2(1)$	0.0803	0.4684	0.0164	0.0225
$Q^2(12)$	5.3956	14.512	0.3103	16.496
Japan Q(1)	3.7129	5.7244	6.2398	10.236***
Q(12)	14.103	15.876	17.855	26.396***
$Q^2(1)$	0.0000	0.1170	0.0807	1.1436
$Q^2(12)$	9.5715	8.0816	1.0118	10.347
Austria Q(1)	0.4380	1.2359		
Q(12)	14.324	21.121		
$Q^2(1)$	0.0329	0.3222		
$Q^2(12)$	6.7743	12.317		
Belgium Q(1)	5.4354			
Q(12)	41.323			
$Q^2(1)$	1.6651			
$Q^2(12)$	6.8916			
Germany Q(1)	0.7260	0.4689	4.3603	4.1453***
Q(12)	21.435**	20.888	18.623	55.912***
$Q^2(1)$	0.3967	0.5315	0.0685	1.6175
$Q^2(12)$	6.0241	4.6558	0.6863	11.336
France Q(1)	1.5711	1.3737	4.1814	
Q(12)	24.808	25.024	21.701	
	0.3097	0.8349	0.0289	

$Q^2(1)$	5.6337	5.7645	0.2792	
$Q^2(12)$				
Ireland Q(1)	7.3912			
Q(12)	41.562			
$Q^2(1)$	1.1358			
$Q^2(12)$	9.0405			
Netherlands Q(1)		0.9736	1.9793	
Q(12)		23.774	18.445	
$Q^2(1)$		0.0358	0.0378	
$Q^2(12)$		12.432	0.8283	
Switzerland Q(1)			2.3450	
Q(12)			14.870	
$Q^2(1)$			0.0246	
$Q^2(12)$			7.0610	

South and East Asia	India	Pakistan	Indonesia	Malaysia	Korea	Philippines
India Q(1)	0.2713	0.0007	3.4471	0.0040	0.2311	0.0102
Q(12)	7.2017	5.2147	6.5705	4.7903	9.9642	8.7017
$Q^2(1)$	1.7537	1.3936	1.6581	0.7362	0.1137	0.0059
$Q^2(12)$	12.597	5.4815	7.1335	4.5076	4.6457	9.6192
Pakistan Q(1)	0.1034	0.1563	0.6402	0.0264	0.0003	0.0000
Q(12)	10.393	13.756	16.493	10.232	11.966	7.1587
$Q^2(1)$	0.2742	0.1005	0.0048	0.0105	0.0373	0.0499
$Q^2(12)$	20.413	17.583	7.2669	16.230	19.339*	32.511***
Indonesia Q(1)	4.8484	5.6187	2.2342	0.2048	0.0101	0.0139

Q(12)	14.965	17.559	6.7403*	7.4857	7.3186	10.418
$Q^2(1)$	0.0580	0.1256	0.2238	0.1037	0.0009	0.0363
$Q^2(12)$	3.4526	4.1290	20.816*	4.0089	6.7403	8.5103
Malaysia Q(1)	89.221***	92.035***	91.944***	0.0452	0.1997	0.0038
Q(12)	433.59***	426.40***	409.83***	12.021	12.821	16.774
$Q^2(1)$	0.0271	0.0255	0.1293	0.6782	0.0954	0.4238
$Q^2(12)$	9.3919	17.004	14.292	8.1432	26.513	5.7652
Korea Q(1)	1.5856	2.4742	0.5606	0.3138	0.3254	0.8869
Q(12)	8.4767	9.4922	10.411	5.3525	5.9445	7.4850
$Q^2(1)$	0.0647	0.2818	0.5129	0.2042	0.5102	0.1626
$Q^2(12)$	6.7833	7.4049	38.092***	20.093	15.068	10.781
Philippines Q(1)	1.0448	1.6977	1.7749	0.3579	0.1425	0.0867
Q(12)	10.971	12.860	18.323	6.2444	4.9242	7.5853
$Q^2(1)$	0.4301	0.3668	0.0065	2.5820	0.7385	1.6473
$Q^2(12)$	21.852	19.079*	14.184	25.098	20.461	22.601**
Thailand Q(1)	0.8692	0.3363	0.4035	0.0043	0.0127	0.0429
Q(12)	14.767	11.453	7.3636	10.526	13.182	13.109
$Q^2(1)$	1.2684	0.5600	1.2002	0.6831	2.2490	0.4077
$Q^2(12)$	10.743	2.2227	8.1325	4.7768	14.866	7.4071
USA Q(1)	0.0050	1.9185	3.1824*	0.0706	0.5735	0.0015
Q(12)	16.219	22.386	24.313**	11.696	12.905	18.780
$Q^2(1)$	0.9038	0.0197	0.1094	2.3770	1.2647	1.0985
$Q^2(12)$	4.1531	11.704	17.401	25.304	5.5412	13.673
UK Q(1)	0.4254	2.0474	5.6378	6.7797***	0.5610	0.5295
Q(12)	11.498	14.706	30.293***	29.771***	10.986	16.835

$Q^2(1)$ $Q^2(12)$	0.0390 10.832	0.0527 5.1894	0.0295 9.7991	0.0453 14.754	0.4363 11.600	0.0501 18.217
Japan Q(1) Q(12) $Q^2(1)$ $Q^2(12)$	1.8407 10.519 0.0082 7.1009	2.7169 13.020 0.9234 7.5837	3.5877* 10.428 0.5532 8.5679	1.17191 11.011 0.2498 9.9453	0.0225 7.0329 1.4576 11.018	0.0146 7.4350 0.3695 11.538
Netherlands Q(1) Q(12) $Q^2(1)$ $Q^2(12)$			1.4617 22.271 0.0958 9.9954			
Australia Q(1) Q(12) $Q^2(1)$ $Q^2(12)$				0.0139 8.3234 0.2093 7.0944	0.0004 7.3608 0.0005 3.8305	
China Q(1) Q(12) $Q^2(1)$ $Q^2(12)$				0.1274 10.229 0.0642 10.615	0.2042 9.8237 0.7763 6.7653	
Singapore Q(1) Q(12) $Q^2(1)$ $Q^2(12)$						0.0410 9.8920 0.0451 9.1093
Germany Q(1) Q(12)						0.2808 11.677 0.5712

$Q^2(1)$ $Q^2(12)$						9.1212

Table 4.9: Mean values for time-varying optimal weights for DCC model denominated in local currencies:

Latin America	Argentine	Brazil	Chile	Colombia	Mexico
Argentine	0.014437	0.00053	0.0000	0.0000	0.0000
Brazil	0.020874	0.182511	0.113957	0.130675	0.152553
Chile	0.084802	0.083302	0.019594	0.002999	0.019940
Colombia	0.174843	0.250549	0.381685	0.258603	0.227904
Mexico	0.0000	0.012229	0.0000	0.0000	0.049553
USA	0.369151	0.156569	0.064746	0.244792	0.206464
UK	0.224274	0.000863	0.003960	0.002931	0.118861
Japan	0.00000	0.00267	0.000243	0.0000	0.0000
Spain	0.083524	0.0243			
Portugal		0.146025			
Germany			0.0000		
Ireland			0.384236	0.0000	
Riskfree	0.028094	0.142048	0.031549	0.359998	0.224724

Africa	Egypt	South Africa
Egypt	0.446141	0.749552
South Africa	0.0000	0.015852
USA	0.054308	0.005337
UK	0.003337	0.004131
Japan	0.0000	0.0000
Germany	0.0000	0.145488
Italy	0.000993	
Jordan	0.28333	
Switzerland	0.193708	
France		0.0643

Ireland		0.0000
Risk Free	0.018183	0.018074

Emerging Europe	**Hungary**	**Poland**	**Russia**	**Turkey**
Czech	0.650211	0.442643	0.358259	0.272428
Hungary	0.012010	0.0000	0.0000	0.010396
Poland	0.0000	0.0000	0.003768	0.0000
Russia	0.0000	0.0000	0.073825	0.055166
Turkey	0.000837	0.017899	0.0000	0.014370
USA	0.019787	0.000861	0.324446	0.085486
UK	0.0000	0.009986	0.067918	0.001521
Japan	0.0000	0.0000	0.0000	0.0000
Austria	0.0000	0.0000		
Belgium	0.0000			
Germany	0.0000	0.0000	0.0000	0.006416
France	0.0000	0.0000	0.0000	
Ireland	0.0000			
Netherlands		0.0000	0.0000	
Switzerland			0.0000	
Risk Free	0.317078	0.528567	0.176772	0.554217

South and East Asia	**India**	**Pakistan**	**Indonesia**	**Malaysia**	**Korea**	**Philippines**
India	0.014572	0.008918	0.046328	0.033735	0.004788	0.011847
Pakistan	0.005167	0.009882	0.002997	0.008625	0.021925	0.027747
Indonesia	0.0000	0.0000	0.014893	0.0000	0.0000	0.001262
Malaysia	0.0000	0.000212	0.000137	0.257054	0.000399	0.059180
Korea	0.0000	0.0000	0.009725	0.118721	0.001039	0.00000
Philippines	0.0000	0.0000	0.0000	0.181056	0.0000	0.00000
Thailand	0.0000	0.0000	0.0000	0.0000	0.0000	0.00000

USA	0.582015	0.398160	0.572954	0.220989	0.037122	0.374116
UK	0.010596	0.180426	0.037724	0.0000	0.0000	0.0000
Japan	0.0000	0.0000	0.002882	0.0000	0.0000	0.00000
Netherlands			0.138198			
Australia				0.0000	0.0000	
China				0.0000	0.0000	
Singapore						0.00000
Germany						0.00000
Risk Free	0.387643	0.415732	0.174162	0.179812	0.934701	0.528430

Table 4.10: Ljung-box Q-statistic for the 1st and 12th orders in levels of the standardised residuals according to the DCC estimation denominated in US Dollar.

Q(1), and Q(12) are the Ljung-box Q-statistic for the 1st and 12th orders in levels of the standardised residuals, while $Q^2(1)$ and $Q^2(12)$ are the Ljung-box Q-statistic for the 1st and 12th orders in levels of the squared standardised residuals.

Country	Q(1)	Q(12)	$Q^2(1)$	$Q^2(12)$
Argentine	0.0984	8.4875	0.0083	14.859
Brazil	0.1672	2.7077	0.0866	10.054
Chile	0.0020	8.0870	0.4068	10.303
Colombia	0.1802	8.7210	1.6872	11.270
Mexico	0.1028	10.897	0.0280	2.7956
USA	0.0843	9.0775	0.0578	2.0575
UK	1.1691	11.599	0.0011	11.142
Japan	0.2911	7.5604	0.6829	8.1335
Spain	0.3948	14.023	0.3186	3.9527
Portugal	0.0000	10.825	0.3223	7.2752
Germany	0.0.5884	9.0393	0.0138	6.3258
Ireland	0.4018	7.8964	0.0279	15.628
Egypt	0.0057	12.823	0.0335	10.645
South Africa	0.2212	6.4633	0.0176	2.2032
Italy	0.3121	10.867	0.2461	3.9912
Jordan	0.0319	4.9836	0.7524	5.4242
Switzerland	0.2080	15.901	0.1786	7.2248
France	0.1601	8.9545	0.0814	6.8289
Hungary	0.1579	9.22930	0.0993	1.0035
Czech	0.2826	11.432	0.0567	8.1730
Poland	0.0008	10.859	0.0005	4.7551
Russia	0.4755	3.8895	0.0242	7.5259
Turkey	0.0607	7.2682	0.0500	6.8211

Austria	2.0190	16.795	0.2154	5.9393
Belgium	0.1567	8.1439	0.0126	1.7815
Netherlands	0.3879	10.995	0.0929	4.7336
Australia	0.2506	9.2773	0.0718	7.3116
China	0.3403	12.331	0.0250	9.1894
Singapore	0.1259	8.7937	0.1298	6.1141

Table 4.11: Mean values for time-varying optimal weights for DCC estimation in US Dollars:

Latin America	Argentine	Brazil	Chile	Colombia	Mexico
Argentine	0.001732	0.001511	0.003482	0	0
Brazil	0.047373	0.002708	0.111492	0.036472	0.282738
Chile	0.013978	0.001073	0.012142	0.004792	0.005117
Colombia	0.43261	0.949349	0.365204	0.383672	0.546981
Mexico	0.002205	0.001627	0.002147	0	0
USA	0.033715	0.003177	0.050634	0.020846	0.107715
UK	0.001007	0.000529	0.002061	0.002783	0.001274
Japan	0.002378	0.003549	0.001346	0	0
Spain	0.396816	0.002034			
Portugal		0.01759			
Germany			0.001285		
Ireland			0.405263	0.394116	
Riskfree	0.068185	0.016853	0.044944	0.157303	0.056176

Africa	Egypt	South Africa
Egypt	0.407873	0.349289
South Africa	0.000185	0.000165
USA	0.031325	0.079229
UK	0.001358	0.00711
Japan	0.076397	0.045537
Germany	0	0
Italy	0	
Jordan	0.267012	
Switzerland	0.173681	
France		0.024673
Ireland		0.397605
Risk Free	0.042169	0.096387

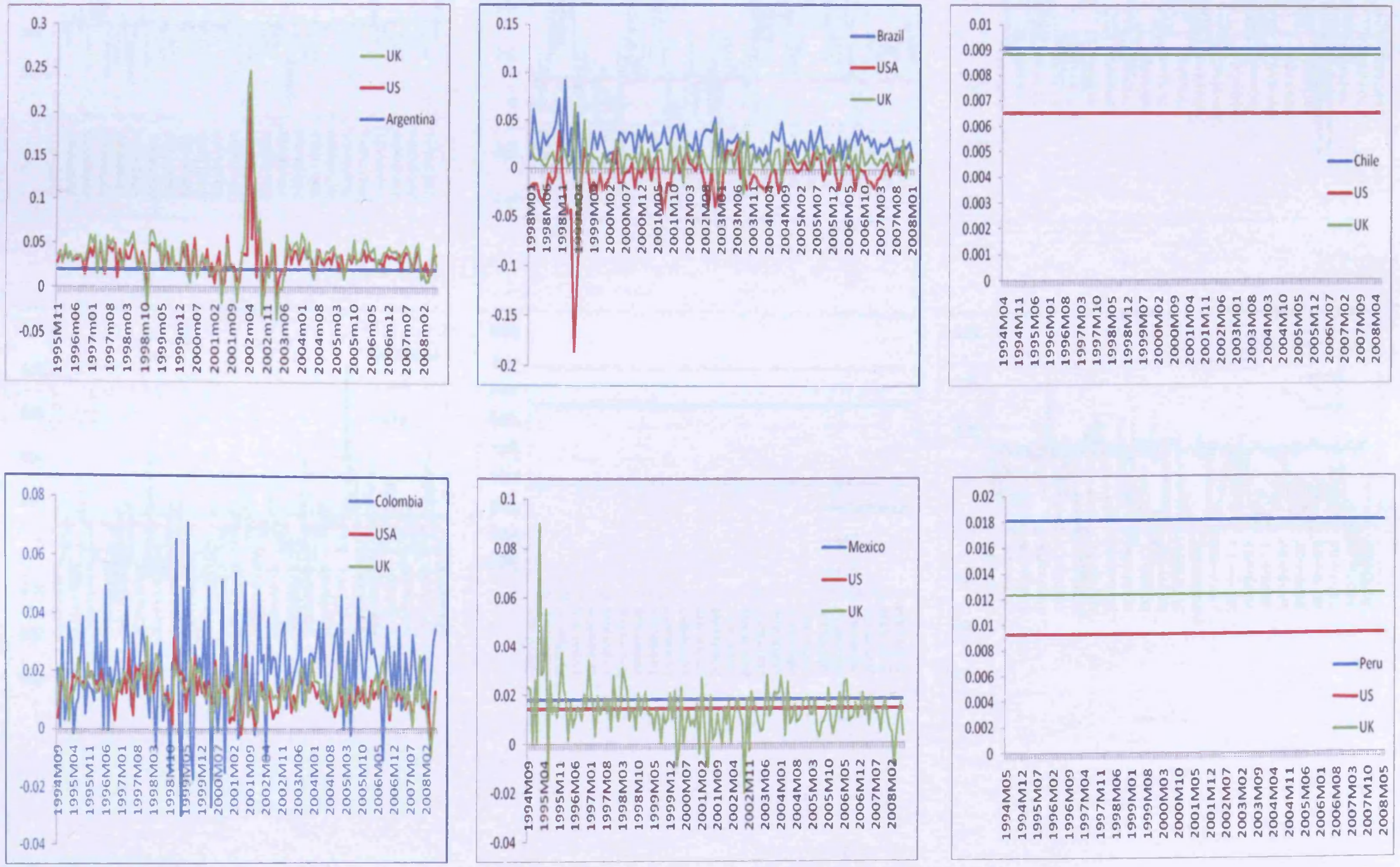
Emerging Europe	Hungary	Poland	Russia	Turkey
Czech	0.074264	0.562122	0.510566	0.587785
Hungary	0.094672	0	0	0.061856
Poland	0.056403	0	0.001624	0
Russia	0.027177	0	0.027068	0.031323
Turkey	0.050821	0.003385	0	0.000119
USA	0.041848	0.001982	0.185892	0.107161
UK	0.081925	0.015238	0.000239	0.016441
Japan	0.045629	0.197458	0.186904	0.188899
Austria	0	0		
Belgium	0			
Germany	0	0	0	0
France	0	0	0	
Ireland	0			
Netherlands		0	0	
Switzerland			0	
Risk Free	0.527261	0.252714	0.120682	0.06627

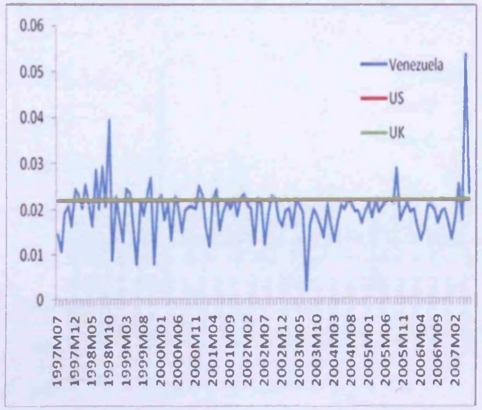
South and East Asia	India	Pakistan	Indonesia	Malaysia	Korea	Philippines
India	0.004462	0.004462	0.00637	0.001355	0.001355	0.002261
Pakistan	0.029153	0.029153	0.031291	0.00048	0.00048	0.003268
Indonesia	0.394035	0.394035	0.407992	0	0	0.00024
Malaysia	0.000496	0.000496	0.000802	0	0	0.004821
Korea	0	0	0.000184	0.241181	0.241181	0.190559
Philippines	0.165547	0.165547	0.16903	0.201658	0.201658	0.086942
Thailand	0	0	0	0	0	0
USA	0.377419	0.377419	0.277039	0.105534	0.105534	0.164412
UK	0.004859	0.004859	0.00597	0	0	0

Japan	0	0	0.00022	0	0	0
Netherlands			0.1011			
Australia				0	0	
China				0	0	
Singapore						0
Germany						0
Risk Free	0.084272	0.084272	0	0.44967	0.44967	0.547494

Figure 4.1: Expected Returns and Conditional Variances according to the trivariate GARCH estimation

a) Expected Returns

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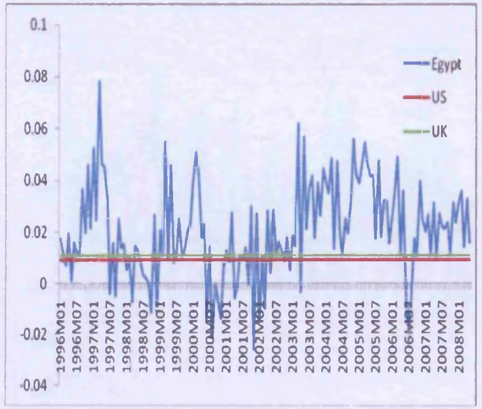
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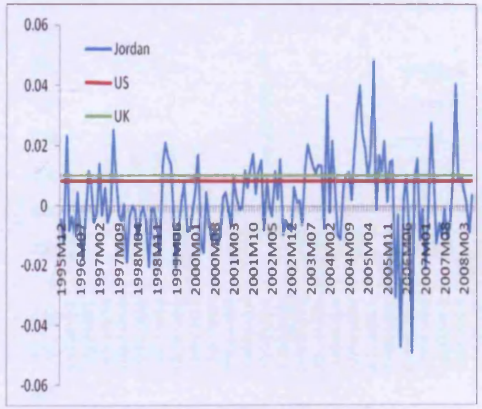
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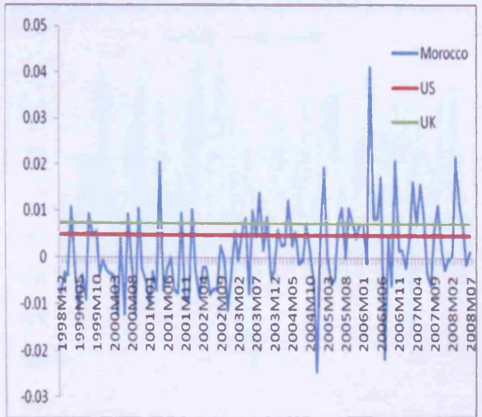
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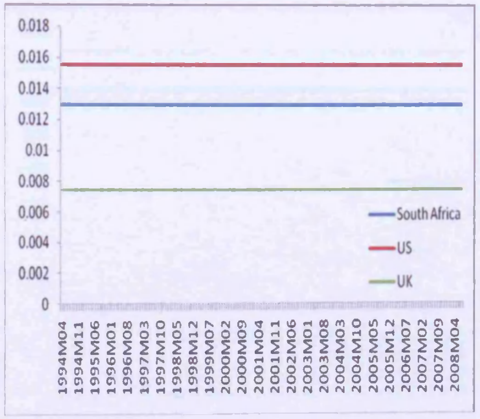
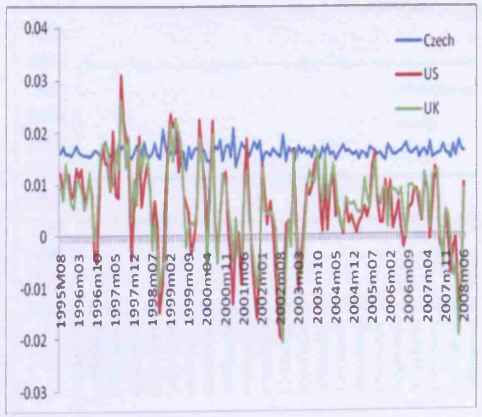
UK


