Time-varying Correlations and Optimal Allocation in Emerging Market Equities for Australian Investors

Gupta, R.¹

Abstract

Australian investors can reduce their overall portfolio risk by diversifying into equities from other markets. Emerging markets are of interest because of the low correlations with Australian equity market returns. However, several studies have indicated that correlations between equity returns are increasing over time, and using unconditional estimates of correlations in a portfolio optimisation model can result in less than optimal portfolio weights.

We use an Asymmetric Dynamic Conditional Correlation GARCH model to estimate time-varying correlations and incorporate these correlation estimates into the portfolio optimisation model. The assets used for portfolio construction comprise seven emerging market indexes that are available for investment to foreign investors. The study finds that, despite increasing correlations, there are still potential benefits in international diversification into emerging markets for Australian investors.

Keywords: Australian investors, Emerging market equities, Time varying correlations, Asymmetric DCC GARCH models, International diversification.

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Introduction and brief literature review

The objective of international diversification is to improve the risk/return trade-off for investors. The benefits of international diversification per se are well documented in the academic literature. During the period 1959 and 1966, US investors could have achieved higher risk adjusted returns by investing part of their portfolio in foreign equity markets, Grubel (1968). Levy and Sarnat (1970) analyse international correlations for the 1951-1967 period, and show the diversification benefits from investing in foreign equity markets including developing markets. Grubel and Fadner (1971) show that between 1965 and 1967, correlations of industries within a country are higher as compared with the correlations of industries across countries. This study looks at the issue of international diversification into emerging markets from an Australian investor’s perspective.

Investors are aware of the fact that international stocks have different characteristics so that by diversifying across different countries or across different industries in different countries, the portfolio performance can be enhanced. Investing in international markets differs from domestic market investment in three important ways (Lessard 1976). Firstly, the covariances among assets within a domestic market are much higher than the co-variances among different markets. Second, barriers imposed by taxation, currency controls or investor tradition may further segment national markets sufficiently such that assets are priced in a domestic rather than an international milieu. Finally, exchange rates between different currencies deviate from each other, giving rise to currency exposure on international portfolios.
A key factor in the determination of the benefits from international diversification is country risk. Rajan and Friedman (1997) use a two-factor CAPM consisting of a world stock index and a country risk factor to show that an international portfolio contains a statistically significant country risk premium. They argue that that the traditional perceptions of country risk encompass the effects of political conditions and restrictions on foreign ownership of domestic stocks. Capital controls may in practice exclude developed nations and only limit global investments to less developed nations, thus adding to the segmentation of the less developed markets from the developed markets. This view is mitigated by defining country risk in a broader context to include all the above and discriminatory tax regulations, lack of information, transactions costs and liquidity differences among foreign and domestic stocks. Hence, the definition of country risk becomes more explicitly recognised in both developed and developing nations and becomes quantifiable. Ex-post results show that country risk is priced by the investors, but the size of the risk premium varies over time. Clark and Tunaru (2001) measure the impact of political risk on portfolio investment when the political risks are multivariate and correlated across countries and find that individual political risks are not uncorrelated with each other. The authors consider the case of multiple sources of risks that are correlated across countries and incorporate the cross-country correlations in the estimation of exposure to loss.

The statistical characteristics of returns for emerging and developed markets arise from the underlying nature of these economies. The capital flows of a country with the rest of the world are different. Different countries have different legal frameworks and
labour markets and are at different stages of development, and there may be potential gains from diversification across countries because of these differences.

A review of the theoretical and empirical research into international diversification indicates that despite increasing globalisation, benefits accrue to investors holding stocks listed in other countries. These benefits arise, in part, from differences between countries in the nature of their real economies. Moreover, the greatest differences in real economy structures arise when comparing the emerging markets with the developed markets. Thus, on theoretical grounds, emerging market investments should provide a means by which an investor can achieve higher risk-adjusted returns for a diversified portfolio. Gupta (2006)\(^2\) and Ibrahim (2006) find there are still potential benefits in diversifying into emerging markets for an investor from developed markets with a long-term investment horizon. However, higher volatility in the equity returns of emerging markets have been of concern for practitioners and academics, a better estimate of the inputs for portfolio estimation can help to alleviate those concerns, Gupta (2006).

Empirical research by Schmukler (2004) and Li, Sarkar and Wang (2003) indicates that there are still benefits to be realised in diversifying internationally, because world financial markets are still not fully integrated. These differences between emerging and developed economies are reflected in the financial markets in the key characteristics of return, risk and correlations. Correlations are of direct relevance for diversification advantages. These financial characteristics change over time as a result of the increase

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\(^2\) Gupta (2006) reviews the literature in the area of international diversification from the perspective of the Australian investor.
in globalisation of world economies. Increasing market integration has significantly reduced the diversification benefits from a portfolio drawn from developed markets but has not influenced the benefits from emerging markets investments to the same degree (Harvey 2000). While differences continue in the real and financial sectors of emerging markets compared to those of the developed markets, these diversification advantages are likely to continue.

Research in international diversification from the perspective of the Australian investor is limited. Allen and Macdonald (1995) studied the diversification benefits available to the Australian investor over the period 1970 to 1992 and find that for most pair-wise portfolios, there exist potential long-run portfolio diversification gains. Similar results are reported by Watson and Dickinson (1981), Mitchell, Wapnah and Izan (1988) and Izan, Jalleh and Ong (1991). International diversification benefits for Australian investors may differ from those compared to the other major equity markets because of the nature of Australia’s economic and financial markets.

This paper aims to address two issues: first this research will assess the diversification benefits from the standpoint of an Australian investor - which may be different from those for the investor from other major markets because of the nature of the Australian economy and/or size of the market. Second, this study addresses the issue of changes

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3 The Australian share market is small compared to the major overseas markets. Country size per se may matter in two ways (Bernstein and Weinstein 1998). First, economic activity in a small country may be geographically localised, so the nearby geographical activity, e.g. monsoons or other local “acts of God”, might have local market-wide effects that would not be as evident in a larger economy. Second, economic specialisation is predicted by standard international trade theory across geographical units of similar size, but not across countries. This is consistent with larger countries having less uniform factor endowments, and implies that the stocks of firms in large economies should respond less to emerging market factors.
in correlations and uses a computationally efficient method to estimate the correlations between the asset returns. Studies over the past two decades have found that correlations of asset returns change over time (Erb, Harvey and Viskanta 1994; Longin and Solnik 1995).