South Africa
US
UK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US
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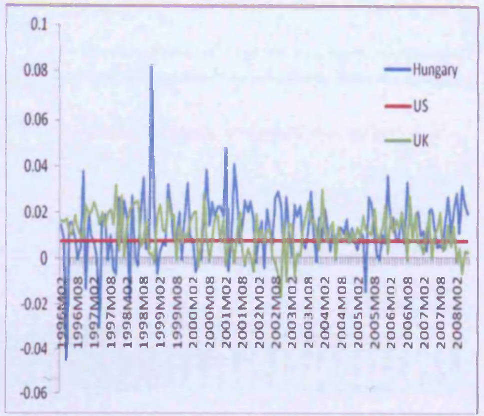
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UK
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0.06
0.04
0.02
0
-0.02
-0.04
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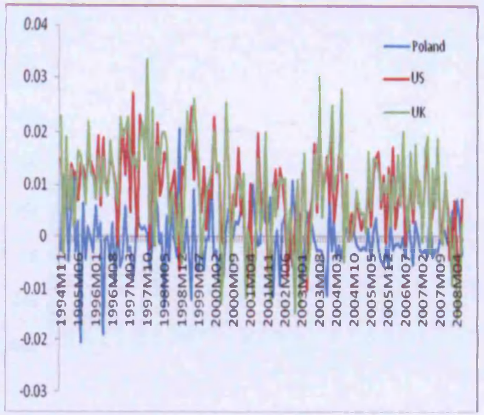
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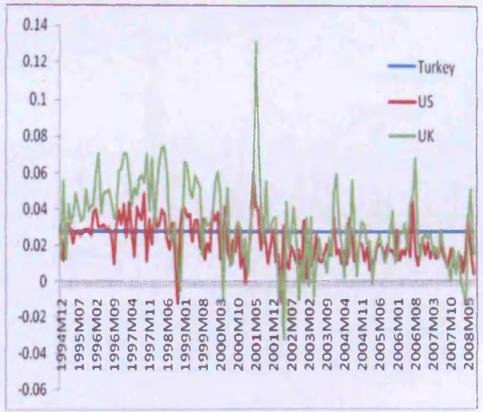
-0.02
-0.03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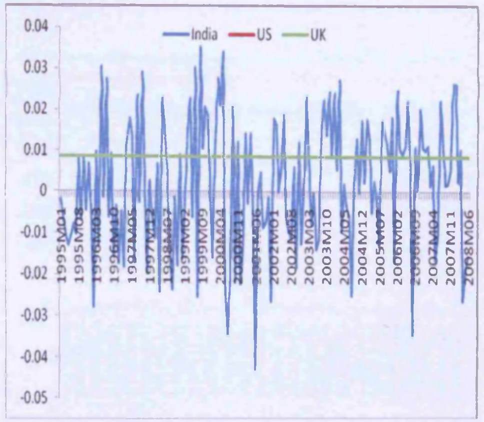
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UK
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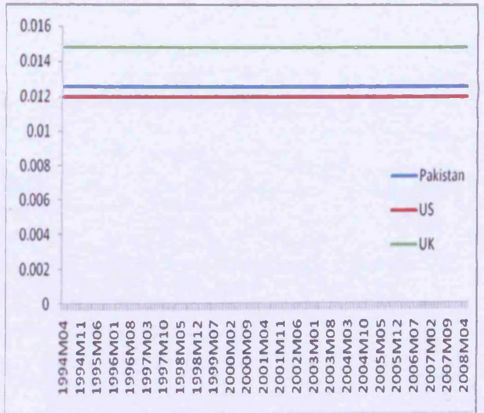
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UK
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0.006
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0.002
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Indonesia
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UK
0.0164
0.0162
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0.0146
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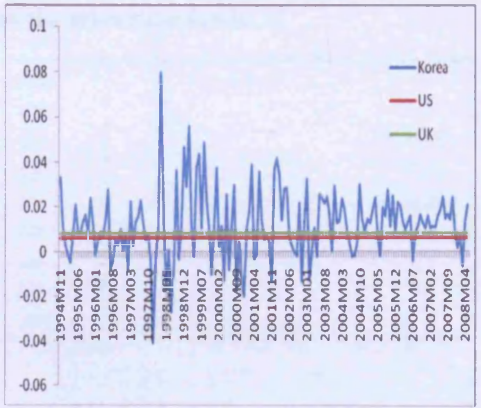
Malaysia
US
UK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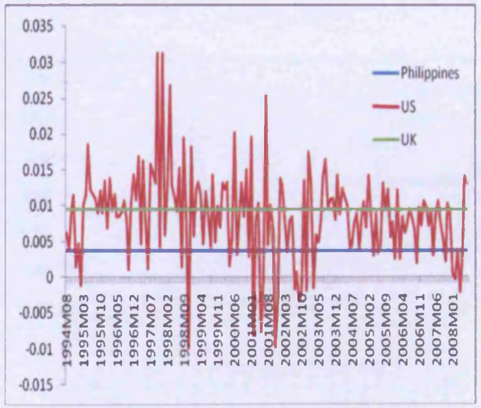
US
UK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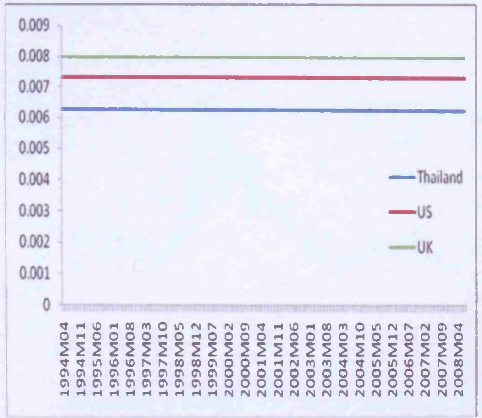
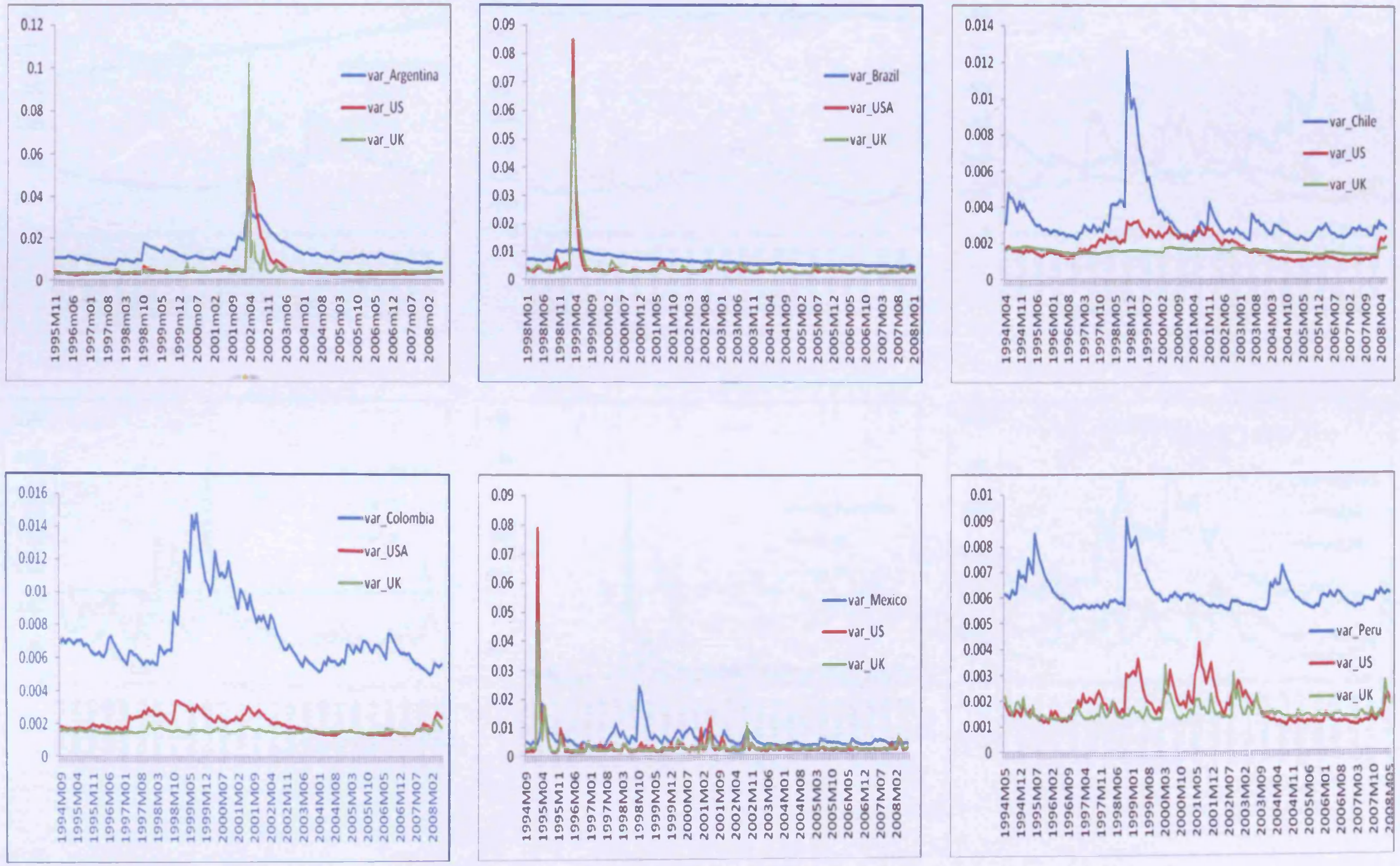
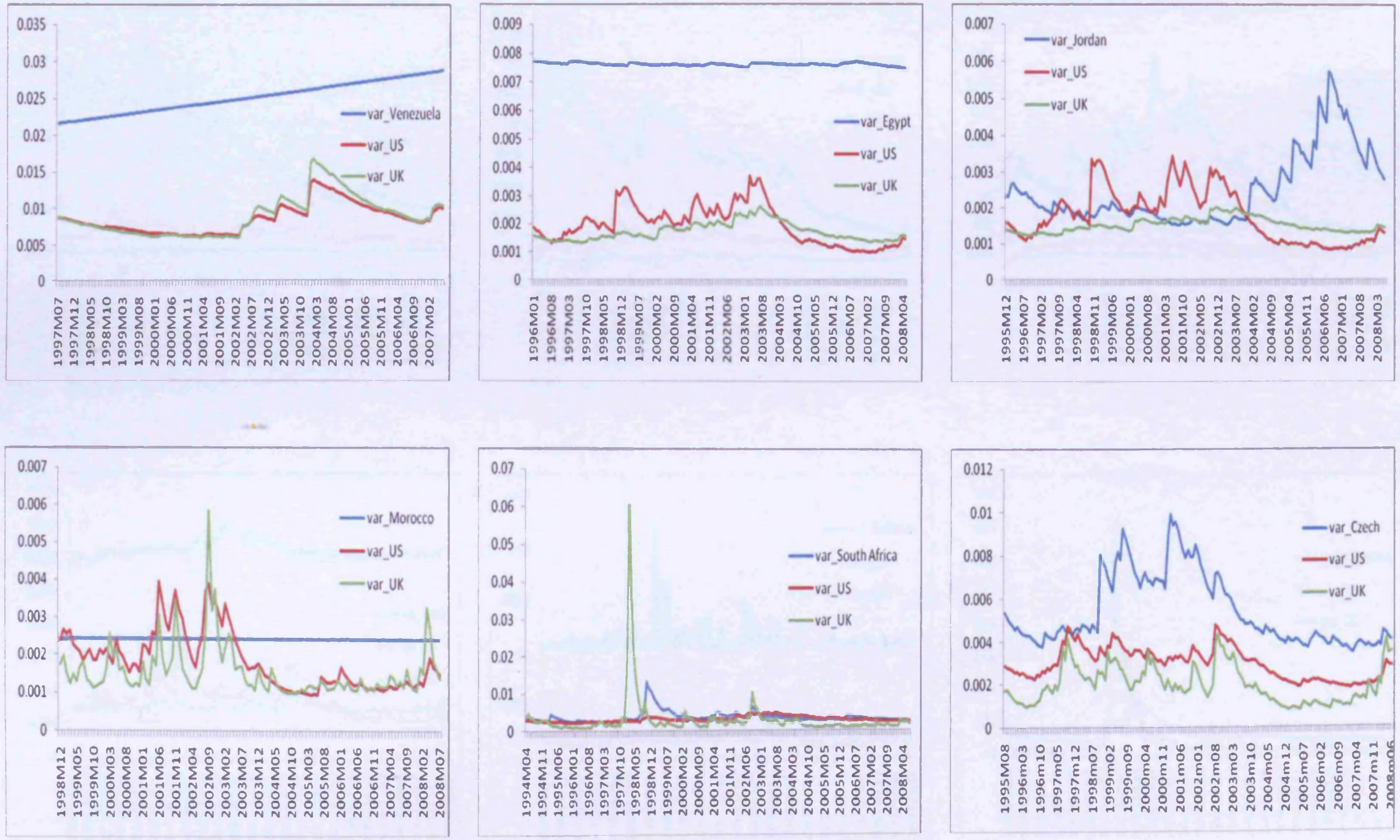
US
UK


Thailand
US
UK

b) Conditional variances resulting from the trivariate GARCH

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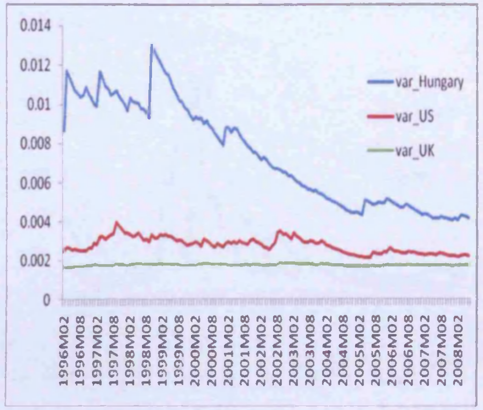
var_South Africa
var_US
var_UK
var_Czech
var_US
var_UK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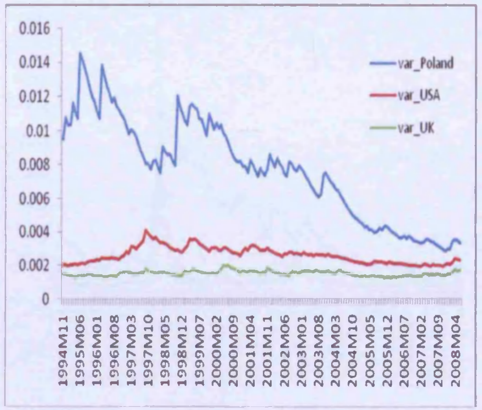
var_UK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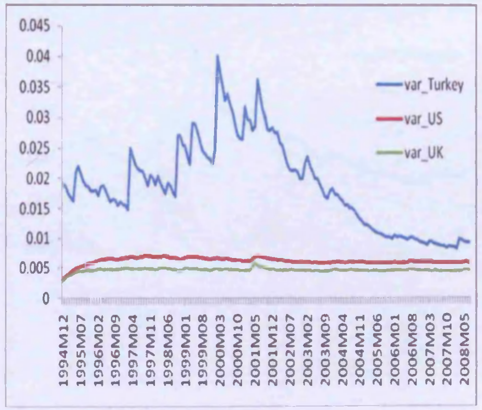
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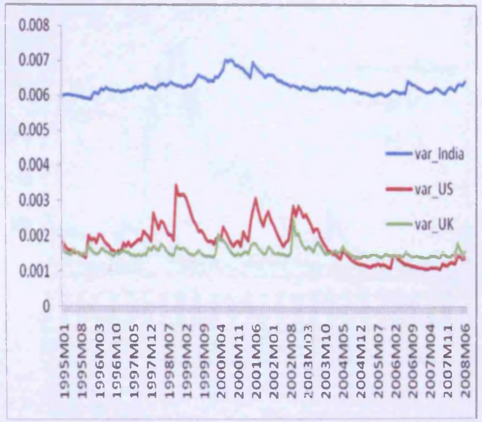
var_UK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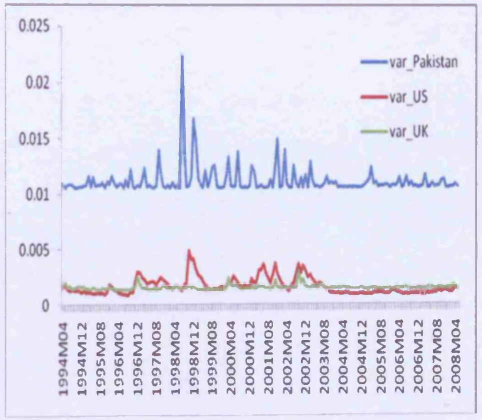
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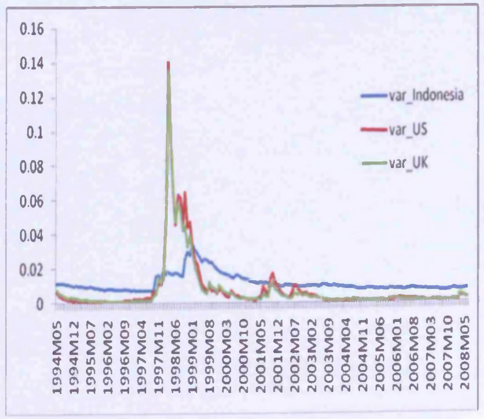
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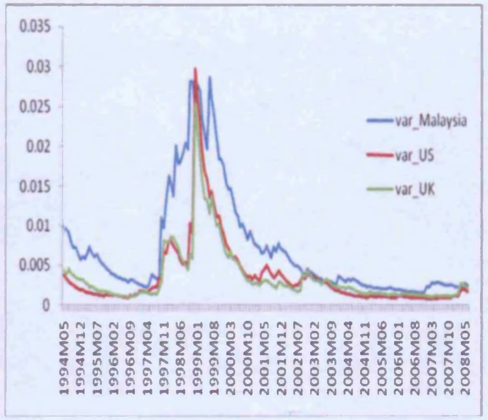
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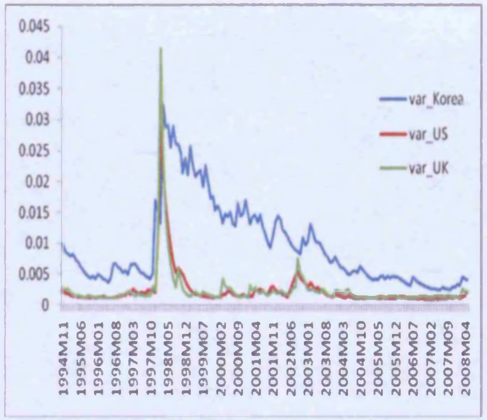
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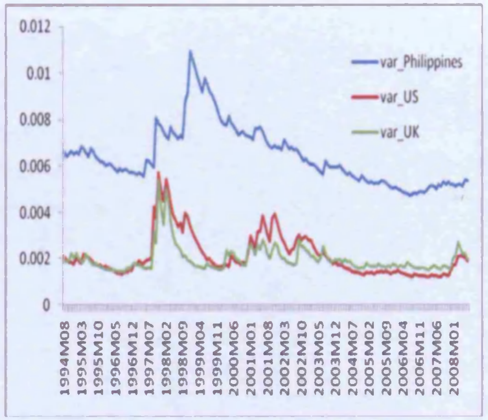
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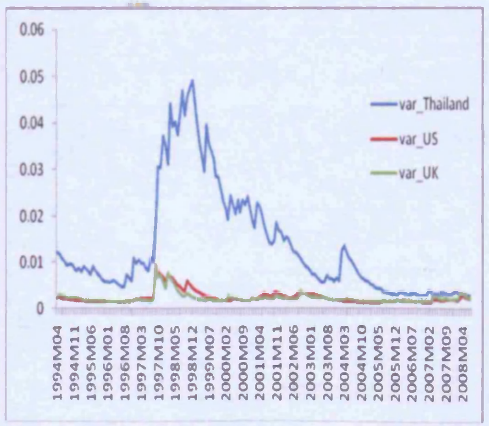
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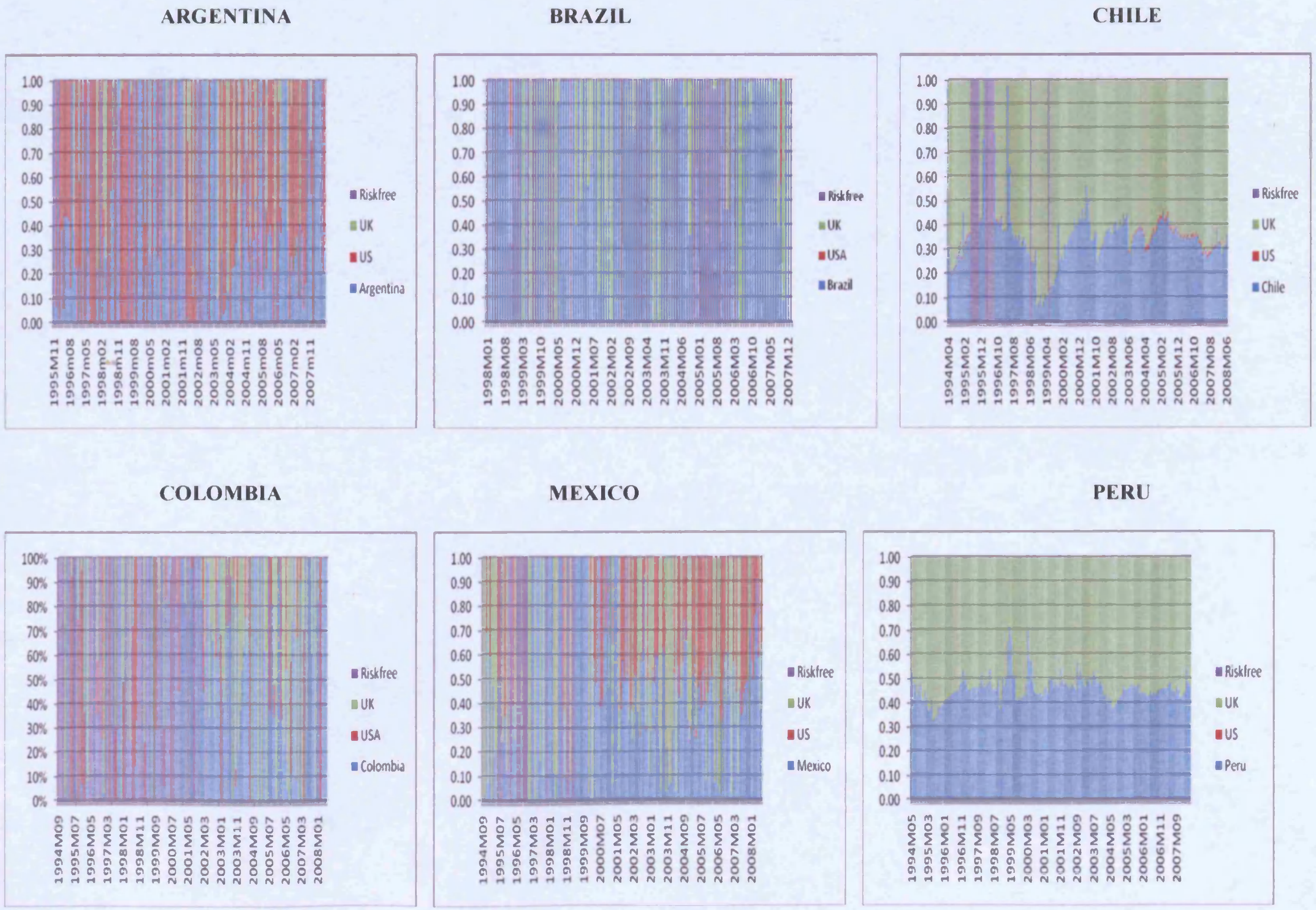
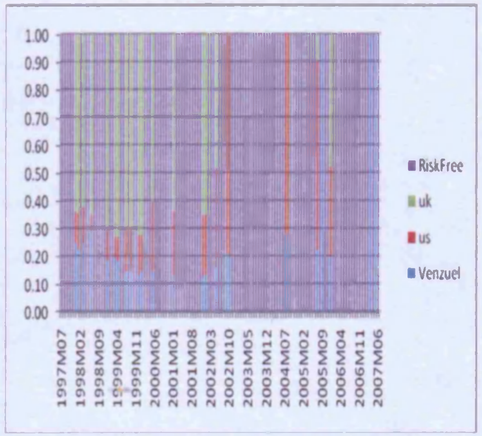
var_US
var_UK

Figure 4.2: Time-varying weights in the optimal portfolio



VENZUELA



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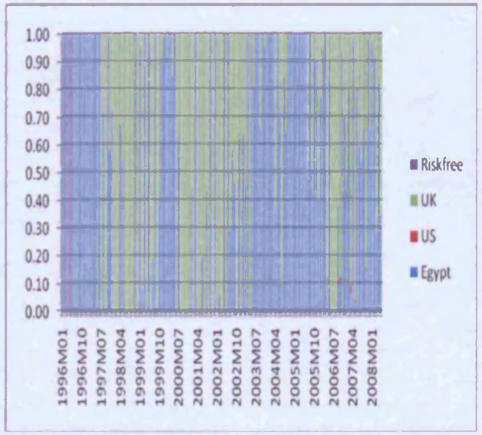
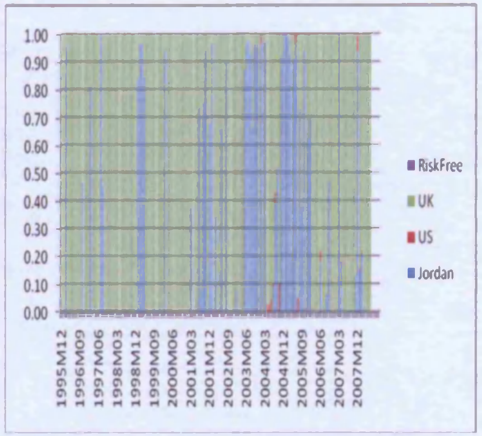
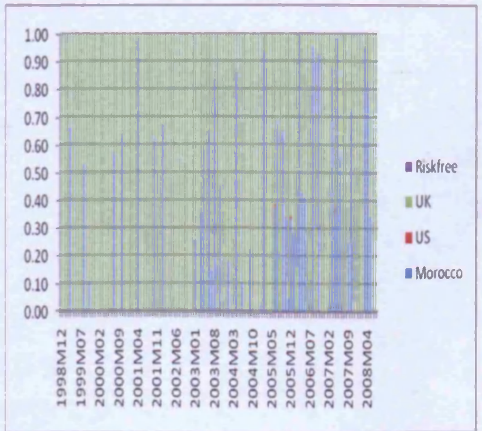


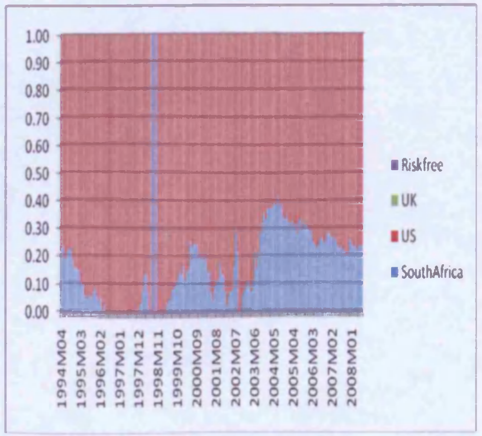
JORDAN



MOROCCO



SOUTH AFRICA



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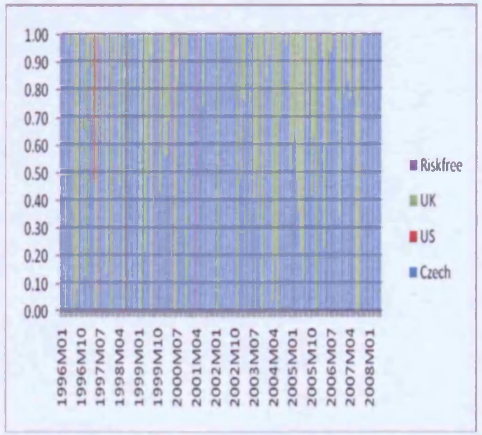

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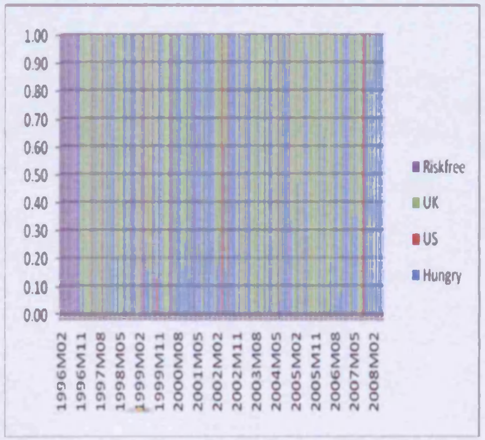

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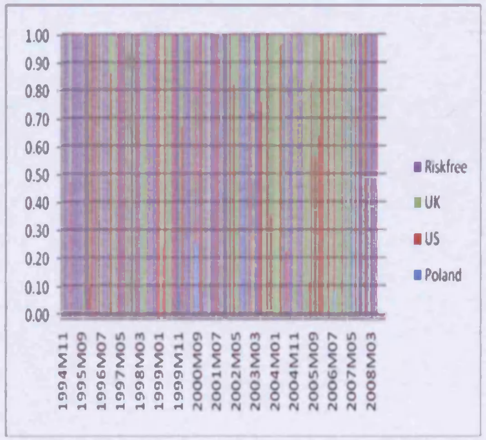

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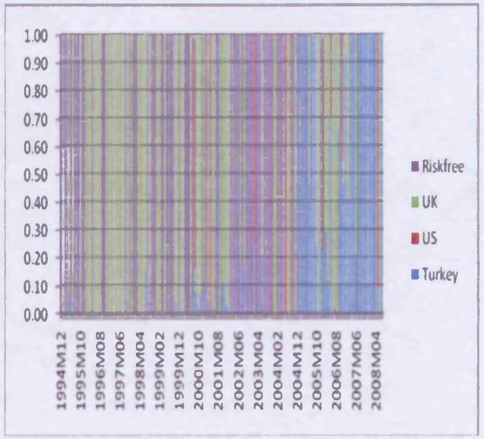

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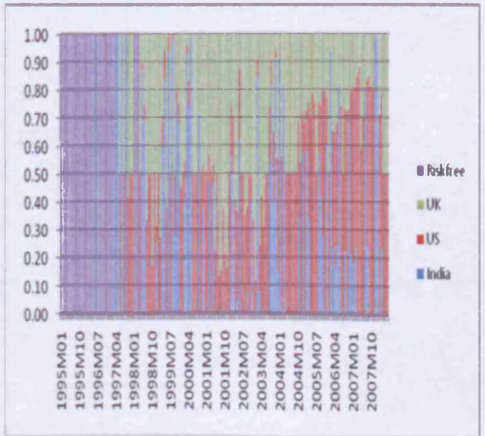

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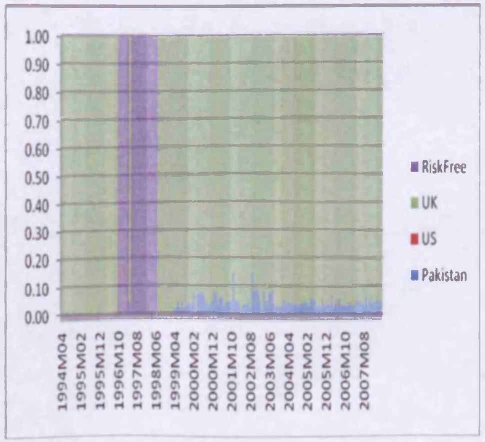

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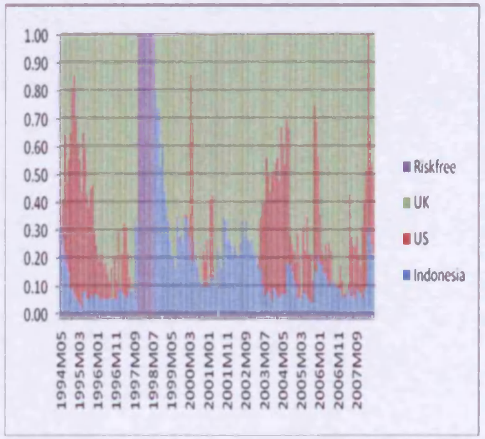
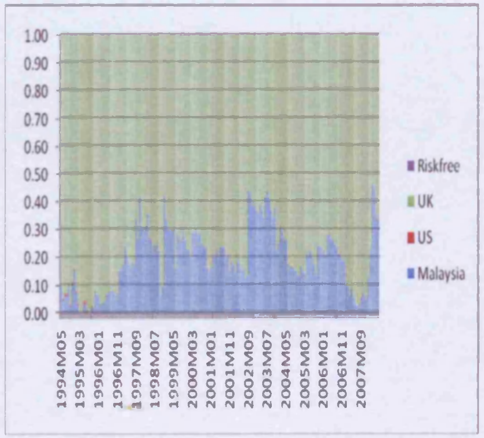
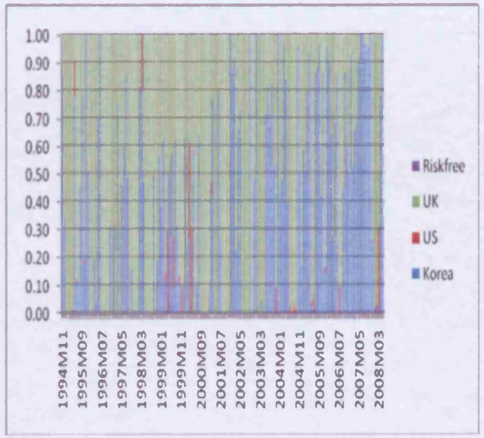


MALAYSIA



KOREA



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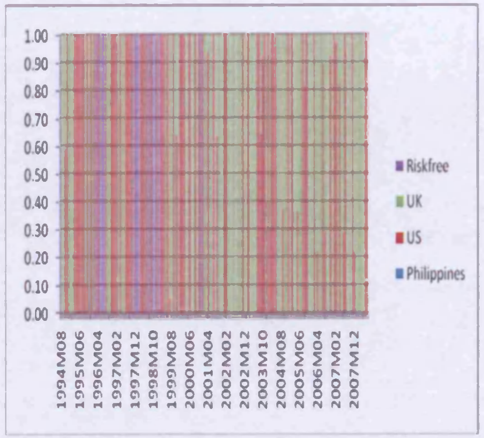


THAILAND

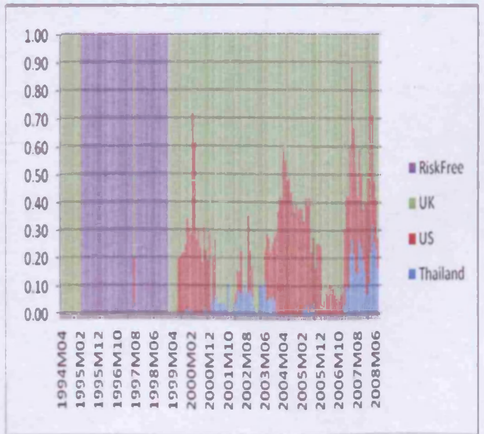
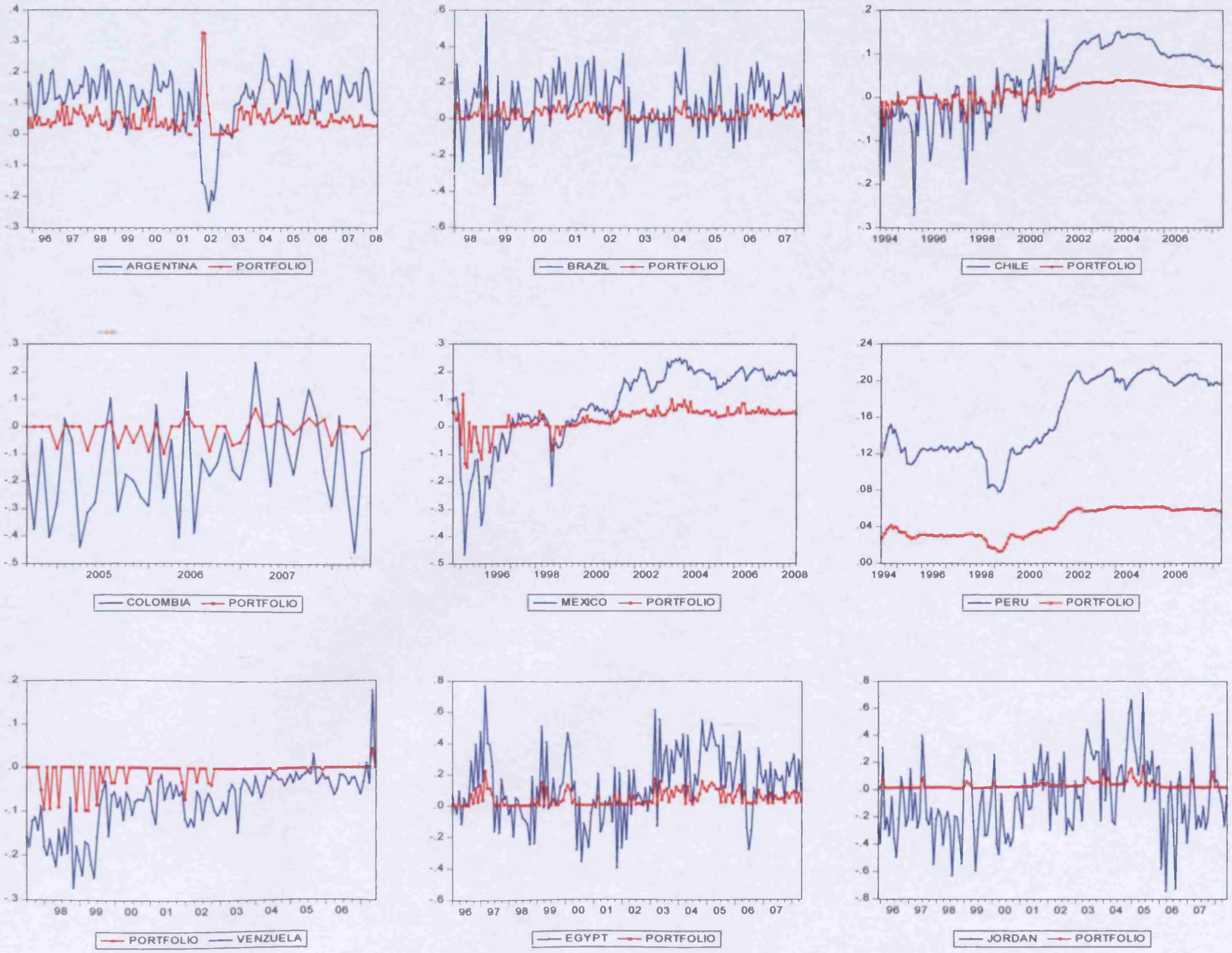
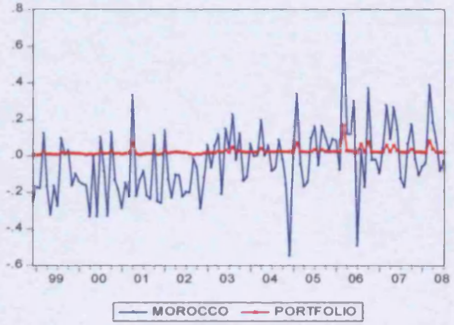
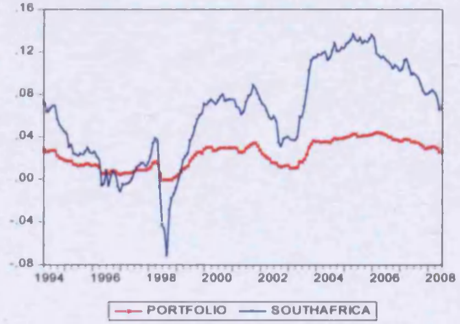
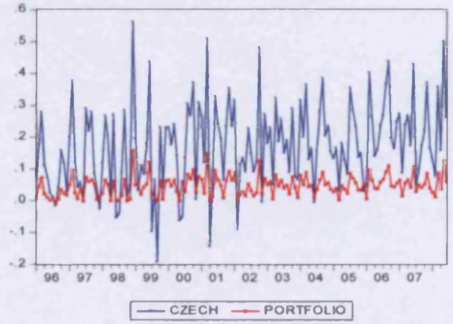


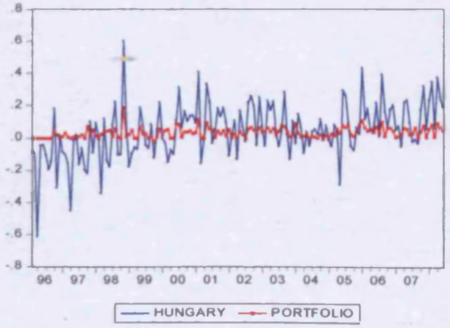
Figure 4.3: Sharpe ratios for optimal portfolios versus domestic based on trivariate GARCH estimations

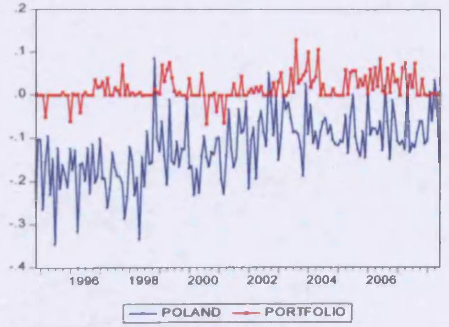


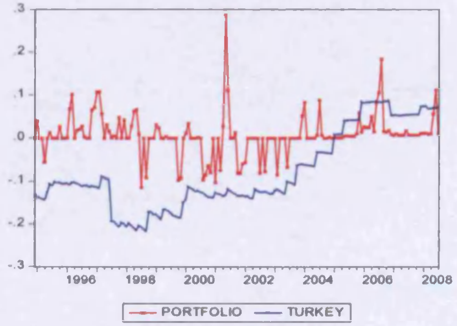

MOROCCO
PORTFOLIO

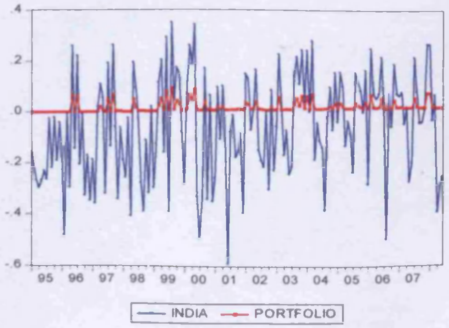

PORTFOLIO
SOUTHAFRICA


CZECH
PORTFOLIO


HUNGARY
PORTFOLIO


POLAND
PORTFOLIO


PORTFOLIO
TURKEY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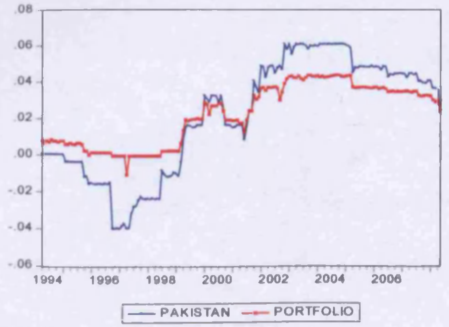
PORTFOLIO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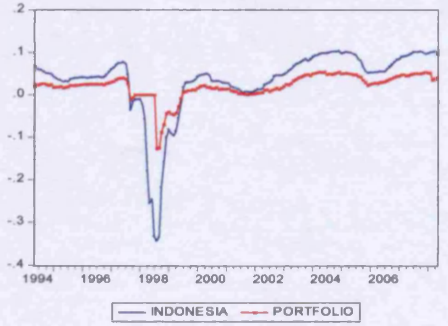
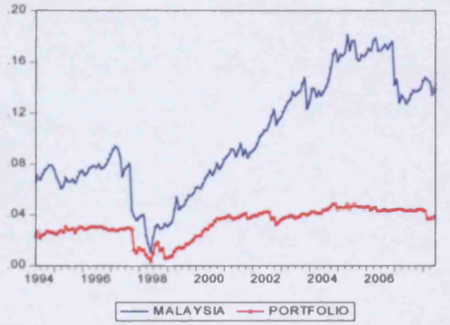
PORTFOLIO


INDONESIA
PORTFOLIO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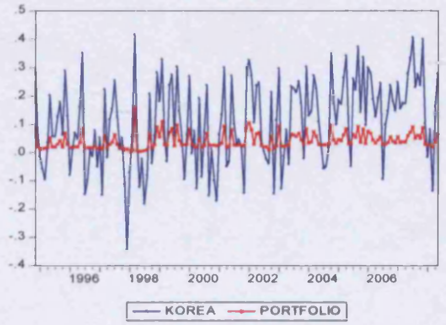
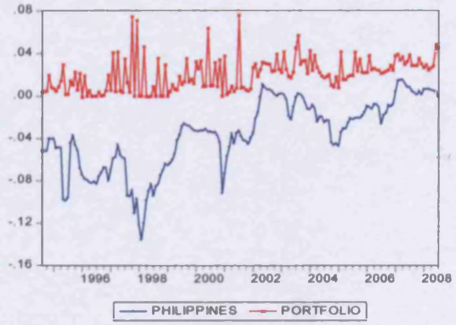

KOREA
PORTFOLIO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PORTFOLIO

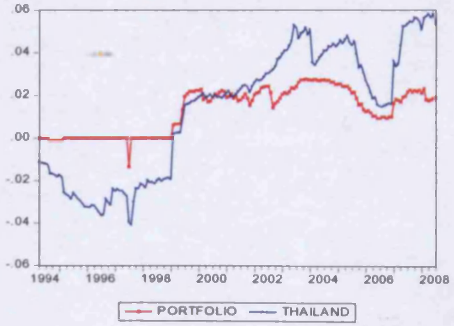
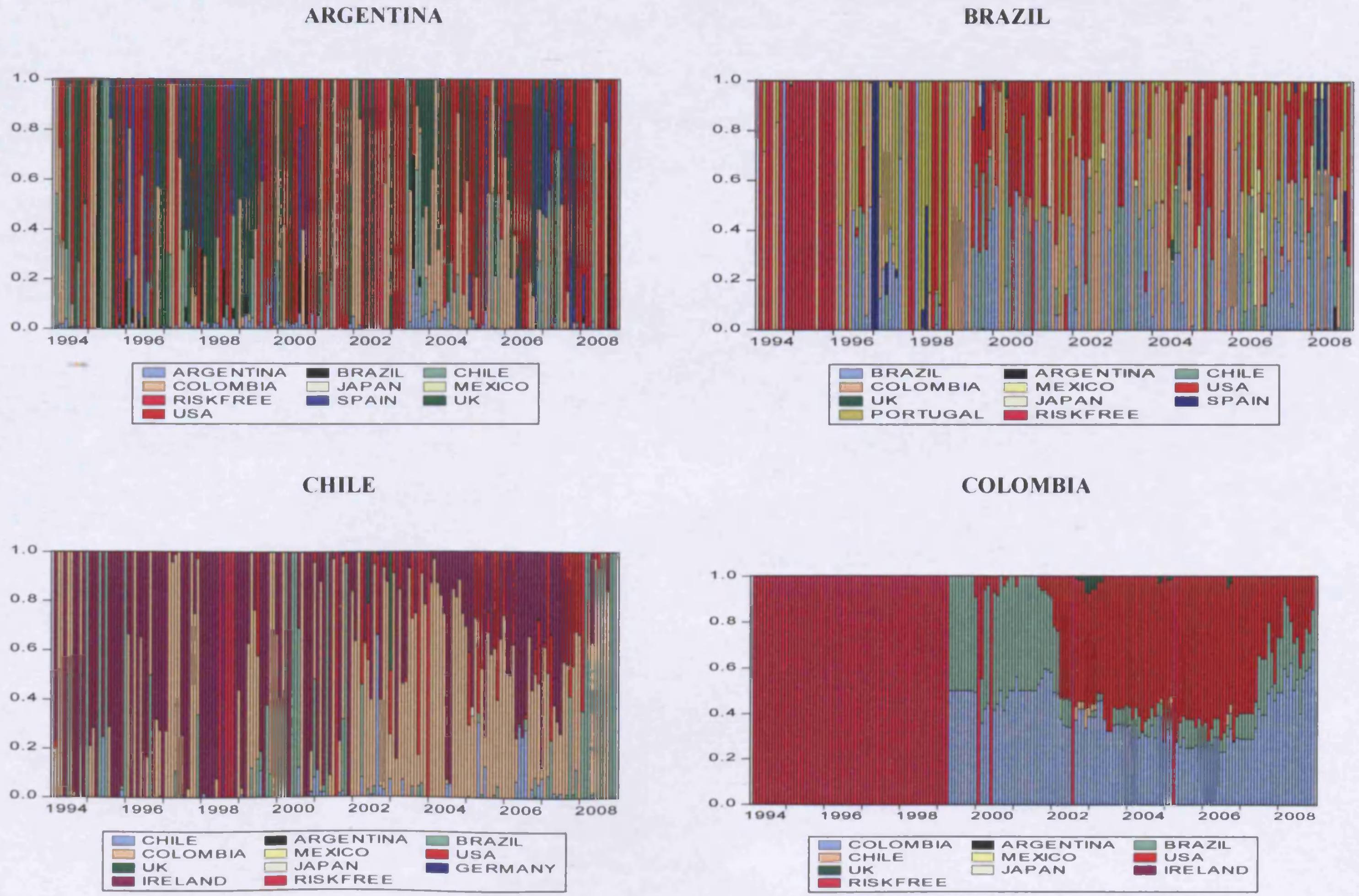
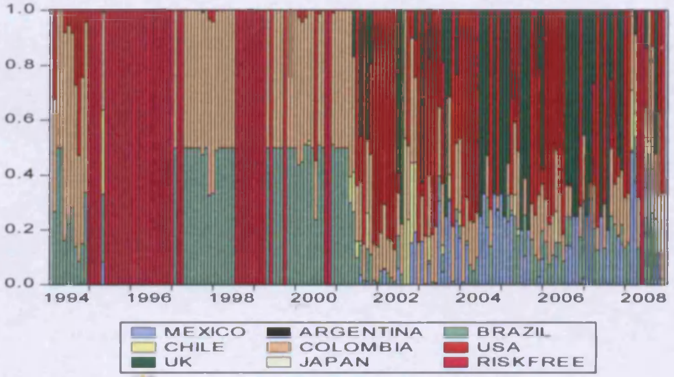

PORTFOLIO
THAILAND

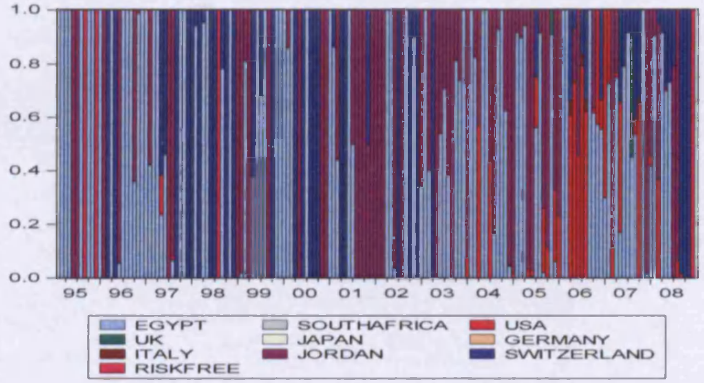
Figure 4.4: Time-varying optimal weights according to DCC model estimation denominated in local currencies