Market integration per se is not stationary and may change over time. Bekaert and Harvey (1995) used a conditional regime switching model in their study of the level of globalisation between equity markets of several countries and find that the level of globalisation changes with time. Adler and Qi (2002) find that market integration is affected by both global and domestic factors as well.

A frequently used method to estimate correlations that change over time is the moving average specification wherein correlations are estimated using a moving window-of-time. The weakness of this method is that it gives equal weight to all the observations, used in the moving average calculations within the window of time. The other method used to calculate time varying correlations is to adopt multivariate GARCH models. Early models of this group were based on the Constant Correlation model of Bollerslev (1990). The main weakness of these models was the assumption that correlations were constant. The second set of models in this category is based on Kroner and Ng (1998). These models, though theoretically sound, were deficient in computational ease, as these models require estimating too many coefficients at the same time. Engle (2002) introduced another variant of the multivariate GARCH model called “Dynamic Conditional Correlation Models”, which combined the theoretical appeal of time-varying correlations and the computational flexibility of the univariate models. In this
paper we use an extended version of this model that incorporates asymmetrical effects to estimate time varying correlations between pairs of assets.$^4$

With capital markets becoming more integrated, the scope for exploiting any “inefficiencies” may be diminishing rapidly as the financial analysts identify the excess returns and then arbitrage them away (Frase, Helliar and Power 1992). However, there may be theoretical justification for potential gains from international diversification as investors gain access to shares in industries which are not represented or are thinly represented in their domestic market. This expansion in the menu of shares available to the potential investor leads to an advantage by an expansion of the feasible set and a change in the shape of the mean variance efficient frontier even if the capital markets are fully integrated.

The main focus of this paper is to test if the efficient portfolios created with correlation estimates using the multivariate GARCH models will have superior ex-post performance over the Australia only portfolio. This paper contributes to the existing literature by using a multivariate GARCH model that allows the correlations to change over time and incorporates asymmetrical effects. Using unconditional correlations in an optimisation may lead to overestimation or underestimation of the benefits of diversification, as the unconditional correlations do not represent the true nature of correlations; consequently the Sharpe ratio calculated using unconditional correlations may not be an accurate assessment of the future. Conditional correlations calculated using the Asymmetric DCC GARCH model may sometimes yield a lower Sharpe ratio

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$^4$ We use Australian index and emerging market indexes as asset classes that are available for an Australian investor for investment.
as compared with the unconditional correlations, but that does not suggest that there are lower benefits in diversification using the Asymmetric DCC GARCH model. The Asymmetric DCC GARCH model gives a better estimate of correlations (Jithendranathan 2005; Gupta, Hobbes and Loudon 2007; and Cappiello, Engle and Sheppard 2006), thus a more accurate estimate of future expected benefits of investing in emerging markets.\(^5\) Another contribution of the paper is to test for an Australian investor if there are benefits for an Australian investor in diversifying his/her portfolio into emerging equity markets.

The DCC GARCH model has been recently used in similar studies, for example, Yang (2005) studies the correlations between Japan, Taiwan, Singapore, Hong Kong and South Korea and finds that return correlations changed considerably during the period of study. Jithendranathan (2005) studies the correlations between the US and Russian equity markets and finds changes in sovereign credit risk, world energy prices and exchange rate to be the reasons for the changes in correlations. Dunis and Shannon (2005) show that for an unconstrained portfolio of the US and emerging markets the portfolio weights are India (6%), Malaysia (52%), Taiwan (6%) and US (36%). For the period 1\(^{st}\) September 2003 to 5\(^{th}\) July 2004, they find that the Sharpe ratio improves from 1.03 to 1.12 by including emerging markets in the optimised portfolio\(^6\). Thus far

\(^5\) The Asymmetric DCC model presents correlations that are not influenced by extreme episodic events such as the Asian crisis of 1997-98. Financial crises have been shown to increase the volatility of the markets and the correlations between the market pairs tend to increase during financial crises (Gupta, 2006).

\(^6\) The authors also look at different restrictions on maximum investments in foreign assets based on the argument that investors are not willing to invest more than a certain proportion of their portfolio into foreign funds. They find an improvement in the Sharpe ratio with as little as 15% investments in foreign funds.
research has ignored looking at the international diversification benefits for an Australian investor.

**DCC Model**

In this study we estimate the time varying correlations using the Asymmetric Dynamic Conditional Correlation (DCC) model of Cappiello, Engle and Sheppard (2006). This model incorporates the introduction of the asymmetric term into the original DCC model of Engle (2002) as modified by Sheppard (2002) as a general model. The conditional correlation between two random variables $r_1$ and $r_2$ that have mean zero can be written as:

$$
\rho_{t,12} = \frac{E_{t-1}(r_{1,t}r_{2,t})}{\sqrt{E_{t-1}(r_{1,t}^2)E_{t-1}(r_{2,t}^2)}}
$$

Let $h_{i,t} = E_{t-1}(r_{i,t}^2)$ and $r_{it} = \sqrt{h_{i,t}} \varepsilon_{i,t}$ for $i = 1, 2$, where $\varepsilon_{i,t}$ is a standardised disturbance that has zero mean and a variance of one.

Substituting the above into equation (1) we get:

$$
\rho_{t,12} = \frac{E_{t-1}(\varepsilon_{1,t}\varepsilon_{2,t})}{\sqrt{E_{t-1}(\varepsilon_{1,t}^2)E_{t-1}(\varepsilon_{2,t}^2)}} = E_{t-1}(\varepsilon_{1,t}\varepsilon_{2,t})
$$

Using GARCH(1,1) specification, the covariance between the random variables can be written as:

$$
\gamma_{12,t} = \rho_{12} + \alpha(\varepsilon_{1,t-1}\varepsilon_{2,t-1} - \rho_{12}) + \beta(\gamma_{12,t-1} - \rho_{12})
$$
The unconditional expectation of the cross product is $\rho_{12}$, while for the variances $\rho_{12} = 1$

The correlation estimator is:

$$\rho_{12,t} = \frac{q_{12,t}}{\sqrt{q_{11,t}q_{22,t}}}$$

This model is mean reverting if $\alpha + \beta < 1$. The matrix version of this model is written as:

$$Q_t = S(1 - \alpha - \beta) + \alpha(\varepsilon_{t-1}\varepsilon'_{t-1}) + \beta Q_{t-1}$$

where $S$ is the unconditional correlation matrix of the disturbance terms and $Q_t = \left| q_{1,2,t} \right|$. The log likelihood for this estimator can be written as:

$$L = -\frac{1}{2} \sum_{t=1}^{T} (n \log(2\pi) + 2 \log |D_t| + \log |R_t| + \varepsilon'R_t^{-1}\varepsilon_t)$$

where $D_t = diag (\sqrt{h_{t,i}})$ and $R_t$ is the time varying correlation matrix.