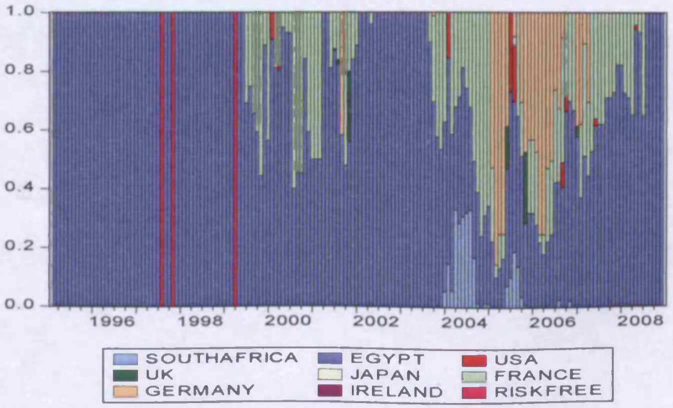
MEXICO



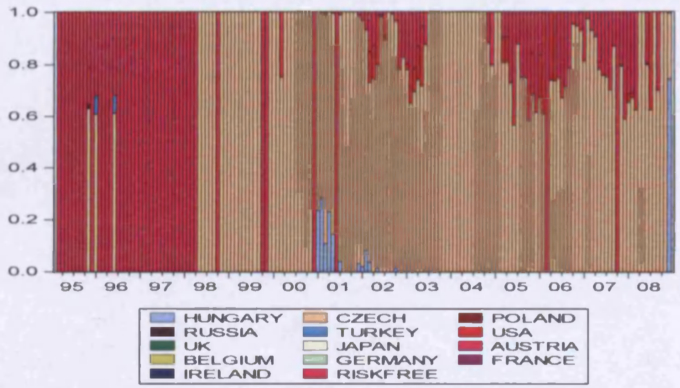
EGYPT



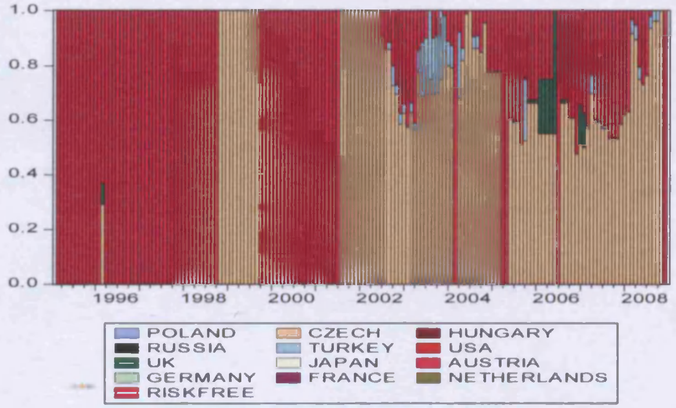
SOUTH AFRICA



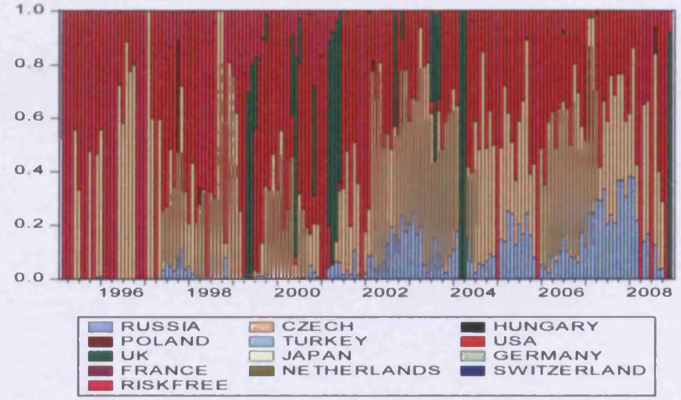
HUNGARY



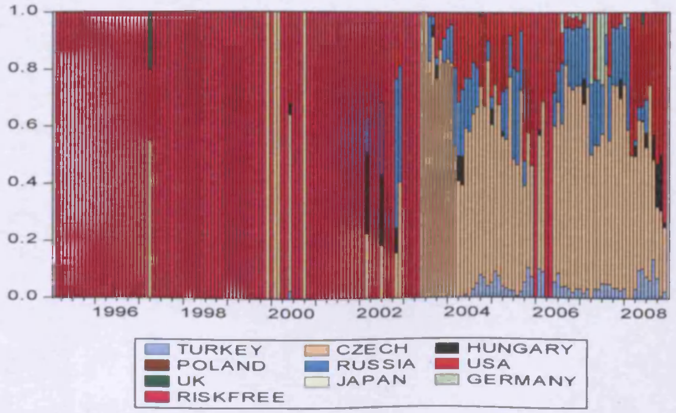
POLAND



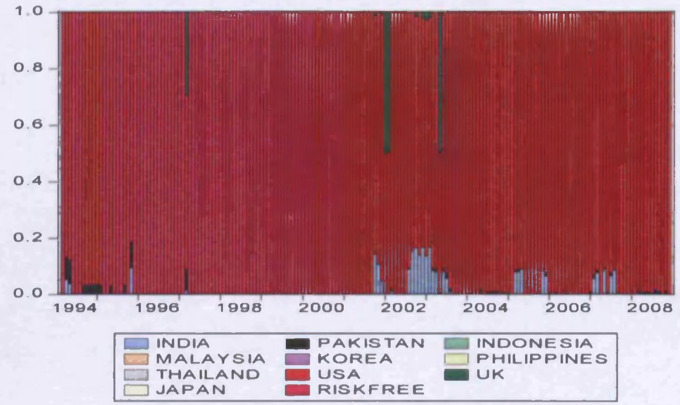
RUSSIA



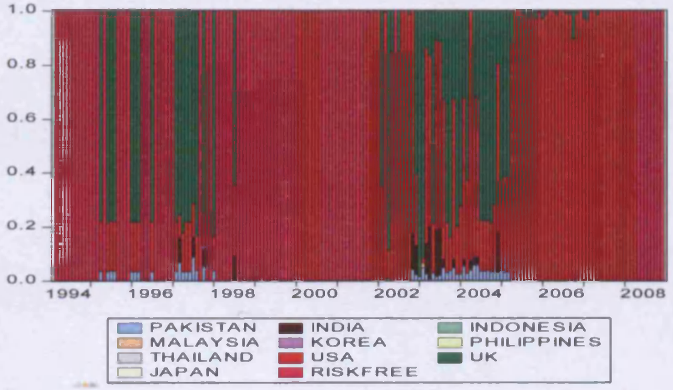
TURKEY



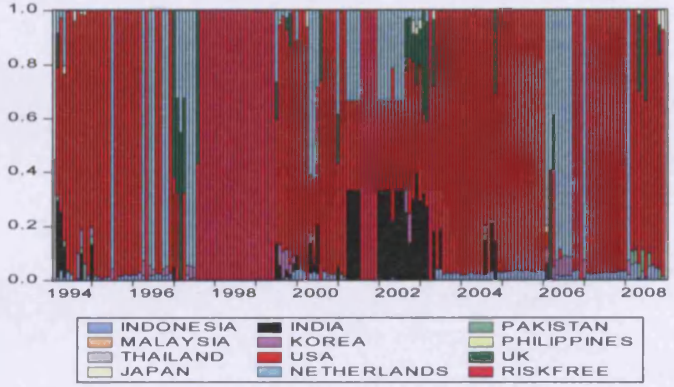
INDIA



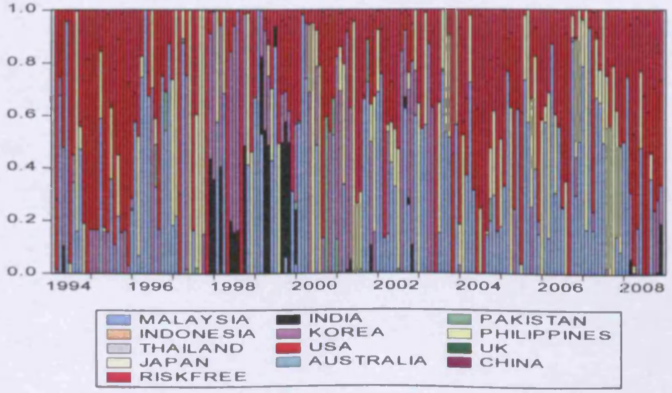
PAKISTAN



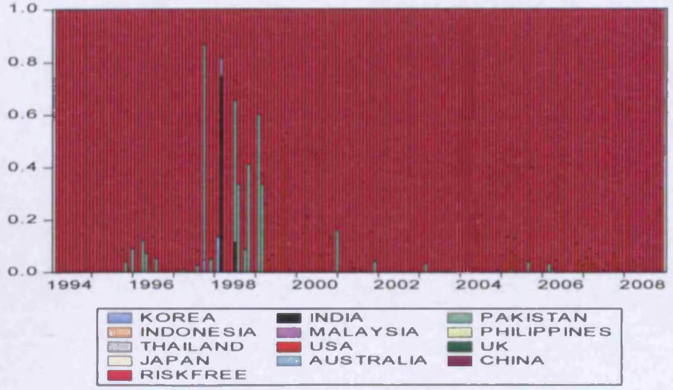
INDONESIA



MALAYSIA



KOREA



PHILIPPINES

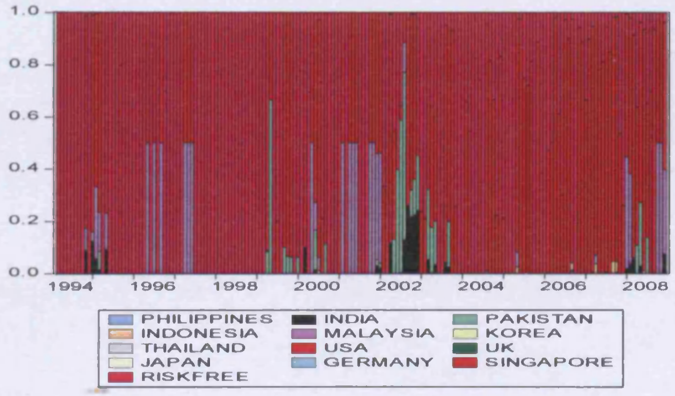
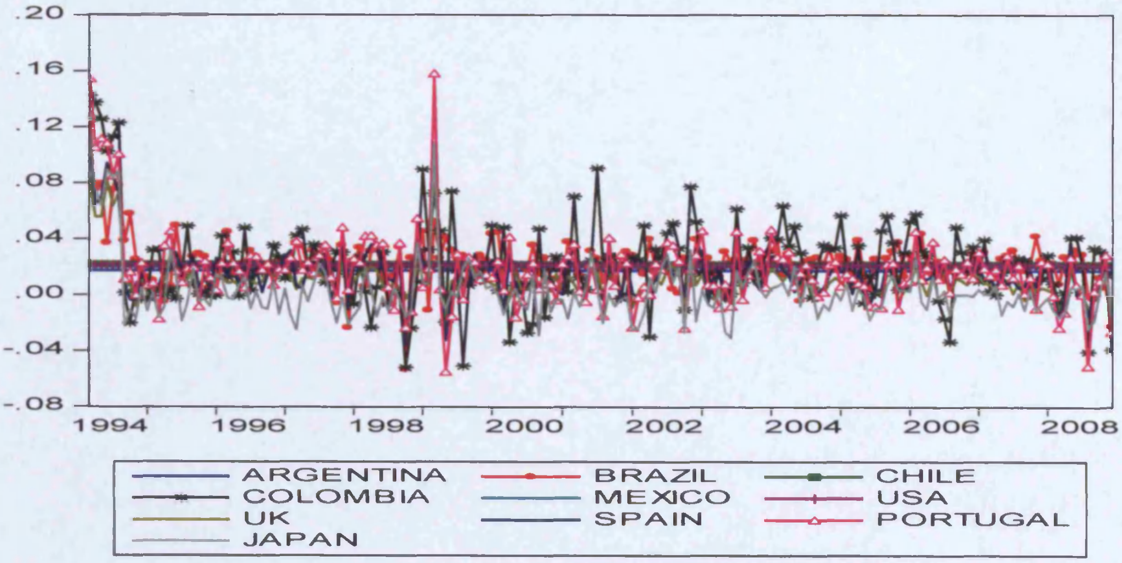
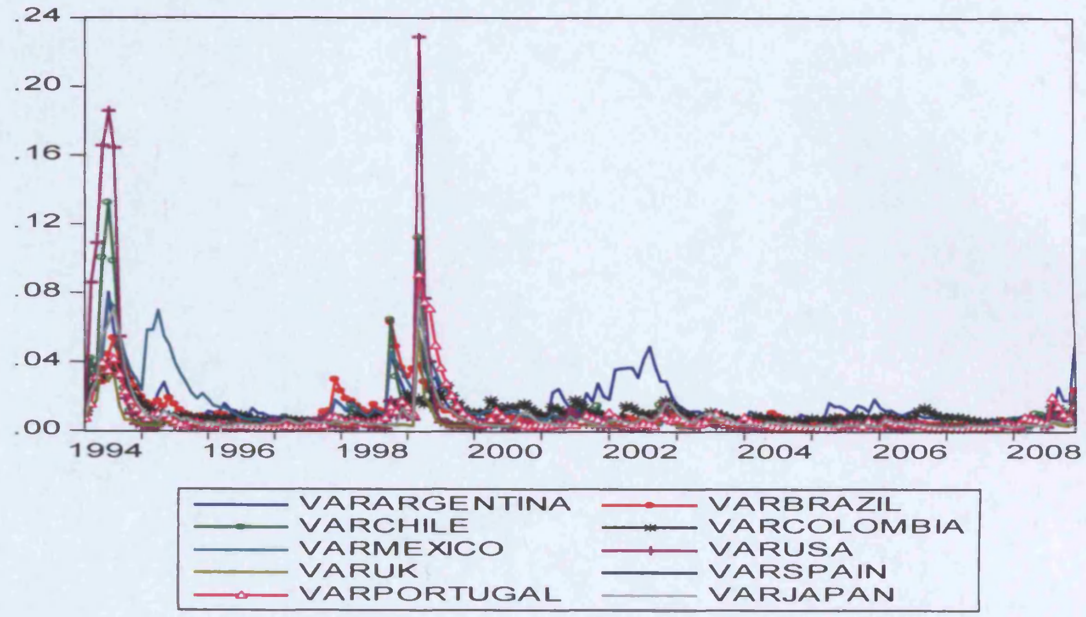


Figure 4.5: Expected returns and conditional variances on selected cases according to the DCC estimations

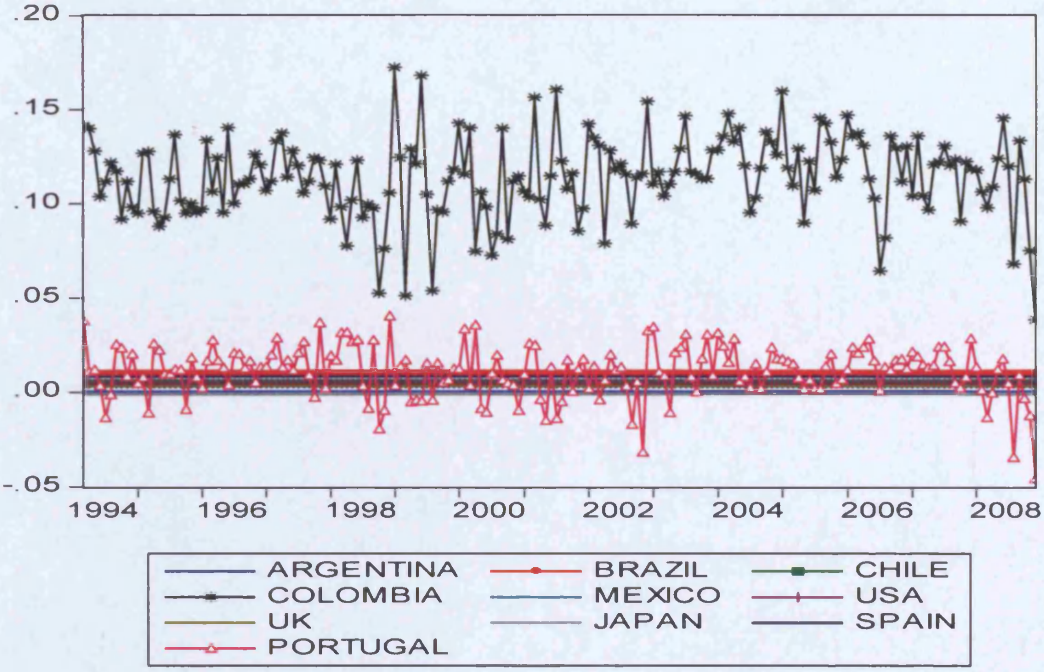
(a) Expected returns from Brazil's estimation with DCC denominated in Local currency



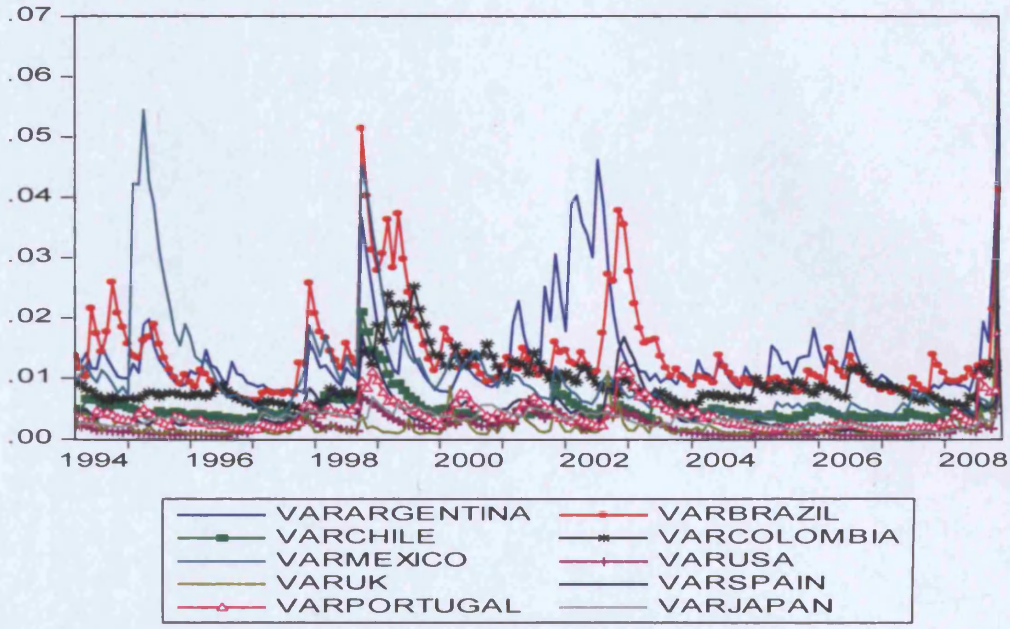
Conditional variances from Brazil's estimation with DCC denominated in Local currency



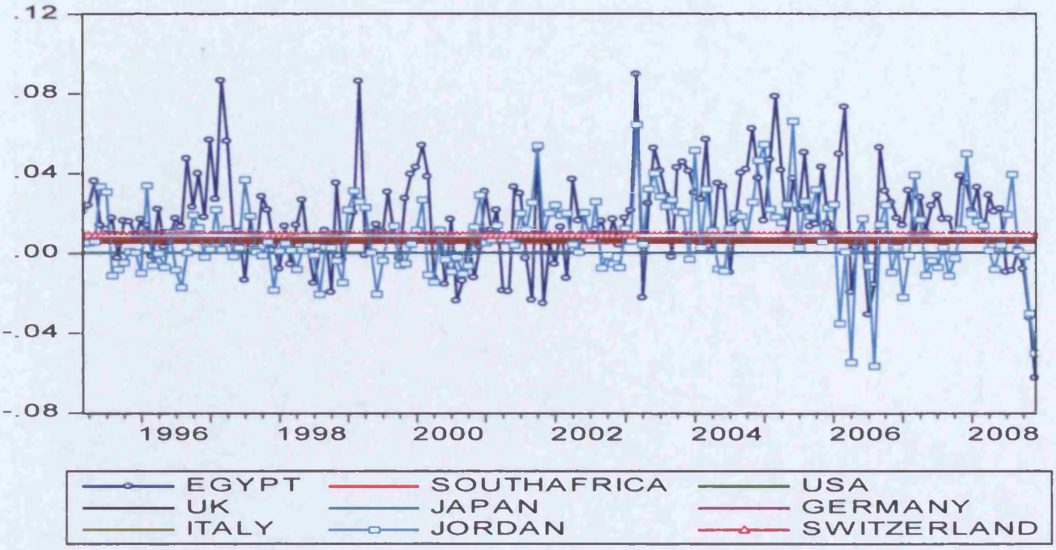
(b) **Expected returns from Brazil's estimation with DCC denominated in US Dollar**



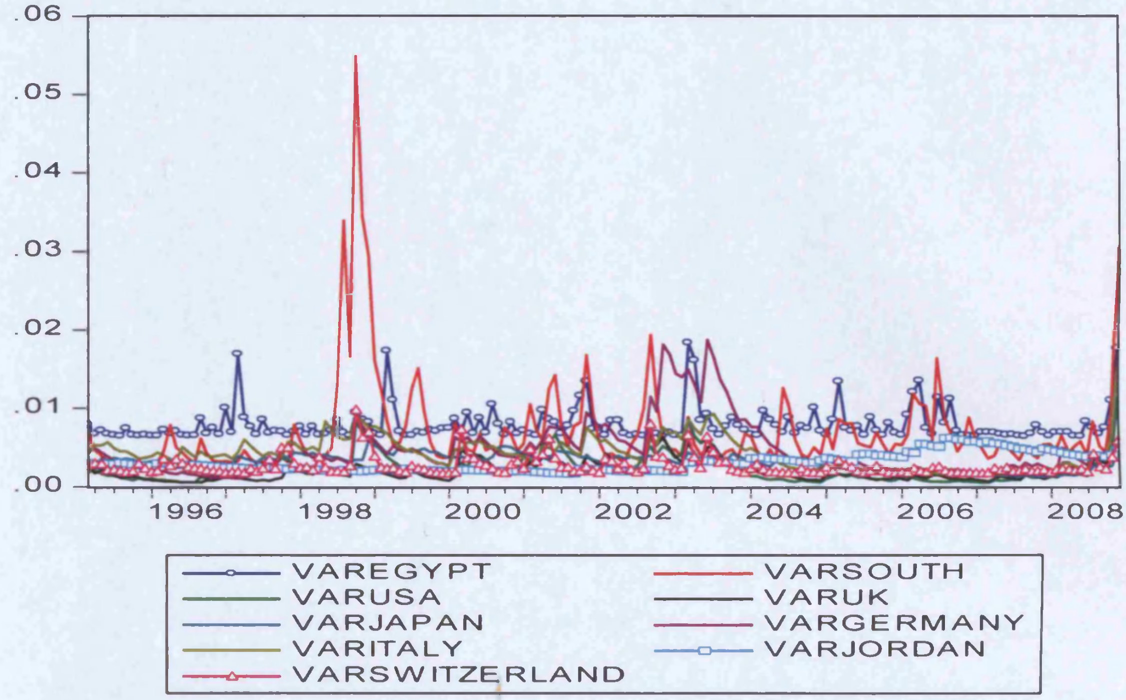
Conditional variances from Brazil's estimation with DCC denominated in US Dollar



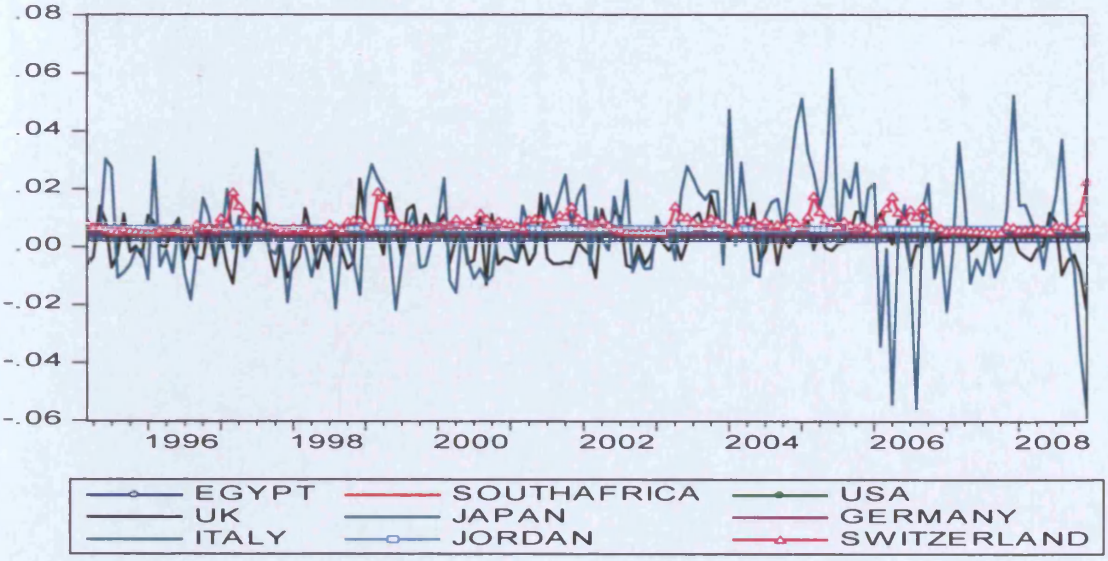
(c) **Expected returns from Egypt's estimation with DCC denominated in Local currency**



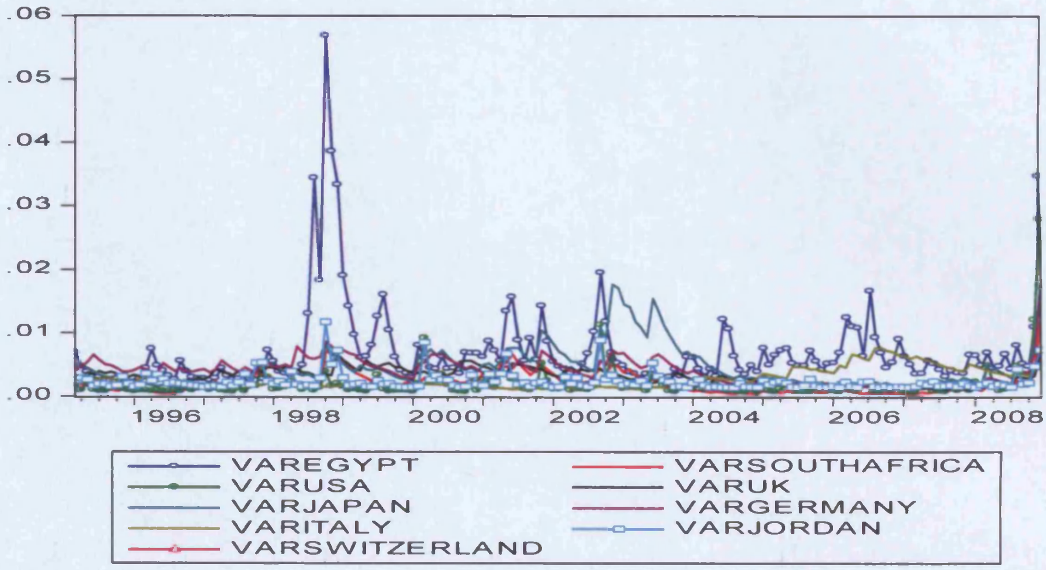
Conditional variances from Egypt's estimation with DCC denominated in Local currency



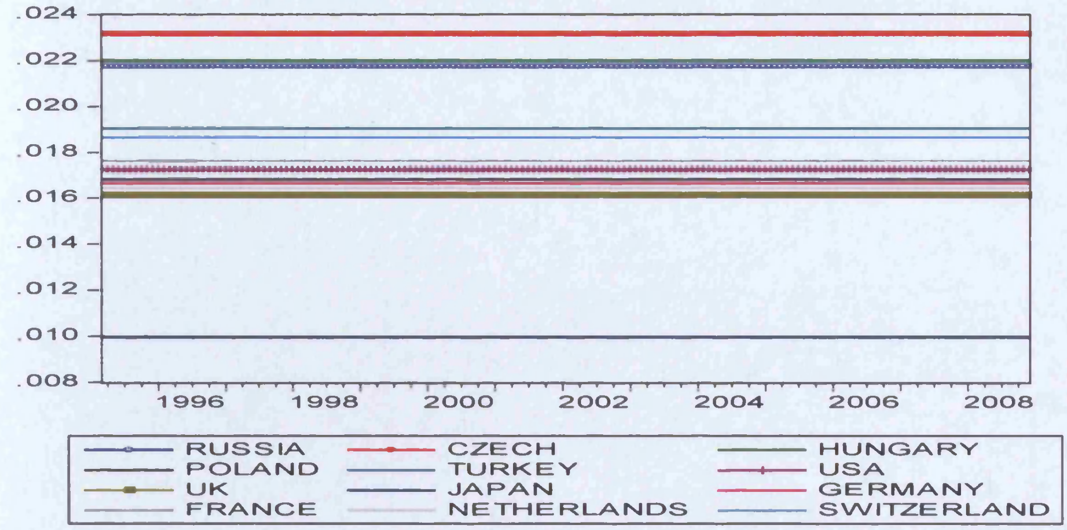
(d) **Expected returns from Egypt's estimation with DCC denominated in US Dollar**



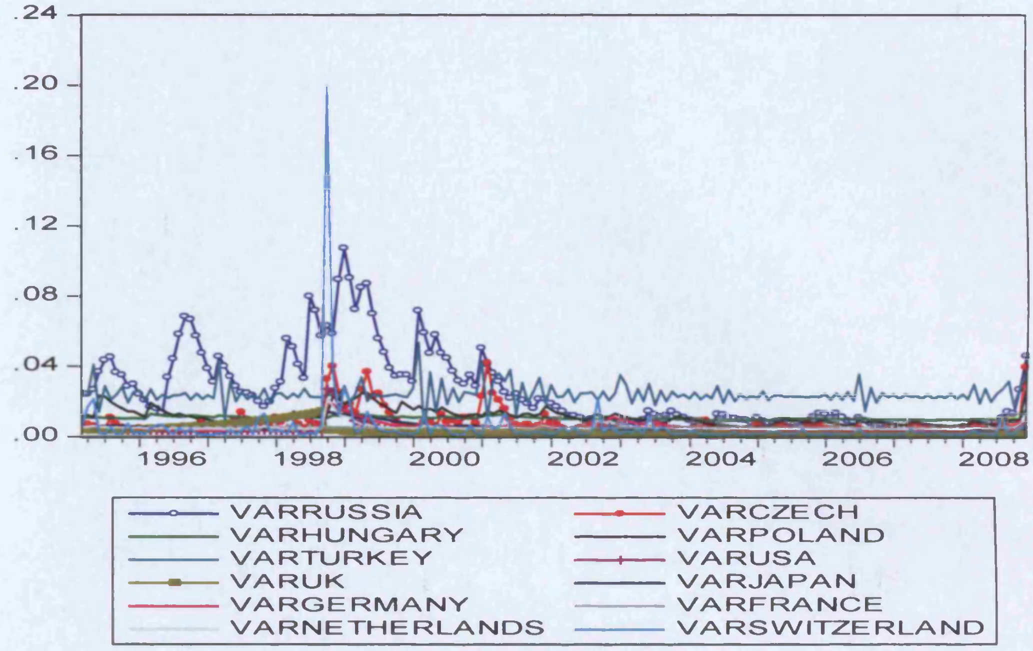
Conditional variances from Egypt's estimation with DCC denominated in US Dollar



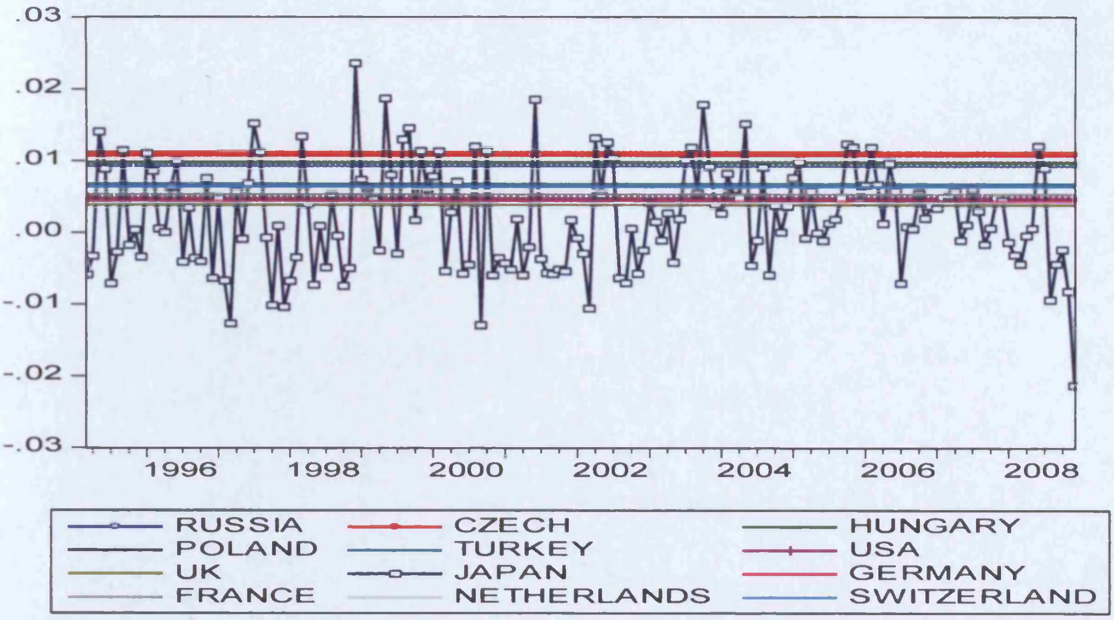
(e) **Expected returns from Russia's estimation with DCC denominated in local currency**



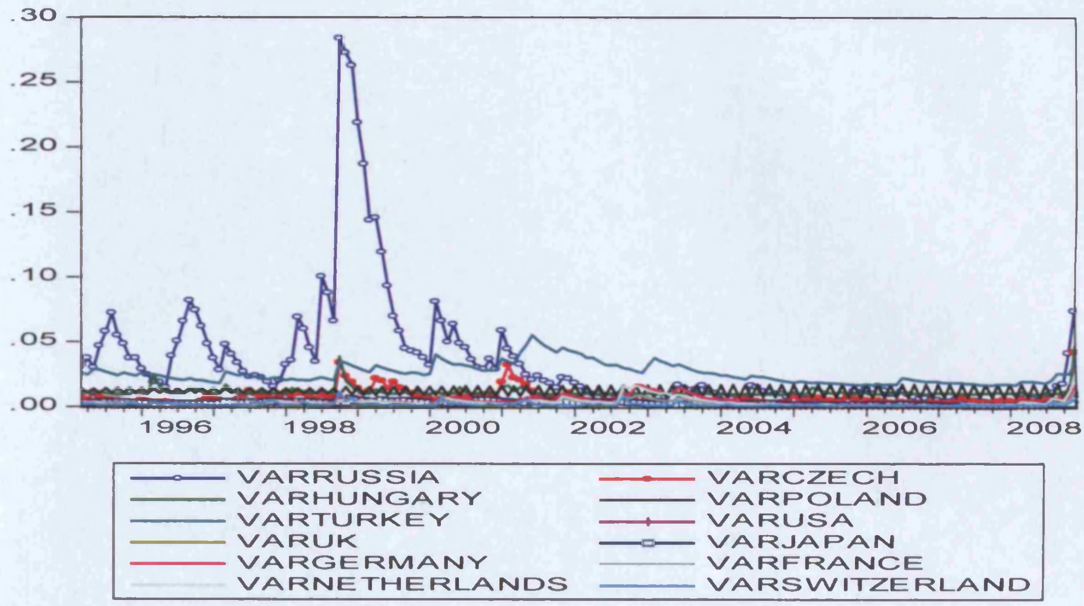
Conditional variances from Russia's estimation with DCC denominated in local currency



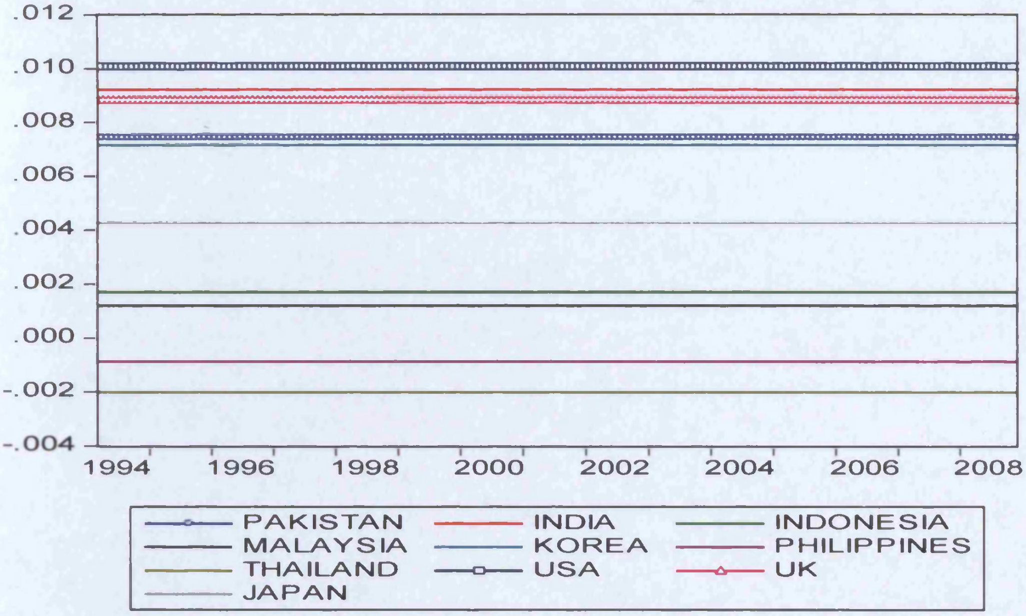
(f) **Expected returns from Russia's estimation with DCC denominated in US Dollar**



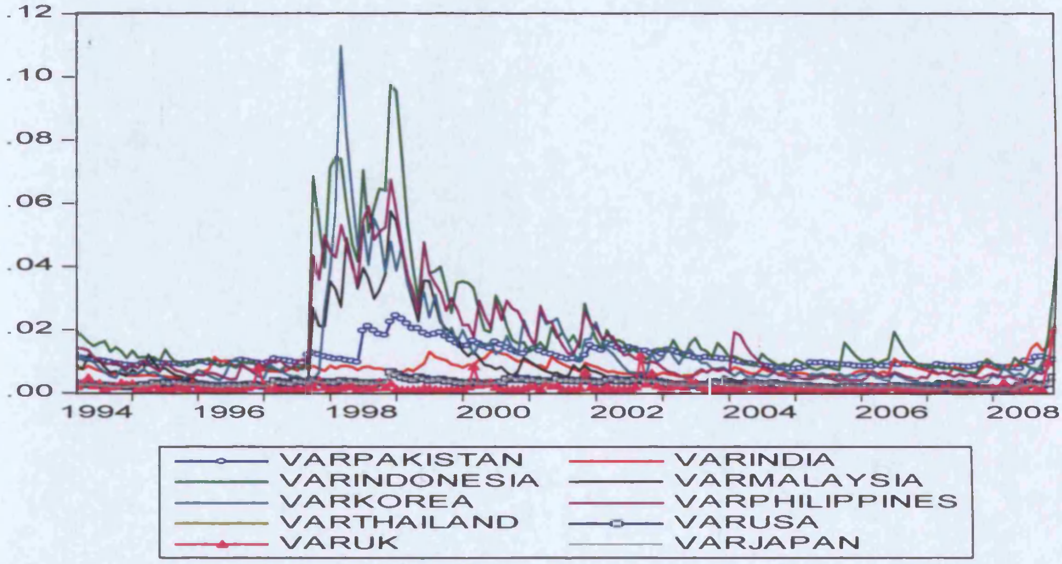
Conditional variances from Russia's estimation with DCC denominated in US Dollar



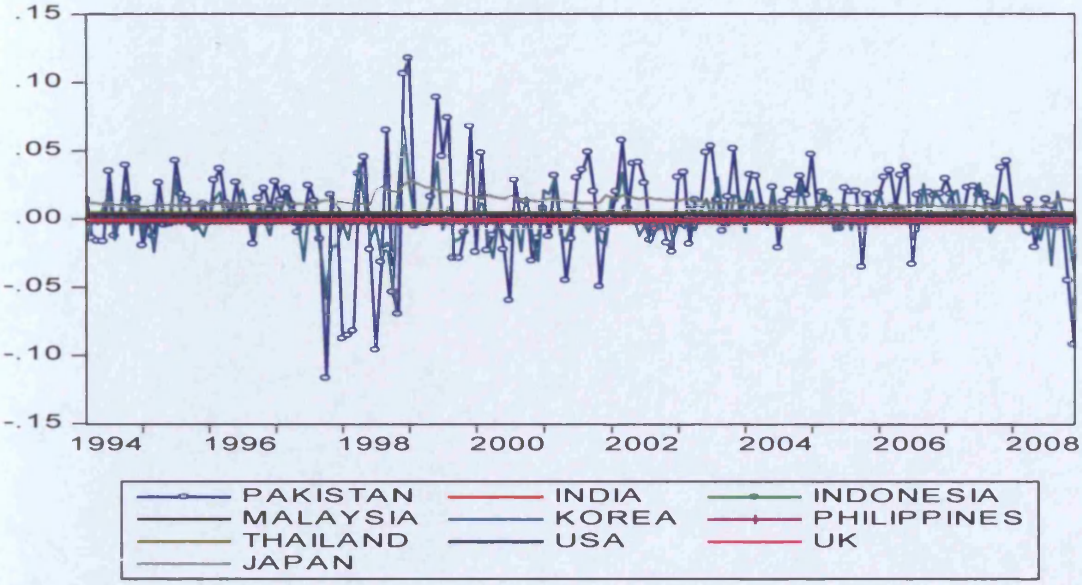
(g) **Expected returns from Pakistan's estimation with DCC denominated in local currency**



Conditional variances from Pakistan's estimation with DCC denominated in local currency



(h) **Expected returns from Pakistan's estimation with DCC denominated in US Dollar**



Conditional variances from Pakistan's estimation with DCC denominated US Dollar

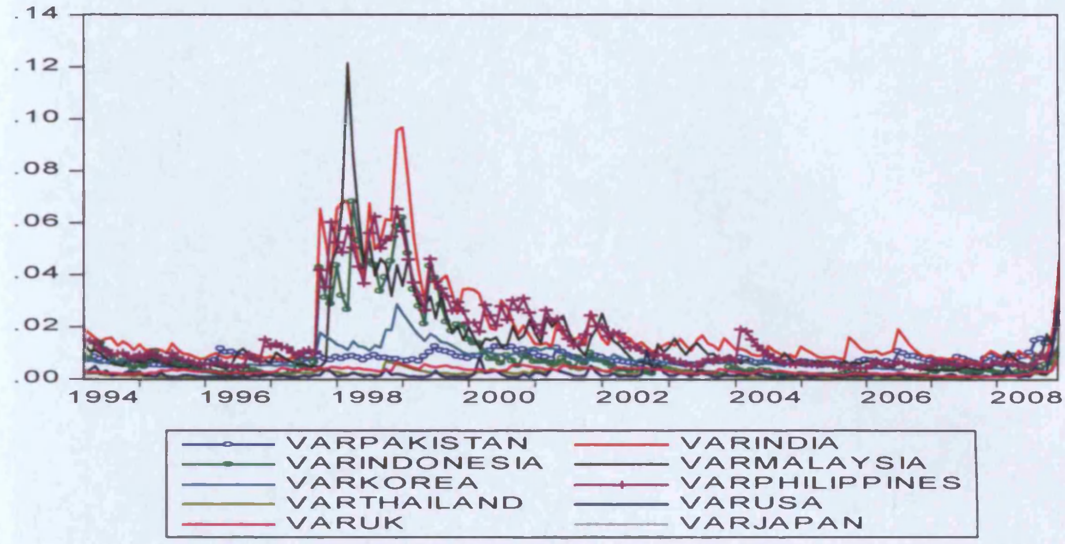
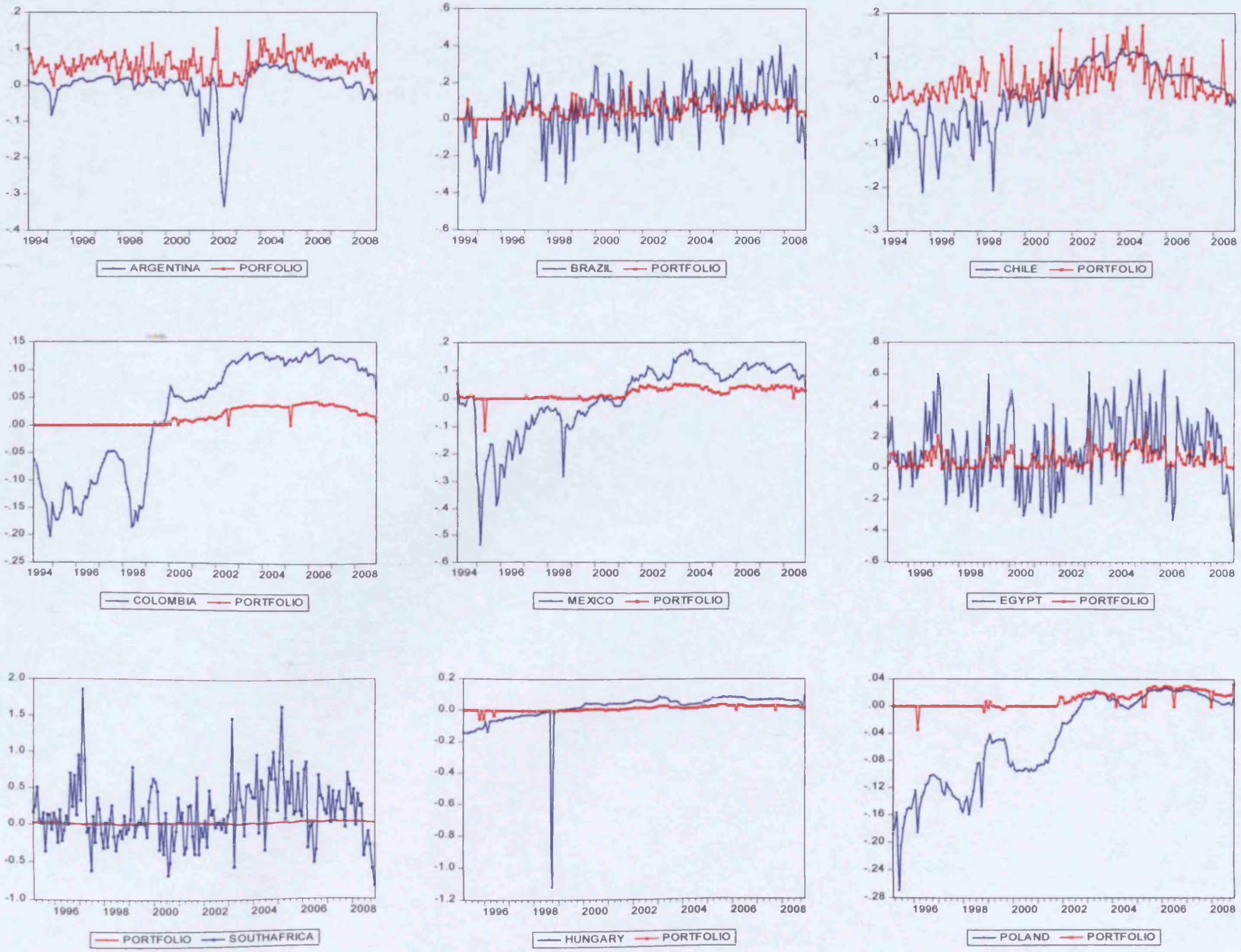


Figure 4.6: Sharpe ratios for optimal portfolios versus domestic equities resulted from the DCC model dominated in local currency



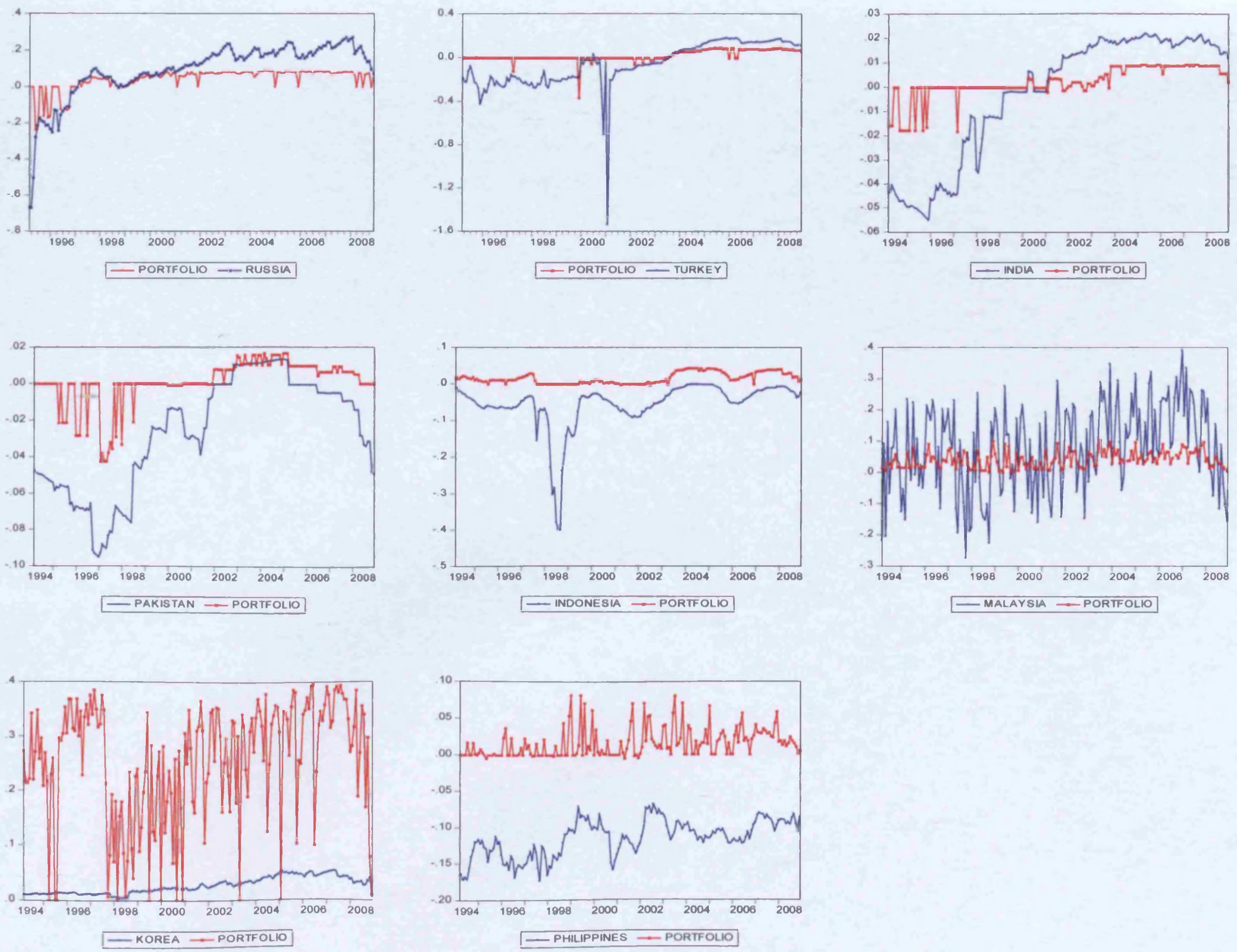
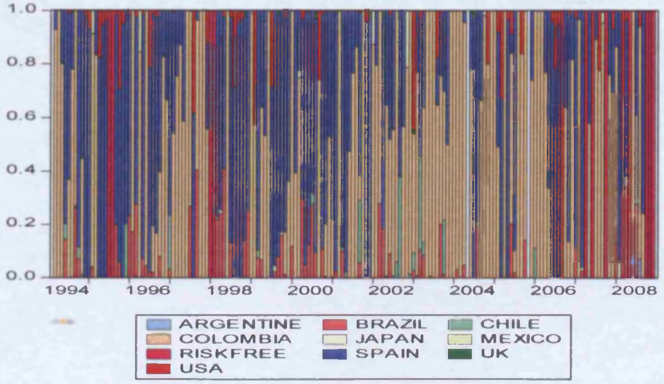
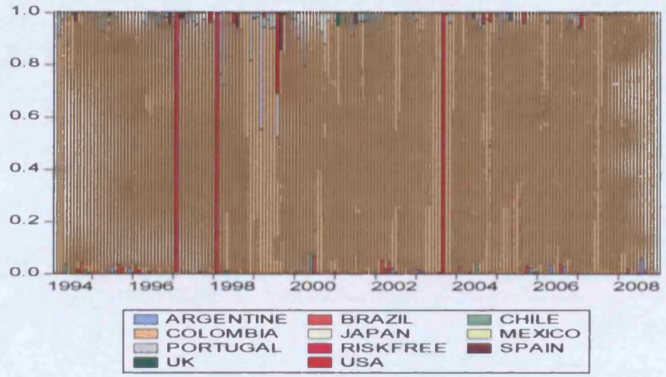

PORTFOLIO RUSSIA
PORTFOLIO TURKEY
INDIA PORTFOLIO
PAKISTAN PORTFOLIO
INDONESIA PORTFOLIO
MALAYSIA PORTFOLIO
KOREA PORTFOLIO
PHILIPPINES PORTFOLIO

Figure 4.7: Time-varying optimal weights according to DCC model estimation denominated in US Dollars

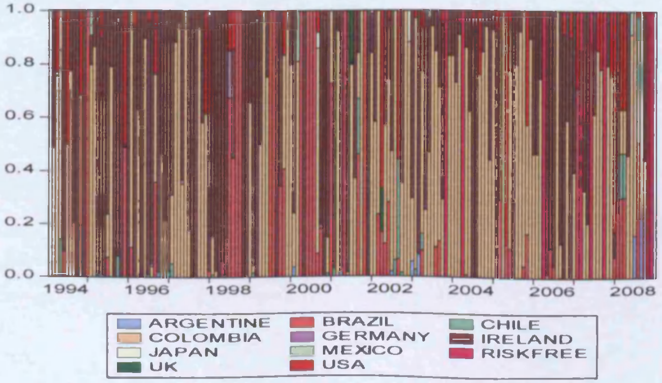
ARGENTINA



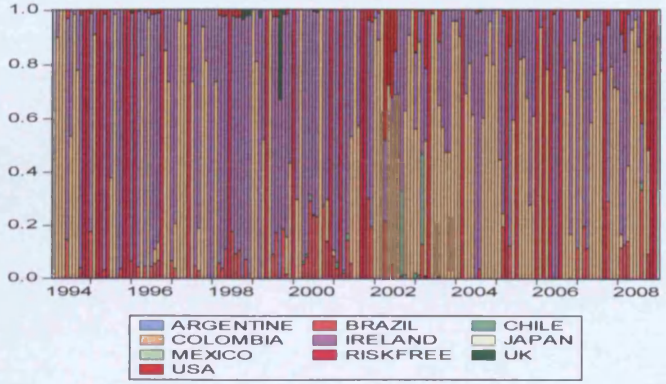
BRAZIL



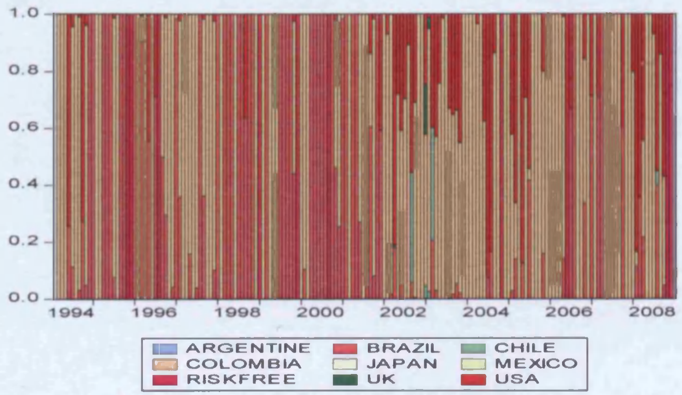
CHILE



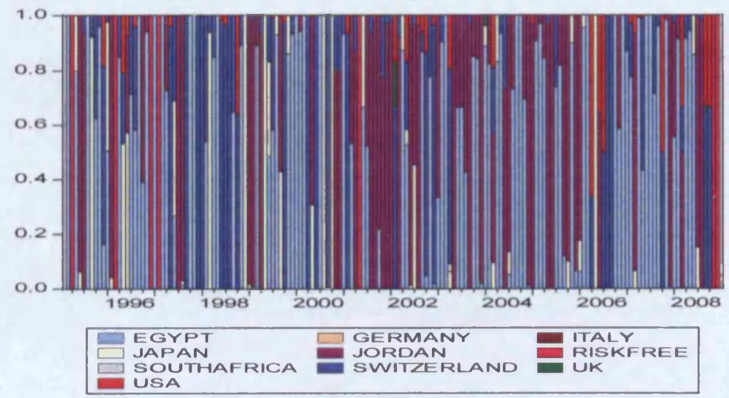
COLOMBIA



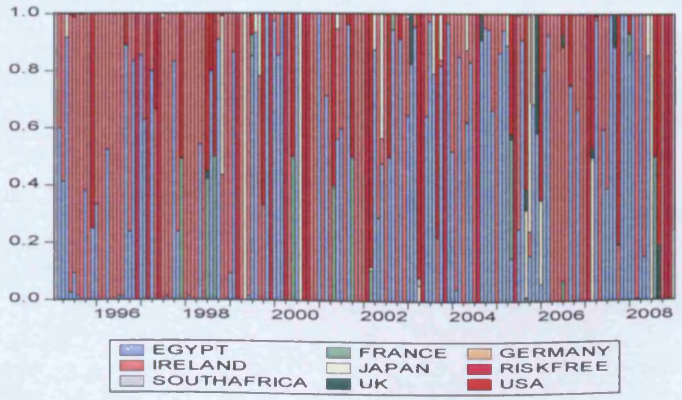
MEXICO



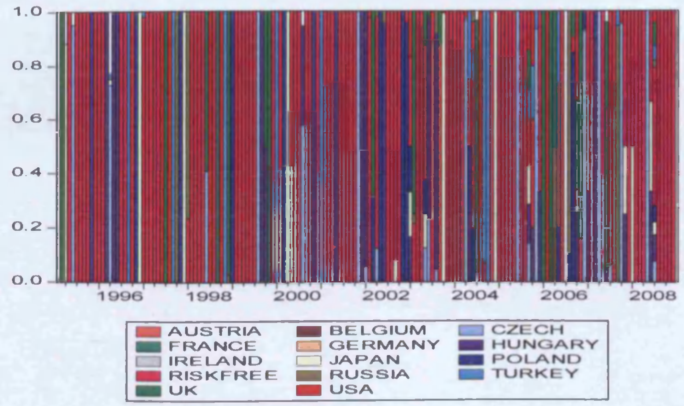
EGYPT



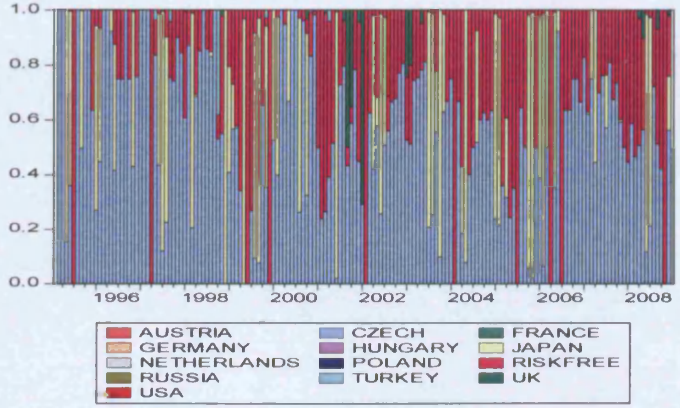
SOUTH AFRICA



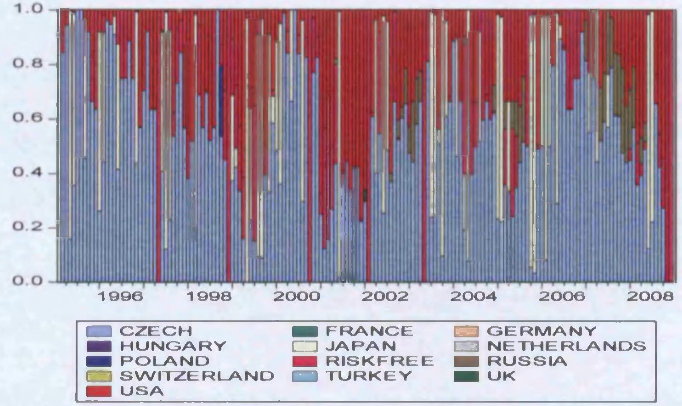
HUNGARY



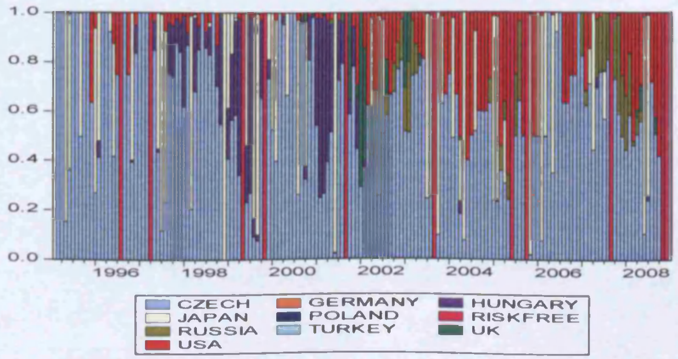
POLAND



RUSSIA



TURKEY



INDIA AND PAKISTAN

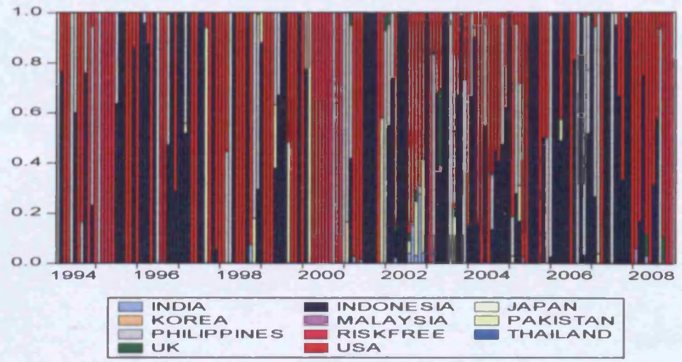
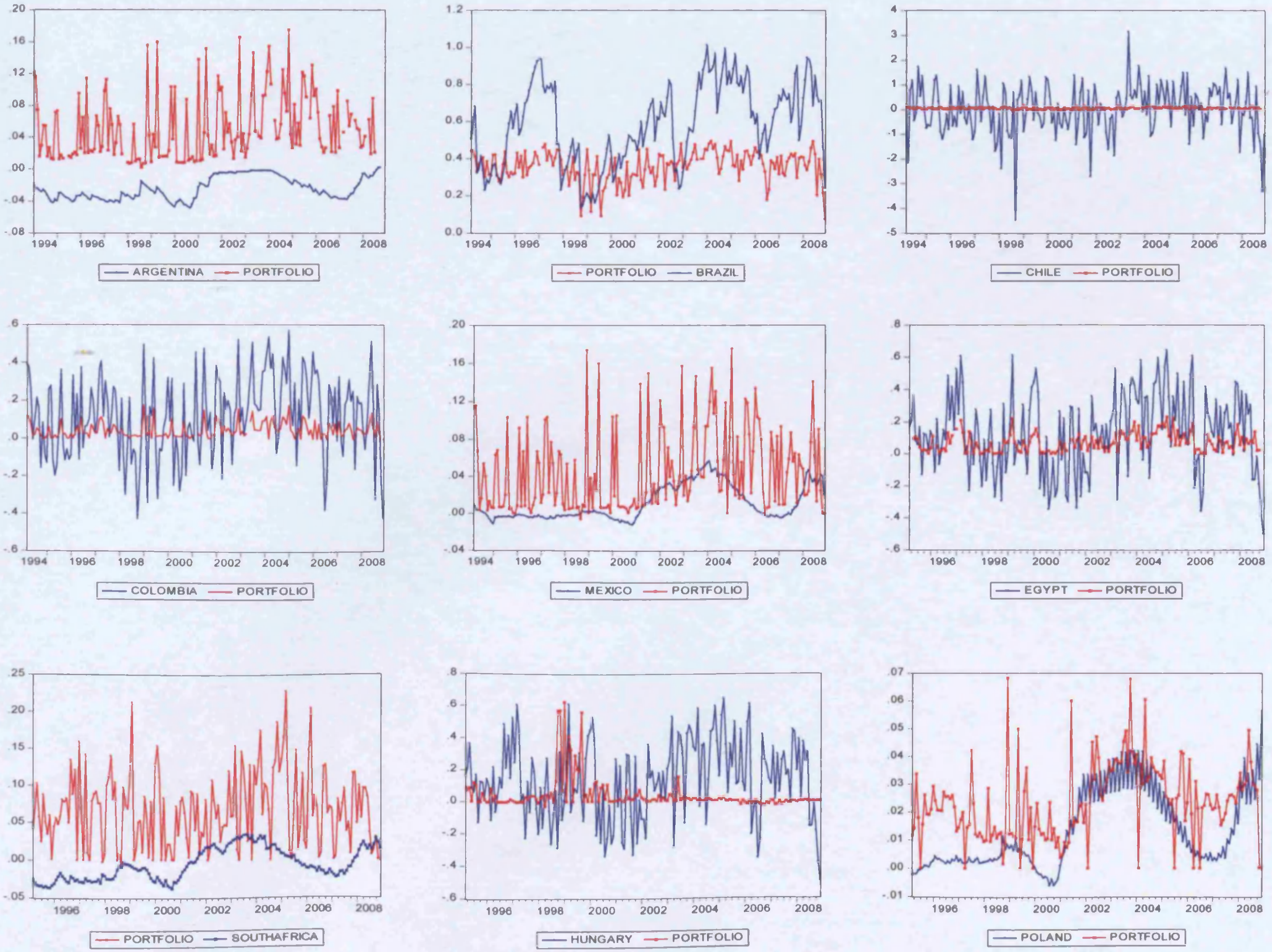