As this model does not allow for asymmetries and asset specific news impact parameters, the modified model which Cappiello, Engle and Sheppard (2006) use for incorporating the asymmetrical effects and asset specific news impacts is:

$$Q_t = (\tilde{Q} - A'\tilde{Q}A - B'\tilde{Q}B - G'\tilde{N}G) + A'\varepsilon_{t-1}\varepsilon'_{t-1}A + B'Q_{t-1}B + G'\varepsilon_{t-1}\varepsilon'_{t-1}G$$
Where $A$, $B$ and $G$ are diagonal parameter matrices, $n_t = I[\varepsilon_t < 0] \circ \varepsilon_t$ (with $\circ$ indicating Hadamard product), $\overline{N} = E[n_t n_t']$. For $\overline{Q}$ and $\overline{N}$, expectations are infeasible and are replaced with sample analogues, $T^{-1} \sum_{t=1}^{T} \varepsilon_t \varepsilon_t'$ and $T^{-1} \sum_{t=1}^{T} n_t n_t'$, respectively. $Q_t^* = [q_{u,t}^*] = [\sqrt{q_{u,t}}]$ is a diagonal matrix with the square root of the $i^{th}$ diagonal element of $Q_t$ on its $i^{th}$ diagonal position. In this paper we only look for the asymmetrical effects and not the asset specific news impacts.

**Efficient Portfolios**

The efficient frontier is defined as the set of portfolios that exhibit the minimum amount of risk for a given level of return or the highest return for a given level of risk, and that lies above the global minimum variance portfolio. Elton, Gruber and Padberg (1976) show that one is able to use a simple decision criterion to reach an optimal solution to the portfolio problem by assuming a risk free asset exists, and that either the single index model adequately describes the variance-covariance structure, or a good estimate of pair wise correlations is a single figure. This simple criterion not only allows one to determine which stocks to include but also how much to invest in each.
The first approach utilises the single-index model to construct optimal portfolios. Where returns are determined as follows:

\[ R_i = \alpha_i + \beta_i R_m + \epsilon_i \]

where \( R_i \) is the return on security \( i \)
\( R_m \) is the return on the market index
\( \alpha_i \) is the return on security \( i \) that is independent of the market's performance
\( \beta_i \) is a constant that measures the expected change in \( R_i \) given a change in \( R_m \)
\( \epsilon_i \) is the random error term with mean of zero and variance of \( \sigma_{\epsilon_i}^2 \)

Assuming that short selling is possible, the task would be to find the unconstrained vector of relative weights for each security so that the Sharpe ratio is maximised. That is:

To find the relative weights, \( X_i \)'s on each security to maximise the Sharpe ratio, \( \theta = \frac{\bar{R}_p - R_f}{\sigma_p} \) (8)
where \( \bar{R}_p \) is the mean return on the portfolio
\( \sigma_p \) is the standard deviation of the return on the portfolio

given that

\[ \bar{R}_p - R_f = \sum_{i=1}^{N} X_i (\bar{R}_p - R_i) \] (9)

and

\[ \sigma_p^2 = E \left( \sum_{i=1}^{N} X_i R_i - \sum_{i=1}^{N} X_i \bar{R}_i \right)^2 \]
\[ \sigma_p^2 = \left[ \sum_{i=1}^{N} X_i^2 \beta_i^2 \sigma_m^2 + \sum_{i=1}^{N} \sum_{j=1}^{N} X_i X_j \beta_i \beta_j \sigma_m^2 + \sum X_j^2 \sigma_{\epsilon_j}^2 \right] \] (10)
These equations are substituted into the Sharpe ratio equation and in order to maximise the Sharpe ratio it is necessary to take the derivative of the Sharpe ratio with respect to each $X_i$ and set it equal to zero. The derivation yields the amount of the portfolio that should be invested $X_i^0$ in any security as:

$$X_i^0 = \frac{(\bar{R}_i - R_f) - C_0 \beta_i}{\sum_{i=1}^{N} \frac{(\bar{R}_i - R_f) - C_0 \beta_i}{\sigma_{\epsilon_i}^2}}$$

where $C_0 = \sigma_m^2 \left[ \frac{\bar{R}_j - R_f \beta_j}{\sigma_{\epsilon_j}^2} \right] \left[ 1 + \sigma_m^2 \sum_{j=1}^{N} \frac{\beta_j^2}{\sigma_{\epsilon_j}^2} \right]^{-1}$

Thus by applying the above equation one is able to determine the respective weightings for each security within the portfolio and to find the optimal portfolio's risk and return measures. That is, the risk and returns are obtained by substituting the respective weights found for each security into the returns and variance formula given in (9) and (10) respectively$^7$.

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$^7$ The model is for no restrictions on short sale. The standard optimisation problem can be written as:

$$\text{Min} \sigma_p^2 = \sum_{i=1}^{N} X_i^2 \sigma_i^2 + \sum_{i=1}^{N} \sum_{k=1}^{N} X_i X_k \sigma_i \sigma_k \rho_{i,k} \text{ subject to the constraint : } \sum_{i=1}^{N} X_i = 1; \text{ if short selling is not allowed the additional constraint will be of non-negative weights, expressed as } 0 \leq X_i \leq 1.$$ Similar minimum or maximum weight restrictions are imposed when introducing restrictions of minimum investments into Australian index and/or maximum restrictions into emerging market indexes.
Data

For this study we use monthly returns of the ‘All ordinaries’ and the monthly returns of the broad based indexes in the emerging market countries for the period February 1988 to December 2005. Since the emerging market indexes are either available in US dollars or their respective currencies, for consistency we use the US dollar denominated index values for all the indices. Returns are calculated in US dollar terms.

In order to calculate the volatility of the respective index, we use daily prices to calculate the daily returns and the daily average volatility of each market index returns. We calculate monthly volatility \( \text{Volatility}_m = \text{Daily volatility} \times \sqrt{n} \), where \( m \) represents period and \( n \) number of trading days in the period) of each market on the basis of the actual number of trading days in the month for the emerging market. We use DataStream for index values of the respective equity indexes. Markets included in the study are: Australia, Brazil, Chile, Greece, India, Korea, Malaysia, and the Philippines.

Data for emerging markets is limited and the series for different emerging market countries start from different dates. We have used the earliest date from which the data is available for most of the emerging market countries. The start date for the data is February 1988 and the end date is December 2005 (December 2005 is the latest date to which data was available). We have used eight markets in this study to

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8 We use the monthly data for the period 1988 to December 2005 for the GARCH estimates; for some countries, the data set starts from a later date. For the volatility estimates, the starting date is chosen as February 1988 and the ending date as December 2005 because of the availability of the daily data.
demonstrate that there are potential benefits in diversifying into emerging markets. We exclude smaller markets from this study as the transactions cost could be higher in smaller markets and the access for foreign investors difficult, which may erode the benefits of diversifying into these markets. Correlations among emerging markets and with Australia have increased over a period of time but there are still potential benefits in diversifying into these markets. This research uses the emerging markets universe as used by Bekaert and Harvey (2000)\textsuperscript{9}.

Table 1 lists market returns and their summary statistics for the seven emerging market indices and the Australian index. Australia has mean returns of 0.6%, minimum returns of -10.2%, and maximum returns of 10.5% with a variance of 0.001 during the period. Brazil has mean returns of 3.3%, minimum returns of -66.9%, and maximum returns of 95.4% with a variance of 0.039. Returns for other indexes that are included in the portfolio range between returns for the Australian index and the Brazilian index.

\textsuperscript{9} The distinction between emerging markets and the developed markets should be based on theoretical constructs, but in most empirical studies, the distinction is drawn from the World Bank definition of emerging markets and the data suppliers use a similar definition. We have randomly selected seven emerging equity markets from the available set of countries.
Table 1 Summary statistics of the returns data

<table>
<thead>
<tr>
<th>Market</th>
<th>Obs.</th>
<th>Mean</th>
<th>Skewness</th>
<th>Kurtosis</th>
<th>Jarque-Bera</th>
<th>Variance</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>215</td>
<td>0.006</td>
<td>-0.270</td>
<td>-0.056</td>
<td>2.648</td>
<td>0.001</td>
<td>-0.102</td>
<td>0.105</td>
</tr>
<tr>
<td>Brazil</td>
<td>215</td>
<td>0.033</td>
<td>0.832</td>
<td>3.598</td>
<td>140.8</td>
<td>0.039</td>
<td>-0.669</td>
<td>0.954</td>
</tr>
<tr>
<td>Chile</td>
<td>215</td>
<td>0.013</td>
<td>0.207</td>
<td>0.098</td>
<td>1.624</td>
<td>0.004</td>
<td>-0.178</td>
<td>0.230</td>
</tr>
<tr>
<td>Greece</td>
<td>207</td>
<td>0.014</td>
<td>1.441</td>
<td>4.612</td>
<td>255.1</td>
<td>0.011</td>
<td>-0.233</td>
<td>0.524</td>
</tr>
<tr>
<td>India</td>
<td>215</td>
<td>0.011</td>
<td>0.546</td>
<td>0.884</td>
<td>17.73</td>
<td>0.008</td>
<td>-2.218</td>
<td>0.374</td>
</tr>
<tr>
<td>Korea</td>
<td>215</td>
<td>0.011</td>
<td>1.184</td>
<td>3.968</td>
<td>191.3</td>
<td>0.011</td>
<td>-0.282</td>
<td>0.556</td>
</tr>
<tr>
<td>Malaysia</td>
<td>215</td>
<td>0.008</td>
<td>0.595</td>
<td>4.662</td>
<td>207.4</td>
<td>0.008</td>
<td>-0.298</td>
<td>0.492</td>
</tr>
<tr>
<td>Philippines</td>
<td>215</td>
<td>0.009</td>
<td>0.563</td>
<td>3.310</td>
<td>109.5</td>
<td>0.008</td>
<td>-0.274</td>
<td>0.454</td>
</tr>
</tbody>
</table>

Results

In this study correlation dynamics of the monthly returns of seven of the emerging market indexes and the Australian index are calculated using the Asymmetric Dynamic Conditional Correlation Model. The period of this study covers February 1988 to December 2005. We use these correlations to construct optimal portfolios for an Australian investor.

The results of correlations of different equity index returns are given in Table 2. Towards the lower end the correlations between Greece and Korea were 0.049 and between India and Philippines were 0.048; on the higher end correlations between Malaysia and Philippines were 0.361 and between Brazil and Chile were 0.350. Low correlations between Greece and Korea and India and the Philippines pairs can possibly be explained by geographical segmentation of these markets from world markets and
smaller capital markets in these countries that add to segmentation. Higher correlations of Malaysia-Philippines and Brazil-Chile could possibly be because of geographical proximity. Australian correlations with emerging markets are low, with average correlations of 0.19, suggesting that there are potential benefits in international diversification into the emerging markets. Average US correlations with emerging markets are 0.23, slightly higher than the Australian correlations\(^{10}\).

**Table 2: Correlations for the period February 1988 to December 2005**

<table>
<thead>
<tr>
<th></th>
<th>Australia</th>
<th>Brazil</th>
<th>Chile</th>
<th>Greece</th>
<th>India</th>
<th>Korea</th>
<th>Malaysia</th>
<th>Philippines</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brazil</td>
<td>0.308</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chile</td>
<td>0.066</td>
<td>0.350</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Greece</td>
<td>0.178</td>
<td>0.217</td>
<td>0.164</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>India</td>
<td>0.092</td>
<td>0.230</td>
<td>0.281</td>
<td>0.119</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Korea</td>
<td>0.257</td>
<td>0.110</td>
<td>0.163</td>
<td>0.049</td>
<td>0.071</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Malaysia</td>
<td>0.190</td>
<td>0.150</td>
<td>0.304</td>
<td>0.117</td>
<td>0.240</td>
<td>0.210</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Philippines</td>
<td>0.284</td>
<td>0.187</td>
<td>0.304</td>
<td>0.153</td>
<td>0.048</td>
<td>0.276</td>
<td>0.361</td>
<td>1</td>
</tr>
</tbody>
</table>

In the next step we use the Asymmetric Dynamic Conditional Correlation GARCH model (Cappiello, Engle and Sheppard, 2006) for estimating the correlations matrix for the indexes to use in our optimisation model. Table 3 shows the correlations between different markets at the end of December 2005\(^{11}\). The highest correlations are between the pairs: Australia-Brazil 0.481, followed by India-Australia 0.436, and the lowest for

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\(^{10}\) Average correlations for US and emerging markets are calculated from Li, Sarkar and Wang’s (2003) paper. These correlations are not directly comparable with Australian correlations, as the sample set used by this study is different in terms of country indices and time period.