Figure 4.8: Sharpe ratios for optimal portfolios versus domestic equities resulted from the DCC model dominated in US Dollars



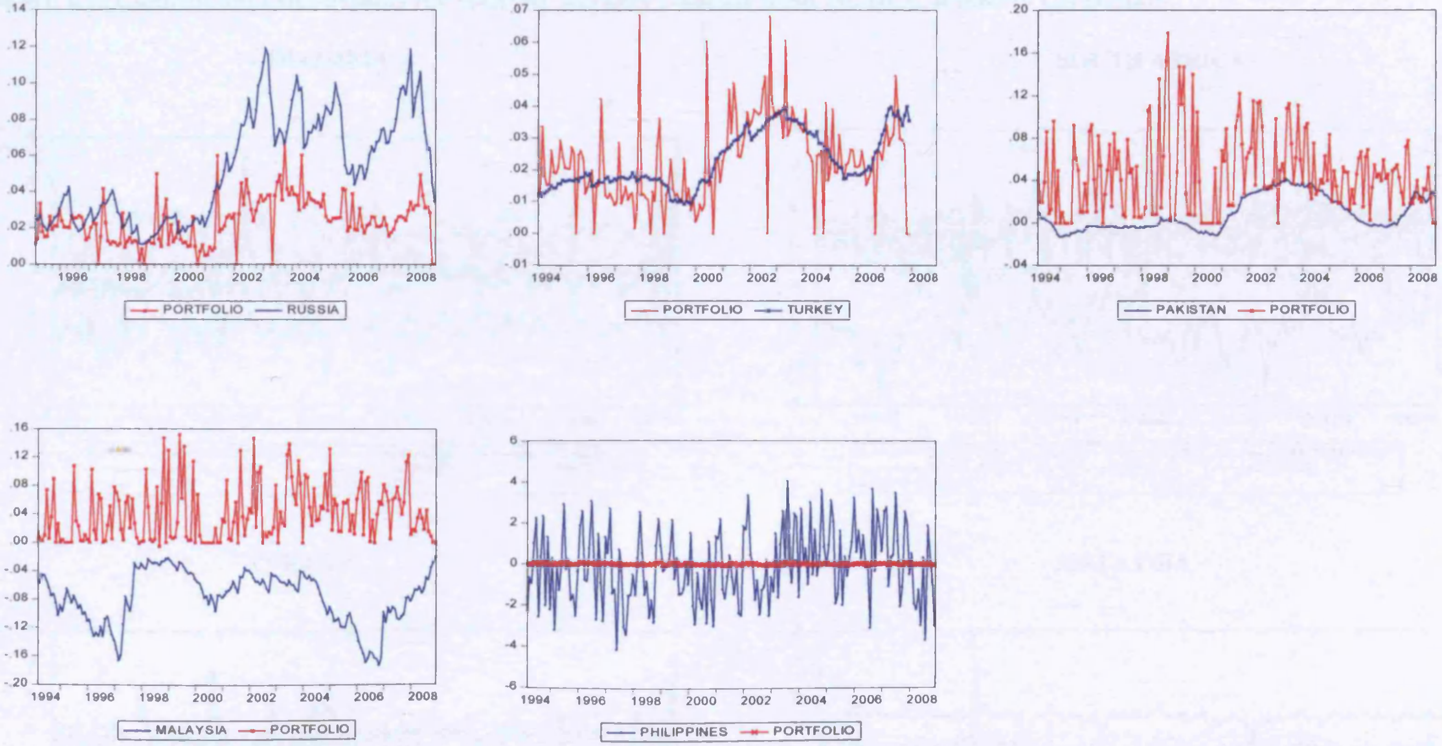
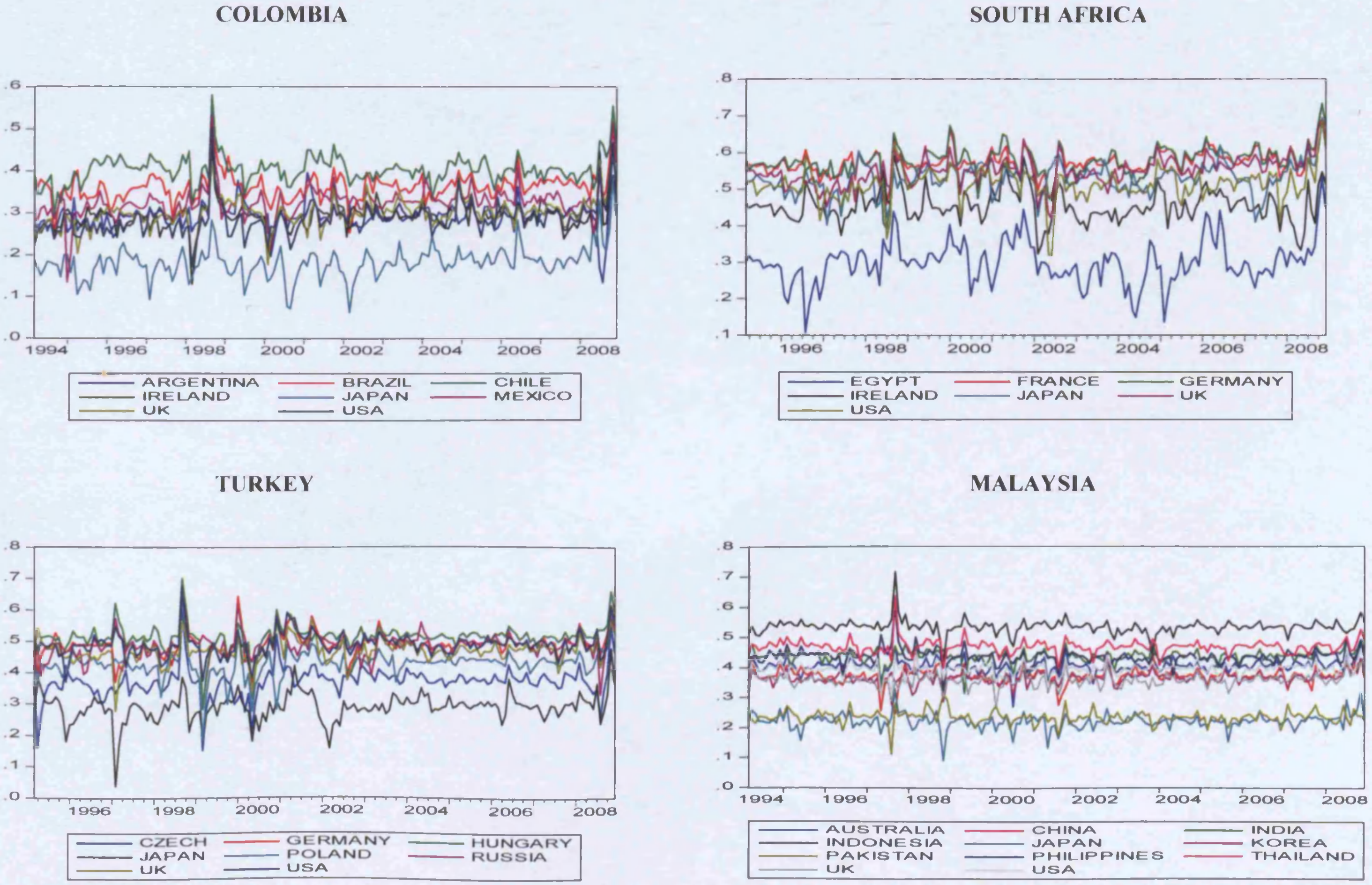

PORTFOLIO RUSSIA
PORTFOLIO TURKEY
PAKISTAN PORTFOLIO
MALAYSIA PORTFOLIO
PHILIPPINES PORTFOLIO

Figure 4.9: Conditional Correlations for selected markets resulted from the DCC model in US Dollars:



Chapter Five: Equity home bias in Emerging markets: Panel Estimation

5.1 Introduction

According to the estimation of the trivariate GARCH model in the previous chapter, domestic equities in most markets constitute a considerable share of the optimal portfolio. With the inclusion of more assets in the investment portfolios, and re-computation of optimal weights through the DCC model, the results show that the shares of domestic equities shrunk and hence represented relatively smaller weights in the international diversified portfolios in most of the markets under study. Accordingly, optimal weights in efficient portfolios seem to divert from the prediction of international CAPM[40], and the actual weights documented in the survey report by the IMF. For instance, according to the data on international portfolio holdings published through IMF annual surveys, the actual domestic equity holdings amounted to an average of 85 per cent of the total equity holdings (as denoted by the Y variable) in the markets under study during the period 2001-2007 (refer to Table 5.2 (page 274)). Domestic bias puzzle refers to the phenomenon where investors tend to overweight domestic assets in their portfolios, which is considered inconsistent with models that assume that financial markets are perfect and information is symmetrical among investors (Karolyi and Stulz, 2002).

This chapter assesses the extent of equity domestic bias in emerging markets, and the reasons behind this. It employs a set of explanatory variables which are derived from

[40] According to the prediction of international CAPM, the US equities are expected to dominate optimal portfolios since the share of US capitalisation in the world capitalisation amounts to around 55 per cent during the period under study.

the current literature, in addition to some previous estimators, and constructed indexes. This chapter takes into account variables reflecting information asymmetries and market inefficiencies, in addition to variables estimated on the basis of markets' efficiencies. Therefore, a test of domestic equity bias in 17 emerging markets during the period 2001-2007 is investigated using panel estimations. The explanatory variables can be classified into five main groups 1) controls on capital flows, 2) information asymmetries, 3) economic and political risks, 4) financial development, and 5) others.

Estimation of fixed country effects, fixed country effects using robust standard errors, and also feasible Generalised Least Squares (GLS) method are calculated in order to control for cross-sectional heteroscedasticity.

This chapter is divided into four main sections. The first section reviews the main approaches pursued empirically in order to measure and explain equity home bias. The second section explains the econometric model employed. The third section presents the model specification and results, and section four concludes.

5.2 Main Empirical studies on equity home bias

5.2.1 Measuring equity home bias

Several studies in the literature refer to equity home bias as the difference between actual and optimal foreign portfolio weights constructed according to the data or model-based approach as mentioned earlier in the first and the second chapters.

5.2.2 Explaining equity home bias

There are essentially three approaches to explaining equity home bias as implied by the theoretical background reviewed in chapter two and Lewis (1999). Firstly, domestic assets tend to provide better hedges against home risks as denominated by the mean-variance approach. Secondly, the gains from international risk-sharing are quite small which are mainly adopted by the consumption-based models. Thirdly, the degree of uncertainty in measuring home bias. This section briefly explains how these explanations are dealt with in the literature.

5.2.2.1 Hedging against home-country risks

The following main home-country risks are discussed in the literature

a) Hedges against domestic inflation

Adler and Dumas (1983) describe that 'the structure of the theory of international finance largely mirrors that of domestic financial theory'. Uppal (1993) extend Dumas' (1982) model, in which he incorporates the exchange rate as the price of the good in the foreign country in terms of domestic prices. He concludes that for higher risk aversion coefficients, investors prefer domestic stocks. Additionally, Karlsson and Norden (2007) examine portfolios constructed as part of the pension fund in Sweden. They show that home bias is affected by investors' willingness to hedge inflation in addition to irrational factors like overconfidence.

However, Cooper and Kaplanis (1994) develop a theoretical mean-variance model and show that hedging domestic prices and deadweight costs cannot explain home bias unless investors have low risk aversion coefficients.

The results are quite confusing since some empirical evidence does not support this explanation. The results are also highly dependent on the assumptions regarding risk aversion coefficients.

b) Hedges against human capital and other nontradables

There is also another source of home-country risks that are referred to in the literature. Mayers (1973) presents a single-period CAPM including marketable and nonmarketable assets. Human capital returns are included as part of the nonmarketable asset. Mayers shows that investors tend to hold stocks to hedge the nonmarketable asset, and that investors hold more domestic stocks if the human capital return is negatively correlated with domestic stock returns. Fama and Schwert (1977) examine this correlation in the US and report little correlation between both returns. Also Bottazzi, Pesenti and Wincoop (1996) test this correlation by adopting a continuous-time VAR model of international portfolio choice, and investigate the effect of human capital returns on the composition of the portfolio. The model is applied on a number of OECD countries, in which they show that hedging human capital returns explain around 30 percent of the home bias. On the other hand, Baxter and Jermann (1997) follow the same approach, and develop a simple model of portfolio choice which they test in four OECD countries. They incorporate labour income as a proxy for the return of nontraded assets. The paper shows that domestic and not foreign stock returns are strongly correlated with domestic physical capital returns. The paper also shows that diversified portfolios consist of short-hold of domestic marketable assets and long-hold of foreign marketable assets, which as the paper reveals, the international diversification is worse than is documented.

In contrast to Mayers' earlier examination of human capital returns, Glassman and Riddick (2001) find that human capital needs to be positively correlated with stock market returns, where this correlation is higher than other foreign markets. A similar approach is carried out by Pesenti and Wincoop (2002) in which they examine the effect of non-tradables (consumption and leisure) on portfolio allocation decisions in 14 OECD countries. They show that non-tradables account for around 27 per cent of the home bias while the average bias towards domestic assets is around 70 per cent. The third explanation for home bias based on home-country risks is next.

c) The benefits from foreign returns are implicitly found in domestic returns

The empirical evidence on US returns reveals that the gains from foreign returns are implicitly found in domestic returns, since the US has many multinational companies abroad. Salehizadeh (2003) examines whether US multinational firms provide a justification for the home bias in the US using daily data over the period 1995-2001. The paper concludes that home bias in the US cannot be explained by the existence of multinational companies.

d) Economic, political and institutional risks

Various empirical studies concentrate on other factors related to home and foreign countries that might explain equity home bias. The financial development of the home and host countries is among the common factors cited. Chan, Covrig and Ng (2005) use several measures of economic development like the gross domestic product (GDP) per capita, real growth rate of the GDP, the average ratio of exports and imports to GDP, and foreign direct stock investment scaled by GDP to test whether these factors contribute to home bias in 26 emerging and developed countries. The paper also uses the ratio of the stock market to GDP in each country as a proxy for stock market development. The authors show that stock market development has a significant effect on the domestic and foreign biases. Additionally, the GDP of the host country is found to have a significant effect on home bias as shown by Faruqee and Yan (2004), and Sercu and Vanpee (2008).

A country's exposure is another factor considered in the literature. For instance, Obstfeld and Rogoff (2000) and Lane and Milesi-Ferretti (2004) show that there is significant relationship between bilateral trade and equity investment. Ahearne, Griever and Warnock (2004) and Mishra (2008) use the ratio of imports and exports to GDP, and find a significant relationship with Australia's home bias. However, Sercu and Vanpee (2008) find that bilateral trade has no significant effect on bilateral equity holdings.

Political and institutional factors are used also in different studies. Erb, Campbell, and Viskantas (1996) investigate the effect of political risks on international investment in emerging markets. Dahlquist and Sallstrom (2002) also show that the differences in corporate governance among countries influence home bias. Gelos and Wei (2005) find strong evidence of the effect of government and corporate transparency on international investments whereas Chan, Covrig and Ng (2005) employ different measures of investor protection indexes and find no significant relation between these measures and domestic bias.

In summary, the factors regarding the hedges of home-country specific seem to have contradictory results empirically. A review of the other approach followed empirically to explain equity home bias is discussed in the next section. It mainly examines whether the costs from international diversification exceed the gains or not.

5.2.2.2 International diversification gains and costs.

The theoretical framework shows that costs can exceed the gains from international diversification, and this could be a plausible reason behind the home bias puzzle.

This section distinguishes between three main themes considered under this approach. Firstly, the costs of international diversification could include taxes, transaction costs and capital controls. Secondly, the costs include costs of acquiring information on foreign companies. Thirdly, the effect of distance, language and other familiarity barriers are possible factors..

a) Capital controls, taxes and transaction costs

Black (1974) develops an international portfolio model in which he incorporates the proportional tax that is placed on short selling, which hence acts as a barrier to investment abroad. Stulz (1981) examines the effect of tax on holdings of foreign stocks, and shows that it leads to holding less foreign stocks by domestic investors. Cooper and Kaplanis (1986) also emphasise the role of international taxes and information, in which they estimate capital market equilibrium relationships including deadweight costs, and test it empirically on 14 countries. More specifically, they show that a UK investor would be willing to invest abroad as long as the deadweight cost is less than 7.2 per cent per annum over the period 1978-82.

Additionally, Eun and Janakiramanan (1986) and Errunza and Losq (1989) examine the effect of ownership restrictions on portfolio choice. Hietela (1989) observes ownership restrictions on Finnish firms, and reports support for the effect of this restriction on the price premium on the stock. The paper also shows that the size of the premium is determined mainly by the domestic and international beta of the stock. A similar trend is followed in Bailey and Jagtiani's (1994) study on Thailand in which they investigate the extent to which premium on share unrestricted to foreign investors tends to vary over time. In Mexico, Domowitz, Glen and Madhavan (1998) demonstrate that ownership restrictions lead to higher stock price premia on unrestricted stocks.

However, during the last twenty years, capital restrictions have been largely eliminated in developed and some developing markets. Hence, recent studies tend to concentrate more on the effect of international integration and transaction costs on home bias[41].

b) Information costs

Knowledge about foreign stocks can be costly especially when considering the different accounting and legal practices in foreign markets (Gehrig, 1993). Kang and Stulz (1997) show that foreign investors hold Japanese stocks with sound accounting performance firms and low leverage rather than relying on high expected returns. Dahlquist and Robertsson (2001) find similar results in the Swedish stock market.

Additionally, the effect of information asymmetries between domestic and foreign companies is examined by French and Poterba (1991), Ahearne, Griever and Warnock

[41] For example; Tesar and Wener (1995), Baxter and Jermann (1997),Bekaert and Harvey (1995, 2003), Rowland (1999), Warnock (2000), Chari and Henry (2001), Glassman and Riddick (2001), Ahearne, Griever and Warnock (2004), Lane and Milesi-Ferretti (2001), Edison and Warnock (2003), Amadi (2004), Chan, Covrig and Ng (2005), Baele, Pungulescu and Horst (2007), Sercu and Vanpee (2007).

(2004), Chan, Covrig and Ng (2005), Ivkovic and and Weisbenner (2005), and Portes and Rey (2005). In Chile, Holland and Warnock (2003) show that Chilean firms listed in the US stock exchange affect firms' portfolio weights. Amadi (2004) shows empirically that the Internet plays a significant role in equity home bias in a number of countries during the period 1995-2002.

c) Effect of distance, language and other familiarity barriers.

Foreign investors in Korea are found to be less familiar with domestic markets, and hence they buy at higher prices than domestic investors and sell at lower prices (Choe, Kho, and Stulz, 2001; Dvorak, 2005). However, this evidence contradicts the findings by Grinblatt and Keloharju (2000) relating to Finnish data, and those of Seasholes (2000) using Taiwanese data. Both papers document that foreign institutional investors outperform domestic investors. Several studies also show empirically the effect of distance, common language, and culture on portfolio choices (Grinblatt and Keloharju, 2000; Amadi, 2004; Sercu and Vanpee, 2008).

In addition to the previous two approaches, the literature shows that there might also be a degree of uncertainty in measuring home bias.

5.2.2.3 Degree of uncertainty in measuring home bias.

This section differentiates between different schemes taken in the literature regarding uncertainty of calculating home bias.

a) Uncertainty in measuring expected returns and variances.

Lewis (1999) investigates that the gains from international diversification through the calculation of expected returns and variances, and foreign diversification might not lead to significant improvement in portfolios, and hence there might not be a real home bias puzzle. French and Poterba (1991) show through variance-covariance matrix of the returns on six indexes that investors expect domestic returns to be higher than foreign ones. The US investors expect the return on U.S. equities to be around 5.5 per cent compared with 3.1 per cent to the Japanese investors and around 4.4 per cent to the British investors. On the other hand, Japanese investors expect the return on Japanese equities to be equal to 6.6 per cent compared with US investors and UK investors' expectations of 3.2 per cent and 3.8 per cent, respectively. The paper verifies the disproportionality in the behaviour of investors' portfolios. Investors seem to be more optimistic towards domestic markets. Further, investors tend not to only evaluate risk according to the historical standard of deviation of returns, but rather they include the unfamiliarity factor regarding foreign markets, firms and institutions.

b) Correct characterisation of the benchmark weights, and behavioural factors

Baele, Pungulescu and Horst (2007) develop five different benchmark weights to which the actual weights are compared and hence equity home bias is determined. They find that choosing benchmark weights can lead to overestimation/underestimation of equity home bias. Several studies use the Bayesian approach to estimate benchmark weights, mean and variances. Merton (1987) develops a model in which investors overestimate risks of stocks they do not know about. Shiller, Kon-Ya, and Tsutsui (1996) show that Japanese and

American investors tend to be more optimistic towards their domestic markets, and that they usually base their forecasts on stock market indexes. Pastor (2000) also reveals that Bayesian investors tend to have extreme beliefs regarding domestic stock returns and hence favour domestic stocks.

Home bias in equity might be explained by people's preference towards investing in familiar opportunities. Heath and Tversky (1991) explain that "people prefer to bet in a context where they consider themselves knowledgeable or competent than in a context where they feel ignorant or uninformed". They conclude that the "competence hypothesis" might verify why some investors do not take into account the gains from diversification and mainly invest in firms they are familiar with.

Social Identity Theory was originally developed by Tajfel and Turner in 1979. The theory mainly aims at understanding intergroup behaviour in the sense that within a certain group, individuals might tend to favour group members at the expense of other members outside the group. The theory gives attention to self-categorisation, and social comparisons. Fellner and Maciejovsky (2003) investigate whether or not equity home bias exists as a result of asymmetric information and social identity variables in a simplified market model. The paper also investigates whether investors exhibit more optimism towards domestic firms. The study conducts an experiment for 144 participants from 12 various markets, and they reveal that investment in home firms exceeds investment in foreign firms throughout the period under both asymmetric information and social identity treatments. Moreover, participants are asked to rank firms according to profit expectations, and the results show that participants are more optimistic towards domestic firms than foreign ones.

In summary, the empirical studies regarding the different explanations for home bias have failed in most cases to reach a common conclusion about the effect of different explanatory variables. This thesis argues that the differentiation between domestic and foreign biases is essential as previously discussed in Chan, Covrig and Ng (2005); also the definition of home bias matters. The next section estimates panel estimation of equity domestic bias in emerging markets for the period 2001-2007.

5.3 Econometric Model

This section investigates the factors that could influence domestic equity bias measured by the share of domestic equity holdings to total equity holdings. This section uses the ratio of domestic equity holdings to total equity holdings, unlike the dependent variables used by several previous studies in the literature as measured by the difference between actual and optimal weights of foreign/domestic asset (Chan, Covrig and Ng, 2005; Fidora, Fratzscher, and Thimann, 2006; Baele, Pungulescu, and Ter Horst, 2007). The choice of the share of domestic equity holdings to total equity holdings as the dependent variable is threefold. Firstly, it would allow to directly measure the degree of domestic bias without the effect of the estimates of optimal weights. Secondly, the usage of the time-varying optimal weights from the DCC model as an explanatory variable and hence the effect of market efficiency could be considered separately. Thirdly, there is no restriction of unit coefficient on optimal weights.

However, the extent of domestic equity biasness can be investigated by Tables 5.3, 5.4 and 5.5 (pages 275-276). Table 5.3 (page 275) shows the end-of-year optimal shares of domestic equities to total portfolio according to the DCC estimation in local currency, Table 5.4 (page 275) shows end-of-year share of actual holdings of domestic equities to total equity holdings according to survey data of the IMF, while Table 5.5 (page 276) shows the difference between both shares. The tables show that the extent of equity domestic biasness seem persistent in most of emerging markets under study; in which investors seem to be approximately 70 per cent biased towards holding domestic equities as denoted by Table 5.5 (page 276).

Data on international portfolio holdings are published through the IMF annual survey CPIS. The survey publishes data on the annual foreign portfolio assets and liabilities for each country vis-à-vis the rest of the world. However, the survey still has some drawbacks, i.e. incomplete country lists and biases resulting from reporting participants in the survey (Sercu and Vanpee, 2008).

Domestic equity holdings are computed as the market capitalisation in a given country minus foreign equity liabilities whereas total equity holdings are calculated as the sum of both domestic equity holdings and foreign equity assets.

Investors in emerging markets hold almost 85 per cent of their investment in domestic markets during the period 2001-2007 as can be seen from summary statistics of the dependent variable Y in Table 5.2 (page 274).

The explanatory variables are drawn from the current literature on equity home bias, which argue that they motivate domestic investors to overweight domestic equities in addition to other variables calculated from previous estimations. The variables used can be classified into: 1) controls on capital flows, 2) information asymmetries, 3) economic and political risks, 4) financial development, and 5) other variables.

5.3.1 Controls on capital flows

Barriers to international investment have reduced during the last 30 years as Kaolyi and Stulz (2003) explain. But more specifically, most emerging markets underwent capital liberalisation around the early nineties (Bekaert and Harvey, 1997). However, according to the IMF's Annual Report on Exchange Arrangements and Exchange Restrictions (AREAER), the emerging markets under study still exhibit some sort of restrictions on capital inflows and outflows. Most studies rely on the construction of dummy variables and indexes with regard to the data published by AREAER to identify the extent of capital restrictions within each country (Lane and Milesi-Ferretti, 2001). This study is interested in domestic bias; hence there is a focus on restrictions on capital outflows. This thesis identifies five main restrictions as proxy for control on capital outflow; foreign exchange sales must be registered with the Central bank, or formal market; the need for prior approval or authorisation; ceilings on foreign exchange purchases by residents for various transactions; controls or limits on residents' purchases of foreign securities abroad, and other forms of capital outflow controls. This study develops a new measure for restrictions on capital outflows, an index CONT by counting how many restrictions are imposed in each country in a given year. The value of the index ranged from zero if none of the restrictions are employed to five when all the restrictions described above are applicable in the country. The details of index construction are in Table 5.6 (page 277) in Appendix C.

Additionally, the study employs a 0/1 dummy variable to account for the control over investible transactions and current transfers (INV), which mainly measures the extent to which there exists controls over transfers regarding travel payments, personal payments, and foreign workers' wages. Hence, INV might give an indication of the extent of control on foreign currency transfers.

The use of CONT and INV show the extent to which domestic investors are restricted to invest abroad, access foreign currency and transfer of exchange payments, and hence domestic investors are likely to invest a higher portion of their investments in the domestic market instead. The study expects a positive relation between both variables and the proportion of domestic equity holdings to the total equity holdings.

The study also considers the use of Edison and Warnock's (2003) proxy of intensity of capital control, which is simply one minus the ratio of total market capitalisation available to foreign investors (International Finance Corporation Investible index) to total market capitalisation (International Finance Corporation Global index). The International Finance Corporation (IFC) Investible index is available to foreign investors according to legal restrictions or low liquidity (Edison and Warnock, 2003)[42]. Even though this measure acts more as a control over capital inflows, it might imply that if foreign investors are restricted from entering the domestic market, domestic investors would tend to on average over-invest in the domestic market. Hence, the study expects a positive relation between this measure and domestic equity holdings.

[42] Edison and Warnock (2001) measure has also been employed by Ahearne, Griever and Warnock (2004), and Sercu and Vanpee (2008)

5.3.2 Information Asymmetries

The literature shows that information on foreign markets might be hard and costly to access compared to information on domestic markets. For instance, Ahearne, Griever and Warnock (2004) show that there is a strong negative relationship between their measure of US investors' home bias and the share of the country's stock market that is listed on the US stock exchange. Other studies use other measures to proxy information asymmetries as mentioned above and investigate their effect on foreign or domestic bias. This includes those of Amadi (2001), Fellner and Maciejovsky, (2003) and Sercu and Vanpee (2008).

This section uses a number of variables to proxy the extent of available information or familiarity with foreign markets.

Following Amadi (2004), and Mishra (2008), this section employs the ratio of foreign listed companies in the total number of companies listed in the domestic market (LIS) as a first proxy of available information on foreign firms. Listing foreign companies in the domestic stock market is likely to reduce the cost of acquiring information about accounting standards and legal practices in foreign markets (Lewis, 1999). As the number of listed foreign firms increases, investors become increasingly familiar with foreign firms. Hence, the study expects a negative relationship between LIS and domestic equity bias.

As a second proxy for the effect of available information on foreign markets, the study uses the number of Internet users per 100 people (INT). Portes, Rey and Oh (2001), Amadi (2004), and Mishra (2008) find a negative significant effect of telephone traffic and Internet users on their measures of equity home bias.

Lane and Milesi-Ferretti (2003), Ahearne, Griever and Warnock (2004), Amadi (2004), Baele, Pungulescu, and Ter Horst (2007), and Mishra (2008) use the sum of imports and exports normalised by GDP as a proxy for trade openness. However, as a third proxy for the familiarity with foreign markets, this study uses the ratio of imports to gross domestic product (IMP) as employed by Fidora, Fratzscher and Thimann (2006). The ratio of imports to GDP is assumed to increase the familiarity with other countries products which might increase the awareness of other markets. Therefore, the study expects a negative relationship between IMP and domestic bias.

5.3.3 Economic and institutional risks

In addition to testing whether there is a significant relationship between these risks and domestic equity holdings. This section tests whether the economic and political risks at home can add to the degree of uncertainty about the domestic market and whether they might in return discourage domestic investors at home, and vice versa.

Okun's misery index is used as a proxy for economic risk, which is simply the sum of unemployment and inflation rates. The higher the index for a country, the more likely is the uncertainty regarding future policies and hence investment decisions. Thus, the study expects a negative relationship between the misery index and domestic equity holdings.

Chan, Covrig and Ng (2005) use six measures of investor protection and explain that foreign investors tend to invest less in markets with less favourable investor protection schemes; thus domestic investors will hold more local equities. This study uses the corruption perception index (CPI) as a proxy of institutional risk. The CPI ranks countries according to their levels of public sector corruption through expert assessments and other survey reports regarding business people perceptions. The index mainly measures the extent of corruption in terms of the frequency and/or the size of bribes in a given country. In 2008, the index covered 180 countries on a scale of zero (highly corrupt) to 10 (highly clean). The CPI and misery index are both used by Sercu and Vanpee (2008)

Additionally, this thesis employs the capital access index (CAI) as a proxy for the overall economic and institutional risks. The index mainly measures the extent to which capital is accessible to innovators and managers in a given country, through the assessment of the macroeconomic, institutional and development of financial markets. Hence, the CAI scores a country's overall position in terms of 58 variables across seven main components; namely the macroeconomic environment, institutional environment, equity market development, bond market development, other sources of capital like credit cards, and international funding. The study assumes that there is a positive relation between equity domestic holdings and the favourability of macroeconomic and institutional environments in a given country. The result is a composite score that identifies the country's overall performance on the index. The scores range from one (lowest rank) to 10 (highest rank) in terms of capital access in countries.

The study expects positive coefficients for both the CPI, and CAI in which a cleaner and a more favourable investment environment would encourage investors to invest domestically.

This section also investigates whether volatility in real exchange rates (EXCH) contributes to increasing domestic equity holdings[43]. Fidora, Fratzscher and Thimann

[43] Previous estimations of chapter four have shown that optimal weights differ according to the estimation of DCC model denominated in local currency compared to the DCC model denominated in US Dollar. The

(2006) and Mishra (2008) find a significant positive relationship between real exchange rate volatility and their measures of equity home bias. This section also uses the standard deviation of the monthly real exchange rate as a measure of exchange rate volatility in line with previous studies. The main question behind introducing EXCH is to understand the extent to which currency risks could affect investors' decisions regarding the allocation of their asset portfolios.

5.3.4 Financial development

Although some of the aspects of financial development are already included in the capital access index, this section aims to test whether the size of capital market and banking system affect domestic investors' holdings of local equities.

It is argued that the larger the capital market, the more advanced it can be and the lower the deadweight costs, hence the more attractive it is to foreign and domestic investors. Whether large capital markets are more attractive to foreign or domestic investors mainly depends on the extent to which costs are reduced by both investors (Chan, Covrig and Ng, 2005).

This section uses the share of stock market capitalisation as a percent of GDP as a measure of stock market size (CAP). A positive relationship between the relative size of the stock market and domestic equity holdings is expected, since domestic investors are

results showed that the shares of domestic equities shrank under the later model, which could imply a significant effect of exchange rate volatility on investment decisions. Hence the thesis tests for this effect on the holdings of domestic equities in this chapter.

assumed to be less tempted to diversify investment portfolio in relatively large capital markets[44].

On the other hand, Mann and Meade (2002) explain that there could exist some sort of trade off between bank and stock market development, meaning that countries with high bank assets could imply a less diversified financial system and therefore would be less attractive to foreign investors. Bank assets are used here in terms of the ratio of deposit money bank assets to GDP (DEP). Deposits include demand, time and other kinds of deposits offered by the banking system in a given country. The study assumes that higher ratio of deposit money bank assets to GDP would have a negative effect on domestic equity holdings.

5.3.5 Others

The effect of increased financial integration on equity home bias is discussed by Baele, Pungulescu and Horst (2007), and their paper concludes that higher financial integration is associated with a decline in equity home bias. Bekaert and Harvey (1995, 2003) and Fratzscher (2001) show that time-varying global betas can be used as proxy for financial integration. Lewis (1999) argues that home bias in equity holdings would be expected in markets that are considered segmented from the world markets. Further, Karolyi and Stulz (2002) explain that domestic markets tend to be less segmented from the world market when the market's world beta significantly influences the determination of domestic market returns.

[44] The ratio of stock market capitalisation to GDP has been also used in Ahearne, Griever and Warnock (2002); Amadi (2004); Mishra (2008).

Hence, this section tests the effect of increased international integration for emerging markets on domestic equity holdings through the usage of end-of-year betas that resulted from the estimated time-varying bivariate GARCH model to test the effect of financial integration (higher betas) on domestic equity holdings. The study expects a negative coefficient on the betas, since it is assumed that higher betas would imply that investors tend to invest overseas, and therefore invest a smaller proportion in the domestic market.

In addition to financial integration, there is evidence that domestic investors would prefer to invest in the domestic market during bull times. Hence the study employs the market excess returns, which is simply market's return subtracted from the risk-free rate in each market to examine whether domestic market profitability affects domestic equity holdings. A positive coefficient on market excess returns is expected.

Lewis (1999) shows that lower risk aversion coefficients lead to greater demand response to higher expected returns, whilst higher risk aversion coefficients would make relative returns overseas less important. Sercu and Vanpee (2008) estimate risk aversion coefficients from real consumption and real exchange rates and find a significant positive relation between risk aversion coefficients and equity home bias. However, this study uses risk aversion coefficients calculated through the mean-variance estimation of optimal weights according to the DCC model (RISK). Accordingly, the study assumes a positive coefficient on risk aversion coefficients.

The study also introduces optimal weights (OPT) estimated from the DCC model as an explanatory variable, instead of including them as part of the dependent variable as commonly used in the literature. The study expects a significant and a coefficient of one if markets are assumed to be efficient.[45]

Brief definitions of the variables used and data sources are in Table 5.1 (page 271).

5.4 Model specification

This section investigates the factors that affect domestic equity holdings in 17 emerging markets over the 2001-2007 period using panel estimation.

This study allows for fixed country effects, fixed country effects using robust standard errors, and feasible GLS method to control for cross-sectional heteroscedasticity.

$$Y_{it} = \alpha_i + \beta_1 CONTROL_{it} + \beta_2 INFORMATION_{it} + \beta_3 ECONOMIC_{it} + \beta_4 SIZE_{it}$$

$$+ \beta_5 BETA_{it} + \beta_6 PRE + \beta_7 RISK + \beta_8 Y^*_{it} + u_{it}, \qquad u_{it} \sim IID(0, \sigma^2_u) \qquad (5.1)$$

where Y_{it} is the ratio of domestic equity holdings to total equity holdings; $CONTROL_{it}$ represents the set of variables that are used as proxy for capital control; $INFORMATION_{it}$ includes independent variables that represents information asymmetries; $ECONOMIC_{it}$ constitutes the four proxies used for the economic and institutional risks; $SIZE_{it}$ includes both the ratio of stock market capitalisation to GDP; and the ratio of deposit money bank assets to GDP. $BETA_{it}$, PRE_{it}, $RISK_{it}$ and Y^*_{it} represent the time-varying betas, excess returns over risk free rates, risk aversion coefficients and optimal weights, respectively.

[45] The risk aversion coefficients, market premium, and optimal weights are extracted from the results of the DCC model denominated in local currency and also in US Dollar. However, the results did not differ much using the DCC denominated in local currency, or US Dollar. This chapter employs the results using factors extracted from the DCC denominated in local currency.

Equation (5.1) is first estimated with fixed effect panel estimation, and the results of the estimated coefficients excluding the constant and individual fixed effects are reported in Table 5.7 (page 291), Columns (1), and (2).

However, after estimating the full model reported in Table 5.7 (page 291), columns (1) and (2), insignificant variables are dropped while maintaining others according to theoretical justification, and variable robustness. Giving this modification, the market's domestic equity holdings is a function of the dummy variable used as proxy for the control over invisible transaction, number of Internet users per 100 people, the ratio of imports to GDP, country's misery index, real exchange rate volatility, ratio of stock market capitalisation to GDP, and optimal weights determined from the DCC model.

An estimation of the augmented model using fixed effects panel estimation is done which assumes that the intercept terms vary over the markets, while the slope estimates (β) are fixed across markets, as well as σ_u^2. The estimated coefficients excluding the constant[46] and individual fixed effects of the fixed effect panel estimation of the augmented model are presented in Table 5.7 (page 291), column (4).

The augmented model seems to explain almost 57 per cent of the variation in the dependent variable. It is argued that the within R^2 provide a better measure of model results under the fixed effects estimation,[47] which equals 24.5 per cent (modest than the

[46] The constant term is highly significant at one per cent level in all model estimations.

[47] Baum (2006), and Verbeek (2006) show that the same estimator for β is obtained if estimations are done using deviations from individual means, and this transformation is referred to as 'within estimator'. The main results of this transformation are that; a) it eliminates the dummy variables constituting the vector of individual effects (α_i), and hence reduces the number of dummy variables estimated; b) the explanatory power of the model is now based on whether the deviations of individual's y from the mean values is significantly correlated with the deviations of individual's X from their mean values. This implies that any

overall R^2[48]). The estimated coefficients for dummy variable representing control over invisible transaction (INV) and the ratio of market capitalisation to GDP (CAP) seem to be the most significant followed by the ratio of imports to GDP (IMP). The remaining explanatory variables are significantly different from zero at higher levels of significance. Furthermore, all the explanatory variables are correctly signed in accordance to the earlier assumptions.

Next section tests whether fixed effect panel estimation fits better the data set than random effect model. It also investigates whether the estimates are consistent, accounting for possible cross-panel heteroscedasticity, serial correlation, multicollinearity, and test for omitted variables that have been eliminated earlier.

First, an examination of augmented model using fixed effects estimation and random effects estimation (also referred to as 'between estimator'). The main difference between the two is that the random effect model specifies the individual effect as a random term, and assumes that it is uncorrelated with model regressors and hence summarizes it within the random error term. The results for the random effect panel estimation is presented in Table 5.7 (page 291), column (3). As can be seen, the coefficient estimates seem to change for some of the explanatory variables, also altering their significance. It is argued that the shorter the time period of panel estimation the more likely it is that the differences in β estimates between fixed and random effects are substantial (Verbeek, 2006)

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explanatory variable that does not change over time will be eliminated; also it dampens the effect of outliers, since the explanatory power lies now within the variation of the individual's unit from their means values.

[48] See also Medvedev, 2006.

Hausman (1978) provides a test in accordance with which is able to choose between fixed effect and random effect estimations. The test relies on the estimations of both fixed effect and random effect models, and determines whether the coefficient estimators are significantly different under both estimations. If the two estimators are significantly different, this might imply that the correlation between x_{it} and α_i is not equal zero, and hence random effect estimations are considered inconsistent (Wooldridge, 2004).

In that sense, Hausman's test examines the difference between the two estimated covariance matrices in order to weight the difference between the fixed effects and random effects vector of estimated coefficients (Baltagi, 1995; Baum, 2006). Under the null hypothesis that there is no correlation between x_{it} and α_i, and both the fixed effect and random effect models are consistent, albeit the fixed effect model is inefficient. Under the alternative hypothesis, the fixed effect model is consistent; however the random effect model is not (Astriou and Hall, 2006).

According to Hausman's test estimation, the null hypothesis of no correlation between x_{it} and α_i is rejected (test statistics $\chi^2\{7\}$=19.15, $Prob$ = 0.0077). Therefore, the study concentrates on the fixed effect model and proceeds to test for the possibility of cross-panel heteroscedasticity, serial correlation, and multicollinearity in addition to testing for the significance of omitted variables.

5.4.1 Test for cross-panel heteroscedasticity

An examination of the presence of cross-panel heteroscedasticity in model residuals is used based on the Breuch-Pagan test with the test statistic of χ^2=7.00, $Prob$ = 0.0081.

The test result implies that the null hypothesis of constant residual variance among different markets is rejected while this still could result in unbiased coefficient estimates, standard errors estimated can be significantly misleading (Medvedev, 2006). More specifically, the variance of u_i may be changing across the markets under study. However, this does not imply that the error terms are mutually uncorrelated.

Verbeek (2006) suggests different ways to tackle heteroscedasticity in error terms. Corrections for heteroscedasticity range from estimating OLS (using White standard errors) to using feasible GLS in addition to alternatively changing the estimated model.

Firstly, as with most panel studies, this section employs robust panel standard errors by using the Huber-White sandwich method. The White (diagonal) method is argued to be robust to observation in which there exists specific heteroscedasticity in the disturbances without making assumptions about the form of heteroscedasticity. However, it does not account for correlation between residuals that might be present as well. The results of the fixed effect model with White (diagonal) robust standard errors are presented in Table 5.7 (page 291), column (5). As implied by the Breuch-Pagan test, the results in column (4) of fixed effect model without robust standard errors differ but not substantially from the one estimated with robust standard errors in which there exists some alterations in the standard errors. In addition, significance levels seem to change as well mainly in the case of the dummy variable used as proxy for control on invisible transactions, which might imply the existence of some sort of mild heteroskedastic error variances.

Secondly, an estimation of the feasible GLS model, which is also referred to as a weighted least squares estimator is conducted. The FGLS random effect is considered as a matrix-weighted average of the within (fixed effect) and random effect estimators (Baltagi, 1995; Baum, 2006). The method relies on weighting each observation with a factor that is inversely proportional to the error variance.

We can state equation (5.1) as:

$$y_{it} = X_{it}\beta + u_{it} \tag{5.2}$$

Where $i = 1,....N$ denotes the markets under study, $t = 1,...T$ denotes the number of observations for market i and X represents the exogenous variables (as denoted by CONTROL, INFORMATION, ECONOMIC, SIZE, BETA, PRE, RISK and Y*).

Alternatively,

$$\begin{bmatrix} y_1 \\ y_2 \\ \dots \\ \dots \\ y_N \end{bmatrix} = \begin{bmatrix} X_1 \\ X_2 \\ \dots \\ \dots \\ X_N \end{bmatrix} \beta + \begin{bmatrix} u_1 \\ u_2 \\ \dots \\ \dots \\ u_N \end{bmatrix}$$

Accordingly, the variance matrix of disturbance terms is expressed by:

$$E[uu'] = \Omega = \begin{bmatrix} \sigma_{1,1}\Omega_{1,1} & \sigma_{1,2}\Omega_{1,2} & \dots & \sigma_{1,N}\Omega_{1,N} \\ \sigma_{2,1}\Omega_{2,1} & \sigma_{2,2}\Omega_{2,2} & \dots & \sigma_{2,N}\Omega_{2,N} \\ \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot \\ \sigma_{N,1}\Omega_{N,1} & \sigma_{N,2}\Omega_{N,2} & \dots & \sigma_{N,N}\Omega_{N,N} \end{bmatrix}$$

Wooldridge (2002, p.152-154) explains that the asymptotic variance of the feasible GLS is $\mathrm{A\,v\hat{a}r}(\hat{\beta}) = \hat{A}^{-1}/N \equiv \left(\sum_{i=1}^{N} X_i'\hat{\Omega}^{-1}X_i\right)^{-1}/N$, which is used to estimate asymptotic standard errors. $\hat{\Omega}$ represents the unconditional variance matrix of u_i ($\hat{\Omega} \equiv E(u_i u_i')$). Similar to the OLS estimation, the β_i^* in the equation (5.2) minimise sum of squared residuals according to the GLS; however the latter estimation minimises weighted sum of squared residuals. Accordingly, each observation in the model whether it is the explanatory variables (denoted by X_i) or the constants (denoted by α_i) is weighted/divided by (a factor proportional to) the inverse of its error (Verbeek, 2006; p.84). Hence, observations with higher variance will be given smaller weight in the estimation.

It might not be possible to compare the results in column (4) with those of column (5) partially because the estimators according to the FGLS method are a non-linear function of y_{it}. However, the FGLS coefficient estimates seem fairly close to those estimated with OLS estimation of the fixed effect model in Column (4). One additional factor worth noting is that the larger R^2 estimated through the FGLS method compared to fixed effects with robust standard error estimation can be misleading, partially because the transformed model using the feasible GLS method does not contain an intercept term, and accordingly an uncentred R^2 is computed instead (Verbeek, 2006).

Thirdly, the usage of FGLS method is maintained in addition to the usage of White robust standard errors in order to make sure that our inference regarding heteroscedasticity of the error term is correct. Verbeek (2003) explains that, following this, the results are expected to be more efficient than the estimation of OLS, and robust to the general forms of heteroscedasticity.

5.4.2 Test for Serial Correlation

The fixed effect estimations in Table 5.7 (page 291), column (4) needs to be tested for possible presence of serial correlation in the residual term. Serial correlation might lead to biases in standard errors and hence may result in less efficient estimators. A common test is that of Wooldridge (2002, p. 282-283). The test relies on estimating the parameters β_i by regressing the first difference in $y_{it}(\Delta y_{it})$ against the first difference in $x_{it}(\Delta x_{it})$, and accordingly obtaining the residuals Δu_{it}. Wooldridge shows that if u_{it} are not serially correlated, then $corr(\Delta u_{it}, \Delta u_{it-1}) = -0.5$ which corresponds to the null of no serial correlation. Based on this observation, the test proceeds by testing the regression with first-differenced variables against their lags and examines the coefficients on the lagged residuals whether it is equal to -0.5 or not (Drukker, 2003).

An estimation of Wooldridge's (2002) test reveals that (F(1,15)= 0.962 with prob=0.3422), which implies that the null hypothesis of no serial correlation (for a two-sided t test, 5 per cent level) cannot be rejected. Hence, model disturbances are independently distributed.

5.4.3 Test for Multicollinearity

Collinearity among the model's explanatory variables could inflate standard errors and therefore might lead to over fitting of the model. In other words, it might result in over-estimating the effects of some explanatory variables that are collinear with others (Medvedev, 2006) while under-estimating the effects of others (Verbeek, 2006). In addition, multicollinearity would imply that the effect of explanatory variables individually would be hard to recognise.

Hence, Baum (2006) explains that even though the model's overall fit (R^2, or *adj* R^2) may seem very good, collinear variables might have high standard errors and sometimes incorrect signs than they would otherwise in the case of no collinearity.

If the correlation between x_{i1} and x_{i2} is high, amounting to perfect collinearity of r_{12}=1 or -1, OLS estimation cannot be calculated and some software packages like STATA for example drops either of the variables until the resulting regressor matrix is invertible. However, cases of near-collinearity can be detected using variance inflation factor (VIF), which shows the extent to which the variance of β_i is inflated because there exists collinearity between regressor i and another explanatory variable. This factor is usually compared to a hypothetical case in which there is no correlation between x_i and any other regressors. It is commonly used that there is an expectation of multicollinearity if the largest VIF is greater than 10.

An estimation of VIF shows the following:

Variable	VIF	1/VIF
Misery Index	1.80	0.56
Internet users (per 100 persons)	1.53	0.66
Ratio of Imports to GDP	1.38	0.72
Real Exchange Rate Volatility	1.36	0.73
Control over Invisible Transaction	1.26	0.79
Ratio of Market Capitalisation to GDP	1.11	0.90
Optimal weights from DCC model	0.18	0.07
Mean VIF	1.36	

The model seems to be well conditioned since the maximum VIF is less than two.

5.4.4. Test for Omitted Variables

The study tests for the significance of the omitted variables that are eliminated from the full version of the model by implementing a likelihood test for the significance of each explanatory variable separately and also the joint significance of all the eliminated variables. The F-test of 0.77132, with prob=0.629 does not reject at conventional significance levels the null hypothesis that the omitted explanatory variables are jointly irrelevant.

5.5 Conclusion

The share of actual domestic equity holdings to total equity amounts to around 85 per cent in emerging markets during the period 2001-2007. This percentage is considered high compared to the share of emerging markets in the world market, or the optimal weights determined by the DCC model estimated in chapter four. This chapter investigated the reasons why investors tend to have a preference for domestic equities in emerging markets.

There are several contributions to the vast body of literature on equity home bias. This chapter only concentrates on the study of domestic bias (why investors overweight domestic equities) rather than foreign bias (why investors underweight foreign equities) since both biases are used interchangeably in the literature. Accordingly, the study uses the ratio of domestic equity holdings to total equity holdings as the dependent variable unlike the dependent variables used by several studies in the literature while excluding the effect of the estimates of optimal weights. The study employs the time-varying optimal weights from the DCC model as an explanatory variable and hence the effect of market efficiency is investigated separately. Further, the study uses risk aversion coefficients calculated through the time-varying mean-variance model rather than postulated or consumption data.

The present thesis postulates that the explanatory variables used serve the analysis in two key ways. Firstly, to directly test the variables that affect domestic bias in emerging markets, and secondly to understand the characteristics of emerging stock markets by incorporating economic and institutional variables. The explanatory variables mainly concentrate on capital control restrictions, information asymmetries, economic and institutional risks, financial development factors, and others. However, the following variables are found significant: the misery index, number of Internet users per 100 people, ratio of imports to GDP, real exchange volatility, control over invisible transaction and the size of stock market. The most significance effects amounted to the size of stock market, ratio of imports to GDP, control over invisible transaction, and number of Internet users. It can be also noted that among the significant variables, volatility and the control over exchange rate transactions seem to dominate. This result emphasises the effect of volatility in real exchange rates and control over foreign exchange transactions on investors' decisions regarding portfolio choice in emerging markets.

Appendix C

Table 5.1: Data Description and Sources

Variable		Brief Description	Expected Sign	Sources	Used by the following studies
Dependent Variable		Ratio of domestic equity holdings to total equity holdings, denominated in US Dollars		Stock market capitalisations are available online from the World Federation of Exchanges (www.world-exchanges.org). While international equity holdings are available on the International Monetary Fund (IMF) website for the Coordinated Portfolio Investment Survey (CPIS) www.imf.org	Thesis contribution
Explanatory Variables					
Capital control	CONT	Index constructed reflecting restrictions on capital outflows	+	IMF Annual report on Exchange Arrangements and Exchange Restrictions (AREAER).	Thesis contribution
	INV	0/1 dummy variable accounting for control over investible transactions and current transfers	+	IMF Annual report on Exchange Arrangements and Exchange Restrictions (AREAER).	Thesis contribution
	IFCI	1-(Total market capitalisation available to foreign investors /Total market capitalisation). In other words, equals to 1-(IFCI/IFCG)	+	The International Financial Corporation Investible and Global indices (IFCI & IFCG) are available on DATASTREAM Database	Edison and Warnock (2003)
Information Asymmetries	LIS	Ratio of foreign listed companies to the total number of companies listed in a given domestic market	-	Available online from the World Federation of Exchanges (www.world-exchanges.org)	Amadi (2004); Mishra (2008)

	INT	Number of internet users (per 100 people)	-	World Development Indicators, World Bank Publications, available online on International Financial Statistics(IFS), IMF (www.esds.ac.uk)	Amadi (2004); Mishra (2008)
	IMP	Ratio of imports to Gross Domestic Product (GDP) denominated in US Dollars	-	Available online on IFS, IMF (www.esds.ac.uk)	Fidora, Fratzscher and Thimann (2006)
Economic and Institutional Risks	MIS	Misery index, calculated as the sum of unemployment and inflation rates. Inflation rates are computed as the rate of change in consumer price indices.	-	World Development Indicators, World Bank Publications, available online on International Financial Statistics, IMF (www.esds.ac.uk)	Sercu and Vanpee (2008)
	CPI	Transparency International Corruption Perception Index	-	Available online from Transparency International (www.transparency.org)	Sercu and Vanpee (2008)
	EXCH	Standard deviation of monthly real exchange rates	+	Consumer price indices of emerging markets and United States were extracted from IFS, IMF. While, exchange rates of emerging markets vis-a-vis US Dollar are available online from World Development Indicators, World Bank Publications. Both records are available online on (www.esds.ac.uk)	Fidora, Fratscher and Thimann (2006); Mishra (2008)
	CAI	Capital Access Index. An index used as proxy for economic and institutional risks.	+	Details of the index are available online through Milken Institute website. Various reports were used from www.milkeninstitute.org	Thesis contribution
Financial Developm ent	DEP	Proxy for banking size. Computed as the ratio of deposit money bank assets to GDP, denominated in US Dollars	-	Data on GDP and bank deposits are available online on IFS, IMF (www.esds.ac.uk)	Mann and Meade (2002)

	CAP	The ratio of market capitalisation to GDP, denominated in US Dollars	+	Available on the World Federation of Exchanges, various reports online.	Ahearne, Griever and Warnock (2002); Amadi (2004); Chan, Covrig and Ng (2005); Mishra (2008)
Other	Beta	End of year betas that result from an estimated conditional bivariate GARCH Capital Asset Pricing model.	-	Estimated from Chapter three	Baele, Pungulesca, and Horst (2007)
	PRE	Excess domestic returns. Calculated as domestic return on market index minus the riskfree rate, defined as the Treasury bill rate, if not available money market rate or discount rate were used instead.	+	The domestic indices are extracted from DATASTREAM Database. The Treasury bill rate, money market rate and discount rate are available online on IFS, IMF (www.esds.ac.uk).	Thesis contribution
	RISK	Risk aversion coefficients, calculated from mean-variance estimations of time-varying optimal weights according to Dynamic Conditional Correlation model (DCC). End of year coefficients were used in the current panel estimation.	+	Estimated from Chapter four	Sercu and Vanpee (2008)
	OPT	Optimal weights estimated from the DCC model. End of year coefficients were used in the current panel estimation.	+	Estimated from Chapter four	Thesis contribution

Table 5.2: Summary Statistics for variables used during the period 2001-2007

Variable	Mean	Std. Dev.	Min	Max
Y	.8586726	.1777212	-.02	.99
LIS	.2718709	1.114476	0	9
CAI	4.460756	.9694854	2.74	7.14
CPI	3.752101	1.295811	1.9	7.5
MIS	15.86394	9.71217	1.502764	56.22262
EXCH	.0209955	.0536206	.0006471	.508695
IMP	29.68128	19.08698	7.562273	88.96688
IFCI	.1144843	.1632622	0	.6767169
INVI	.4117647	.494234	0	1
CONT	1.720339	.8461637	0	4
DEP	41.52588	93.41367	.1885571	641.2421
CAP	59.54561	54.30158	11.3	292.5
INTR	18.12723	17.50264	.68	75.93
RISK	4.033613	2.332282	3	15
BETA	1.285042	.484974	-.12	2.7
OPT	0.084822	0.165843	1	0
PRE	.0056764	.0096151	-.0201207	.0353505

Table 5.3: Optimal weights of domestic equities (Using DCC model estimation in local Currency)

Dec	Argentina	Brazil	Chile	Colombia	Mexico	Egypt	South Africa	Hungary	Poland	Russia	Turkey	India	Indonesia	Pakistan	Malaysia	Korea	Philippines
2001	0.021	0.046	0	0.590	0	0	0	0.032	0	0.014	0	0.045	0	0	0	0	0
2002	0	0.404	0	0.337	0.190	0	0	0	0	0.175	0	0.166	0	0.023	0	0	0
2003	0.058	0.484	0	0.348	0.231	1	0	0	0	0.083	0	0	0.025	0.024	0.562	0	0
2004	0.017	0	0	0.384	0.270	0.043	0.014	0	0	0.083	0.038	0	0.032	0.030	0.159	0	0
2005	0	0	0	0.298	0.027	0.061	0	0	0	0.079	0.071	0.064	0.035	0	0.149	0	0
2006	0	0.553	0	0.294	0.001	0.556	0	0	0	0.172	0.031	0.002	0.035	0	0.297	0	0
2007	0.004	0.291	0.053	0.458	0.144	0.016	0	0	0	0.307	0.026	0	0.032	0	0.083	0	0

Table 5.4: Actual holdings of domestic equities to total equity holdings

Dec	Argentina	Brazil	Chile	Colombia	Mexico	Egypt	South Africa	Hungary	Poland	Russia	Turkey	India	Indonesia	Pakistan	Malaysia	Korea	Philippines
2001	0.817	0.980	0.930	0.898	NA	0.978	0.715	0.963	0.994	0.996	0.998	NA	0.999	NA	0.987	0.990	0.993
2002	0.691	0.976	0.911	0.901	NA	0.983	0.780	0.970	0.992	0.998	0.998	NA	0.996	1.085	0.984	0.988	0.992
2003	0.814	0.985	0.886	0.946	0.995	0.946	0.858	0.972	0.992	0.998	0.999	NA	0.999	1.230	0.994	0.983	0.991
2004	0.819	0.819	0.878	0.976	0.977	0.935	0.901	0.935	0.988	0.998	0.998	0.999	0.999	0.996	0.993	0.966	0.992
2005	0.826	0.992	0.849	0.979	0.981	0.988	0.888	0.905	0.978	0.998	0.999	0.999	0.998	0.991	0.990	0.973	0.996
2006	0.805	0.993	0.789	0.971	0.978	0.989	0.906	0.818	0.961	0.997	0.998	0.999	0.996	0.994	0.981	0.943	0.997
2007	0.777	0.993	0.755	0.973	0.986	0.991	0.913	0.771	0.938	0.987	0.547	0.999	0.997	0.995	0.966	0.890	0.997

Table 5.5: The extent of domestic equity bias (The difference between the actual share of domestic equity holdings and optimal domestic equity weights)

Dec	Argentina	Brazil	Chile	Colombia	Mexico	Egypt	South Africa	Hungary	Poland	Russia	Turkey	India	Indonesia	Pakistan	Malaysia	Korea	Philippines
2001	0.796	0.934	0.930	0.307	NA	0.978	0.715	0.931	0.994	0.981	0.998	NA	0.999	NA	0.987	0.990	0.993
2002	0.691	0.572	0.911	0.564	NA	0.983	0.780	0.970	0.992	0.823	0.998	NA	0.996	1.062	0.984	0.988	0.992
2003	0.755	0.500	0.886	0.597	0.763	-0.053	0.858	0.972	0.992	0.915	0.999	NA	0.973	1.205	0.432	0.983	0.991
2004	0.802	0.819	0.878	0.591	0.707	0.891	0.886	0.935	0.988	0.915	0.960	0.999	0.966	0.966	0.834	0.966	0.992
2005	0.826	0.992	0.849	0.681	0.953	0.926	0.888	0.905	0.978	0.918	0.927	0.935	0.963	0.991	0.840	0.973	0.996
2006	0.805	0.439	0.789	0.677	0.976	0.433	0.906	0.818	0.961	0.825	0.967	0.997	0.960	0.994	0.684	0.943	0.997
2007	0.772	0.702	0.701	0.515	0.842	0.974	0.913	0.771	0.938	0.680	0.521	0.999	0.964	0.995	0.882	0.890	0.997

Note: NA indicates not available data

Table 5.6: Construction of capital outflow control index (CONT)

2001	Argentina	Brazil	Chile	Colombia	Egypt	Hungary	India	Indonesia
Foreign exchange sales must be registered with the Central Bank (CB) or formal market			Capital transactions over $10,000 must be conducted through formal exchange market or CB			1		
Prior approval is needed				1			1	
Ceiling for purchases of foreign exchange by residents for various transactions								
Controls or limits on resident's purchases of foreign securities abroad		Residents may invest only on stock markets in MERCOSUR countries. Outside that, they are only allowed to purchase DRs issued by companies headquarters						No controls applies as long as shares are not listed on the Indonesian Stock Exchange, otherwise they should comply with the capital market act.
Other controls on capital	1				1		1	
Total	1	1	1	1	1	1	2	1

2001	Korea	Malaysia	Mexico	Pakistan	Philippines	Poland	Russia	South Africa	Turkey
Foreign exchange sales must be registered with the Central Bank (CB) or formal market									1
Prior approval is needed		For purchases amounting to RM 10,000 or more	1	1	1	To Purchase securities with maturities less than 1 year	1	1	1
Ceiling for purchases of foreign exchange by residents for various transactions								Purchases by residents are allowed within the R750,000 foreign investment limit	
Controls or limits on resident's purchases of foreign securities abroad									
Other controls on capital	1		1	1	1	Limit to investment in EU, EEA, and OECD (free of charge)	1	1	1
Total	1	1	2	2	2	2	2	3	3

2002	Argentina	Brazil	Chile	Colombia	Egypt	Hungary	India	Indonesia
Foreign exchange sales must be registered with the Central Bank (CB) or formal market			Foreign exchange operation must be conducted through formal exchange market or CB					
Prior approval is needed		1		1			1	
Ceiling for purchases of foreign exchange by residents for various transactions								
Controls or limits on resident's purchases of foreign securities abroad		Residents may invest only on stock markets in MERCOSUR countries. Outside that, they are only allowed to purchase DRs issued by companies headquarters						No controls applies as long as shares are not listed on the Indonesian Stock Exchange, otherwise they should comply with the capital market act.
Controls on capital	1			1	1		1	
Total	1	2	1	2	1	0	2	1

2002	Korea	Malaysia	Mexico	Pakistan	Philippines	Poland	Russia	South Africa	Turkey
Foreign exchange sales must be registered with the Central Bank (CB) or formal market									1
Prior approval is needed		1 for transactions amounts to RM 10,000 or more	1	1	1	Foreign exchange permit is needed	1	1	1
Ceiling for purchases of foreign exchange by residents for various transactions								Purchases by residents are allowed within the R750,000	
Controls or limits on resident's purchases of foreign securities abroad									
Controls on capital	1	1	1	1	1	Limit to investment in OECD	1	1	1
Total	1	2	2	2	2	2	2	3	3

2003	Argentina	Brazil	Chile	Colombia	Egypt	Hungary	India	Indonesia
Foreign exchange sales must be registered with the Central Bank (CB) or formal market	1		Capital transactions over $10,000 must be conducted through formal exchange market or CB					
Prior approval is needed	1			1			1	
Ceiling for purchases of foreign exchange by residents for various transactions	1							
Controls or limits on resident's purchases of foreign securities abroad	Purchases maybe limited as a result of restrictions on capital flows from Argentina to foreign jurisdictions	Residents may invest only on stock markets in MERCOSUR countries. Outside that, they are only allowed to purchase DRs issued by companies headquarters						No controls applies as long as shares are not listed on the Indonesian Stock Exchange, otherwise they should comply with the capital market act.
Controls on capital					1		1	
Total	4	1	1	1	1	0	2	1

2003	Korea	Malaysia	Mexico	Pakistan	Philippines	Poland	Russia	South Africa	Turkey
Foreign exchange sales must be registered with the Central Bank (CB) or formal market					1				1
Prior approval is needed		1	1	1	1	1 to Purchase securities with maturities less than 1 year	1 for securities exceeding $75,000	1	1
Ceiling for purchases of foreign exchange by residents for various transactions		Credit facilities in foreign currency is up to RM 5 million						Purchases by residents are allowed within the R750,000 foreign investment limit	
Controls or limits on resident's purchases of foreign securities abroad									
Controls on capital	1		1	1		Limit to investment in EU, EEA, and OECD (free of charge)	1	1	1
Total	1	2	2	2	2	2	2	3	3

2004	Argentina	Brazil	Chile	Colombia	Egypt	Hungary	India	Indonesia
Foreign exchange sales must be registered with the Central Bank (CB) or formal market			Capital transactions over $10,000 must be conducted through formal exchange market or CB					
Prior approval is needed	For amounts over US $ 500,000						1	
Ceiling for purchases of foreign exchange by residents for various transactions	1							
Controls or limits on resident's purchases of foreign securities abroad	Purchases maybe limited as a result of restrictions on capital flows from Argentina to foreign jurisdictions	Residents may invest only on stock markets in MERCOSUR countries. Outside that, they are only allowed to purchase DRs issued by companies headquarters						No controls applies as long as shares are not listed on the Indonesian Stock Exchange, otherwise they should comply with the capital market act.
Controls on capital				1	1		1	
Total	3	1	1	1	1	0	2	1

2004	Korea	Malaysia	Mexico	Pakistan	Philippines	Poland	Russia	South Africa	Turkey
Foreign exchange sales must be registered with the Central Bank (CB) or formal market					1				1
Prior approval is needed		1	1	1	1		1 for securities exceeding $150,000	1	1
Ceiling for purchases of foreign exchange by residents for various transactions		Credit facilities in foreign currency is up to RM 5 million						Purchases by residents are allowed within the R750,000 foreign investment limit	
Controls or limits on resident's purchases of foreign securities abroad									
Controls on capital	1		1	1		1	1	1	1
Total	1	2	2	2	2	1	2	3	3

2005	Argentina	Brazil	Chile	Colombia	Egypt	Hungary	India	Indonesia
Foreign exchange sales must be registered with the Central Bank (CB) or formal market	1		Capital transactions over $10,000 must be conducted through formal exchange market or CB					
Prior approval is needed	1			1				
Ceiling for purchases of foreign exchange by residents for various transactions	Was raised to $2 million from $500,000							
Controls or limits on resident's purchases of foreign securities abroad	Purchases maybe limited as a result of restrictions on capital flows from Argentina to foreign jurisdictions	Residents may invest only on stock markets in MERCOSUR countries. Outside that,they are only allowed to purchase BDRs issued by companies headquarters		Companies managing obligatory pension funds may not invest more than 20% of the value of their portfolio outside the country			Residents and companies may invest in companies listed abroad in recognized stock exchanges that have atleast a 10% holding in an Indian companies list	
Controls on capital					1		1	1
Total	4	1	1	2	1	0	2	1

2005	Korea	Malaysia	Mexico	Pakistan	Philippines	Poland	Russia	South Africa	Turkey
Foreign exchange sales must be registered with the Central Bank (CB) or formal market					1				1
Prior approval is needed			1	1	1	1	1	1	1
Ceiling for purchases of foreign exchange by residents for various transactions								Purchases by residents are allowed within the R750,000 foreign investment limit	
Controls or limits on resident's purchases of foreign securities abroad									
Controls on capital	1	1	1	1			1	1	1
Total	1	1	2	2	2	2	2	3	3

2006	Argentina	Brazil	Chile	Colombia	Egypt	Hungary	India	Indonesia
Foreign exchange sales must be registered with the Central Bank (CB) or formal market			Capital transactions over $10,000 must be conducted through formal exchange market or CB					
Prior approval is needed	1			1				
Ceiling for purchases of foreign exchange by residents for various transactions	Was raised to $2 million							
Controls or limits on resident's purchases of foreign securities abroad		Residents may invest only on stock markets in MERCOSUR countries. Outside that,they are only allowed to purchase BDRs issued by companies headquarters		Companies managing obligatory pension funds may not invest more than 20% of the value of their portfolio outside the country		Controls apply if purchase of securities issued by non-residents ……	Residents and companies may invest in companies listed abroad in recognized stock exchanges that have atleast a 10% holding in an Indian companies list	
Controls on capital					1	1	1	1
Total	2	1	1	2	1	2	2	1

2006	Korea	Malaysia	Mexico	Pakistan	Philippines	Poland	Russia	South Africa	Turkey
Foreign exchange sales must be registered with the Central Bank (CB) or formal market					1				
Prior approval is needed	1	1	1	1	1	1	1	1	1
Ceiling for purchases of foreign exchange by residents for various transactions		RM 10 MILLION					Need to open special bank accounts for capital transactions abroad	Purchases by residents are allowed within the R 2 MILLION	
Controls or limits on resident's purchases of foreign securities abroad	Controls on insurance companies investment abroad over 30% of its asset								
Controls on capital			1	1		1	1	1	1
Total	2	2	2	2	2	2	2	3	2

2007	Argentina	Brazil	Chile	Colombia	Egypt	Hungary	India	Indonesia
Foreign exchange sales must be registered with the Central Bank (CB) or formal market	1							
Prior approval is needed	1			1			1	
Ceiling for purchases of foreign exchange by residents for various transactions	$2 million							
Controls or limits on resident's purchases of foreign securities abroad	1			Companies managing obligatory pension funds may not invest more than 20% of the value of their portfolio outside the country			Residents and companies may invest in companies listed abroad in recognized stock exchanges that have atleast a 10% holding in an Indian companies list	No controls apply as long as the shares are not listed on the Indonesian stock exchange,..
Controls on capital					1	1		1
Total	4	0	1	2	1	1	2	1

2007	**Korea**	**Malaysia**	**Mexico**	**Pakistan**	**Philippines**	**Poland**	**Russia**	**South Africa**	**Turkey**
Foreign exchange sales must be registered with the Central Bank (CB) or formal market					1				1
Prior approval is needed	1		1	1	Purchases in excess of US $12 million requires approval	1	1	1	1
Ceiling for purchases of foreign exchange by residents for various transactions								Purchases by residents are allowed within the R 2 MILLION foreign investment limit	
Controls or limits on resident's purchases of foreign securities abroad	Controls on insurance companies investment abroad over 30% of its asset					Purchase from countries other than OECD,EU,& EEA			
Controls on capital		1	1	1		1	1	1	1
Total	2	1	2	2	2	2	2	3	3

Table 5.7: Panel Estimations (Dependent variable: Ratio of domestic equity holdings to total equity holdings)

	Fixed Effect	Fixed Effect with robust standard errors	RANDOM EFFECTS Pooled least squares	FIXED EFFECTS ESTIMATION RESULTS	FIXED EFFECTS with robust standard errors	FGLS	FGLS with white diagonal standard errors and covariance
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
CONT	-0.002	-0.002					
	(-0.26)	(-0.24)					
INV	0.008	0.008	0.038	0.045	0.045	0.018	0.018
	(0.49)	(0.45)	(2.12)**	(2.27)*	(1.30)	(2.19)**	(2.38)**
IFCI	0.013	0.013					
	(0.15)	(0.23)					
LIS	0.074	0.074					
	(1.08)	(1.58)					
INT	-0.002	-0.002	-0.001	-0.001	-0.001	-0.001	-0.001
	(-1.45)	(1.78)***	(-1.93)***	(-1.06)	(-0.94)	(-2.30)**	(-2.56)**
IMP	-0.001	-0.001	-0.0001	-0.005	-0.005	-0.002	-0.002
	(-0.41)	(0.57)	(-0.15)	(-2.02)*	(-1.73)*	(-1.43)	(-1.90)*
CAI	-0.006	-0.006					
	(-0.62)	(-0.67)					
CPI	-0.018	-0.018					
	(-0.73)	(-0.736)					
MIS	-0.001	-0.001	-0.002	-0.002	-0.002	-0.001	-0.001
	(-1.55)	(-1.345)	(-2.28)**	(-1.38)	(-1.11)	(-1.17)	(-1.30)
EXCH	0.055	0.055	0.392	0.325	0.325	0.249	0.249
	(0.33)	(0.417)	(2.49)**	(1.87)	(1.12)	(0.93)	(1.03)
DEP	-0.00002	-0.00002					
	(-0.23)	(-0.54)					
CAP	0.001	0.001	0.0002	0.001	0.001	0.001	0.001
	(1.77)*	(2.87)*	(1.35)	(3.08)*	(3.10)*	(3.87)*	(3.06)*
BETA	-0.012	-0.012					
	(-0.57)	(-0.64)					
PRE	0.778	0.778					
	(0.96)	(1.169)					
RISK	0.002	0.002					
	(0.72)	(0.81)					
OPT	0.005	0.005	0.028	0.0005	0.0005	-0.010	-0.010
	(0.13)	(0.11)	(0.64)	(0.01)	(0.01)	(-0.51)	(-0.53)
Adj. R-Squared (%)	72.4	72.4	7.81	57.2	57.2	73.9	73.9
F-ratio	9.22*	9.22*	2.26**	7.04*	7.04*	13.81*	13.81*

Figures between parentheses are t statistics

*significance at the 1% level

**significance at the 5% level

***significance at the 10% level

Chapter Six: Conclusion

6.1 Introduction

This chapter summarises the main findings; financial and policy recommendations from the thesis, limitations and further extensions of the thesis. The chapter is divided into two sections. Firstly, an overview of the main findings of the thesis, contributions and the financial and policy recommendations is presented. Secondly, limitations of the study and suggestions for further research are discussed.

6.2 Summary of Findings and contributions.

Firstly, an investigation of returns' characteristics in emerging markets is analysed and following the current literature, chapter two shows that returns' characteristics seem to differ from those documented for developed markets. The results show that emerging markets seem to offer high returns accompanied by high volatility. In addition, returns tend to be leptokurtic and exhibit volatility clustering. Moreover, emerging markets' returns show signs of predictability and modest unconditional correlation with the rest of the world.

The static and conditional CAPM is tested for 23 emerging markets over the period February 1997-December 2007. This period is considered a turbulent one that witnessed financial crises in most of the sampled markets (Mateus, 2004). Furthermore, most of the emerging markets undertook financial liberalisation reforms by mid 1995 (Harvey and

Bekaert, 1997). The thesis argues that estimation of static CAPM would lead to misleading results since it does not take into account the dynamic changes in asset returns. The thesis also assumes that the estimation of conditional CAPM is enhanced after the liberalisation of the emerging markets under study since any prior estimation could be rejected as a result of markets' segmentations.

In fact, the results reveal little support in favour of the static CAPM while the results of the conditional bivariate GARCH indicate that the betas are significantly time-varying in most of the markets. The results seem to match our earlier assumption on volatility clustering in emerging markets' returns and that the conditional CAPM provides a better representation of the dynamics on markets' premia in emerging markets.

The results of the bivariate GARCH estimation show that constant terms in the variance equation are generally statistically insignificant while the ARCH and GARCH coefficients are highly significant in most markets. The study also computes time-varying betas, conditional variances of emerging markets' excess returns and conditional covariances between excess markets' returns and the world market premium. The results show that conditional variances on markets' excess returns and their betas reached the peak during the Asian financial crisis in most of the markets under study with few exceptions. The majority of the markets also reveal higher betas at the end of the study period compared to the beginning of the period. This could imply increased integration of these markets into the world market.

As a result of increased integration of emerging markets, one would assume that investors would tend to diversify their portfolios to include more foreign assets.

Additionally, the estimation of the conditional CAPM shows that the variance-covariance matrices between emerging markets' returns and the world market are time-varying. Hence, the study expects that the optimal weights in efficient portfolios are re-balanced each period to adjust for the time-varying variance-covariance matrices.

Secondly, the thesis determines the optimal weights through the application of the mean-variance approach to asset allocation. The study uses a modified version of the trivariate GARCH model to identify the optimal weights in a portfolio of three assets; namely the return on the domestic, the US and the UK indexes. The analysis is conducted using monthly data over the period April 1994 to July 2008 in local currencies for emerging markets in order to consider investment from a local perspective. The results reveal that domestic equities dominate most of the markets in Latin America, the Czech Republic and Egypt in Emerging Europe and Africa, respectively. On the other hand, the UK equities constitute a large share of optimal portfolios in Chile, Peru, Morocco, Jordan and all the markets in East and South Asia. The results differ from those expected according to the international CAPM in which a high share of the US equities are expected to dominate in accordance with the high share of US capitalisation in the world capitalisation. The present thesis also computes Sharpe ratios for optimal portfolios and for the domestic equities to investigate the potential gains from international diversification for emerging markets. The estimations illustrate that there seems to be more gains from international diversification for South and East Asian markets as well as Emerging European markets.

The number of assets in the portfolio is increased in order to test whether the optimal weights on domestic equities would increase or decrease as a result of a wider range of assets in the investment portfolio. A Modified DCC model is employed in order to extend the number of assets in the portfolio. The analysis is done in local currencies as well as in US Dollars to investigate the influence of exchange rate risk on optimal weights. The construction of investment portfolios includes a relatively large number of assets and mainly reflects the inclusion of other emerging markets' equities, main developed markets' equities and other markets that seem significant according to the recent survey reports. Such investment portfolios have not been investigated in the current literature in studies regarding asset allocation.

Through the estimation of the DCC model denominated in local currency, the share of domestic equities declines substantially compared to the estimates of trivariate GARCH in most of the markets under study. However, a high share of Colombian equities, Egyptian equities, and Czech equities still dominate the markets in Latin America, Africa, and emerging Europe, respectively. The estimates are consistent with the results of conditional variances, expected returns, and conditional correlations in these countries, in which they offer relatively low conditional variances, modest cross-correlations and higher expected returns. Moreover, the share of risk-free rates as proxied by deposits or discount rates in emerging markets constitutes a considerable share in the optimal portfolios as well.

On the other hand, the estimation of the DCC model denominated in US Dollars shows that the shares of domestic equities and risk-free rate (represented by the US Treasury bill rate) further decline, giving rise to the effect of exchange rate volatility on investment decisions.

Conditional cross-correlations are estimated according to the DCC model over the period April 1994- December 2008. The estimates show high persistent levels in the conditional correlation for most of the markets, and an increasing trend in turbulent times. Moreover, the estimates of conditional cross-correlations show an increasing trend by the end of 2008 compared to those found during the Asian crisis, which indicates that the latest financial crisis had more effect on the cross-correlations of these emerging markets and the rest of the world compared to the Asian crisis during 1997/1998.

So far the results imply potential gains from international diversification, and that the share of domestic equities in the optimal portfolio shrinks with the inclusion of more equities in investment portfolios. The relatively small share of domestic equities in most of the markets resulting from the DCC estimation shows that optimal share for domestic equities seems to be inconsistent with actual equity holdings according to survey reports, and the benchmark weights proposed by international CAPM. Hence, the equity domestic bias in emerging markets seems quite obvious.

Thirdly, the thesis concentrates on the analysis of domestic equity bias (the phenomenon by which investors are tilt towards investing in domestic assets). Examination of the factors affecting domestic equity bias in emerging markets is tested through the incorporation of factors reflecting markets' efficiencies and inefficiencies. The analysis is done through panel estimation for the 17 emerging markets in our sample during the period 2001 to 2007. The thesis tests the feasible GLS method in order to control for cross-sectional heteroscedasticity. In addition to the use of explanatory variables derived from the current literature, the thesis accounts for capital outflows by constructing an index reflecting restrictions on capital outflows based on the publication of the IMF's AREAER. Moreover, the study employs a dummy variable to proxy control over investible transactions and current transfers. In addition to the usage of measures of risk aversion coefficients, time-varying betas and optimal weights estimated in chapters three and four rather than relying on postulated data. The explanatory variables can be categorised according to five main groups: controls on capital flows, information asymmetries, economic and political risks, financial development indicators and other estimates from previous chapters.

The results show that economic risk as proxied by the misery index, information asymmetries as represented by number of Internet users, and ratio of imports to GDP, real exchange rate volatility, control over invisible transaction and the size of stock market have a significant effect on domestic equity holdings in emerging markets.

The estimated results in chapters three, four and five have financial and policy implications. According to survey reports, investors in emerging markets tend to invest in other emerging and less developed markets, which are considered inconsistent with the international CAPM predications. However, the results of the mean-variance approach using the DCC model in local currencies found partial justification for these investments in most of the markets. On the other hand, estimations of time-varying betas, and time-varying cross-correlations for these emerging markets imply that the effect of financial crises in these markets is persistent, and volatility clustering and conditional cross-correlations show a significant increase in turbulent times in most of the markets under study, implying a request for a more prompt response from policy makers in emerging markets during times of financial crises. Furthermore, actual equity holdings seem to divert from the estimation of optimal shares of domestic equities in efficient portfolios, and are considered higher than similar estimates from developed markets. This indicates that domestic equity bias is more acute in emerging markets. Sercu and Vanpee (2007) also document that 'countries with the most volatile stock markets (emerging markets) are also the ones with their equity portfolios most heavily tilted towards domestic assets'. Chapter five shows that investors in emerging markets hold a large proportion of domestic equities in their portfolios due to markets' inefficiencies like governmental restrictions on exchange rate transfers, volatility in exchange rates, and information asymmetries. This implies that a substantial decline in exchange rate transfers' restrictions, and available information through the increase in the number of Internet users and imported goods could decrease equity domestic bias and provide potential gains from international diversification in most emerging markets.

6.3 Limitations of the study and Suggestions for further work

Due to data unavailability, China, Taiwan and Israel are excluded from estimation in the sample.

The study has also concentrated on domestic equity bias. However, the analysis could also be extended to examine foreign equity bias, since optimal weights were computed against each market in chapter four. A future study can then incorporate the reasons behind the overweight/underweight of developed and other markets in the portfolios of emerging markets.

The thesis has also used aggregate data for portfolio holdings without further disaggregation according to different types of investors. For example, the behaviour of governmental and other giant investors versus small investors might differ with regard to international investment.

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