\(^{11}\) We use the correlations at the end of the period for portfolio construction as the portfolio construction forward looking and Asymmetric DCC GARCH model estimates the current correlations based on the lagged conditional variances, i.e. current estimate of correlations (or the current conditional variances) is the best predictor for future correlations.
India-Philippines 0.149, followed by Greece-Korea 0.152. We will use these correlations for constructing our optimal portfolios.

We use a simple test for testing if these correlations are different from unconditional correlations presented in Table 3 below within parenthesis. We do this by testing against a null hypothesis that these correlations have equal strength\(^{12}\). The results for the test are mixed. Theoretical rationale for using the Asymmetric DCC GARCH model was discussed in the introduction section of the paper and based on theory and empirical results from other papers; use of the Asymmetric DCC GARCH is strongly recommended\(^{13}\).

**Table 3: Correlations calculated using Asymmetric DCC GARCH**

<table>
<thead>
<tr>
<th></th>
<th>Australia</th>
<th>Brazil</th>
<th>Chile</th>
<th>Greece</th>
<th>India</th>
<th>Korea</th>
<th>Malaysia</th>
<th>Philippines</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brazil</td>
<td>0.481 (0.034)</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chile</td>
<td>0.275 (0.026)</td>
<td>0.340 (0.907)</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Greece</td>
<td>0.196 (0.848)</td>
<td>0.245 (0.761)</td>
<td>0.226 (0.507)</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>India</td>
<td>0.43 (0.000)</td>
<td>0.345 (0.196)</td>
<td>0.317 (0.684)</td>
<td>0.187 (0.473)</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Korea</td>
<td>0.352 (0.28)</td>
<td>0.229 (0.207)</td>
<td>0.232 (0.46)</td>
<td>0.152 (0.284)</td>
<td>0.132 (0.526)</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Malaysia</td>
<td>0.222 (0.731)</td>
<td>0.207 (0.544)</td>
<td>0.346 (0.629)</td>
<td>0.157 (0.675)</td>
<td>0.252 (0.895)</td>
<td>0.269 (0.519)</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Philippines</td>
<td>0.315</td>
<td>0.221</td>
<td>0.350</td>
<td>0.086</td>
<td>0.048</td>
<td>0.260</td>
<td>.361(^{14})</td>
<td>1</td>
</tr>
</tbody>
</table>

\(^{12}\) Two correlation coefficients are transformed with the fisher Z-transform

\[
Z_f = \frac{1}{2} \times \ln\left( \frac{(1 + R)}{(1 - R)} \right)
\]

the difference \(z = (Z_{f1} - Z_{f2}) / \sqrt{(1/(N_1 - 3) + 1/(N_2 - 3))}\) is approximately standard normal distribution.

\(^{13}\) Cappiello, Engle and Sheppard (2006) use weekly data to estimate the correlations for the 21 equity markets and 13 bond markets using this model and strongly dismiss the argument of constant correlations.

\(^{14}\) As the Asymmetric DCC GARCH model for the country pairs the Philippines-Malaysia and India-Philippines do not converge, we use unconditional correlation coefficients for these pairs.
In terms of comparing the benefits of diversification we will compare the returns from the Australia only portfolio against the optimised portfolio. Table 4 shows the mean returns and the standard deviation of the Australia only portfolio (returns of the Australian Index). The Australia only portfolio has mean returns of 0.68% with a standard deviation of 8.16% and the Sharpe ratio of 0.199. We use 5.5% as the risk free rate for calculations of the Sharpe ratio. Chincarni and Kim (2006, p. 479) state, ‘For the risk-free rate, the exact value actually does not matter for comparison purposes, as long as some consistent rate is chosen. Many people use the average monthly return on 1-month or 3-month U.S. Treasury bills for $r_f$. However, to test if our results are sensitive to the risk free rate, we repeat the calculations of the Sharpe ratios using an average of risk free rate for the sample period. We also calculate the probability of achieving the mean returns in a simulation process with 12,800 iterations. In all cases the probability of achieving the mean returns is similar to that for the Australia only portfolio.

Table 4:  Australia only portfolio

<table>
<thead>
<tr>
<th>Australia only portfolio</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean annual returns</td>
<td>8.16%</td>
</tr>
</tbody>
</table>

Figures in parenthesis are ‘p’ values.

Null hypothesis is both correlations: unconditional correlations and conditional correlations have equal strength.

The results of optimisation using simple correlations are given below in Table 5, the mean annual returns for the portfolio are 19.19%, with a standard deviation of 21.61% and a Sharpe ratio of 0.63 for a portfolio with no restrictions. The Sharpe ratio of this portfolio is considerably better than for the Australia only portfolio. We also calculate another risk adjusted performance measure referred to as the M2 measure. Allocations into Australian market for an unrestricted portfolio are very small, i.e. 6.96% of the total portfolio and the Australian investors may be hesitant in investing major proportion of their portfolio into foreign markets. The unrestricted optimisation, in this instance may look attractive from a theoretical standpoint but many investors are reluctant to invest a larger proportion of their portfolio into one emerging market and expose themselves to a foreign market because of perceived unfamiliarity.

As such, we construct portfolios with different restrictions: one with maximum 10% in an individual emerging market, maximum 20% in an individual emerging market,

<table>
<thead>
<tr>
<th>Standard deviation</th>
<th>13.99%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sharpe ratio risk free return 5.5%</td>
<td>0.19</td>
</tr>
<tr>
<td>Sharpe ratio risk free return 7.3%</td>
<td>0.06</td>
</tr>
<tr>
<td>Probability of achieving mean returns</td>
<td>56.68%</td>
</tr>
</tbody>
</table>

\[ RAP(i) = \left( \frac{\sigma_M}{\sigma_i} \right)(r_i - r_f) + r_f \]

where \( \sigma_M \) and \( \sigma_i \) are the volatilities of the market and the stock, \( r_i \) and \( r_f \) are the returns of the portfolio and risk free returns respectively and RAP(i) is the risk adjusted performance measure of the portfolio, also sometimes referred to as the M2 measure.

---

17 5.5% risk free return is at the end of the sample period, i.e. December 2005, and 7.30% is the average of the short term rates for the sample period.
18 Probability is the probability of achieving at least the target return; we use probability of achieving the mean returns in a similar meaning through the rest of the paper.
19 The M2 measure is a common name for a measure proposed by Modigliani and Modigliani (1997). The M2 measure is equivalent to the return a portfolio would have achieved if it had had the same risk as the benchmark risk (in this case we use Australian index as a benchmark index). The risk adjusted performance (RAP) measure can be calculated as:

\[ RAP(i) = \left( \frac{\sigma_M}{\sigma_i} \right)(r_i - r_f) + r_f \]

where \( \sigma_M \) and \( \sigma_i \) are the volatilities of the market and the stock, \( r_i \) and \( r_f \) are the returns of the portfolio and risk free returns respectively and RAP(i) is the risk adjusted performance measure of the portfolio, also sometimes referred to as the M2 measure.
maximum 50%\textsuperscript{20} into emerging markets with 10% in each market and finally maximum 50% in emerging markets with a maximum limit of 20% in one single market. We also impose no short sale constraint in the optimisation, as many emerging markets have direct or indirect constraints on short sales. Results from optimisation show that with maximum 50% investment into emerging markets and a restriction of not more than 10% in a single emerging market the portfolio gives us an annualised return of 14.02%, standard deviation 15.54, the Sharpe ratio 0.55, and the M2 measure of 13.17. This is a substantial improvement from the Australia only portfolio that has a mean return of 8.16% with a standard deviation of 13.99 and a Sharpe ratio of 0.19. The probability of achieving the mean returns of the optimal portfolio equal to at least that of the Australia only portfolio is around 60%, which is very similar to that of the Australia only portfolio.

The main focus of the paper is a computationally efficient model for estimating the correlations; we repeat the optimisation process using correlations generated by the Asymmetric DCC GARCH model. In the next step we construct an unrestricted portfolio and portfolios with restrictions similar to the ones used in the preceding analysis. The results show that in the unrestricted optimisation the allocation in Australian market is very small, i.e. 6.47%, maximum allocation is in to Chile, i.e. 43.57%. Higher allocation into Chile can be explained intuitively on the basis of geographical segmentation of the Chilean market with Australia and empirically on

\textsuperscript{20} This is based on the common practice in portfolio management, called the ‘prudent man rule’, derived from the argument that a portfolio manager is risk averse and will not diversify away from his/her home market securities, despite the suggestions from the portfolio optimisation model for a higher investment into foreign equities. Dunis and Shannon (2005) use 15% restriction on emerging market investment and Stevenson (2000) uses a similar argument to constrain the equity investments into emerging markets to a maximum 10% in the analysis of a mixed international portfolio of equity and real estate.
lower correlations with Australian equity returns. The markets that are in close geographical proximity to Australia and are considered developed have allocations, e.g. Malaysia has an allocation of 2.51% (see Table 6).

The results on the proportion invested into different markets, annualised returns, and standard deviation of the portfolio with the Sharpe ratio and the M2 measure are given in Table 6. Annual mean returns for the unrestricted portfolio are 19.56%, with a standard deviation of 23.14 and the Sharpe ratio of 0.61 and the M2 14.00. This is much better than for the Australia only portfolio. The mean return for a restricted portfolio that has 50% restriction on foreign investments and 10% in a single emerging market is 14.04%, with a standard deviation of 17.29; the Sharpe ratio is 0.49 and the M2 measure is 12.41. The restricted portfolio does not perform as well as the unrestricted portfolio, but the improvement in mean annual returns and risk adjusted returns are substantially higher than those of the Australia only portfolio. In all cases the probability of achieving the expected mean returns is very similar to what it would be with the Australia only portfolio.

We repeat the portfolios constructed using Asymmetric DCC GARCH correlations by changing the risk free rate to an average (7.299%) for the period February 1988 to December 2005, (see Table 7). As the risk free rate increases, the investment into the Australian market further drops and overall portfolio returns also improve. The Sharpe ratio and the M2 measure also slightly improve with the changed risk free rate.

Results in Tables 5 to 7 show that the optimal portfolios with no restrictions on investing into emerging markets have very low allocation into Australian equities and
higher allocations into emerging markets. As investors are risk averse and because of their perceived familiarity with the Australian market they tend to restrict their investments into emerging markets to an arbitrary level. Results show that substantial improvement in portfolio returns could be achieved even if investors restricted their investments into emerging markets to the level of maximum 50% in total into emerging market equities and no more than 10% into any one emerging market.
Table 5: Australian portfolio with different restrictions on emerging markets investments using unconditional correlations.

<table>
<thead>
<tr>
<th>Country</th>
<th>Aus</th>
<th>Brz</th>
<th>Chi</th>
<th>Gre</th>
<th>Ind</th>
<th>Kor</th>
<th>Mal</th>
<th>Phi</th>
<th>Optimal Portfolio Return</th>
<th>Standard Deviation</th>
<th>Sharpe Ratio*</th>
<th>M2 Measure</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Investment weights (Unrestricted-simple correlations)</td>
<td>6.96</td>
<td>17.15</td>
<td>34.09</td>
<td>13.37</td>
<td>11.94</td>
<td>10.07</td>
<td>2.51</td>
<td>3.91</td>
<td>19.19</td>
<td>21.61</td>
<td>0.63</td>
<td>14.36</td>
<td>69.56</td>
</tr>
<tr>
<td>Investment weights (Max 10% in emerging market)</td>
<td>42.60</td>
<td>10.00</td>
<td>10.00</td>
<td>10.00</td>
<td>10.00</td>
<td>10.00</td>
<td>0.70</td>
<td>6.70</td>
<td>14.50</td>
<td>16.05</td>
<td>0.56</td>
<td>13.30</td>
<td>65.34</td>
</tr>
<tr>
<td>Investment weights (Max 20% in emerging market)</td>
<td>8.42</td>
<td>20.00</td>
<td>20.00</td>
<td>20.00</td>
<td>20.00</td>
<td>10.07</td>
<td>0.27</td>
<td>1.25</td>
<td>19.89</td>
<td>23.09</td>
<td>0.63</td>
<td>14.21</td>
<td>69.42</td>
</tr>
<tr>
<td>Investment weights min 50% Aus &amp; 10% emerging markets</td>
<td>52.66</td>
<td>10.00</td>
<td>10.00</td>
<td>8.36</td>
<td>10.00</td>
<td>0.10</td>
<td>0.10</td>
<td>2.08</td>
<td>14.02</td>
<td>15.54</td>
<td>0.55</td>
<td>13.17</td>
<td>64.73</td>
</tr>
<tr>
<td>Investment weights min 50% Aus &amp; 20% emerging markets</td>
<td>50.57</td>
<td>10.63</td>
<td>16.19</td>
<td>10.54</td>
<td>7.03</td>
<td>4.30</td>
<td>0.63</td>
<td>0.12</td>
<td>14.56</td>
<td>15.86</td>
<td>0.57</td>
<td>13.49</td>
<td>65.70</td>
</tr>
</tbody>
</table>

* Proxy for Risk free rate is overnight rates for December 2005, acquired from International Financial Statistics Online available through Central Queensland University database (5.50%).
Table 6:  Australian portfolio with different restrictions on emerging markets investments using
Asymmetric DCC GARCH correlations.

<table>
<thead>
<tr>
<th>Country</th>
<th>Aus</th>
<th>Brz</th>
<th>Chi</th>
<th>Gre</th>
<th>India</th>
<th>Korea</th>
<th>Mal</th>
<th>Phi</th>
<th>Optimal Portfolio Return</th>
<th>Standard Deviation</th>
<th>Sharpe Ratio*</th>
<th>M2 Measure</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Investment weights (Unrestricted-DCC correlations)</strong></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>6.47</td>
<td>17.54</td>
<td>43.57</td>
<td>10.15</td>
<td>10.84</td>
<td>3.59</td>
<td>0.17</td>
<td>7.68</td>
<td>19.56</td>
<td>23.14</td>
<td>0.61</td>
<td>14.00</td>
<td>50.76</td>
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<tr>
<td><strong>Investment weights (Max 10% in emerging market)</strong></td>
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<tr>
<td></td>
<td>38.32</td>
<td>10.00</td>
<td>10.00</td>
<td>10.00</td>
<td>10.00</td>
<td>1.68</td>
<td>10.00</td>
<td>14.64</td>
<td>18.01</td>
<td>18.01</td>
<td>0.51</td>
<td>12.59</td>
<td>59.28</td>
</tr>
<tr>
<td><strong>Investment weights (Max 20% in emerging market)</strong></td>
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<tr>
<td></td>
<td>8.44</td>
<td>20.00</td>
<td>20.00</td>
<td>20.00</td>
<td>11.94</td>
<td>8.84</td>
<td>2.41</td>
<td>8.36</td>
<td>19.56</td>
<td>24.11</td>
<td>0.58</td>
<td>13.65</td>
<td>59.28</td>
</tr>
<tr>
<td><strong>Investment weights min 50% Aus &amp; 10% emerging markets</strong></td>
<td></td>
<td></td>
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<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>51.87</td>
<td>10.00</td>
<td>10.00</td>
<td>10.00</td>
<td>9.55</td>
<td>1.85</td>
<td>0.25</td>
<td>6.49</td>
<td>14.04</td>
<td>17.29</td>
<td>0.49</td>
<td>12.41</td>
<td>59.27</td>
</tr>
<tr>
<td><strong>Investment weights min 50% Aus &amp; 20% emerging markets</strong></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>50.30</td>
<td>14.68</td>
<td>13.84</td>
<td>6.83</td>
<td>4.13</td>
<td>3.56</td>
<td>2.74</td>
<td>3.92</td>
<td>15.24</td>
<td>19.09</td>
<td>0.51</td>
<td>12.63</td>
<td>59.15</td>
</tr>
</tbody>
</table>

* Proxy for Risk free rate is average money market rates for December 2005, acquired from International Financial Statistics Online available through Central Queensland University database (5.50%).
Table 7: Australian portfolio with different restrictions on emerging markets investments using Asymmetric DCC GARCH correlations

<table>
<thead>
<tr>
<th>Country</th>
<th>Aus</th>
<th>Brz</th>
<th>Chi</th>
<th>Gre</th>
<th>India</th>
<th>Korea</th>
<th>Mal</th>
<th>Phi</th>
<th>Optimal Portfolio Return</th>
<th>Stad. Deviation</th>
<th>Sharpe Ratio*</th>
<th>M2 Measure</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Investment weights (Unrestricted-DCC correlations)</td>
<td>4.01</td>
<td>32.13</td>
<td>30.35</td>
<td>21.92</td>
<td>4.41</td>
<td>1.35</td>
<td>2.34</td>
<td>3.49</td>
<td>23.52</td>
<td>30.28</td>
<td>0.54</td>
<td>14.79</td>
<td>58.88</td>
</tr>
<tr>
<td>Investment weights (Max 10% in emerging market)</td>
<td>37.08</td>
<td>10.00</td>
<td>10.00</td>
<td>10.00</td>
<td>10.00</td>
<td>2.92</td>
<td>10.00</td>
<td>2.92</td>
<td>14.64</td>
<td>18.05</td>
<td>0.41</td>
<td>12.98</td>
<td>59.26</td>
</tr>
<tr>
<td>Investment weights (Max 20% in emerging market)</td>
<td>2.20</td>
<td>20.00</td>
<td>20.00</td>
<td>20.00</td>
<td>19.28</td>
<td>5.65</td>
<td>3.73</td>
<td>9.13</td>
<td>19.92</td>
<td>24.66</td>
<td>0.51</td>
<td>14.45</td>
<td>59.23</td>
</tr>
<tr>
<td>Investment weights min 50% Aus &amp; 10% emerging markets</td>
<td>50.71</td>
<td>10.00</td>
<td>10.00</td>
<td>10.00</td>
<td>10.00</td>
<td>6.12</td>
<td>0.32</td>
<td>2.85</td>
<td>14.16</td>
<td>17.49</td>
<td>0.39</td>
<td>12.78</td>
<td>59.27</td>
</tr>
<tr>
<td>Investment weights min 50% Aus &amp; 20% emerging markets</td>
<td>52.63</td>
<td>18.26</td>
<td>16.04</td>
<td>6.94</td>
<td>2.35</td>
<td>0.44</td>
<td>1.55</td>
<td>1.78</td>
<td>16.32</td>
<td>20.68</td>
<td>0.44</td>
<td>13.40</td>
<td>59.98</td>
</tr>
</tbody>
</table>

* Proxy for Risk free rate is average money rates for the period February 1988 to December 2005, acquired from International Financial Statistics Online available through Central Queensland University database (7.30%).
We also construct minimum variance portfolios to test if the results are driven by a particular choice of portfolio. We construct portfolios with no restriction on investment in emerging markets and another portfolio with a 10% maximum investment into any one emerging market and no less than 50% in the Australian market. Risk free rate of return\(^{21}\) used for the portfolio below is 5.5%. These results (Table 8) show that minimum variance portfolio for the Australian investor including emerging equity markets is superior to the Australia only portfolio as given in Table 4. The allocation into emerging equity markets for the minimum variance portfolio is small, as most emerging markets have a higher volatility as compared to the Australian equity market and the optimal solution in this case seeks for the portfolio that has minimum variance.

**Table 8: Minimum variance portfolio**

<table>
<thead>
<tr>
<th>Minimum variance portfolio</th>
<th>Expected return</th>
<th>Standard deviation</th>
<th>Sharpe ratio*</th>
<th>M2 measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>With no restriction on emerging market investments</td>
<td>9.84%</td>
<td>13.09%</td>
<td>.3315</td>
<td>10.14</td>
</tr>
<tr>
<td>With maximum investment in emerging market restricted to 10% and no more than 50% in total.</td>
<td>9.60%</td>
<td>13.16%</td>
<td>.3114</td>
<td>9.86</td>
</tr>
</tbody>
</table>

*Proxy for risk free rate is overnight rates for 31 December 2005, acquired from International Financial Statistics Online available through Central Queensland University database (5.5%).

\(^{21}\) We also construct portfolios with 20% constraint and with a risk free rate of return of 7.30%. For space reasons the results presented are for an unrestricted portfolio and a portfolio with maximum 10% into any one emerging market and minimum 50% into the Australian market.
We test the diversification benefits by having an Australian investor invest into emerging markets with different levels of restrictions on investment into emerging markets: firstly with no restriction into emerging market allocations; secondly, with maximum 10% into any one emerging market and no more than 50% into emerging markets; and thirdly, with maximum 20% into any one emerging market and no more than 50% into emerging markets. We find benefits to be significant in all cases. Results indicate that the expected returns of the optimised portfolio with maximum 50% into emerging markets and no more than 10% in one single emerging market are substantial. The mean annual return increases to 14.16%, with a standard deviation of 17.49 and a Sharpe ratio of 0.39, as against 8.16%, 13.99%, and 0.19 respectively for an Australia only portfolio. The M2 measure, which is a measure of the expected return of the portfolio, assuming the same level of risk for the optimal portfolio, is 15.88.

**Conclusion**

In this paper, we estimate the benefits that accrue to the Australian investor by investing into emerging markets. Over the years portfolio managers and academics have found that the benefits of international diversification have been significant, but as the world markets move towards integration from the stage of segmented markets, the benefits that an investor can derive from international diversification are gradually declining. Nonetheless, there are still realised gains to be made by Australian investors diversifying into emerging markets. We find that an Australian investor can improve expected returns of his/her portfolio from 8.16% to 14.16% without significant increase in risk. On a per unit measure of risk as measured by the Sharpe ratio, there is a significant improvement in expected returns for an
Australian investor by diversifying into emerging markets. The benefits of investing into these markets are apparent despite restricting the foreign investments to a maximum of 50% and investment into a single emerging market to the maximum of 10%. The M2 measure suggests that despite the restrictions the optimised portfolio will have an expected mean return of 15.88.

We find that correlations within emerging market pairs and correlations of the emerging markets with Australia are low and that despite increasing globalisation, there are still unrealised gains to be made by Australian investors in diversifying into emerging markets. Relatively high returns and low correlations offer better diversification benefits, while high volatility in the equity returns of these markets require better econometric models to capture the time-varying nature of the correlations. Based on the results, this study recommends use of emerging markets to improve the risk-return relationship for an Australian portfolio manager.

Some emerging markets have restrictions on short sales and these restrictions limit the benefits of portfolio optimisation. Despite the restrictions on short sales, the results show significant benefits in diversifying into emerging markets.

The results for benefits by diversifying into emerging markets are similar, both when using a simple correlations measure and when using the more complex ‘Asymmetric DCC GARCH model’. Theoretically, Asymmetric DCC GARCH estimates should provide us with a better estimate of correlations and the results indicate that correlations do change over time. On theoretical grounds this study recommends using the Asymmetric DCC GARCH model for estimates of correlations. The academic literature also indicates that the Asymmetric DCC
GARCH model provides an accurate estimate of the changing correlations (Cappiello, Engle and Sheppard 2006; Jithendranathan 2005). As such use of unconditional correlations in an optimisation process can lead to selection of incorrect portfolios that will not represent the true nature of benefits of diversification.

The findings of this study, i.e. that correlation of Australian equity returns with foreign equity markets, specifically with emerging market equity returns, have been changing and increasing in general, have important implications for Australian fund managers seeking to diversify their portfolios internationally to achieve an optimal risk-return ratio for their investors. This study makes two major contributions to the existing literature in the area of benefits of international diversification, specifically into emerging markets for Australian investors. Firstly, the study finds that Australian investors can still continue to benefit by investing into emerging markets, as correlations of Australian equity returns with emerging markets are still lower and Australian investors can improve their risk adjusted returns by investing into emerging equity markets. The second contribution of the study is in proposing a computationally efficient method of estimating changing correlations that will reflect the true potential benefits of international diversification. In order to test the robustness of our findings we test different sets of portfolios, use different risk free rates and also different restrictions on emerging market investments including, no short-sale constraint in the emerging markets.
References:


