Looking at New Markets for International Diversification: A Frontier Markets Perspective for Australian and US Investors

Aswini Sukumaran

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School of Business and Informatics

Central Queensland University Rockhampton

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Certificate of Authorship and Originality of Thesis

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Abstract

Investors and academics around the world are intrigued by new possibilities to reduce risk and increase the returns of portfolios. The portfolio theory suggests that diversifying to include assets from different industries and various markets will reduce a substantial part of the total risk of the portfolio and hence bring gains to the investor. Ever since the portfolio theory was developed in 1952 by Markowitz, there have been various improvements of it, and the central argument that the inclusion of diverse assets in a portfolio is beneficial to the investor has stayed afloat. However, whether or not the assets are diverse enough to bring about significant gains has become the primary area of examination.

In the early years of diversification studies, international diversification across developed markets was found to be profitable. As the advanced capital markets increasingly became integrated with each other, these gains diminished. Investors, in their search for better avenues for diversification, identified emerging markets as a new asset during the 1990s, and they achieved unprecedented benefits from diversifying into them. Globalisation and the financial integration of markets since then have resulted in a decline in benefits from emerging market diversification in the recent years. This investment scenario has set the premise for venturing into the less researched area of frontier market diversification.

The primary objective of this thesis is to examine whether there are significant benefits for a developed market investor from frontier market diversification. Frontier markets are the smaller and less developed markets among the developing economies that are not large enough to be included in the emerging

markets category. There are around 60 frontier markets around the world and these have been recently opened to international investors and are theoretically highly segmented from the developed capital markets. This study analyses whether the potential benefits from frontier market diversification differ for a small developed market (Australia) compared to that of a large developed market (the U.S.A).

The importance of looking into the Australian perspective of frontier market diversification stems from the facts that the Australian market is distinct enough to hedge major effects during a crisis such as the GFC; and also because of the investment environment in Australia that is witnessing a tremendous growth in managed funds. There is no previous research that has compared the diversification benefits from frontier markets for Australian and US investors. This thesis will bridge these significant gaps in the existing literature.

The findings of this study provide a significant contribution to the literature. The study finds that frontier market diversification is beneficial to both groups of developed market investors that are analysed. But the benefits for the US investor are much larger than that for the Australian counterpart. One of the major contributions of this thesis is the out-of-sample analysis; the results from the holding out period test also emphasise on the vast disparity in diversification benefits accruing to the two investors in consideration. The findings of this study are robust; a statistically advanced and computationally efficient model, AG-DCC GARCH, has been employed to estimate the time varying correlations between the markets. The ex-post analysis enhances the significance of the results

presented. The results from this thesis will provide the investors the confidence to consider frontier markets as potential additions to their portfolio, and will also generate further research interest in the area.

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Chapter 1
Introduction

In the complex spectrum of the finance world, the process of making appropriate investment decisions is an important issue faced by researchers and practitioners alike. Business managers or investors address the problem of deciding the amount to be invested in various assets and the composition of that investment, and researchers in this area are concerned about whether there exists a particular composition of investment that provides better returns than others, and what factors influence these variations. Research has established that combining various assets into a portfolio in such a manner that the total risk of the portfolio can be minimised while the return from the portfolio can be maximised is more beneficial than holding an undiversified portfolio. Diversification of a portfolio is thus a process of continuously rebalancing the assets included in the portfolio in order to maximise returns and minimise risk. Markowitz (1952) showed that combining assets with different characteristics and low correlations would result in a diversified portfolio with reduced risk, and his theory has formed the basis of Modern Portfolio theory; improvements of this version have resulted in the Capital Asset Pricing Model (CAPM), Arbitrage Pricing Theory (APT) and the Blackman-Litterman Model.

Ever since the concept of diversification was theoretically developed and put into practice, there have been various discussions on whether there exists a foolproof formula for achieving significant benefits from diversification, as domestic diversification, sectoral or industry diversification, or international diversification. The primary objective of this thesis is to explore whether there exists any potential gains for an Australian investor in comparison to gains for a US investor from diversifying into frontier equity markets. This thesis will contribute to

existing knowledge by providing an in-depth analysis including an out-of-sample analysis of potential benefits from frontier market diversification for investors from a small developed market (Australia) in comparison with a large developed market (USA). This results of this analysis is expected to provide accurate and reliable information for investors that could be used to develop future diversification strategies. The importance of examining this issue is discussed in the following sections.

Diversification of a portfolio can be achieved in many ways, such as domestic diversification and international diversification; domestic diversification involves investing in different industries or sectors within a domestic market or in multinational companies (MNCs), and international diversification involves investing into different international markets. Diversification across industries or across sectors within a domestic market may not provide high gains from diversification because those assets are exposed to a similar economic, financial and political environment and hence will be strongly correlated with each other. However, investing into multinational companies operating in the domestic market is considered to provide similar benefits to international diversification. The rationale behind treating investments in multinational corporations as international diversification was discussed by Wright and McCarthy (2002) that the returns of MNCs are influenced by factors that govern foreign companies rather than those affecting domestic companies, and hence they tend to be less correlated with domestic companies. However, research has documented that the extent of benefits from diversifying using MNCs relies on the extent and nature of international participation from such corporations, and the empirical evidence on

diversification benefits from MNCs is not unanimous (Hughes, Lounge and Sweeny 1975; Senchak and Beedles 1980; Wright and McCarthy 2002).

The general consensus is that since the assets in domestically diversified portfolios are affected by the same economic policies, financial market conditions and political scenarios, these assets tend to have higher correlations than that of assets in an internationally diversified portfolio, and hence might produce lower gains from diversification. Hence, diversifying into various markets is likely to produce higher diversification gains, as those markets are subject to diverse conditions and might be less correlated with each other.

The theoretical rationale for international portfolio diversification is based on Markowitz's (1952) proposition that addition of assets from markets that are less correlated with the domestic market of the investor could result in potential benefits from diversification. Since the assets in different markets are subject to diverse market conditions as well as differences in economic and financial structure and government policies, these assets would react differently to any specific event. Hence, combining such assets into a portfolio will, theoretically, bring about a decline in the total risk of the portfolio. Markowitz (1952) noted that with the addition of new assets to a portfolio, the total non-systematic or company-specific risk can be reduced. But the extent to which this reduction in risk is possible depends greatly on the level of correlation between assets included in the portfolio. The area of international portfolio diversification and its benefits has been researched in detail, and a comprehensive analysis of these studies is presented in chapter 4, Literature Review. The earliest method of international

diversification was geographical diversification, as proposed by Lowenfeld (1909). Since the 1960s, there have been several studies on international diversification, and the majority of these are focussed on diversifying into developed capital markets (Agmon 1972; Grubel 1968; Solnik 1974). In the dynamic financial system that exists currently, diversifying into the developed capital markets no longer provides significant benefits, as these markets are nearly completely integrated with each other, and hence it is necessary to search for other possibilities such as less developed markets.

Among the factors that have been considered to influence the benefits from international diversification, the level of market integration is highly significant, as it impacts the extent of diversification gains that can be achieved (Daly 2003; Fraser, Helliar and Power 1992; Yang, Tapon and Sun 2006). Fraser et. al. (1992) note that as the level of market integration increases, it becomes more and more difficult to find alternative ways to exploit any 'inefficiencies' across markets. Based on the rationale put forth by Markowitz (1952), over the years there has been an enormous increase in investor and academic interest in diversifying into less developed markets, mainly the emerging markets. The increase in globalisation and integration of capital markets around the world has led to a rise in the level of integration between emerging markets and the developed capital markets. Several of the recent studies on emerging market diversification confirm this scenario (Cashin, Kumar and Mcdermott 1995; Gupta and Donleavy 2009; Serrano and Rivero 2003; Turgultu and Ucer 2010). These studies have noted a significant rise in the level of integration between emerging markets and developed markets, resulting in higher correlations and lower benefits from

diversification. In this scenario, investors and researchers are on a quest to find better avenues for accruing diversification benefits, and thus the stage is set for the emergence of frontier markets.

Frontier markets represent one new asset class that potentially may have lower correlations with other markets and among themselves, owing to the different economic and financial structures and different stages of development. Frontier markets are defined as the pre-emerging markets which have a lower market capitalisation and liquidity than the emerging markets. They are the smaller and illiquid markets that are not large enough to be classified as emerging. A detailed examination of the nature and characteristics of frontier markets is presented in Chapter 3. Frontier markets have always enjoyed very low correlations amongst themselves and with emerging and developed markets. This, along with the structural features of frontier markets, make these a hot destination for investors seeking diversification benefits. The recent launch of a number of frontier market indices by Standard & Poors (S&P), Morgan Stanley Capital International (MSCI), Financial Times Stock Exchange (FTSE) and Russell Index underlines the significance of frontier market diversification. However, since frontier markets are a recent addition to the asset class, this field has not been sufficiently researched, and there is a significant level of vagueness and doubt associated with the potential benefits from including frontier markets in a diversified portfolio. This thesis intends to bridge the gap in existing literature by providing a comprehensive analysis of potential diversification benefits from frontier markets to investors from two advanced markets.

Research on international diversification of portfolios has mostly focussed on a US investor perspective. Studies from an Australian perspective have been limited and mostly emphasised diversifying into other developed markets and emerging markets (Gupta and Donleavy 2009; Izan, Jalleh and Ong 1991; Mitchell, Wapnah and Izan 1988; Watson and Dickinson 1981). Studies from an Australian perspective are significant for various reasons. The characteristic features of the Australian economy during, before and after the Global Financial Crisis have resulted in an increase in academics' and practitioners' interest in the region. McDonald and Morling (2011) note that even though the Australian economy slowed down during the crisis, it did not plunge down into a depression. Since the basic nature and characteristics of the Australian economy are different from the USA, results from studies based on a US perspective might not hold true for an Australian investor. Another important reason to look into the Australian perspective on portfolio diversification is the enormous growth in the managed funds industry in the recent years. The total assets of the managed funds industry as on June 2011 exceeded A$1.8 trillion and the Reserve Bank of Australia estimates that this will grow to A$2.5 trillion by the end of 2015. The vastness of these funds compares with the total market capitalisation of the Australian equity market in 2011 at just A$1.3 trillion (Australian Bureau of Statistics). This tremendous increase in the managed funds sector provides motivation to seek alternative diversification strategies for the Australian investor. Since frontier markets are the latest addition to the asset class, it is relevant to examine whether frontier market diversification could provide potential benefits to the Australian investor. This thesis will examine the potential benefits for an Australian investor

in comparison to that of an investor from the USA and will attempt to explore any potential differences.

1.1 Background

Three major factors that make international diversification attractive for investors were listed by Lessard (1976). First, the covariances among securities within national markets are higher than those among securities in different markets. Secondly, domestic barriers like taxation and currency control may significantly influence the domestic asset prices alone. Thirdly, fluctuations in exchange rate between different currencies increase the possibility of exchange risk in international investment. Previous research has showed that investors benefit by diversifying their portfolios internationally, even with increased globalisation (Bekeart and Harvey 2003; Driessen and Laeven 2007; Yang, Tapon and Sun 2006). Theoretically, as the correlations between international equity markets increase, the benefits from international market diversification will decline (Markowitz, 1952). Frontier markets are of interest here, as the major developed equity markets are considered to be highly correlated, and there may not be significant benefits from diversifying among developed markets, while the benefits of investing into emerging markets have also started to diminish. The lack of wide range of empirical results from frontier market diversification studies add to the vagueness associated with these markets. Providing reliable empirical observations regarding the potential benefits from frontier market diversification is the driving rationale for the first research question that this thesis aims to address.

There has not been much research conducted into international portfolio diversification from the Australian perspective, and particularly regarding frontier markets. The differences in structural characteristics of Australian and US markets, combined with the unprecedented growth in the Australian managed funds industry, demand research into this area. Since the Australian equity market is less than one-tenth of the US market, size effect will influence results from these two perspectives significantly. Different factors affecting the market and investor sentiments in the Australian and US scenarios are different and hence the potential benefits from diversifying into frontier markets would be distinct for a smaller market (Australia) investor compared to a larger market (US) investor. Research on diversification into frontier markets from the perspective of markets other than the US is also scarce and not current. These factors have shaped the second research question that this study intends to answer. Watson and Dickinson's (1981) study was the earliest work on international diversification from an Australian perspective, and was followed by Mitchell, Wapnah and Izan (1988). The results of these studies showed that Australian investors could benefit from international diversification. Most of the early studies used ex-post analysis, assuming that the required parameter inputs to form the international portfolio are known with certainty, and hence ignored the problem of estimation of risk in the current or subsequent periods. Izan, Jalleh and Ong (1991) studied the benefits to an Australian investor from international diversification while controlling for estimation risk, and also analysed the implications of hedging; they found that an Australian investor at that time could benefit from international portfolio diversification, and confirmed that strategies using estimation risk are dominant

over those which do not use them. Allen and Macdonald (1995) analysed the diversification benefits for an Australian investor and concluded that there are potential long-run portfolio diversification gains to the Australian investor for most of the pairwise portfolios.

These early studies on international diversification have been based on diversifying into developed capital markets, and since these markets are more integrated with high correlations with each other today, investors will benefit more from diversifying into the less integrated markets of the developing world; of these, emerging markets are the first set of markets that were explored by international investors. Emerging markets are defined by Standard and Poor's (S&P) as those equity markets in economies that are considered as low or middle income by the World Bank. The World Bank, from 2009 data, classifies economies that have a GNI per capita of below $12,196 as low or middle income1. S&P's criterion for classifying a market as emerging is that the market should fall under World Bank's classification of low or middle income and that the market capitalisation is relatively low. Also, if any market exceeds the cut-off level of income stated by the World Bank for three consecutive years, it will no longer be treated as emerging market. An increase in investor and academic interest in emerging markets was witnessed during the 1990s. Wilcox (1992), Divecha, Drach and Stefek (1992), Speidell and Sappenfield (1992), Conover, Jensen and Johnson (2002), Gupta and Donleavy (2009), are some of the studies

[1] The World Bank revises this classification of economies each year based on the GNI per capita for the previous year. As of 1 July 2015, low income economies are defined as those with a GNI per capita, calculated using the World Bank Atlas method, of $1,045 or less in 2014; middle income economies fall between $1,045 and $12,736 and high income economies are those with GNI per capita of $12,736 or more.

that provide evidence on the significant benefits from emerging market diversification. Studies of the Australian perspective of diversification into developing markets have been limited. Gupta and Donleavy (2009) studied the benefits to an Australian investor from diversifying into emerging equity markets, and found that the correlations between emerging markets and correlations of emerging markets with Australia are low, and hence an Australian investor can still accrue gains from investing in emerging markets. However, due to increasing integration, the benefits are declining (Chittedi, 2014). Since the correlations of emerging markets with other markets have started to increase, the benefits from investing in them will eventually disappear, and therefore, research into the benefits of diversifying into frontier markets is significant, as these could set the stage for the next destination for diversification benefits.

Frontier markets are a subset of emerging markets, also known as pre-emerging markets, since their market capitalisation is small, accompanied with low annual turnover and the presence of market restrictions and lower infrastructure facilities which prevent them being included under the classification of the larger emerging markets. The term 'frontier markets' refers to the smaller and less accessible equity markets of the developing world which are investible (Berger, Pukthuanthong and Yang 2011). The term was coined in the IFC's Emerging Markets Database in 1992 and denoted the smaller markets among the developing markets group. Speidell and Krohne (2007) differentiate frontier markets from the emerging markets based on factors such as low market turnover, lower number of companies listed in their stock markets, and low levels of foreign investments. The frontier markets have very low correlations with the developed markets and

other emerging markets and are hence considered as segmented from the world capital market. In terms of modern portfolio theory, the benefits of diversification into international markets accrue because of lower correlations among assets (asset classes in this case, each additional market is included as an asset class) included in the portfolio. The frontier markets have historically enjoyed very low correlations with developed capital markets, thus providing potential diversification benefits from investing in them (Schultz, 2010). These markets have very high growth potentials and as a result offer higher potential returns for investors. Frontier markets may represent the final frontier for global capital, as today's emerging markets are integrating with the developed world (Speidell and Krohne, 2007).

About 60 frontier markets exist across the globe, and are located in Africa, Asia, Europe and South America (Speidell, 2011). The increasing investor interest in frontier markets is evident from the establishment of a number of frontier market indices over the past few years. In 2010, S&P published Frontier BMI (Broad Market Index) that measured the performance of 37 relatively small and illiquid markets, which were selected on the basis of criteria such as market turnover, number of listings and minimum amount of foreign investor interest. In 2007, MSCI introduced the MSCI Frontier Markets Index including 29 markets, following which, FTSE and Russell Investments also launched FTSE Frontier 50 index and Russell Frontier Market Index with 25 and 35 markets respectively. As of 2010, there are 47 markets included in these four indices that are considered as frontier markets. However, due to the vagueness in definition and classification of markets, there is significant overlap in the markets included in these four indices;

only 17 markets are present in all four of the indices, 20 are included in either two or three of the indices, while 10 markets are included in only one of the indices. A detailed discussion on the nature of frontier markets and reasons for the overlap are included in Chapter 3. This study considers as frontier markets the 37 countries included in the S&P Frontier BMI in 2011, which are: Argentina, Bahrain, Bangladesh, Botswana, Bulgaria, Colombia, Croatia, Cote d'Ivoire, Cyprus, Ecuador, Estonia, Ghana, Jamaica, Jordan, Kazakhstan, Kenya, Kuwait, Latvia, Lebanon, Lithuania, Mauritius, Namibia, Nigeria, Oman, Pakistan, Panama, Qatar, Romania, Slovakia, Slovenia, Sri Lanka, Trinidad and Tobago, Tunisia, U.A.E, Ukraine, Vietnam and Zambia. This study will use data from 10 frontier markets based on availability and consistency of data.

Research on frontier market diversification is limited. Speidell and Krohne (2007) examined the structural characteristics of the frontier equity markets and analysed their returns and correlations with other markets, and concluded that investing in these markets may be highly rewarding. Segot and Lucey (2007) studied the benefits of diversifying into seven countries in the Middle East and North Africa, most of which are considered as frontier markets, and concluded that there are substantial diversification benefits to be attained from these markets. They emphasise that these underestimated and under-investigated markets could attract more portfolio investments in the future. The most recent study on frontier market diversification is that of Berger, Pukthuanthong and Yang (2011), which examines the level of integration of frontier markets. They examine 25 frontier markets and analyse the level of integration; they conclude that the frontier markets exhibit no signs of integration with the world market, and hence diversifying into these

markets would be beneficial to the investors. Chen, Chen and Lee (2014) examined the level of integration of frontier markets with the U.S market and find that there could be significant benefits from diversifying into frontier market assets. Benefits of diversification may differ according to the perspective of investors from different markets. This is because of the different factors affecting the market that prevail in different countries. In order to examine the effect of these factors from the perspectives of a larger market and smaller market, this research will compare the benefits of diversifying into frontier markets from the perspective of the Australian and the US investors.

Frontier markets being the less developed of the emerging markets category that are investible in nature, provide a possible new destination to channel investments. However, frontier markets are a relatively new category of assets available to international investors, and the lack of reliable and accurate empirical research on frontier market diversification is a significant gap in the literature. This study explores the potential benefits of considering frontier markets in an optimised portfolio context. The case for an Australian investor diversifying into frontier markets in comparison to that of a US investor is examined, and this analysis is expected to provide new knowledge regarding the potential benefits from frontier market diversification for two different types of developed market investors.

1.2 Research questions

Research has established that diversifying internationally into markets with lower correlations with the investor's domestic market is beneficial (Bekeart and Harvey 2013; Daly 2003; Markowitz 1952; Speidell and Sappenfield 1992; Wilcox 1992; Yang, Tapon and Sun 2006). In the context of increasing levels of integration between world capital markets, an investor in search of avenues that provide better risk adjusted returns would find frontier markets as an interesting asset to diversify his/her portfolio. Studies by Cashin, Kumar and Mcdermott (1995), Serrano and Rivero (2003), Gupta and Donleavy (2009), Turgultu and Ucer (2010) have shown that increased level of market integration have resulted in higher correlations between developed and emerging markets. Thus, there exists a scenario where investors are searching for new avenues that provide better risk adjusted returns. As frontier markets are the latest addition to the investible asset class available to international investors, it is essential to investigate whether this set of markets provides any potential benefits from diversifying into them.

Since frontier markets are a relatively new classification, research into this area is not vast. A review of previous literature on frontier market diversification revealed three gaps. Firstly, there are no studies on frontier market diversification from an Australian perspective. In the present financial and investment scenario in Australia, it is timely to undertake an investigation into this issue. The Australian investment atmosphere warrants a search into better avenues that could potentially provide significant gains from diversification and specifically if frontier markets are promising for the Australian investor. This gap in current literature has

formulated research question 1. This research aims at bridging this gap by examining whether there exists significant benefit to an Australian investor from diversifying into these frontier markets. Research Question 1 of this study is structured to investigate these under investigated areas in existing literature and provide reliable results for researchers and investors.

Secondly, there are no studies investigating the differences in benefits from frontier market diversification to an Australian investor in comparison to a US investor. Benefits to an investor from diversification into frontier markets would largely be influenced by the characteristics of the domestic market. Most of the international portfolio diversification studies have been conducted from a US investor perspective. The basic differences in the nature and characteristics of the Australian and US markets make it difficult for the results of such studies not suitable for the Australian investor. For instance, the Australian equity market is less than one-tenth the size of the US market. There are significant structural and characteristic differences between the two markets. Also, the unprecedented growth in the Australian managed funds industry requires studies to be conducted from an Australian investor perspective for a better practical comparison and understanding. To the best of my knowledge, there have not been any studies that provide a comparison of US and Australian perspectives in an in-sample and out-of-sample framework regarding diversification benefits from less developed markets. The second research question presented in this thesis will address this gap in current literature by providing a comparison of the potential benefits from frontier market diversification to an Australian investor with that of a US investor.

Thirdly, previous studies on frontier market diversification are restricted to in-sample analysis. Most of the diversification studies conducted so far fail to present an out-of-sample analysis (Conover, Jensen and Johnson 2002; Chiang, Jeon and Li 2007; Gupta and Donleavy 2009; Chittedi 2014). Ex-post analyses tend to overstate the true level of gains because they are estimated based on the assumption that investors have perfect foresight regarding the inputs of portfolio selection (Fifield, Power and Sinclair 2002). Conducting an out-of-sample analysis is significant because this is one way to test whether the results provided by the in-sample analysis hold true in the out-of-sample as well. Results arising from an in-sample analysis may be either data period-specific or model-specific for various reasons, and hence providing an out-of-sample analysis will validate the results as well as provide a detailed insight. There have not been any previous studies that examined the issue of frontier market diversification from an out-of-sample analysis and I believe that such a discussion will assist in developing appropriate investment strategies for practitioners. The empirical significance of an out-of-sample analysis and the practical applicability of accumulated wealth over time in a frontier market diversification scenario have been addressed in the third research question that this thesis will explore. This research will provide an out-of-sample analysis to compare the end of period returns to the Australian and the US investors from a rebalanced portfolio.

Based on the gaps identified in the existing literature, the research questions of this study are stated as:

1. Are there any significant benefits from including frontier markets in a diversified portfolio for a developed market investor?

2. Are these potential benefits different for a US investor when compared to an Australian investor?

3. Are the results from the in-sample analysis consistent with the outcomes of the out-of-sample analysis?

In the light of empirical and theoretical evidence from previous studies by Markowitz (1952), Wilcox (1992), Speidell and Kronhe (2007), this study will test the following hypothesis:

The null hypothesis for RQ1, H_{o_A}: There are potential benefits from frontier market diversification to a developed market investor.

The alternative hypothesis for RQ1, H_{1_A}: There exist no benefits from frontier market diversification to a developed market investor.

The null hypothesis for RQ2, H_{0_B}: The potential benefits from frontier market diversification are not the same for an Australian investor when compared to a US investor.

The alternative hypothesis for RQ2, H_{1_B}: The potential benefits from frontier market diversification are the same for an Australian investor when compared to a US investor.

The null hypothesis for RQ3, H_{0_C}: The results from an in-sample analysis are supported by the evidence from the out-of-sample analysis.

The alternative hypothesis for RQ3, H_{1_C}: The results from an in-sample analysis are contradicted by the evidence from the out-of-sample analysis.

The null hypothesis is implicitly tested by examining whether the benefits from a diversified portfolio constructed using time-varying correlations are significantly higher than for a non-diversified portfolio. A number of diversified portfolios are constructed and the overall performances of these diversified portfolios are compared to that of the non-diversified portfolio.

This study will investigate whether there are benefits to be had from diversifying internationally into frontier equity markets for Australian and US investors, and will quantify the potential gains. This will be the first research to examine the potential gains to Australian and US investors from diversifying into frontier markets and to examine whether there are any significant differences in diversification benefits for an investor from a small market and an investor from a large market. Jithendranathan (2005) used a Dynamic Conditional Correlation model in his study to identify the economic factors that influence correlations of US and Russian equity returns. Bekaert and Wu (2000) used a similar model to study volatility and equity market risk. DCC GARCH models have been proposed as superior in performance to simple multivariate GARCH models by Kroner and Ng (1998) and Engle (2002). Gupta and Mollik (2008) studied volatility as a factor that causes correlations to change over time using the ADCC model among Australia and emerging markets. Following Jithendranathan (2005) and Gupta and

Mollik (2008), this study will use the AG-DCC GARCH model to test the causal effects of economic factors and volatility on changes in correlations over time. This study will be the first to estimate frontier market diversification using AG-DCC GARCH. To estimate the benefits of diversifying into frontier markets, this study will follow the methodology of Jithendranathan (2005) and Gupta and Donleavy (2009).

The primary contribution of this thesis is that the relatively less researched field of frontier market diversification is examined in detail, using computationally efficient models from the perspectives of Australian and US investors. The results of this research will bridge a significant gap in literature by providing an examination of potential benefits from frontier market diversification for investors from two different developed markets – a larger developed market and a smaller developed market. The comparison between US and Australian investors' perspectives will shed light on the impact of size effect and other structural differences of the domestic market on diversification benefits for the investor.

One of the important contributions of this research is that it provides an out-of-sample analysis of the potential benefits from frontier market diversification for Australian and US investors. The significance of providing an out-of-sample analysis arises from the fact that the conditions prevailing during an in-sample period may not hold true during subsequent periods, and also the results from an in-sample analysis on its own might be data specific. Since frontier market diversification is a relatively new area of investor interest, out-of-sample results from this thesis will assist in strengthening the argument for/against the inclusion

of frontier markets in a diversified portfolio. Previous studies have failed to examine whether the potential benefits from frontier markets are achievable in an ex-ante frame work as well. A comparison of in sample and out-of-sample analysis will help to establish a clearer picture of the potential gains from diversification into these markets and assist in developing a stronger case for or against frontier market diversification in the long run. The study uses computationally efficient AG-DCC GARCH model to estimate correlations between Australian/US markets and frontier markets which are known to be time varying. The Markowitz mean variance method is used to create optimal portfolios using these time varying correlations. This study also looks into the nature and characteristics of frontier markets and provides a comparison of frontier markets and emerging markets. This analysis and comparison will help in understanding the basic reasons behind the vagueness and ambiguity associated with frontier markets and the overlap that has been present in various frontier market indices.

This thesis is further organised in the following chapters. Chapter 2 presents the theory of portfolio diversification and examines the theoretical rationale for diversification. This chapter will outline the basic concepts of risk and return and modern portfolio theory including Markowitz's model, Capital Asset Pricing Model (CAPM) and Arbitrage Pricing Theory (APT). Chapter 3 provides a detailed examination of the characteristics of frontier markets and analyses the reasons for the vagueness associated with the concept of frontier markets. This section will also present a comparison of the nature of frontier markets of today and the emerging markets of 1990s in order to examine whether there exist any

similarities between the two sets. A detailed review of the relevant academic literature is presented in Chapter 4. Chapter 5 outlines the methodology used for the analysis of data in this research. The results from the data analysis and discussion of the results are presented in Chapter 6. Finally, Chapter 7 presents the concluding remarks from the study.

Chapter 2
Theory of Diversification

2.1 Introduction

The process of financial decision-making involves a wide spectrum of risks, and investors in particular are faced with the risk of the portfolio they hold and whether they can maximise the returns from the portfolio at a given level of risk. To understand and perform the complex processes involved in holding an efficient portfolio, it is important to understand the concept of risk and return of an asset and that of a portfolio. This chapter presents the basic concepts of risk and return and how the addition of certain assets to a portfolio will be beneficial to the investor.

The basic concepts of finance and investment revolve around the return on an investment and the risk associated with that investment. Combining a wide variety of assets in order to construct a portfolio that provides a high return while maintaining the overall risk at a low level is the ideal situation for an investor. This is where the concept of diversification and gains from the diversification of a portfolio arises. The naive understanding of portfolio diversification can be stated as "not to put all your eggs in the same basket". In a nutshell, it is a process through which the investor attempts to hold a variety of assets within a portfolio and aims to achieve a maximisation of the returns from the portfolio at a minimum level of risk. Researchers and investors have always investigated whether there are any specific assets whose inclusion in a portfolio will certainly improve the diversification benefits from that portfolio. The primary objective of this thesis is to examine whether frontier markets provide significant diversification benefits to the developed market investors. This study is motivated

by the fact that frontier markets have historically enjoyed low correlations with developed capital markets, and theory suggests that the inclusion of less correlated assets could improve the performance of the portfolio. In order to understand the dynamics of frontier market diversification and potential benefits from them, it is essential to examine the theoretical and practical aspects of diversification. This chapter will outline the basic theories of portfolio diversification and the practical aspects of diversification.

The following sections of this chapter will examine the basic concepts of risk and return of assets and portfolios followed by the major theories of diversification – Modern Portfolio Theory of Markowitz, Capital Asset Pricing Model (CAPM) and Arbitrage Pricing Model. The theoretical basis that these models provide for international diversification is examined in the last section before the concluding remarks.

2.2 Risk and return

Developing an understanding of the basic concepts of risk and return of an investment is essential before entering the complex world of investments. Financial decision making for an investor involves understanding the dynamics of risk and return of various assets. Return on an investment is the financial outcome for the investor and risk is said to be present when there exists uncertainty about the outcome of that investment (Pierson, Brown, Easton and Howard 2002). The dollar return on an investment is usually converted into a rate of return, which is the percentage of return. For instance, if a $100 investment in an asset grows to $125, the dollar return is $25 and the rate of return is 25%.

On the other hand, the risk associated with achieving the expected returns is related to the dispersion of the distribution (Pierson et.al 2002). If the distribution of possible returns is more widespread, the risk attached to attaining the expected return is greater. Measures such as range, mean absolute deviation and variance have been some of the tools used to calculate risk. Variance and standard deviation have been widely accepted as a measure of risk; variance is the mean of squared deviations from the expected value and standard deviation is the square root of variance. Variance can be represented as follows:

$$\sigma^2 = \sum_{i=1}^{n} [R_i - E(R)]^2 P_i \qquad (2.1)$$

where R_i is the return on the ith asset, P_i is the associated probability and $E(R)$is the expected r

The selection of an asset or a set of assets based on the expected return and risk greatly depends upon the investor's attitude towards risk. A risk averse investor will prefer to choose an asset or portfolio that has lower risk for a given level of return. Finance theory usually assumes that investors are risk averse and this implies that the investor regards risk as undesirable but worth taking up if it is compensated through the expected returns. It is this basic attitude of a risk averse investor that drives the notion of portfolio diversification through which the expected returns from a portfolio can be improved without increasing the risk.

2.3 Risk and return of assets and portfolios

Financial managers and individual investors attempt to create an efficient portfolio of assets which maximises return for a given level of risk or minimises risk for a given level of return. Rather than concentrating all their wealth in one asset, investors hold a variety of assets which is known as the portfolio. The return on a portfolio is calculated as a weighted average of the assets included in the portfolio:

$$k_p = (w_1 \times k_1) + (w_2 \times k_2) + \cdots + (w_n \times k_n) = \sum_{j=1}^{n} w_j \times k_j \qquad (2.2)$$

where $\sum_{j=1}^{n} w_j = 1$

w_j = proportion of the portfolio represented by the asset j

k_j = return on asset j.

And the risk of a portfolio could be measured with the standard deviation of all the assets included in the portfolio.

Investors and financial managers endeavour to minimise risk and maximise returns from their portfolios, which means to lower the value of standard deviation and improve the value of portfolio returns. One important factor that affects the level of returns from a portfolio is the extent of correlation between the assets included in the portfolio. Researchers and practitioners agree that combining assets that have a negative or very low positive correlation with each other will reduce the overall portfolio risk. Diversification is the process of balancing and rebalancing the assets in a portfolio so as to maximise returns and minimise risk.

2.4 The theory of portfolio diversification

Diversification is a risk management technique that enables investors to reduce their portfolio risk without significant reductions in returns. The naive understanding of diversification can be summed up as "not putting all your eggs in the same basket" and investors in the earlier years were driven by this common understanding and performed random diversification. Markowitz (1952) developed the modern portfolio theory of diversification and provided a formal argument highlighting the benefits of diversification. Diversification that was practiced before the work published by Markowitz was predominantly based on the extent of returns from assets, and hence portfolio construction relied heavily on identifying securities that offered high expected return with least risk and investment in them (Chen, Chung, Ho and Hsu 2010). The portfolio selection model put forth by Markowitz initiated a paradigm change in the way diversification was approached; he emphasised that investors could reduce the risk of the portfolio instead of focussing on return alone.

The Markowitz model of portfolio optimisation is based on several assumptions: investors can estimate the probability distribution of expected returns over a period of time; investors have single period utility functions and diminishing marginal utility of wealth applies to the maximisation of utility; the measure of risk used by investors is the variability of expected returns; investors are concerned about the mean and variance of portfolio returns over a specific period of time; investors are risk averse; financial markets are frictionless.

Markowitz developed a framework to estimate the portfolio risk and returns after examining the covariances of different securities. Portfolio risk is a function of the standard deviation of the individual assets in the portfolio and the covariances between the returns of asset pairs in the portfolio; it is not a simple weighted average of the risks of the assets in the portfolio.

The portfolio risk is calculated as:

$$\sigma_p^2 = \sum_{i=1}^{n} w_i^2 \sigma_i^2 \sum_{i=1}^{n} \sum_{\substack{j=1 \\ i \neq j}}^{n} w_i w_j \sigma_{ij} \quad (2.3)$$

Where σ_p^2 is the variance of the return on the portfolio,

σ_i^2 is the variance of the return of the asset,

σ_{ij} is the covariance of the returns of assets *i* and *j*,

w_i is the percentage of investable funds invested in security *i*.

The total risk of an asset is made up of systematic risk and non-systematic risk. Systematic risk is the market-wide risk; all assets will be exposed to it and hence it is non diversifiable. Non-systematic risk is company specific and hence can be diversified through investing in assets of different companies. Addition of different assets to a portfolio will reduce the risk as it will bring about a reduction in the non-systematic risk. The extent of reduction in portfolio risk also depends on the level of correlation between the assets included in the portfolio.

The correlation between two assets is a statistical measure of the relationship between the price and return movements of the two assets, which is represented

within the range -1 to +1. A correlation coefficient of -1 between two assets means that they are perfectly negatively correlated; a correlation coefficient of +1 between two assets means that they are perfectly positively correlated; and a correlation coefficient of 0 means that there is no systematic correlation between the two. The significance of correlation between assets in portfolio diversification arises from the fact that investors seek to diversify in order to achieve a lower portfolio risk by investing in different assets which have different risk, volatility and returns. A portfolio constructed with assets that display a high correlation between them is likely to be exposed to a greater degree of risk. An efficient portfolio is one that offers the maximum expected return at a given low level of risk. The existence of a high positive correlation between the assets in a portfolio will limit the degree of risk reduction from diversification. Adding perfectly positively correlated assets to a portfolio will not provide any risk reduction, but result in risk averaging alone. Risk reduction through portfolio diversification can be achieved only through the addition of assets that are less than perfectly positively correlated. The addition of assets with lower correlation will result in a significant fall in the portfolio risk as a result of a reduction in the non-systematic risk. Hence, to achieve effective diversification the assets included in a portfolio should not be highly correlated.

Markowitz (1952) defined an efficient portfolio as one that has the lowest portfolio risk at a given level of expected returns or the highest expected returns for a given low level of risk. Thus, an investor can attain an efficient portfolio by specifying the expected returns and minimising the risk or by specifying the risk level and maximising the expected returns. Figure 2.1 below shows how the

optimal complete portfolio (the entire portfolio that includes risk-free assets and risky assets) is determined at the point where the indifference curve is tangent with the Capital Allocation Line (CAL). The optimal risky portfolio is determined at the tangency point of the CAL and the opportunity set of risky assets.

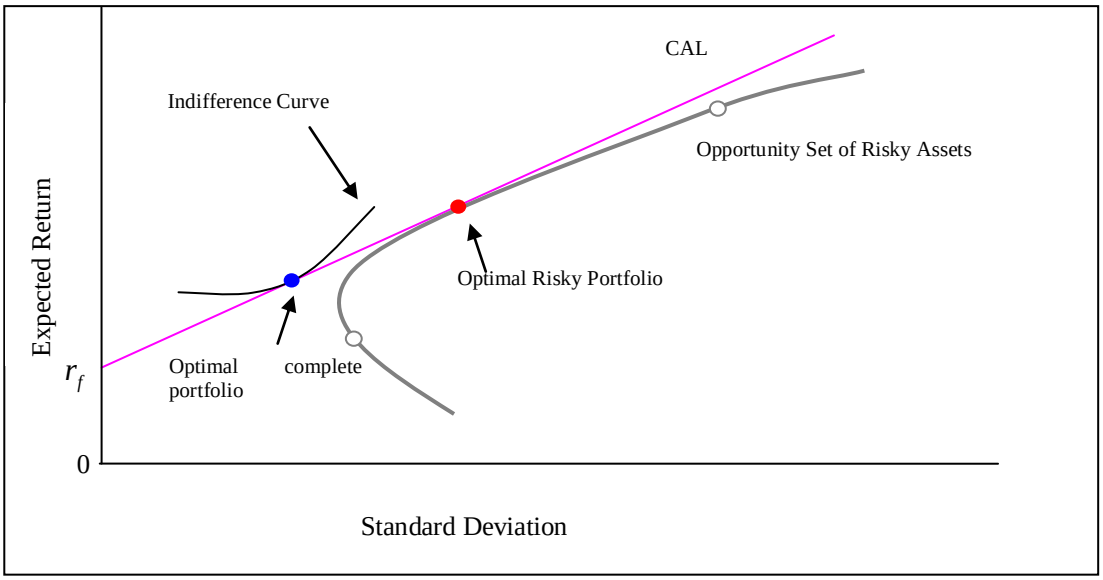

Figure 2.1 Determination of the optimal portfolio

Markowitz (1952) identified that there are two steps that are employed during the process of selecting a portfolio; first is observation and experience that creates beliefs about future performances of available securities and the second is choosing the portfolio based on the beliefs built. Michaud (1989) outlined some of the strong points of the Markowitz model: a) satisfaction of client objectives and constraints can be achieved using this model because of the convenient framework; b) control of portfolio risk can be performed using Markowitz's portfolio optimiser; c) implementation of style objectives and market outlook is possible, whereby the investor can easily choose the appropriate exposure to various levels of risk; d) efficient use of investment information is designed into

the model; e) timely portfolio changes are possible; and lastly, but most importantly, the model is designed to process large amounts of data quickly. The Markowitz mean variance method of portfolio optimisation has been widely used in diversification studies, and this research will employ the Markowitz mean variance method for the same.

2.5 Capital Asset Pricing Model (CAPM)

The primary criticism of the Markowitz theory is that it requires a total of $2n + n\frac{(n-1)}{2}$ parameters, which is a large number of parameters to be modelled. This complex data requirement was later on simplified in a new model put forth by Sharpe in 1964. The Capital Asset Pricing Model (CAPM) was initially developed by Sharpe (1964) and Linter (1965) and was subsequently advanced and refined by various authors. The Sharpe-Linter-Mossin CAPM is known as an equilibrium model in which the market participants as a whole act to put the market in equilibrium (West, 2006). The major assumptions of the model are: short sales are permitted; a risk free rate exists for lending and borrowing; transaction costs do not apply in buying and selling of capital assets; there are no capital gains or income taxes and all assets are available in the market, none are exclusively private.

CAPM links together the risk of all assets included in a portfolio and their returns and it provides a detailed explanation of the types of risk and their effect on return. According to CAPM, the total risk of an asset consists of two parts – systematic and unsystematic risk. Unsystematic risk, also known as diversifiable risk, represents that part of an asset's risk which is specific to the asset and is not

related to the factors that affect the market as a whole. Systematic risk or non-diversifiable risk is that portion of an asset's risk that is common to all assets in the market. CAPM is based on the assumptions that returns from assets are normally distributed, there are no transaction costs, there are rational investors and there are risk-free assets. CAPM puts forth that in a competitive market, investors are compensated for the systematic risk of the assets they hold because it cannot be eliminated by diversification, and investors are not compensated for the non-systematic risk which can be diversified away.

CAPM thus draws a relation between the non-diversifiable risk and returns of all assets. Non-diversifiable risk is measured by the beta coefficient of the asset or portfolio, which is an indicator of the degree of change in an asset's return in relation to a change in market returns (Gitman, Juchau and Flanagan, 2008).

The expected return of an individual asset or portfolio is represented below:

$$E(R_i) = R_f + \beta\big(E(R_m) - R_f\big) \tag{2.4}$$

Where $E(R_i)$ = expected return of the asset or portfolio,

- R_f = return on the risk free asset,
- β= systematic risk of the asset or portfolio,
- $E(R_m)$= expected return on the market.

The CAPM equation shown in 2.4 is graphically represented as the security market line (SML) in Figure 2.2 below. The SML plots the level of non-diversifiable risk required for each expected return in the market, and the

significance of SML is that, in equilibrium each risky asset should be priced so that it plots exactly on the line.

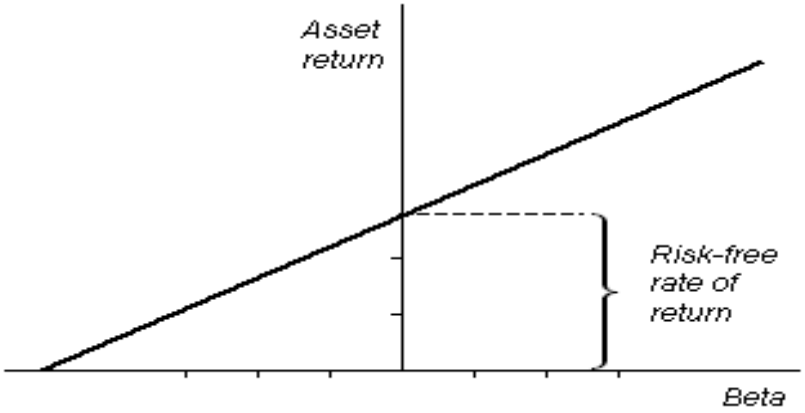

Figure 2.2 Security Market Line

CAPM suggests that by adjusting the assets included in the portfolio, the portfolio can be optimised. In order to arrive at the optimum portfolio, equation 2.4 can be optimised for minimising risk and maximising returns. The resultant portfolio will indicate the highest possible return at a given level of risk or the lowest possible risk at a given level of return. Since there are no trading costs involved, the inclusion of each additional asset will further diversify the portfolio and reduce the risk and hence the optimal portfolio will include all the assets available in the market. All the optimal portfolios, each for a specific level of expected return, can be plotted together as the efficient frontier.

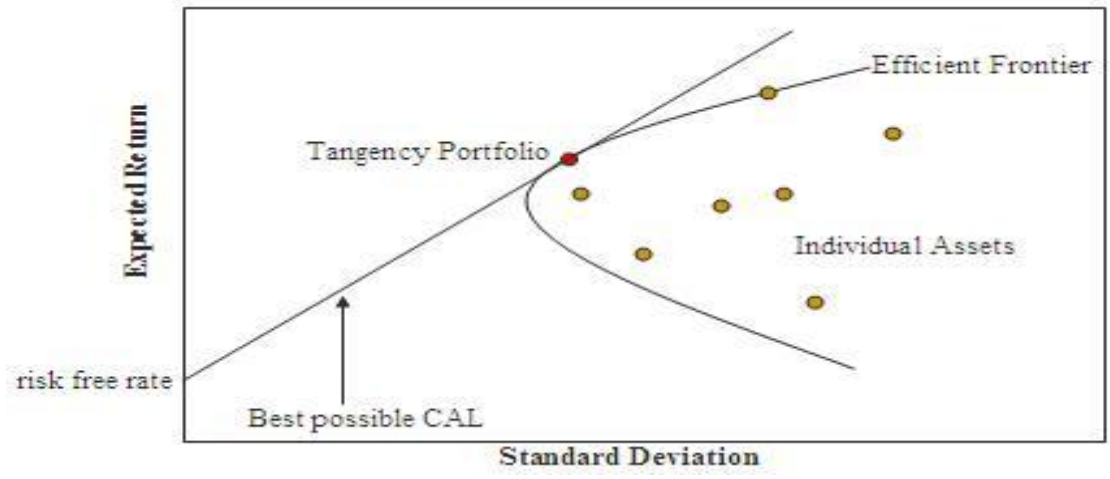

Figure 2.3 Efficient frontier

In figure 2.3, CAL is the capital allocation line, and the tangency portfolio is the optimum portfolio that provides the lowest risk for the given expected return level.

In spite of the wide acceptance of CAPM, the model is not free from shortcomings. Roll (1977) critically examined the limitations of CAPM, in what is known as Roll's Critique. CAPM makes a number of assumptions such as rational expectations, standard deviation as a perfect measure of risk of assets, and that normally distributed returns may not be valid in the real market situations. Black et al. (1972), Fama and MacBeah (1973) and Blume and Friend (1973) are studies that have supported the CAPM model. However, after Roll's critique, several studies have questioned the effectiveness of the model and subsequently developed more advanced theories, which will be outlined below.

2.6 Arbitrage Pricing Model

The arbitrage pricing model was formulated as an advancement over CAPM, and it describes the risk premium of an asset as a linear combination of various risk factors, not just mean returns and variances. The model assumes that assets are priced in such a way that arbitrage profits are not available. The assumptions on which the APT model is based on are as follows:

a) Investors are risk averse and they seek to maximise their wealth.

b) A risk free rate for lending and borrowing exists.

c) Market frictions are absent.

d) The number and identity of the factors that influence asset pricing are agreed upon by the investors.

e) Riskless arbitrage pricing opportunities do not exist.

The APT model prescribes the value of an asset as a linear function of various risk factors, and this is shown in equation 2.5.

$$E(R_i) = \alpha_i + \beta_{i1}F_1 + \beta_{i2}F_2 + \cdots + \beta_{ij}F_j + \varepsilon_i \quad (2.5)$$

Where α_i is a constant specific to asset i,

- β_i is the measure of the sensitivity of returns on asset i to factor F,
- F is the risk factor that explains returns,
- ε_i is the error term.

Rewriting equation 2.5 gives:

$$R_i = \alpha_i + \sum_{j=1}^{j} \beta_{ij} F_j + \varepsilon_i \quad (2.6)$$

West (2006) notes that equation 2.6 could be stated as a multi-factor version of CAPM in which the returns are influenced by the levels of indices rather than by the returns of the single index of the CAPM. Upon solving the above equation for ER_i, the model can be written as follows:

$$\bar{R} = R_f + \sum_{j=1}^{j} \beta_{ij} \lambda_j \quad (2.7)$$

Where R_f is the risk free interest rate,

- λ_j is the risk premium for the j^{th} factor,
- β_{ij} is the measure of the sensitivity of returns on asset *i* to risk factor *j*.

The major difference between CAPM and APT is that in CAPM, one factor, the market portfolio, is identified as the single source of risk, whereas APT puts forth several possible risk factors. Empirical evidence on APT is mixed; Sinclaire (1977), Stulz (1981), Cho, Elton and Gruber (1984) and Fama and French (1992) have found up to three factors affecting the pricing of assets. The scope of this thesis does not allow for an in-depth examination of the models of asset pricing, and this chapter is intended to provide a basic theoretical understanding of the theory of diversification. The major theories of diversification have been examined in this chapter, and the methodology used for this research, based on the theory outlined in the previous sections, is described in detail in Chapter 5.

2.7 International portfolio diversification

The CAPM provides some important insights into the complex phenomena of investment markets. One is that since investors are risk averse, they need to be compensated for investing in risky assets. Another is that investors are compensated only for the risk that cannot be diversified away. Though the second notion is criticised heavily in APT, researchers mostly agree that the addition of different assets that have low correlations with each other will create a well-diversified and efficient portfolio. Portfolio diversification could be achieved by diversifying internationally into different markets or domestically into different industries or multinational companies.

Benefits from domestic diversification could potentially be lower than that from international diversification as the assets in a domestically diversified portfolio tend to have higher correlations, since they are influenced by the same government policies, factors and information. On the other hand, in an internationally diversified portfolio, the assets are potentially influenced by different government policies, economic and financial situations. As a result, the level of correlation between these assets is expected to be lower and hence the potential benefits from an internationally diversified portfolio could be higher. Research on the benefits from international diversification of portfolio is examined in detail in the Literature Review in Chapter 4.

2.8 Conclusion

One of the important objectives of this thesis is to examine whether there are significant benefits from frontier market diversification for a developed market investor (US vs. Australian investor). The basic rationale behind seeking diversification benefits from less developed markets arise from the theoretical basis provided by Markowitz (1952) in his Modern Portfolio Theory that addition of less correlated assets to a portfolio diversifies away risk. This study uses Markowitz's mean variance method of portfolio optimisation to determine potential benefits from frontier market diversification. The method used for arriving at an efficient portfolio and determining the weights for each asset are discussed in detail in Chapter 5.

This chapter highlights the primary theoretical basis for portfolio diversification and examines the basic concepts and three major models. Empirical evidence on each of these models is varied. The model put forth by Markowitz has been widely accepted and employed by researchers and investors alike, but it has been criticised by studies such as Sharpe's (1964). The Capital Asset Pricing Model put forth by Sharpe (1964), Linter (1965) and Mossin (1966) incorporate significant improvements over the Markowitz model. Various asset pricing models have also been developed by Stulz (1981), Cho, Eun and Senbet (1986), and Milne (1988). The aim of this thesis is not to test the models of portfolio diversification, but to provide an understanding of the basic theories of portfolio diversification. An examination of the theory of portfolio diversification provides evidence that diversification by the inclusion of certain assets that are less correlated with the

portfolio will result in significant benefits. Since frontier markets are the least integrated investible markets available for international investors, the theoretical rationale arising from the three major models discussed in this chapter suggests that inclusion of frontier market assets in the portfolio of a developed market investor could provide benefits from diversification. The primary objective of this thesis is to examine whether an Australian investor will attain potential benefits from frontier market diversification in comparison to a US investor. There have not been any previous studies that have looked into frontier market diversification from an Australian perspective, comparing it with a US investor's perspective. Empirical evidence and theoretical findings over the past decades regarding portfolio diversification are presented in Chapter 4, Literature Review. Based on the theoretical rationale arising from the discussion in the preceding sections of this chapter, a detailed discussion of the methodology that this study employs is provided in Chapter 5, Research Methodology.

Chapter 3
Frontier Markets – Definition and Key Characteristics

3.1 Introduction

Markets across the globe have been classified into developed and emerging and more recently into frontier markets. The term 'frontier markets' refers to the smaller and less accessible equity markets of the developing world which are open to international investors. (Berger, Pukthuanthong and Yang, 2011). The term was coined in the IFC's Emerging Markets Database in 1992 and denoted the smaller markets among the developing markets group. They are a subset of emerging markets, also known as pre-emerging markets since their market capitalisation is small, with low annual turnover and presence of market restrictions and lower infrastructure facilities which prevent them being included under the classification of the larger emerging markets. Speidell and Krohne (2007) differentiate frontier markets from the emerging markets based on factors such low market turnover, lower number of listings in their stock markets and low levels of foreign investments.

Frontier markets have had the attention of investors across the globe in recent years and are sometimes even described as the "Holy Grail" of diversification (BlackRock, 2013). Despite the increased interest in frontier markets, the lack of reliable and accurate empirical studies and the absence of a clear definition have adversely affected investor participation. Since frontier markets are a relatively new asset class, there is a lack of clear definition and criteria for classification of frontier markets. As a result of this issue, the markets listed as frontier by the major indices have significant overlap. Such an overlap in indices could potentially cause the problem of duplication of markets for a potential investor.

This chapter will present a detailed examination of the major characteristics of frontier markets listed in the major indices and analyse the issue of overlap between indices.

The total market capitalisation of the frontier markets currently stands at $400 billion (BlackRock, 2013). This can be compared to the position of the emerging markets during the peak time in the 1990s. Since the 1990s, the emerging markets have grown tremendously to $5 trillion currently (BlackRock, 2013). This pattern has been a major incentive for investors and academics to keep a close watch on frontier markets and their dynamics in the coming years as it is anticipated that they will follow a similar growth pattern to that of the emerging markets in the 1990s. This chapter also presents a comparison of the characteristics of the emerging markets when they first caught investor interest and the frontier markets of the current environment. Such a comparison will assist in understanding the functioning of frontier markets and the potential growth pattern these markets might follow. This analysis will assist investors to develop a clearer understanding of frontier market dynamics.

3.2 What are frontier markets?

The frontier markets have very low correlations with the developed markets and other emerging markets and are hence considered as segmented from the world capital market (Berger et. al., 2011, Speidell and Kronhe 2007). This difference has invoked immense investor interest in frontier market investments from the international investor. The increasing investor interest in frontier markets is evident from the establishment of a number of frontier market indices. S&P

launched the S&P/IFC Frontier Markets Composite in 2007, comprising 150 companies in frontier markets. Later in 2007, MSCI introduced the MSCI Frontier Markets Index which currently covers 29 markets. S&P revised its Frontier Markets Index and introduced a new index called the S&P Frontier BMI which currently covers 37 markets. FTSE launched its FTSE Frontier 50 Index in 2008 and it currently includes 25 frontier markets. Russell Investments also introduced the Russell Frontier Market Index which includes 35 markets. Table 3.1 presents the lists of markets considered as frontier markets by S&P, MSCI, Russell Investments and FTSE. Among the 47 markets, 17 are included in all the 4 indices and 20 are included in either 2 or 3 of the indices. There are 10 markets which are included in only one of the four indices.

The differences in markets included in various indices can result in significant confusion among investors. For instance, among the 46 markets that are considered as frontier by these four indices, 4 are exclusive to S&P Frontier list (Colombia,2 Ecuador, Latvia and Panama) and 5 markets are exclusive to the Russell Frontier list (Gabon, Kyrgyzstan, Papua New Guinea, Senegal and Tanzania). This kind of an overlap could result in duplication of portfolio weights if investors use different indices for different type of markets. For example, Colombia was included in the frontier markets list of S&P while it was considered as an emerging market by MSCI and Russell (Colombia is now classified as an emerging market by S&P currently). Similarly, UAE is listed in the frontier markets category in both S&P and MSCI frontier markets lists, but is considered

2 Colombia is no longer included in the S&P frontier markets list, but is mentioned here as it was a considered as frontier at the time of data analysis for this study. All the index lists are revised frequently.

as an emerging market by Russell Investments. For instance, if an investor chooses to use MSCI Emerging market index and S&P Frontier Index, the investor will be faced with a duplication problem with Colombia, and there is a similar issue with UAE. This overlap in the inclusion of markets in the frontier category is primarily due to the ambiguity associated with frontier markets, and the lack of specific criteria for distinguishing a market as frontier.

The markets considered as frontier by the major indices fall in Asia, Africa, Latin America, Europe and the Middle East. However, the weighting given by each index to these regions varies widely. Table 3.2 presents the market capitalisation of frontier markets in these five regions and the weighting given to each region by the major indices. The market capitalisation of the frontier markets in the five major regions shown in Table 3.2 together form a total of approximately US$1.1 trillion, as per 2010 World Bank data. The Middle East forms a major part of this, with 35.62% followed by Latin America at 26.84%. Africa and Asia are the smaller regions considering the size of market capitalisation with 14.51% and 10.12% respectively. The weightings allocated by the four major indices presented in Table 3.2 vary widely. While S&P allocates 13.9% to the Asian region, Russell Frontier index puts it at more than 20%. Latin America consumes 7.3% in the MSCI frontier index, but takes up more than 25% in the S&P frontier BMI. In all the four indices, the Middle East forms a major region, allocated more than 35%. The MSCI frontier index allocates a huge 58.9% to the Middle East region, followed by the Russell index's 42.1% and FTSE's 41.8%. These disparities in weighting allocated to the major regions point towards the differences and overlaps in the methodologies undertaken and practised.

Table 3.1 Frontier markets listed in S&P, MSCI, Russell Investments and FTSE

Market	Index	Index	Index	Index	Market	Index	Index	Index	Index
Argentina	S&P	MSCI	RUSSELL	FTSE	Macedonia	-	-	RUSSELL	FTSE
Bahrain	S&P	MSCI	RUSSELL	FTSE	Malta	-	-	RUSSELL	FTSE
Bangladesh	S&P	MSCI	RUSSELL	FTSE	Namibia	S&P	-	RUSSELL	-
Botswana	S&P	MSCI	RUSSELL	FTSE	Nigeria	S&P	-	RUSSELL	FTSE
Bosnia and Herzegovina	-	MSCI	RUSSELL	-	Oman	S&P	MSCI	RUSSELL	FTSE
Bulgaria	S&P	-	RUSSELL	FTSE	Pakistan	S&P	MSCI	RUSSELL	-
Colombia	S&P	-	-	-	Panama	S&P	-	-	-
Croatia	S&P	MSCI	RUSSELL	FTSE	Papua New Guinea	-	-	RUSSELL	-
Cote d'Ivoire	S&P	-	-	FTSE	Qatar	S&P	MSCI	RUSSELL	FTSE
Cyprus	S&P	-	RUSSELL	FTSE	Romania	S&P	MSCI	RUSSELL	FTSE
Ecuador	S&P	-	-	-	Serbia	-	MSCI	RUSSELL	FTSE
Estonia	S&P	MSCI	RUSSELL	FTSE	Senegal	-	-	RUSSELL	-
Gabon	-	-	RUSSELL	-	Slovakia	S&P	-	RUSSELL	FTSE
Ghana	S&P	MSCI	RUSSELL	-	Slovenia	S&P	MSCI	RUSSELL	FTSE
Jamaica	S&P	MSCI	RUSSELL	-	Sri Lanka	S&P	MSCI	RUSSELL	FTSE
Jordan	S&P	MSCI	RUSSELL	FTSE	Tanzania	-	-	RUSSELL	-
Kazakhstan	S&P	MSCI	RUSSELL	-	Trinidad and Tobago	S&P	MSCI	RUSSELL	-
Kenya	S&P	MSCI	RUSSELL	FTSE	Tunisia	S&P	MSCI	RUSSELL	FTSE
Kuwait	S&P	MSCI	RUSSELL	-	UAE	S&P	MSCI	-	-
Kyrgyzstan	-	-	RUSSELL	-	Ukraine	S&P	MSCI	RUSSELL	-
Latvia	S&P	-	-	-	Vietnam	S&P	MSCI	RUSSELL	FTSE
Lebanon	S&P	MSCI	-	-	Zambia	S&P	-	RUSSELL	-
Lithuania	S&P	MSCI	RUSSELL	FTSE	Zimbabwe	-	MSCI	-	-
Mauritius	S&P	MSCI	RUSSELL	FTSE					

Source: Frontier market indices of S&P, MSCI, Russell and FTSE in 2010

Table 3.2 Region-wise breakdown and index comparison

	Market cap World Bank ($US million)	Market cap % World Bank	S&P Frontier BMI Region Weights	MSCI Frontier Region Weights	Russell Frontier Region Weights	FTSE Frontier Region Weights
Asia	164,723	14.51%	13.9%	14.1%	20.7%	10.8%
Africa	112,090	10.12%	13.1%	9.5%	14.6%	27.4%
Latin America	304,806	26.84%	25.6%	7.3%	9.5%	9.8%
Europe	139,789	12.91%	7.7%	10.2%	13.1%	10.2%
Middle East	404,439	35.62%	39.7%	58.9%	42.1%	41.8%
Total	1,135,501	100%	100%	100%	100%	100%
Number of countries	44*	44	37	29	39	25

Note: *Out of the 47 markets presented in Table 3.1, World Bank data for market capitalisation is not available for Bosnia and Herzegovina, Gabon and Senegal.

Sources: World Bank data 2010, S&P, MSCI, Russell Frontier and FTSE Frontier.

3.3 The relevance of frontier markets in portfolio diversification

The current spike in academic and investor interest in frontier market diversification can be attributed to a number of factors. Firstly, the theoretical understanding that segmented markets provide better diversification benefits supports the potential advantages of including frontier markets in a portfolio since they are considered to be highly segmented from the developed capital markets. Secondly, the decline in benefits from emerging market diversification has created an investment puzzle wherein academia and practitioners are intrigued to discover the next best investment destination and frontier markets appear to be the potential solution.

The analytical distinction between emerging and frontier markets is very vague since there have not been specific criteria for classification of frontier markets. While frontier markets are a subset of emerging markets, they are smaller and less developed than the latter and hence more segmented from the developed capital markets. During the late 1980s and 1990s, the isolated nature of emerging markets from the developed markets was identified and empirically proven (Divecha, Drach and Stefek 1992; Harvey 1995; Wilcox 1992). This resulted in a large influx of foreign investments into emerging markets and significant diversification benefits were reaped up until the last decade. The increase in financial integration of capital markets and the effects of globalisation have bridged the segmentation between emerging and advanced capital markets (Cashin, Kumar and McDermott 1995; Dunis and Shannon 2005; Serrano and

Rivero 2003). As a result, the gains from including emerging markets in a developed market investor's portfolio is no longer as appealing as before (Chiang, Jeon and Li 2007; Chittedi 2014; Gupta and Donleavy 2009). This underlines the fact that a developed market investor who is in search for significant gains from portfolio diversification will require to search for new avenues beyond emerging markets.

However, the less developed group of markets within the developing markets have stayed segmented from the advanced capital markets and hence would theoretically provide potential benefits from diversification. The unique nature of the frontier markets present investors with a scenario similar to that of the emerging market in the 1990s wherein "the first in, best dressed" obtained immense diversification benefits. The smaller, less correlated frontier markets that are significantly segmented from the major developed and emerging markets will provide potential benefits and also buffer the impacts of crisis. The differences in the nature, size and level of segmentation of the frontier and emerging markets result in significant differences in the level of diversification benefits from them. As the larger emerging markets converge into the category of advanced markets, the differences in characteristics of frontier markets and emerging markets will become more pronounced and the contrast in diversification benefits from them will also be amplified. The unique nature of frontier markets can be established through a descriptive examination of their basic characteristics which is presented in the next section.

3.4 Frontier markets – basic characteristics

Theoretically, distinctions between economies are made based on the differences in economic and financial features between the markets, such as market segmentation, political or country risk, factor endowments, investor participation, liquidity, risk premium, market deepening. However, in practise, this distinction is based on the World Bank's definition of developed and developing markets. The World Bank defined developed economies as those which have a GNP per capita of more than $12,196.[3] Based on this definition, all countries with GNP per capita of less than $12,196 are considered as low and middle income economies, which were described as emerging economies by the World Bank. However, the World Bank emphasises that this categorisation based on GNP per capita does not imply that all countries in one group are experiencing similar stages of development, and that this categorisation does not reflect their respective stages of development. As a result, the income classification on its own cannot be used to determine the classification of markets into developed, emerging or frontier markets. S&P defines an emerging stock market according to criteria such as whether it is a low or middle income economy as stated by the World Bank, and/or whether its market capitalisation is relatively low. Later on, S&P introduced a new criterion: if an economy's GNP per capita exceeds the World Bank's lowest limit for an upper income country for at least three consecutive years, then that economy can no longer be treated as emerging. However, there is not a specific income limit or

[3] The descriptive analysis presented in this chapter is based on the World Bank classification of economies as of 2009 which was current when this study was started. Based on 2009 data, the World Bank threshold for developed economies is GNP per capita higher than $12,196. This threshold is revised frequently and as of July 2015, this is $12,736.

market capitalisation requirement for frontier markets, and the definition for frontier markets is quite vague and largely generalised.

Even though the World Bank's income specification does not differentiate between emerging markets and frontier markets, investors and market participants have differentiated frontier markets as a subset of emerging markets. Since there are no specific income, capitalisation or turnover rate level cut-offs to differentiate frontier markets from emerging markets, there is a significant overlap between markets classified as frontier by different indices. Distinctions are arbitrary. There is an argument that if investors perceive a market as a separate asset class, then it will tend to behave as a separate asset class and this is based on the heterogeneous expectations theory (Arthur, Holland, LeBaron, Palmer and Tayler, 1996).

The remainder of this chapter analyses the major features of frontier markets with respect to their GNI per capita, market capitalisation as a percentage of GDP, market turnover and number of listed companies. The frontier markets are characterised by high risks of various types – political risk, currency exchange risk, economic instability risk and so on. This chapter looks into the economic characteristics alone, and the risks associated with the markets are not within the scope of this thesis.

3.4.1 GNI per capita indicator

The World Bank uses GNI per capita as the criterion for distinguishing between developed and emerging economies. S&P uses the World Bank's definition with an additional specification while defining emerging markets. This section will use the World Bank's GNI per capita lower limit for developed markets as the cut off

for all developing markets and therein highlight the features of frontier markets. As stated above, according to 2009 data, any country with a GNI per capita of higher than $12,196 is classified as a developed country. Among the 214 countries listed in the World Bank data for GNI per capita, 58 had a GNI per capita of more than $12,196. Taking into account the S&P criteria that a market should have achieved a GNI per capita upper level for 3 consecutive years to be categorised as a developed market, 57 of these countries are classified as developed markets. All the remaining 136 countries had GNI per capita of less than $12,196 and hence are considered as developing markets.

These 136 countries consist of the larger and faster growing emerging markets and the less accessible and illiquid frontier markets. There has not been a clear dividing limit between emerging and frontier markets. Based on the frontier markets included in S&P, MSCI and Russel Investments Frontier Market Lists, this section will identify the range of GNI per capita for frontier markets. The markets included in at least two of the three frontier market lists are as follows:

> Argentina, Bahrain, Bangladesh, Botswana, Bulgaria, Croatia, Cyprus, Estonia, Ghana, Jamaica, Jordan, Kazakhstan, Kenya, Kuwait, Lebanon, Lithuania, Mauritius, Nigeria, Oman, Pakistan, Qatar, Romania, Slovakia, Slovenia, Sri Lanka, Trinidad and Tobago, Tunisia, UAE, Ukraine, Vietnam and Zambia.

The S&P frontier markets list includes six other markets – Colombia, Côte d'Ivoire, Ecuador, Latvia, Namibia and Panama—which were not part of MSCI and Russell Frontier markets. MSCI frontier markets include Serbia, Bosnia and

Herzegovina and Zimbabwe that were not included among S&P and Russell frontier markets. Russell Frontier markets list includes six markets that are not included in S&P and MSCI frontier markets – Macedonia, Tanzania, Papua New Guinea, Malta, Gabon and Krygstan. There are 46 markets in total in all the three lists and 31 of these markets are included in at least 2 of the lists.

The GNI per capita of the 46 markets is given is Table 3.3. The lowest GNI per capita is of Zimbabwe ($460) and the highest is Qatar ($61,532). Nearly one fourth (26%) of the markets have GNI per capita of more than the World Bank limit of $12,196. These markets are Bahrain, Croatia, Cyprus, Estonia, Kuwait, Malta, Oman, Qatar, Slovakia, Slovenia, Trinidad and Tobago and UAE. Many of these markets, despite being of high GNI per capita, have been included into the frontier markets category since they have been opened to international investors only recently, while there are some markets which have lower per capita GNI but larger market capitalisation and turnover that are categorised as emerging markets.

34 markets have GNI per capita below the World Bank level of $12,196. These markets are Argentina, Bangladesh, Botswana, Bosnia and Herzegovina, Bulgaria, Colombia, Côte d'Ivoire, Ecuador, Gabon, Ghana, Jamaica, Jordan, Kazakhstan, Kenya, Krygstan, Latvia, Lebanon, Lithuania, Macedonia, Mauritius, Namibia, Nigeria, Pakistan, Panama, Papua New Guinea, Romania, Serbia, Sri Lanka, Tanzania, Tunisia, Ukraine, Vietnam, Zambia and Zimbabwe. Among these countries, 23 have GNI per capita of less than $6000 and 11 fall within the range $6000 - $12,000. The average GNI per capita of these 46 frontier markets is $10,473. So this average could be taken as the upper limit for frontier markets to be distinguished from emerging markets.

Table 3.3 GNI per capita of markets included in S&P, MSCI and Russell frontier market lists

Market	GNI per capita	Market	GNI per capita
Argentina	8,620	Macedonia	4,570
Bahrain	18,730	Malta	19,130
Bangladesh	700	Mauritius	7,850
Bosnia and Herzegovina	4,770	Namibia	4,510
Botswana	6,740	Nigeria	1,230
Bulgaria	6,280	Oman	18,260
Colombia	5,510	Pakistan	1,050
Côte d'Ivoire	1,160	Panama	6,970
Croatia	13,890	Papua New Guinea	1,300
Cyprus	29,430	Qatar	61,532
Ecuador	3,850	Romania	7,850
Estonia	14,460	Serbia	5,630
Gabon	7,650	Slovakia	16,840
Ghana	1,250	Slovenia	23,900
Jamaica	4,800	Sri Lanka	2,240
Jordan	4,340	Tanzania	540
Kazakhstan	7,580	Trinidad and Tobago	15,380
Kenya	810	Tunisia	4,160
Kuwait	47,790	UAE	41,930
Kyrgyzstan	830	Ukraine	3,000
Latvia	11,640	Vietnam	1,160
Lebanon	8,880	Zambia.	1,070
Lithuania	11,510	Zimbabwe	460

Source: World Bank data 2010

3.4.2 Market capitalisation-GDP ratio indicator

Another criterion necessary for a market to be classified as frontier market is that the market capitalisation is low and liquidity is also low when compared to the emerging markets. In order to examine this, market capitalisation as a percentage of GDP is taken as an indicator, and an arbitrary upper limit of 30% is marked.

25 of the 46 markets have market capitalisation to GDP ratio of less than 30%, while 6 markets have lower than 10%. Bahrain, Jordan, Colombia, Kuwait, Mauritius, Papua New Guinea, Qatar, Trinidad and Tobago and Zimbabwe are the markets which have a market capitalisation to GDP ratio greater than 50%. Zimbabwe, with 153.5%, has the highest market capitalisation to GDP ratio, and Kyrgyzstan has the lowest at 1.7%. Table 3.4 below presents the data for 46 frontier markets. Among the 46 markets, more than half have market capitalisation to GDP ratio of less than 30%, and 6 markets are relatively smaller within the group.

3.4.3 Turnover ratio indicator

Turnover ratio is the total value of shares traded during the period divided by the average market capitalisation for the period. Average market capitalisation is calculated as the average of the end-of-period values for the current period and the previous period. Frontier markets are characterised by low market turnover, and this indicator examines the turnover ratio across the 46 markets listed as frontier markets in the S&P, MSCI and Russell frontier market lists. A market turnover ratio of less than 20% has been selected as the arbitrary level for frontier markets.

The frontier markets are characterised by low market turnover when compared with the larger emerging markets. The World Bank data on market turnover for the 46 markets included in S&P, MSCI and Russell Frontier markets shows that 43 of the 46 markets have a market turnover ratio of less than 20%. Only 3 markets recorded a turnover ratio of over 20%. The table below shows that more than 90% of the markets have low turnover, 29 markets have a turnover ratio of 10% or lower, and 10 markets have a turnover ratio ranging between 10 and 20 percent.

Table 3.4 Market cap/GDP ratio

Market	Market cap/GDP ratio	Market	Market cap/GDP ratio
Argentina	17.3	Macedonia	28.8
Bahrain (’09)	82.2	Malta	29.1
Bangladesh	15.6	Mauritius	66.9
Bosnia and Herzegovina	-	Namibia	9.7
Botswana	27.4	Nigeria	25.1
Bulgaria	15.2	Oman	36.9
Colombia	72.2	Pakistan	21.6
Cote d’Ivoire	31.2	Panama	40.9
Croatia	40.9	Papua New Guinea	102.8
Cyprus	29.5	Qatar	89.4
Ecuador	9.1	Romania	20.0
Estonia	11.8	Serbia	25.2
Gabon	-	Slovakia	4.8
Ghana	10.9	Slovenia	20.1
Jamaica	46.5	Sri Lanka	40.2
Jordan	111.9	Tanzania	5.5
Kazakhstan	40.8	Trinidad and Tobago	59.0
Kenya	44.9	Tunisia	24.1
Kuwait (’09)	87.6	UAE	35.2
Kyrgyzstan	1.7	Ukraine	28.6
Latvia	5.2	Vietnam	19.2
Lebanon	32.3	Zambia	17.4
Lithuania	15.6	Zimbabwe	153.5

Source: World Bank data, 2010

Table 3.5 Market turnover ratio

Market	Market turnover ratio	Market	Market turnover ratio
Argentina	4.8	Macedonia	2.0
Bahrain (’09)	1.5	Malta	1.7
Bangladesh	92.6	Mauritius	8.0
Bosnia and Herzegovina	-	Namibia	1.2
Botswana	3.6	Nigeria	9.2
Bulgaria	3.4	Oman	12.9
Colombia	13.3	Pakistan	28.6
Cote d’Ivoire	1.8	Panama	0.6
Croatia	4.1	Papua New Guinea	0.6
Cyprus	10.0	Qatar	18.6
Ecuador	1.9	Romania	12.0
Estonia	12.6	Serbia	3.7
Gabon	-	Slovakia	10.2
Ghana	4.1	Slovenia	6.5
Jamaica	3.1	Sri Lanka	25.1
Jordan	13.9	Tanzania	2.5
Kazakhstan	2.1	Trinidad and Tobago	1.2
Kenya	7.1	Tunisia	11.0
Kuwait (’09)	19.4	UAE	15.9
Kyrgyzstan	2.7	Ukraine	14.1
Latvia	4.4	Vietnam	29.5
Lebanon	4.5	Zambia (’09)	9.2
Lithuania	5.0	Zimbabwe (’09)	15.0

Source: World Bank data, 2010

3.4.4 Number of listed companies indicator

The number of listed companies in a market is taken as an indicator of market maturity. More than 90% of the markets in the three lists have more than 20 listed companies. Only 4 markets have less than 20 listed companies: Estonia (15), Namibia (7), Papua New Guinea (11) and Tanzania (17). 24 markets have more than 50 listed companies and 13 have more than 100 listed companies. Romania and Serbia are the only markets that have more than 1000 listed companies.

Table 3.6 No: of listed companies

Market	No of listed companies	Market	No of listed companies
Argentina	99	Macedonia	32
Bahrain (’09)	44	Malta	20
Bangladesh	216	Mauritius	86
Bosnia and Herzegovina	-	Namibia	7
Botswana	23	Nigeria	196
Bulgaria	393	Oman	136
Colombia	79	Pakistan	638
Cote d’Ivoire	33	Panama	21
Croatia	209	Papua New Guinea	11
Cyprus	117	Qatar	42
Ecuador	41	Romania	1267
Estonia	15	Serbia	1322
Gabon	-	Slovakia	81
Ghana	36	Slovenia	66
Jamaica	37	Sri Lanka	253
Jordan	247	Tanzania	17
Kazakhstan	63	Trinidad and Tobago	37
Kenya	58	Tunisia	57
Kuwait	206	UAE	104
Kyrgyzstan	34	Ukraine	195
Latvia	32	Vietnam	301
Lebanon	10	Zambia	20
Lithuania	33	Zimbabwe	75

Source: World Bank data, 2010

Summarising the analysis of the basic economic and financial characteristics, this study proposes the following criteria for classification of markets as frontier:

(a) GNI per capita of less than $10,500

(b) Market capitalisation-GDP ratio of less than 50%

(c) Low market turnover ratios of less than 20%

(d) Smaller number of companies listed in the domestic market index – at least 10

(e) Newly opened to international investors.

At least two of the first four criteria listed must be satisfied to be included in the frontier markets category; however, larger markets such as Bahrain and Kuwait have been recently opened to international investors, and hence such markets can be classified as frontier as well. Among the 47 markets included as frontier markets in S&P, MSCI and Russell indices, all markets except four – Bahrain, Kuwait, Qatar and Trinidad and Tobago — meet at least three of the first four criteria listed above. The inclusion of Bahrain, Kuwait and Qatar can be justified because they are relatively new investment opportunities for international investors and in the near future these markets are highly likely to move on to the emerging markets category. Qatar and UAE have already been upgraded to the emerging markets category by MSCI in May 2014, and other major indices are likely to follow the same procedure. Similarly, Trinidad and Tobago were removed from the MSCI frontier index in May 2011 to be a standalone country index, and are under consideration to be included back into the frontier markets category.

In conclusion, the classification of markets into the frontier market category is a highly dynamic process and the major indices frequently revise their lists of markets. From a practical standpoint, investors interested in frontier markets need to be aware of such frequent updates and revise their investment strategy accordingly, so as to avoid the risk of duplication of markets in their diversified portfolios.

3.5 Frontier markets potential growth pattern

The increased investor attention to frontier markets can be attributed to a number of factors such as the decline in diversification gains from emerging markets and the search for better avenues to diversify away the portfolio risk. Despite the vagueness and ambiguity associated with frontier markets, there has been significant emphasis on diversifying into frontier markets in the recent years. As Kuczynski (1994) notes, as the level of market integration rises, the larger advanced markets will eventually slow down and gradually give way to the emergence of newer rapidly growing markets. With the decline in benefits from emerging market diversification as the emerging markets are increasingly integrated with the advanced capital markets, frontier markets become the final frontier for attaining diversification benefits. The possible similarities between the structure of emerging markets at the beginning of the 1990s and the current structure of frontier markets could provide insights into the predictability of growth for frontier markets to come in the future. The next section will therefore

analyse the basic similarities between emerging markets in the 1990s and the frontier markets of 2010.[4]

During the 1990s, emerging markets were the most sought after diversification area for international investors, as these markets provided immense benefits from their inclusion in a diversified portfolio. Since then, these markets have grown manifoldly and have become part of the mainstream investment scenario. Frontier markets, being the less developed of the emerging markets, fit the same scenario as the emerging markets did two decades ago (BlackRock, 2013). Hence, an examination of the similarities and differences between the nature and characteristics of these two categories will help to establish a potential growth path for the frontier markets. Wilcox's 1992 study *Taming Frontier Markets* is the earliest investigation into emerging market diversification. Wilcox examined 20 emerging markets of the late 1980s, and proposed that the frontier is where opportunities are greatest. Twenty years after the publishing of this seminal paper by Wilcox, the markets included in his study have grown into the emerging market giants of today and undergone immense investor preference for diversification benefits. This section will compare the characteristics of the markets in Wilcox's sample and the markets that are considered as frontier today and examine the similarities and differences between the two.

Wilcox studied 20 markets during the late 1980s and examined various factors such as the risk and return from these markets, market capitalisation and real growth. He analysed the diversification benefits from frontier markets using the

[4] The markets listed as "frontier markets" in 2010 have been presented in this section as was current at the time of data collection, but the list is revised frequently by indices such as S&P, MSCI and Russell.

PB-ROE chart which plots Price-to-Book ratio against Return on Equity for a number of securities. The markets that were included in Wilcox's sample as emerging markets have evolved into today's emerging market giants. The countries included as emerging markets in Wilcox's sample were: Argentina, Brazil, Chile, Colombia, Mexico, Venezuela, Korea, Philippines, Taiwan, India, Indonesia, Malaysia, Pakistan, Thailand, Greece, Jordan, Nigeria, Portugal, Turkey and Zimbabwe. This section will compare the markets of Wilcox's sample and the frontier markets of today based on the basic economic and financial parameters – market capitalisation, number of listed companies, growth of GDP, and a comparison of the two sets of markets with regard to the US market. This comparison will help to clarify the similarities and/or differences in the two sets of markets and trace the growth pattern that the markets of late 1980s followed in becoming today's emerging markets. The results of this overview will provide important insights for investors and fund managers who wish to consider frontier markets in their portfolios.

The emerging markets examined by Wilcox in 1992 had market capitalisation varying from 5.3% to 119.3% of their GDP. Zimbabwe, with US$1,390 million and Chile, with US$4,040 million, had the smallest market capitalisation, and Mexico with US$98,200 million had the largest market capitalisation in 1991. The GDP figures of these markets included Zimbabwe with the lowest of US$8,641million and Brazil with US$407,337 million at the highest. The annual GDP growth rates of these markets varied between -0.6% (Philippines) and 1.1% (India) on the lower side to a whopping 8.0% (Chile) and 9.4 % (Korea).

The markets that are considered as frontier today have a market capitalisation varying between 4.7% (Slovakia) to 111.9% (Jordan) of their GDP. Namibia (US$1,176 million) and Latvia (US$1,251 million) have the lowest market capitalisation, while Colombia (US$208,501 million) and UAE (US$109,619 million) have the highest. The annual growth rates of these markets vary between -1.2% (Croatia) and -0.5% (Jamaica) on the lowest ranks, and 8.6% (Qatar) and 9.2% (Argentina) at the top.

The market size of the emerging markets of the 1980s in comparison with the US market included 2.35% (Korea), 2.40% (Mexico) and 1.16% (India) as the larger markets, and 0.06% (Jordan), 0.09% (Chile) and 0.03% (Zimbabwe) as the smaller markets. While examining the market size of the frontier markets of 2011 in relation to the US market, the largest is Colombia (1.21%) followed by UAE (0.63%) and Qatar (0.51%). All the other markets in today's frontier market category have market size less than 0.5% of the US market. This can possibly be attributed to the tremendous growth in market capitalisation in the US equity market in the last decade. A detailed examination of these indicators is presented in the following sections.

3.5.1 Emerging markets in 1991 and 2010

The structure of the financial market in the emerging markets included in Wilcox's 1992 study in comparison with their structure in 2010 is examined here in order to present the extent of growth these markets have undergone in twenty years. The market structure of the emerging markets in Wilcox's study is detailed in Table 3.7 below. Mexico had the largest market capitalisation at US$98,200 million, followed by Korea at US$96,399 million. Jordan, Nigeria and Zimbabwe were among the markets with the smallest market capitalisation, with US$2,510, US$1,880 and US$1,390 million respectively. India with US$47,700 million, Thailand with US$35,799 million, and Brazil with US$42,800, were among the comparatively larger markets in the emerging market set of Wilcox's study. The market capitalisation as a percentage of their GDP varied from 119.3% in Malaysia, 76.9% in Chile and 59.9% in Jordan, to 6.9% in Nigeria and 5.3% in Indonesia. Markets such as Brazil, India and Thailand had market capitalisation at 10.5%, 17.8% and 36.4% of their GDP respectively. The number of listed companies in these markets ranged between as low as 60 and 87 in Zimbabwe and Venezuela to 686 in Korea and 2,556 in India. Brazil (540), Pakistan (542), Chile (221), Malaysia (321) and Thailand (276) had a greater number of listings in their markets.

These markets that were examined by Wilcox in 1991 have undergone tremendous changes in the past two decades and some of them have become the emerging market giants of today's economic world. Table 3.8 presents the market structure of these markets as in 2011. Brazil and India have recorded the highest

increase in market capitalisation in the last two decades, where Brazil's market capitalisation grew from US$42,800 million to US$1,545,565 million, and India's market capitalisation grew from US$47,700 million to US$1,615,860 million.

Table 3.7 Wilcox's emerging markets – market structure in 1991

Country	Market capitalisation (Millions of US $)	Market capitalisation (% of GDP)	Number of listed domestic companies
Argentina	18,499	9.8	174
Brazil	42,800	10.5	540
Colombia	28,000	9.8	83
Chile	4,040	76.9	221
Greece	13,100	12.9	126
India	47,700	17.8	2,556
Indonesia	6,819	5.3	141
Jordan	2,510	59.9	101
Korea	96,399	31.3	686
Malaysia	58,600	119.3	321
Mexico	98,200	31.2	209
Nigeria	1,880	6.9	142
Pakistan	7,329	16.1	542
Philippines	11,399	25.1	161
Portugal	9,610	10.9	180
Thailand	35,799	36.4	276
Turkey	15,699	10.4	134
Venezuela	11,200	21.6	87
Zimbabwe	1,390	16.1	60

Source: World Bank data, 1991

Table 3.8 Wilcox's emerging markets – market structure in 2010

Country	Market cap (Millions of US $)	Market cap (% of GDP)	Number of listed domestic companies
Argentina	63,909	17.3	101
Brazil	1,545,565	74.0	373
Colombia	208,501	72.3	84
Chile	341,584	167.9	227
Greece	72,638	23.8	287
India	1,615,860	93.5	4,987
Indonesia	360,388	51.0	420
Jordan	30,864	111.9	277
Korea	1,089,216	107.4	1,781
Malaysia	410,534	172.6	957
Mexico	454,354	43.7	130
Nigeria	50,882	26.3	215
Pakistan	38,168	21.8	644
Philippines	157,320	78.8	251
Portugal	81,995	35.9	47
Thailand	277,731	87.1	541
Turkey	306,662	41.7	337
Venezuela	3,991	1.0	55
Zimbabwe	11,476	153.6	76

Source: World Bank data, 2010

A comparison of the structure of the financial market of emerging markets in 1991 and 2010 shows that these markets have been catapulted to tremendous growth over a span of twenty years. The market capitalisation of Korea also increased manifold from US$96,399 million to US$1,089,216 million. Almost all these markets have undergone a significant increase in market capitalisation in the past two decades. Investors' interest in the frontier markets today is partially driven by the notion that frontier markets would benefit from the same processes of development that the emerging markets underwent (BlackRock, 2013). The next section will examine the features of current frontier markets in comparison to the structure of emerging markets in 1991.

3.5.2 Frontier markets in 2010: Similarities

The basic features of the financial markets included in Wilcox's study were presented in the previous section. An analysis of the characteristics of the frontier markets in 2010 in comparison to the emerging markets of 1991 will be of interest to investors. Table 3.9 depicts the market structure of the 37 markets that were considered as frontier markets by S&P Frontier BMI as of 2011. Colombia had the largest market capitalisation at US$ 208,501 million followed by UAE (US$109,619) and Kuwait US ($95,938). Latvia (US$1,251), Namibia (US$1,176) and Estonia (US$2,260) had the smallest market capitalisation among this set of frontier markets. Argentina (US$63,909), Nigeria (US$50,882), Pakistan (US$38,168) and Sri Lanka (US$19,923) were the other major markets. The market capitalisation of these markets as a percentage of their GDP ranged from 111.9% (Jordan), 89.4% (Qatar) to 5.2% (Latvia), 4.7% (Slovakia). Argentina's market capitalisation was 17.3% of their GDP, Colombia's was 72.3%, Nigeria's was 26.3% and UAE's was 47.6%. The number of companies listed in these markets varied between 1383 (Romania), 644 (Pakistan), 390 (Bulgaria), 19 (Zambia) and 7 (Namibia).

From Tables 3.7 and 3.9, it is evident that the emerging markets of 1991 and frontier markets of 2010 have similar market structures. The market capitalisation in both the market sets ranged from US$1,300 million to US$98,000 million (with the exception of Colombia at US$208,501 million). The number of companies listed is also similar with only two countries with a very high number of listings.

Table 3.9 Frontier markets of 2010: Market structure

Country	Market capitalisation (Millions of US $)	Market capitalisation (% of GDP)	Number of listed domestic companies
Argentina	63,909	17.3	101
Bahrain	16,933	82.8	44
Bangladesh	46,999	47	302
Botswana	4,075	27.4	21
Bulgaria	7,275	15.2	390
Colombia	208,501	72.3	84
Côte d'Ivoire	7,099	31.2	38
Croatia	24,911	40.9	221
Cyprus	4,992	19.9	123
Ecuador	5,262	8.9	40
Estonia	2,260	12.1	15
Ghana	3,531	11.3	35
Jamaica	6,626	47.3	39
Jordan	30,864	111.9	277
Kazakhstan	60,724	42.5	60
Kenya	14,460	46.0	53
Kuwait	95,938	87.6	215
Latvia	1,251	5.2	33
Lebanon	12,585	32.1	10
Lithuania	5,660	15.6	39
Mauritius	6,505	66.9	86
Namibia	1,176	9.7	7
Nigeria	50,882	26.3	215
Oman	17,301	36.9	120
Pakistan	38,168	21.8	644
Panama	10,917	40.8	34
Qatar	87,855	89.4	43
Romania	32,384	20.0	1383
Slovakia	4,149	4.7	90
Slovenia	9,428	19.7	71
Sri Lank	19,923	40.2	241
Trinidad & Tobago	12,158	59.6	37
Tunisia	10,681	24.1	54
UAE	109,619	47.6	101
Ukraine	39,457	28.6	183
Vietnam	20,385	19.7	164
Zambia	2,816	17.4	19

Source: World Bank data, 2010.

Another useful way to compare the two sets of markets will be to look at the sizes of their markets in comparison with the US market. The US market capitalisation in 1991 was US$4,090,000 million and in 2010 stood at US$17,138, 978 million. The emerging markets in 1991 and frontier markets in 2010 are both very small when compared to the US market. Table 3.10 presents a comparison of the two sets of markets in relation to the US market. In 1991, the largest market was Mexico (2.40) followed by Korea (2.35%), Malaysia (1.43%), India (1.16%) and Brazil (1.04%). All the other markets in 1991 were less than 1% each of the US market. Among the frontier markets of 2010, Colombia was the largest at 1.21%, followed by UAE (0.63%) and Argentina (0.37%), and all the other markets were less than 0.3% of the US market. This significant difference in the comparative size of the frontier markets can be partially attributed to the tremendous growth of the US market. The market capitalisation of the US has increased almost five times in the span of twenty years, and this immense growth has not been matched by any of the smaller markets. As a result, when comparing the sizes of the emerging markets of 1991 and the frontier markets of 2010 with respect to the US market, frontier markets seem to be much smaller than their emerging counterparts in 1991. For instance, in the 1991 set of emerging markets, 14 markets were less than 1% the size of the then US market. But in the 2010 frontier markets, 34 out of 37 markets were less than one third the size of the US market currently.

Table 3.10 Market size of the two market sets in comparison with the US market

Wilcox's emerging markets (1991)	Market size % compared to the US market	Frontier markets 2010	Market size % compared to the US market
Argentina	0.45	Argentina	0.37
Brazil	1.04	Bahrain	0.09
Colombia	0.68	Bangladesh	0.27
Chile	0.09	Botswana	0.02
Greece	0.32	Bulgaria	0.04
India	1.16	Colombia	1.21
Indonesia	0.16	Cote d'Ivoire	0.04
Jordan	0.06	Croatia	0.14
Korea	2.35	Cyprus	0.02
Malaysia	1.43	Ecuador	0.03
Mexico	2.40	Estonia	0.01
Nigeria	0.04	Ghana	0.02
Pakistan	0.17	Jamaica	0.03
Philippines	0.27	Jordan	0.18
Portugal	0.23	Kazakhstan	0.35
Thailand	0.87	Kenya	0.08
Turkey	0.38	Kuwait	0.55
Venezuela	0.27	Latvia	0.00
Zimbabwe	0.03	Lebanon	0.07
		Lithuania	0.03
		Mauritius	0.03
		Namibia	0.006
		Nigeria	0.29
		Oman	0.10
		Pakistan	0.22
		Panama	0.06
		Qatar	0.51
		Romania	0.18
		Slovakia	0.02
		Slovenia	0.05
		Sri Lanka	0.11
		Trinidad& Tobago	0.07
		Tunisia	0.06
		UAE	0.63
		Ukraine	0.23
		Vietnam	0.11
		Zambia	0.01

Source: World Bank data, 1991 and 2010. Calculated based on World Bank data US market capitalisation in 1991 –US$4,090,000 million and in 2010- US$17,138, 978 million.

An examination of the GDP patterns will also assist in drawing conclusions about the similarities between the two sets of markets. In 1991, Brazil, Korea, Malaysia and India were the largest among the emerging markets, and Jordan, Zimbabwe and Nigeria were among the smaller economies. Among the frontier markets of 2010, Argentina, Colombia, UAE and Nigeria were the four largest economies, and Botswana, Jamaica, Namibia and Mauritius were among the smallest economies. The GDP growth rate of the two market sets is presented in Table 3.11. In 1991, Argentina was the forerunner with 12.37% growth, followed by Venezuela (9.7%), Korea (9.4%) and Malaysia (9.5%). Philippines (-0.6%) and Turkey (0.7%) had the lowest growth rates. Indonesia (8.9%), Thailand (8.6%) and Chile (8.0%) also performed well in 1991. All the other markets had a GDP growth rate between 1% and 6%.

Table 3.11 Comparison of the GDP growth rates of the two market sets

Wilcox's emerging markets (1991)	GDP growth rate (1991)	Frontier markets 2011	GDP growth rate (2010)
Argentina	12.7	Argentina	9.2
Brazil	1.5	Bahrain	6.3
Colombia	2.3	Bangladesh	5.8
Chile	8.0	Botswana	7.2
Greece	3.1	Bulgaria	0.2
India	1.1	Colombia	4.3
Indonesia	8.9	Cote d'Ivoire	3.0
Jordan	1.8	Croatia	-1.2
Korea	9.4	Cyprus	-1.0
Malaysia	9.5	Ecuador	3.6
Mexico	4.2	Estonia	1.8
Nigeria	4.8	Ghana	6.6
Pakistan	5.1	Jamaica	-0.5
Philippines	-0.6	Jordan	3.1
Portugal	4.4	Kazakhstan	7.0
Thailand	8.6	Kenya	5.3
Turkey	0.7	Kuwait	4.4
Venezuela	9.7	Latvia	-0.3
Zimbabwe	5.5	Lebanon	7.0
		Lithuania	1.3
		Mauritius	4.0
		Namibia	4.8
		Nigeria	7.9
		Oman	1.1
		Pakistan	4.4
		Panama	7.5
		Qatar	8.6
		Romania	0.9
		Slovakia	0.5
		Slovenia	1.2
		Sri Lanka	8.0
		Trinidad& Tobago	0.1
		Tunisia	3.7
		UAE	-0.7
		Ukraine	4.2
		Vietnam	6.8
		Zambia	7.6

Source: World Bank data, 1991 and 2010.

The frontier markets of 2010 had GDP growth rates similar to the emerging markets of 1991. Argentina, with 9.2%, had the highest growth, followed by Qatar (8.6%) and Sri Lanka (8.0%). Markets such as Croatia (-1.2%), Cyprus (-1.0%), UAE (-0.7%) and Latvia (-0.3%) recorded negative growth during 2010. Bulgaria, Jamaica and Slovakia also had growth rates lower than 1%. Nigeria (7.9%), Vietnam (6.8%), Bahrain (6.3%) and Bangladesh (5.8%) are the other major markets in this group that recorded more than 5% growth. More than 60% of the markets in the frontier markets category in 2010 category had a GDP growth rate of more than 3%. This is very similar to the case of the emerging markets of 1991 where more than 65% of the markets had growth rates higher than 3%. This comparison shows that the frontier markets have high potential to follow the tremendous growth path that was followed by the emerging markets since the 1990s. This anticipation has been one of the major reasons for the increased interest in frontier markets from both investors and academics.

Less developed markets, both emerging and frontier, have historically enjoyed very low correlations with developed capital markets, thus providing potential diversification benefits from investing in them (Schultz, 2010). These markets have very high growth potentials and as a result offer higher potential returns for investors. Frontier markets may represent the final frontier for global capital as today's emerging markets are integrating with the developed world (Speidell and Krohne, 2007). This comparative analysis of the market structure and GDP growth rates of the emerging and frontier markets of 1991 and 2010 shows striking similarities between the two market sets. The emerging markets of 1991 have, in the last two decades, undergone significant changes in market structure

and economic growth. Their market capitalisations have increased as much as 50 times for markets like Indonesia. The growth rates of the markets in the two sets possess similar characteristics also. Based on these initial indicators, it is highly likely that the frontier markets of today may follow a similar growth pattern as that followed by the emerging markets of 1991. Quisenberry Jr and Griffith (2014) conclude that various financial characteristics of the frontier markets are of high similarity with that of emerging markets 20 years ago. The authors underline the significance of frontier markets in future international diversification considerations as the larger emerging markets have come increasingly converged with the developed capital markets.

There is great need for further research on the issue of frontier market diversification in order to provide investors, academics and policy makers with reliable information on which to base their strategies in researching and trading in frontier markets. The primary objective of this thesis, to examine whether there exist any significant diversification benefits for an Australian and US investor from diversifying into frontier markets, will be addressed in the following chapters.

3.6 Conclusion

This chapter analyses GDP per capita, market capitalisation to GDP ratio, market turnover and the number of listed companies in frontier markets. The analyses of all the four indicators discussed in the previous sections shows that most of the frontier markets included in S&P, MSCI and Russell Frontier market lists fall within the limits of the four discussed indicators. 18 of the markets comply with all the four indicators, and 26 markets fall within at least 2 of the indicators.

The emerging markets included in S&P and MSCI emerging market indices are more or less compatible in terms of the member countries. However, with regards to frontier market indices, there is a large extent of overlap and vagueness. The analysis of data for the four indicators examined in this chapter indicates that 44 out of the 46 markets classified as frontier markets by S&P, MSCI and Russell Investments fall within the limits of the four indicators. The analysis of the four indicators presents broad criteria for classification of markets as frontier, and finds that most of the markets included in the major indices of frontier markets comply with these criteria. However, the dynamic nature of these markets requires frequent revision of the standards to be met, and hence, investors interested in frontier market diversification have to revise their markets often so as to avoid the risk of duplication of markets in a portfolio. Investor interest in frontier markets is evidenced by the establishment of numerous frontier market indices. Based on the argument that if market participants perceive markets as in a separate asset class, the markets tend to behave as such, this study will consider frontier markets as a separate asset class.

The 47 markets included in the frontier market indices of S&P, MSCI, Russell Investments and FTSE will be considered as the universe of frontier markets in this study. The examination of the salient features of frontier markets in this chapter has brought to light the common characteristics of these markets. With further research in the future, a clearer definition and specific criteria for classification of frontier markets will no doubt emerge. However, this research will use definitions of frontier markets as stated in recent studies and consider them as a separate asset class according to the perception of market participants.

Chapter 4
Literature Review

4.1 Introduction

One of the primary objectives of this thesis is to examine whether the addition of frontier market assets to a developed market investor's portfolio will provide potential benefits from diversification. In the present financial environment, investors as well as academics need to understand, develop and select appropriate investment strategies and create future advancements in theory regarding frontier market diversification. As frontier markets are the less developed of the emerging markets, they are characterised by smaller, segmented markets, and lower market capitalisation and turnover than the emerging markets. These distinct characteristics, along with other dynamic factors, make frontier markets less correlated with the developed markets and amongst themselves. The primary basis for increased interest in frontier market diversification and potential benefits from the same is the theoretical rationale put forth by Markowitz (1952) which suggests that the addition of less correlated assets to a portfolio would reduce the total risk of the portfolio. However, in the event of increased integration between world capital markets, the possibility of achieving benefits from diversifying using frontier markets needs to be analysed thoroughly. In order to explore the dynamics of frontier market diversification and possible benefits from it for an investor from a developed capital market, it is important to review the relevant literature in detail.

Previous research on portfolio diversification is extensive. The theory of diversification evolved from Lowenfeld's (1909) theory of geographical diversification, and later on from Markowitz's widely accepted theory of

diversification (1952). A large number of empirical studies have also been conducted on whether international diversification of portfolio is beneficial or not, and while some of these have concluded that international diversification of portfolio is not beneficial, the general consensus is that it does result in significant benefits to the investor. Various studies have examined the factors that influence the benefits of diversification, and many factors have been identified. A review of the major factors that affect an investor's benefits from diversification is highly important so that appropriate techniques can be employed in the diversification strategy adopted. The increased investor interest in less developed markets for diversification of portfolios has been evident since the early 1990s. In the initial years of this change, the focus was primarily on the emerging markets during the 1990s. With increased globalisation and integration of world capital markets, benefits from emerging markets have started to decline, and a new set of markets called frontier markets has emerged as the potential next avenue for diversification. Previous research has documented the benefits from emerging market diversification and the recent decline in benefits from these markets. Recent studies have outlined the immense significance of the inclusion of frontier markets in a diversified portfolio. This chapter summarises the basis of the theory of portfolio diversification and reviews previous empirical studies on this subject, in order to examine the significant differences in the nature of frontier markets, emerging markets and developed markets, and the differences in diversification benefits from these markets.

The majority of diversification studies have been conducted from the perspective of a US investor (Grubel (1968), Levy and Sarnat (1970), Agmon (1972)). The

results from such studies may not be directly applicable to smaller markets such as Australia because of the large differences in the sizes of the two markets, and the effects on the investor's benefits will be different. The Australian market is less than one-tenth the size of the US market; hence a separate study from an Australian perspective is significant. In recent years, there has been an unprecedented growth in the managed funds sector in Australia, and it is expected to grow even further in the coming years. Such a growth in potential investment funds available to the Australian investor makes it necessary to investigate the various diversification options available. There have been no studies on frontier market diversification from the perspective of an Australian investor, and my research will bridge that gap. Along with examining the potential benefits to an Australian investor, drawing a comparison between the US and Australian perspectives will be of great use to both investors and researchers. This chapter will review previous research on international diversification by Australian investors and the primary conclusions drawn from them.

One of the issues regarding frontier market diversification is the vagueness and lack of precise definitions for frontier markets as a separate category of assets. The world capital markets are classified into developed markets, emerging markets and most recently frontier markets. This categorisation is based on the World Bank's criteria for high and middle income economies, along with various benchmarks used by the major index operators such as S&P and MSCI. Since 2007, a number of frontier market indices have been launched, and this is evidence for increased investor interest in these new markets. The classification of frontier markets as a separate asset class has been subject to criticism, and this

chapter will also examine the theoretical basis for classification of markets. A detailed analysis of the economic and financial characteristics of frontier markets was presented in Chapter 3, which outlines the major criteria for categorisation of a market as a frontier market.

Frontier markets are a recent addition to asset classes available for international investors. Hence, the amount of research into frontier markets is limited. The theoretical rationale that suggests the addition of less correlated assets to a diversified portfolio will reduce the total risk of the portfolio forms the basis of the increased investor interest in frontier markets. With increasing level of integration between the world capital markets, investors are in search of avenues that could provide better risk adjusted returns, and frontier markets are considered a potential destination. This chapter will examine studies outlining the significance of frontier market diversification in the present global financial scenario.

4.2 The benefits of diversifying an investor's portfolio

Portfolio diversification is a technique employed by investors in order to reduce risk by allocating investments across various assets and to maximise return in such a way that these assets react differently to the same event. For instance, if a portfolio is constructed with exclusively aviation industry stocks, the portfolio is susceptible to high losses when a negative shock in the aviation industry occurs. On the other hand, if the portfolio is constructed with stocks across industries and markets, all the units included in the portfolio will react differently to the aviation industry's event and hence the total risk to the portfolio is diversified away.

Diversification would act as a safety net from the volatile nature of assets for investors. Over the past few decades the naive understanding of diversification as "not to put all your eggs in the same basket" has given way to more refined theories of portfolio diversification.

The recent years have witnessed wide fluctuations in financial markets, accompanied by crisis and recovery periods. From an investor's perspective, it is immensely significant to safeguard their investments from such volatile periods and the high risk of incurring losses. Diversification is important because there is no accurate way of predicting which investments or assets will perform well or badly and at which period (Wohnlner, 2013). Hence, if a portfolio is composed of a variety of assets that are exposed to different conditions, the total risk of the portfolio can be minimised to a great extent. This simple rationale underpins the importance of portfolio diversification in the current market conditions.

The concept of portfolio diversification is theoretically backed by models developed by Markowitz in 1952 and subsequently modified by the contributions of Grubel (1968), Levy and Sarnat (1970), and Agmon (1972). Modern portfolio theory postulates that the addition of less correlated assets to a portfolio will reduce the non-systematic risk of the portfolio and thus bring about a fall in the total risk of the portfolio. The application of this notion can be tested by diversifying the assets of a portfolio into different industries and/or markets that are unrelated or that have low correlations with each other. Diversifying a portfolio across industries within a market will reduce risks that are particular to each industry, but the market wide risk will not be diversified away. However,

holding assets that are diversified across markets that are less correlated with each other will provide greater diversification of market-specific risk, while at the same time risks of exchange rate volatility and transaction costs will affect the portfolio. Industry diversification and international diversification each have their own advantages and risks and these are examined in detail in subsequent sections of this chapter. Markowitz's theory was criticised primarily for the requirement of a large number of parameters to be modelled, and it was further developed into the CAPM by Sharpe (1964) and Linter (1965). Various improvements of these models have been made subsequently in the form of the APT models and the Blackman-Litterman model. The theoretical basis for portfolio diversification and the major models were examined in detail in Chapter 2. Empirical evidence from a number of studies also supports the argument that there are significant benefits from international portfolio diversification and a detailed analysis of these studies is presented in the following sections of this chapter.

The discussion of portfolio diversification from an Australian perspective is important for various reasons; the growth of Australian managed funds sector and research and investor interest in Australia during and after the GFC period are some of them. The Australian financial services sector is in a phase of tremendous growth in managed funds; the Reserve Bank of Australia (RBA) estimates the managed funds sector will stand at $2.5 trillion[5] in 2015 (Australian Bureau of Statistics, 2007). There is an immense need to understand diversification options better and search for avenues that might provide better risk adjusted returns for

[5] The total managed funds as of December 2015 is $2.64 trillion. The immense rate of growth in this sector is evident while comparing this figure was $1.78 trillion in June 2011 and rose to $2.59 trillion by September 2015.

the investor. In the earlier years, the major emphasis of investors from developed markets was to invest in the equities listed in other developed markets. Historically, Australian investments to overseas markets have been primarily directed towards other developed markets, particularly USA, UK, other European Union countries and New Zealand (ABS, 2011). The capital markets across the globe have become more and more integrated with each other because of higher levels of globalisation and increased multi-lateral linkages between markets. The developed markets have almost completely integrated with one another, which is evident from high correlations amongst themselves, and the similarity prevailing in the patterns of reactions to economic and financial events and also in the market systems prevailing. The increase in interdependence between developed equity markets over the past years was a result of increased synchronisation of fundamental economic policies such as interest rate correlations, bilateral trade, similar GDP growth rates, and more importantly, openness of capital accounts (Quinn and Voth, 2010). Quinn and Voth (2010) examine 16 developed equity markets over the period 1890–2001 and find that the rise in openness of capital accounts caused an increase in correlations and eventually brought a marked decline in diversification benefits. In the event of full integration among the developed capital markets, the potential for attaining benefits from diversifying amongst them is very low. If an investor from a developed capital market were to diversify his/her portfolio into equities from other developed markets alone, in the event of a financial/economic/political shock, these markets are highly likely to move in the same direction and thus fail to provide a safety net for the investor. This emphasises the need for investors from developed markets to search for and

identify appropriate markets that are segmented from the domestic market so that there will be significant gains from diversifying into them.

The importance of looking into emerging markets for diversification benefits has captured investor interest since the 1990s as the advanced capital markets increasingly integrated with each other. Emerging markets are the bigger markets among the less developed group of markets and these were highly segmented from the developed markets with regard to their capital account openness, economic policies, financial structures and even political scenarios. These distinct characteristics created a barrier of segmentation between the developed and emerging markets and provided investors from the former with potential benefits from diversifying into the later. Since the early 1990s, there has been a major inflow of foreign investments into the emerging markets and a large number of studies have validated the benefits from emerging market diversification (Speidell and Sappenfield, 1992; Wilcox, 1992). In the last two decades, a significant portion of Australian investments have been directed towards emerging markets, and Malaysia, Philippines, Thailand and India are the prominent destinations. As put forth by Quinn and Voth (2010), with the increase in capital account openness and synchronisation of the major economic and financial policies, emerging markets have become increasingly integrated with the developed capital markets, and hence there has been a reduction in the potential benefits from emerging market diversification. Studies by (Chiang, Jeon and Li, 2007; Gupta and Donleavy, 2009) have found that there has been a decline in benefits from emerging market diversification over the recent years, which has motivated

investors from developed markets to spread their search for new avenues that could provide better diversification benefits.

Frontier markets have in the past couple of years been recognised as a separate set of assets by the international financial world, which is evident from the setting up of a number of frontier market indices such as S&P Frontier Index, MSCI Frontier Index and Russell Frontier Markets Index. Frontier markets, the smaller markets in the less developed category, are highly segmented from the developed capital markets and provide a potential sector for the international investor to gain diversification benefits. These markets are much smaller than the emerging markets in terms of market capitalisation, market turnover, number of trading companies, GDP growth rates and overall openness of the capital account for international investors. The specific characteristics of frontier markets are presented in Chapter 3; these distinct features of frontier markets cause segmentation between these markets and the developed capital markets. The lack of integration with frontier markets is evident from significantly low correlations between developed markets and frontier markets and offers a greater possibility of attaining diversification benefits before these markets are synchronised with the other major markets. The uncertainty and vagueness associated with frontier markets have hindered the inflow of international investments into these markets to a certain extent and access to reliable empirical evidence regarding this will assist in developing appropriate investment strategies. Given the unprecedented growth of managed funds forecast in Australia, frontier markets could potentially offer a better destination for portfolio diversification, as benefits from emerging

markets have declined. In this scenario, it is immensely important to understand the future of international diversification in the light of previous literature.

4.3 International portfolio diversification

The return on a portfolio is calculated as the weighted average of all the assets included in that particular portfolio, and the risk of the portfolio is measured as the standard deviation of all the assets included in that portfolio. Better risk-adjusted returns from a portfolio would mean that the standard deviation is low, paired with a higher return. One of the established methods of reducing the overall portfolio risk is to combine assets that have very low correlations with each other. Markowitz (1952) demonstrated the combining of assets with different characteristics, proving that diversification reduces risk, and his study became the foundation of modern portfolio theory (MPT) and later on for the capital asset pricing model (CAPM). Markowitz identified that the total risk of a portfolio is made up of systematic and non-systematic risk. Systematic risk is that part of the portfolio risk which is market-wide risk and is non-diversifiable. Non-systematic risk, on the other hand, is company-specific and thus can be diversified by holding assets in different companies. Markowitz noted that when different assets are added to a portfolio, the total non-systematic risk of the portfolio could be reduced. However, the extent to which the total risk of the portfolio could be reduced would be dependent on the correlations between the assets that are included in the portfolio. Investors agree that creating a portfolio with assets that are not correlated or that have low correlations will reduce risk and potentially improve the performance of the portfolio

The concept of international portfolio diversification is based on the notion that addition of assets from markets that have low correlations with the domestic market of an investor could provide the investor with potential benefits. For instance, an investor from a developed capital market such as the US could benefit from holding a diversified portfolio of assets from markets that are less correlated with the US such as certain emerging and frontier markets. The returns on individual securities within an economy tend to move together and if the degree of this co-movement is higher, there is much lower possibility of reducing risk through diversifying domestically (Levy and Sarnat, 1970). These similarities in individual domestic securities could apply to a great extent to markets that are similar in nature and characteristics, hence the significance of diversifying into less developed markets is evident.

The benefits of international diversification of portfolio have been widely discussed and well documented in academic research. The quantitative analysis of international diversification dates back to Henry Lowenfeld's (1909) study of equal weighted, industry neutral, risk adjusted, international diversification strategies, using price data from the global securities trading on the London Exchange around the turn of the century (Goetzmann, Li and Rouwenhorst, 2001). Lowenfeld (1909) developed the Theory of Geographical Diversification and proposed a portfolio of securities to be divided among North American, British, Swedish, South American, Indian and South African railways for a five-year sample period. He argued that allocation of capital over different geographical areas in equal proportions and a regular rebalancing of these proportions would result in superior investment performance. Subsequent advancements in research

have concluded that a geographical diversification alone cannot guarantee benefits, and a thorough methodology needs to be adopted while formulating the strategy for portfolio diversification. Jayasuriya and Shambora (2009) analysed the efficient frontiers of several portfolios from developed and underdeveloped countries and found that a globally diversified portfolio has higher benefits than a non-diversified individual regional portfolio. Their results show that in the previous eight years of the study, the benefits to a US investor from a diversified portfolio would have been much higher than from a non-diversified portfolio.

Since the 1960s, there has been greater interest in the issue of interdependence among financial markets, and many research studies were produced. This chapter aims to provide a comprehensive presentation of various sections of the literature on portfolio diversification. The primary purpose is to examine whether there is evidence to support the theory that international portfolio diversification is beneficial, and if so, what are the most accurate ways to measure potential gains from diversification? The general consensus in literature is that an internationally diversified portfolio will accrue benefits to the investor, and that multivariate techniques are highly accurate in estimating benefits from diversification. Congruent with this broad conclusion, my study will use the multivariate AG-DCC GARCH model to examine whether diversification into frontier markets is beneficial to an Australian and a US investor.

Based on the classification of literature provided by Da Costa, Nunes, Ceretta and Da Silva (2005), the literature on international portfolio diversification can be categorised into three major areas. The first one focuses on examining the benefits

from international diversification of portfolio based on covariance or correlation estimation; the second looks at whether correlations are stable over time; and the third group focuses on the use of multivariate techniques to understand market co-movements and the impact on gains from diversification. Accordingly, the following section will examine in detail the relevant studies in the three categories. The earlier studies on international diversification focussed mainly on correlation and covariance estimation to draw conclusions about potential benefits from international diversification, and many of those studies recorded that international diversification is gainful (Agmon 1972; Grubel 1968; Lessard 1973). During the late 1970s and early 1980s, evidence was recorded on unstable correlations between markets over time, and hence, the use of simple correlation or covariance models to estimate benefits from international diversification was rejected. Various multivariate models have been developed to estimate diversification benefits, and the AG-DCC GARCH model is considered to be a computationally efficient and superior method.

Among the early studies in the first category that examined the benefits from diversification, Grubel (1968), Levy and Sarnat (1970), Agmon (1972) and Lessard (1973) are the most prominent. Grubel (1968) examined the potential gains to an American investor from diversifying into 10 foreign equity markets for the period 1959–1966. Using the monthly data from these markets, he estimated ex-post returns and variances and calculated each market's pattern in the US market. He found that investors could have attained higher rates of return or lower variances of portfolio through international diversification. Levy and Sarnat (1970) presented more empirical evidence of the potential benefits of diversifying

portfolio internationally in their study of 28 countries for the period 1951–1967, and included less developed equity markets in the portfolio, noting that this considerably improved the risk-return position for the investor. The authors propose that the additional benefits of including less developed markets would arise due to inefficiencies arising from the barriers to capital flows, and hence if existing restrictions on capital flows are eliminated, higher gains from diversification can be attained.

Following the studies by Grubel (1968) and Levy and Sarnat (1970), Agmon (1972) examined the relationship among share price movements in the equity markets of the United States, United Kingdom, Germany and Japan, and found that there are no major benefits from diversifying into these developed markets. Prodhan (1986) notes that this finding from Agmon (1972) could be due to the fact that the sample size is relatively small, and that all markets included were developed markets with similar characteristics. Agmon (1973) agreed with this explanation and in his subsequent research established some degree of dependency among the markets during the period 1961–1966 and also noticed that there were certain unique country factors that cause differences.

The international diversification potential among a group of four Latin American countries – Colombia, Chile, Argentina and Brazil, was analysed by Lessard (1973). He used quarterly returns from 110 common stocks for a period covering 1958–1968. A multivariate examination of the structure of the returns and a comparison of the historical performances of domestic and international portfolios were carried out. The multivariate analysis found that substantial gains can be

obtained from a wide range of investment strategies. A similar study was conducted by Solnik (1974) with the United States and seven European equity markets. He used weekly data from Belgium, France, Germany, Italy, Netherlands, Switzerland, the UK and the US over a period of six years. He selected stocks in a random manner based on the assumption that investors could not select profitable investments, and then assigned equal weights to each stock and calculated the additional variance reduced through the increment of the stocks included in the portfolio. He examined various methods of diversification strategies such as across countries, across industries and across countries with currency hedging. The results indicate that the strategy of diversifying across countries provided higher benefits than domestic diversification for the US investor. You and Diagler (2010) studied international diversification using three methods – conditional correlations, tail risk and trade-off between standard deviation with correlation, skewness and kurtosis. They conclude that estimating international diversification based entirely on constant correlations could be misleading, because correlations are time varying, benefits from diversification are affected by non-normality, and benefits depend on the country benchmarks that are used. In general, the early empirical studies that looked into benefits from international diversification conclude that investors will benefit from increasing their expected return, decreasing the returns variation and lowering correlations between foreign security returns and domestic security returns (Mansoufar, Mohamad and Hassan, 2010). In conclusion, many of the early studies in international portfolio diversification were based on correlation or covariance methods for understanding and forecasting the benefits from diversification.

During the 1980s, various studies provided evidence that market co-movements are not stable over time, and hence the use of simple correlation or covariance methods to forecast diversification benefits may be insufficient. The second category of international portfolio diversification research is focussed on examining whether correlations between equity returns across markets are stable over long periods of time. Makridakis and Wheelwright (1974) analysed the inter-relationships between the major stock markets in the world. The authors used daily stock index data from 14 markets over the period of 1968–1970. The study finds that the interrelationships between these markets are unstable over time. They conclude that even though the correlations between these markets were lower than 1 at all times, their unstable nature and unpredictability make it difficult for investors to reap benefits from international diversification. Joy et. al (1976) examined the co-movements in returns of the major European equity markets and found low levels of correlation between them. The authors used cluster analysis and concluded that the international markets tend to present some stability and structure while certain markets exhibit higher degrees of similarity. Ripley (1973) investigated the systematic covariation between the stock markets of 19 developed countries. He used average monthly stock price indices for the period 1960–1970. Using factor analysis, Ripley found that most of the movement in the developed market index is unique to each country. Hilliard (1979) examined the daily data from 10 developed markets during 1973–1974, using the autospectrum of price change method, and found that most intra-continental prices move simultaneously, whereas most inter-continental prices are not closely related.

Most of the early research on the co-movement of equity markets during the 1960s and 1970s found that there are low correlations between the developed markets, but this finding shifted after the 1987 crash of the US market. Lee and Kim (1994) concluded that national stock markets tended to be more inter-related after the crash. Jeon and Von-Furstenberg (1990) found that after the 1987 crash, the co-movements between markets became much stronger than before. Roca (1999) examined the relationship between eight markets to determine long run relationship between them. He found that the US and the US markets significantly influence the Australian market. Similarly, Lamba (2005) examined the long run relationship between the major developed equity markets and the South Asian markets using a multivariate co-integration framework. He concluded that the Indian market is greatly influenced by the US, UK and Japanese markets. In general, during the 1960s and 1970s, the equity markets were less dependent on each other with very low correlations.

As the world capital markets have become more and more linked with each other, markets have become integrated and highly correlated, especially the developed markets. Recent studies have shown that emerging markets have also started to become integrated with the developed equity markets, and hence the potential for achieving diversification benefits from them is declining rapidly. Summarising the literature in the second category, the inter-relationships between equity markets are unstable over a long run, and hence the use of simple unconditional correlation or covariance methods to estimate potential benefits from international portfolio diversification could lead to misleading conclusions. This scenario frames research on frontier market diversification, and the importance of using

computationally efficient models to estimate potential benefits from diversification is central to the methodology.

Analysis of the literature in the previous sections reaches a general consensus that equity markets are dynamic over time, and the impact of this instability on diversification benefits cannot be estimated and forecasted using the simple unconditional correlation and covariance methods that were employed in the earlier studies. Advancing from this conclusion, studies have adopted various multivariate analysis techniques in order to analyse co-movements of equity markets and their impact on potential benefits from portfolio diversification. These studies are examined in the following passages.

Lessard (1973) used a multivariate analysis to examine the structure of stock market returns from four Latin American countries. He noted that this methodology appeared to be a useful approach to analyse international diversification of portfolio. Philippatos, Christofi and Christofi (1983) use the Principal Components Analysis (PCA) Test as an alternative method to test for the stability of interrelationships between equity markets. The authors also provided various bivariate statistical techniques and note that multivariate analysis is superior. Meric and Meric (1989) use various inter-temporal stability tests and various seasonality tests in their study, and find that diversification across countries will provide greater benefits than domestic diversification. The authors also find that within their sample period, the co-movements of stock markets were stable during certain periods and highly unstable at other times. Kaplanis (1988) used the Box M test which is designed to test the equality of variance-covariance

matrices during various periods of time. Kaplanis (1988) also used Jenrich's Chi Square test to examine the hypothesis of equal correlation matrices of return indices. The author found that the correlation matrix was more stable than the covariance matrix over four sub-periods. Driessen and Laeven (2007) examine whether there are benefits to non-US investors from international diversification using the Huberman and Kandel (1987) model. They used the monthly index returns for 52 countries for the period 1985 to 2002, and estimated the potential improvements in expected returns and diversification benefits subject to the constraints of short-sales. The study finds that for a globally diversified portfolio, the Sharpe ratio increased from 10% to 21%. They conclude that due to the global integration of world capital markets, the benefits from diversification fell during the period of study.

Multivariate GARCH models have been extensively used and accepted as a computationally efficient way of estimating time varying correlations. King, Sentana and Wadhwani (1994) analysed the interrelationships between stock markets around the world using a multifactor GARCH process, and noted that the variation in correlations over time were not completely explained by the inclusion of economic variables. The authors failed to find any empirical evidence pointing towards a rise in correlation between the markets over the period of their study. Login and Solnik (1995) examined seven markets and tested for constant correlation hypothesis using a bivariate GARCH model. They also examined whether correlations between these markets increased when volatility was high, using the Threshold GARCH approach. The results indicate that correlation and volatility are positively related and also that correlations between these markets

have increased over time. Analysis of the third category of international diversification studies concludes that appropriate multivariate techniques need to be adopted to accurately estimate the potential benefits from international diversification of portfolios. Based on studies that have used multivariate GARCH models for estimating time varying correlations and recorded those models as accurate estimation tools, my study applies the AG-DCC GARCH model. Chapter 5 presents a detailed examination of the various tests for diversification benefits: regression-based mean variance spanning tests, stochastic discount factor-based GMM tests, numaraire portfolio tests, multivariate GARCH models, and the superiority of AG-DCC GARCH model.

All the studies discussed in the preceding sections have concluded that there is at least some degree of gain to be achieved from international diversification of portfolios. However, there are some studies which argue that international portfolio diversification is not as beneficial as recorded previously. Bartram and Dufey (2001) state that international diversification involves various risks such as taxation issues, currency risk, political risk, and several institutional barriers. The authors emphasise that the direct purchase of foreign securities involves major complexities like transaction costs and lack of sufficient information, whereas international mutual funds will involve the problem of choosing the appropriate benchmark/index. They suggest that domestic diversification through multinational companies could be considered as an alternative strategy. You and Diagler (2010) state that looking at constant correlations alone for international diversification can be misleading. They found that diversification benefits calculated using conditional correlations vary over time, and also that

diversification benefits diminish between US and European markets. When they consider standard deviation, skewness and kurtosis as factors determining diversification benefits, very little benefit was found for the S&P500 index, indicating that the superiority of international stock market diversification from the S&P500 perspective will need to be revised. De Roon, Nijman and Werker (2001) found that portfolios of US, Europe and Japan with emerging markets provide significant diversification benefits when major factors of market friction are not taken into account. When they took into consideration factors such as transaction costs and short sale constraints, benefits from diversification diminished significantly. Kalra, Stoichev and Sundaram (2004) studied the effectiveness of international diversification in the presence of periodic rebalancing and associated transaction costs, and found that allocating only a small percentage of the portfolio to international assets can be justified. They suggest that even the smaller benefits from international diversification will disappear when taxation restrictions are imposed, and make a case against the benefits of international diversification. Das and Uppal (2004) also found that the gains from diversification are reduced when systemic risk is incorporated in the portfolio selection model and the potential losses from holding highly levered positions is large.

However, on balance, research has accepted that an investor benefits from international diversification despite transaction costs. These benefits are more pronounced when considering less developed markets for potential inclusion in a diversified portfolio. Research has also found that these benefits can still be realised after accounting for higher transaction costs and higher potential volatility

of the developing markets (Bekeart and Harvey, 2003). However, the presence or absence of certain economic/financial/political factors could greatly affect the extent of benefits from international diversification of a portfolio. A detailed examination of some of the factors that affect diversification benefits is presented in the next section.

4.4 Factors affecting benefits from international portfolio diversification

The issue of what factors influence returns from equities and benefits from diversification has been largely unsettled in finance. Some of the factors that have been examined previously are: level of market integration, country risk, currency risk, exchange rate volatility and home bias. There have been several studies that looked into the impact of these factors on benefits from diversification, but a consensus has not been reached on the prominent factor.

4.4.1 Market integration

Market integration is a factor that greatly influences international diversification. The theory of portfolio diversification puts forth that diversifying across countries whose stock returns are less than perfectly correlated could lead to diversification benefits for the investor. The basic requirement for this rationale is that stock markets exhibit independent price behaviours (Xu, 2011). Market integration will result in similar co-movements of asset returns regardless of the geographical separation of the markets, and hence there will be low or no gains from diversification. In a scenario where the capital markets are fully integrated, there

would not be any potential for making above normal profits in the long run because any such profits would be arbitraged away in the long run (Xu, 2011). Thus, the presence of market cointegration has a significant impact on the possibilities of international portfolio diversification. Even though country specific factors make stock markets different from each other, since the 1990s, globalisation has resulted in increasingly integrated equity markets. Xu notes that many studies have emerged since the 1990s, looking into the level of integration between markets in the long run, and these have investigated the cointegration between developed markets, between emerging markets, and between developed and emerging markets.

The measure for level of integration between markets is based on three methods – the empirical tests of CAPM or APT, the calculation of correlations, and various co-integration tests (Fadhlaoui, Bellalah and Lahiani, 2011). Fadhlaoui et al. state that the first method suffers from the drawback that it does not address the issue of partial integration/segmentation. The correlation method, being computationally simple to implement and efficient in estimating the level of integration, is used in a part of their study. They also use a cointegration test in their study. They examine the impact of market integration on international diversification using five developed markets and 26 emerging markets. Using the correlation method, they find that all the developed markets are highly correlated, hence the gains from diversification among them are insignificant. On the contrary, correlations between emerging markets and developed markets in their sample are low. The authors use various multivariate and bivariate cointegration tests and find that the developed markets are more integrated than the emerging

markets. They conclude that diversifying into emerging markets will hence be an efficient strategy for international diversification.

The cointegration of the US market with other markets has been examined in a number of studies. Eun and Shim (1989) present a Vector Autoregressive Analysis (VAR) of the US market with eight other markets; results indicate that there are significant multi-lateral interactions between the markets. The study finds that the markets included in the study are highly influenced by news originating in the US, and also that the correlations of the markets with the US have become stronger after the 1987 crash. Based on the results which indicate that the US market affects all the other markets, the authors conclude that the USA is the most dominant market in the world. Cheung and Ng (1992) analysed the cointegration between the US, Japanese and Asia-Pacific markets, and found that the US market was a dominant global factor during 1985–1989. Tokic (2003) examined the dynamic relationships between the US and five developed markets – Australia, Japan, Hong Kong, New Zealand and Singapore, and found evidence for positive long-run relationships. Similar results have been produced by a large number of studies, indicating that the developed capital markets, especially the US market, are increasingly integrated with each other (Arshanapalli and Doukas 1993; Cheung and Mak 1992; Ghosh, Saidi and Johnson 1992; Gilmore and McMannus 2002; Kasa 1992; Wu and Su 1998). Longin and Solnik (2001) studied the stock markets of five developed countries – the US, UK, France, Germany and Japan using a bivariate EVT (Extreme Value theory) method and find that the correlations across these markets increased significantly during bear markets. Chollete, Pena and Lu (2011) also found that the tail dependence from

bivariate EVT model of 14 markets during 1990-2006 period showed an increase in dependence across the markets over time. Bhatti and Nguyen (2012) investigated the level of dependencies across 6 markets – Australia, the US, UK, Japan, Hong Kong and Taiwan using Conditional EVT (C-EVT) and time-varying copula (TVC). They find left tail dependence for Australian market with the US market and both upper and lower tail dependence of Australian market with the UK, Japanese and Hong Kong markets.

The asymmetric behaviour of 31 emerging market returns during 1995 to 2004 was examined by Cheung and Miu (2011), and they analyse these markets across different regimes of global and local markets. The authors found that asymmetric correlation among these markets was much weaker than that between the developed markets. The results of their study indicate that correlations between these markets have a tendency to be higher during a bear market and lower during a bull market. They find little evidence that possessing of asymmetric correlation information does not result in any improvement in performance of the portfolios in the emerging markets considered. Daly (2003) examines the interdependence between five emerging markets (Indonesia, Malaysia, Philippines, Singapore and Thailand) and three developed markets (Australia, Germany and USA). He used the correlation method and cointegration tests to analyse the level of integration before and after the Asian financial crisis of 1997. Using the correlation analysis, he found that the level of interdependencies across the markets increased after the crisis. He found evidence for long run integration between the emerging markets, but also found that post-crisis, the increase in level of integration is not very strong. He concluded that there would be gains to an investor from the developed

markets in diversifying into these Southeast Asian markets. Johansson (2011) examined the equity market movements in East Asia and Europe during the financial crisis period and looked into volatility, covariance and correlations. He found that until the second half of 2008, patterns in covariance and volatility were relatively stable in both East Asia and Europe. During the crisis period, correlations were very high in Europe and relatively high in the East Asian region as well. The study found that regional co-movements were significantly higher in Europe, since the spread of the crisis affected this region much more. The study also found that during the GFC, markets in the two regions moved closer together in comparison to the local effects of the Asian financial crisis.

The impact of the introduction of the euro on stock markets and its effects on country diversification within the Euro zone was examined by Smimou (2011). The study used stock return data from nine markets—five markets in the Euro zone (Austria, Belgium, France, Germany, the Netherlands), three markets in the non-Euro zone in Europe (Denmark, Switzerland, the UK) and one non-European market (the US), and covered a period from 1993 to 2006. The study found that under the Euro currency, abnormal returns in stock market were statistically negative when compared to the past European currencies in two of the markets studied, and no major change was noted in any other European markets. The study concludes that market integration through the introduction of the Euro has resulted in an increase in the correlations between these markets, but it does not preclude the gains from international diversification. The findings of the study have certain practical implications, such as that European investors can potentially improve their portfolio by adding Euro and non-Euro stocks to their portfolio.

The capital markets become more integrated and as the analysts from the world's largest institutions arbitrage away excess returns from different sources, the result will be a rapid decline in the scope for exploiting any 'inefficiencies' (Fraser, Helliar and Power 1992). Yang, Tapon and Sun (2006) found that correlations among equity markets are on the rise, and diversification across countries no longer provides the same level of risk protection as before. They state that diversification across industries around the world would provide better risk reduction benefits than diversifying across countries. They conclude that globalisation has increased the significance of industry level diversification. Flavin and Panopoulou (2009) examined whether the benefits from international diversification are robust enough to withstand the time varying volatility of returns. They looked into the G7 countries during a period of 1973–2005, and concluded that benefits from diversification are not significantly different in calm as well as turbulent markets. In their study, they found that expected returns vary between regimes; calm markets provide positive mean returns while turbulent markets generate negative returns and that even though the benefits from diversification are not as high as perceived, a diversified portfolio stands better than a non-diversified one. The authors conclude that their results strongly support the adoption of international diversification strategies. Bley and Saad (2011) examined the effects of financial liberalisation on stock-return volatility in the Gulf Cooperation Council (GCC) markets – Bahrain, Kuwait, Oman, Saudi Arabia, and UAE and found that higher international participation in local markets does not have any impact on idiosyncratic volatility, but has a rising impact on

total volatility. They conclude that total volatility of a market decreases with stock market development and increases with economic growth.

The effect of globalisation and integration on the benefits from country and industry diversification was studied by Baele and Inghelbrecht (2009). They examined 18 industries, 21 countries and four regions over the time period from 1973 to 2007 and found that benefits from geographical diversification have decreased as a result of increased levels of globalisation and integration of world markets. They also note that if diversification does not consider the time varying factor, the results could be subjected to significant misinterpretations. Baele and Inghelbrecht (2010) also studied 14 European countries during the period 1973–2007 using a two factor model for regional and global market shocks as factors and tested for market integration. They found that there has been a significant increase in global market exposures and correlations, and conclude that market integration has increased in the three decades of the study.

The financial co-movements of both developed G-7 markets and emerging markets have increased in the 1990s; however, the increase in correlations between the G-7 markets is much higher than the increase in correlations between the emerging markets (Brooks, Forbes and Mody, 2003). They attribute the reason for rise in correlations to increased financial openness since the 1990s. The authors summarise that increased policy openness among the world markets has caused a growth in capital flows across borders and a reduction in home bias, and eventually has led to a rise in correlations across markets. The authors examine whether the increase in financial co-movements are underpinned by real co-

movements. After examining recent empirical evidence, the authors conclude that the evidence on the links between real and financial co-movements is mixed and remains debated.

The understanding of links between real and financial sectors is essential to examine the levels of integration between financial markets and what causes changes in integration of these markets. The issue of whether or not the real and financial sectors are related is more or less settled with empirical evidence, while the controversy is around the issue of the causal direction of the links between the two sectors. There are varied views on this causal direction; Brooks et al (2003) point out that according to one of the arguments, financial and real co-movements are inversely related. They also state that there would be certain 'shocks' that may cause these sectors to move in the same direction. Morck, Shleifer and Vishny (1990) examine how stock markets affect investments, and they review four theories that explain the link between the two. First, the passive informant hypothesis puts forth that the market does not play a significant part in determining the allocation of investment funds, and that investor sentiment does not affect investment. This view implies that the only factor that links stock returns to changes in output growth is related to the present discounted value of future dividends. The second theory, the active informant hypothesis, suggests that the stock prices do affect investment levels, as they provide information to managers that could assist in making decisions regarding investments. The authors also distinguish between accurate informant hypothesis and faulty informant hypothesis. A faulty informant hypothesis is that when a manager's investment decisions are based on stock market price movements that are affected

by market sentiments rather than market fundamentals, these would be faulty signals. The third theory, the financing hypothesis, implies that stock market price changes affect investment levels through the issuance of new securities when business owners decide to expand their capital, when stock prices are higher than the replacement cost of capital. The fourth view, the stock market pressure hypothesis, puts forth that stock market price changes can affect investment levels without the above-mentioned three ways, by exerting pressure on the managers' decision to invest.

Even though the debate on the causal direction of links between financial co-movements and real co-movements is largely unsettled, research has pointed out that the level of financial integration between markets has increased in the last two decades (Aggarwal and Kyaw 2005; Fadhlaoui, Bellalah and Lahiani 2011; Johnson and Soenen 2003). With the world capital markets becoming increasingly integrated, the scope for gaining diversification benefits is declining. As frontier markets are one of the asset classes that are considered to be highly segmented from the world capital market, an examination of potential benefits from diversifying into these markets from an Australian investor's perspective will provide new insights into this issue.

4.4.2 Country risk and exchange rate volatility

Many elements affect the gains from international diversification of portfolios, and country risk is one key factor. Khoury (2003) defines country risk as the likelihood of a financial loss resulting from the macroeconomic, political, social and/or natural disasters within a given country, and hence it may be a result of

natural or manufactured factors. He provides an updated version of the Zhou/Khoury country index model (2003) which includes economic indicators for the debt service capacity and currency/financial crisis index, political indicators, political instability index and democracy index. Rajan and Friedman (1997) analyse the impact of country risk on internationally diversifying portfolio and find that significant country risk premiums are incurred in international portfolios. They state that country risk should include factors that in some way limit access to a market or restrain the normal investment process. Hence, along with the effects of political conditions and restrictions on foreign investments, factors such as discriminatory tax regulations, transaction costs, capital controls, lack of information and liquidity differences between markets together form country risk.

With the broader definition for country risk discussed in the preceding paragraph, country risk has become relevant for both developed and developing equity markets. Erb, Harvey and Viskanta (1996) examined five measures of country risk — political, financial, economic and composite risk indexes and country credit ratings. In this study, the authors examined whether these indexes of country risk contain any information about future expected returns. They find that the financial risk index contains the largest information of future expected returns and the political risk index has the lowest. They find that 25% of the cross-sectional variation in book to price ratios are explained by the risk ratings, and of this, almost 18% is explained by the economic risk variable itself. The marginal effect of political risk is evident from the finding that changes in political rating have smaller explanatory power in emerging markets and not in developed markets.

Another one of the major risks that international investors today face when diversifying into less developed countries with volatile political conditions is policy risk (Henisz and Zelner, 2010). They define policy risk as the possibility of the government discriminatorily changing the laws and regulations governing investments or failing to implement certain regulations so that investors' financial returns are reduced. Henisz and Zelner also mention that in the past, investors were greatly concerned about expropriation risk, where the host government had the possibility of seizing foreign assets. With the emergence of stronger international law and integration of world markets, expropriation or seizure risk has disappeared and policy risk has strengthened. Cosset and Suret (1995) analysed the benefits of portfolio investment in markets that are considered politically risky. The authors examine 36 countries during 1982–1991 using monthly stock returns and political risk ratings. Contrary to the general investor perception, they find that inclusion of assets from politically risky markets included in the study, does improve the risk return characteristics of the optimal portfolios and also resulted in the reduction of overall portfolio risk.

Another significant factor affecting the gains from international portfolio diversification is exchange rate volatility. Eun and Resnik (1988) state that exchange rate uncertainty is a largely non-diversifiable factor, and it adversely affects the gains from international portfolio diversification. In order to reduce the exchange rate risk, they propose the simultaneous use of two methods: multi-currency diversification and forward exchange contracts. Harvey (2000) studied whether the sources of risk in developed and emerging markets exert similar effects on both markets and what the factors are that drive expected returns in

international markets. After examining 18 risk factors in a sample of 28 emerging markets and 19 developed markets, he found that the markets react differently to the risk factors, and concluded that the emerging markets are less than completely integrated with the world capital markets. Chordia, Roll and Subrahmanyam (2008) investigated the relationship between liquidity and market efficiency and found that liquidity facilitates efficiency, since a market has greater capacity to accommodate order flow when there is higher liquidity. They concluded that improved efficiency engenders a higher degree of informal efficiency in the market. The extent of dependence and the effects of contagion in Latin American exchange markets is examined by Loaiza-Maya, Gomez-Gonzales and Melo-Velandia (2015). They use a vine copula approach to test for contagion among six countries – Argentina, Brazil, Chile, Colombia, Mexico and Peru over a period of 7 years and find evidence of contagion in 4 of these markets and also find that contagion is less frequent during times of currency depreciation.

The issue of what factors affect international equity returns is examined by Eiling, Gerard, Hillion and De Roon (2012). They analyse the effects of country, currency and industry on stock returns from seven developed markets by testing the mean variance efficiency of the different factor portfolios. They conduct both unconditional and dynamic analysis, and do not detect any significant differences in returns for any of these factors. However, they find that when expected returns, correlations and volatility are time varying, global industry and currency risk factors drive equity returns. Girard and Omran (2009) examine the link between volatility and volume in the Cairo and Alexandria Stock Exchange (CASE) and find that information size and direction have only minor effects on conditional

volatility. Andrei and Hasler (2015) on the other hand, investigate the role of investor's attention to news and the level of uncertainty in relation to the asset prices and they find that both attention to market information and the presence of uncertainty directly determine movements in asset prices.

In conclusion, country risk, exchange rate volatility and policy risk are factors that influence the extend of benefits from international portfolio diversification. In order to overcome the impact of exchange rate volatility in this thesis, I am using all values converted into US dollar terms. This will assist in deriving results without the issue of exchange rate volatility. However, examining the impacts of country risk and policy risk of frontier market diversification in this study is beyond the scope of my thesis and it warrants an individual analysis separately. Apart from the previously discussed major factors, another significant factor that impacts diversification benefits is home bias and a brief review of relevant research is presented in the following section.

4.4.3 Home bias

Research has established another phenomenon called 'home bias' as a factor for poorly diversified portfolios held by investors (Bhattacharya and Groznik 2008; Cooper and Kaplanis 1994; French and Poterba 1991; Hatchondo 2008; Kang and Stulz 1997). The theory of portfolio diversification suggests that investors should hold a well-diversified portfolio of domestic and international assets in order to reduce risk and maximise returns. Despite the vast empirical evidence for this proposition, investors still over-weight their portfolios with domestic assets and this phenomenon is termed as 'home bias' in portfolio diversification (Sendi and

Bellalah, 2010). Dimmock, (2016) provide empirical evidence that home bias and portfolio under-diversification are two among five portfolio choice puzzles that are caused by ambiguity aversion.

Studies have documented geographical biases in investor allocation of portfolios (Cooper and Kaplanis 1994; French and Poterba 1991; Kang and Stulz 1997). Hatchondo (2008) found there could be various factors responsible for home bias, such as domestic regulations, higher transaction costs and the risk of exchange rate volatility. He emphasised that asymmetric information is the most significant factor causing home bias in portfolio allocation, and proposed a theoretical model incorporating an asymmetric information effect on home equity bias. Anderson, Fedenia, Hirschey and Skiba (2011) examined the cultural influences on home bias and found that countries that are characterised by higher uncertainty avoidance have greater home bias in their investments, and portfolios from countries with a higher level of long term orientation display lower home bias. They emphasise that cultural variables have high economic significance and have a direct impact on investor behaviour. Bhattacharya and Groznik (2008) conclude that US investments abroad of immigrant groups are characterised by national origin bias, while other economic geography variables do not affect US investments in that country. Morse and Shive (2011) found that more patriotic countries and US regions with greater patriotism hold smaller foreign equity positions. They conclude that patriotism as a factor is able to explain an additional 5% home bias on equity holdings in addition to the effects of other factors. Demarzo, Kaniel and Kremer (2004) note that behavioural bias arises when some investors are constrained to hold undiversified portfolios due to corporate control

or moral hazard considerations. Behavioural biases such as investor ovrconfidence, illusion of control, local bias and trnd-following behavious are also considered as the causes of the discrepancy between the theory and many empirical findings of undiversified portfolios (Roche, Tompaidis and Yang 2013). Karlsson and Norden (2007) examined the differences in home bias at an individual level from Swedish data and found that significant relationships exist between individual characteristics and the likelihood of home bias. The authors found that demographic features such as the individual's occupation, experience with risky investments, level of education, amount that is invested, and gender influence the possibility and extent of home bias.

After examining the equity holdings of different markets, Sendi and Bellalah (2010) found that home bias is large for the developed countries, but it varies at different levels, and the developed markets in Asia had the highest home bias. The authors conclude that investors from emerging markets are still very reluctant to internationally diversify their portfolios. Sendi and Bellalah (2010) outline various factors that lead to home bias in investors. The authors note that the traditional explanations for home bias can be grouped into two major categories – direct determinants and indirect determinants.

The direct determinants of home bias described by Sendi and Bellalah (2010) are hour shifting, institutional barriers and market restrictions. Hour shifting refers to the difficulty caused to international investors to optimally manage or hold a global portfolio because of the differences in time zones and operational hours in geographically distant markets. Institutional barriers such as transaction costs, tax

discrimination and deadweight costs create friction for international investors and cause segmentation of markets. Empirical evidence from studies by Stulz (1981) and Cooper and Kaplanis (1995) proposed that home bias could be accounted for by the costs associated with these barriers. Finally, several market restrictions could be in place in a segmented market that would prevent foreign investments coming in, such as limits to foreign ownership and restrictions to specific areas for foreign ownership, tax discriminations and pricing discriminations. These types of investment barriers result in market segmentation and prevent investors from efficiently diversifying portfolios.

There are four indirect determinants of home bias, as noted by Sendi and Bellalah (2010)—macroeconomic risks, financial and economic risks, asymmetric information and human capital. The authors identify the various macroeconomic characteristics of a market that could create home bias. The country risk arising from economic and political conditions of that market could greatly influence an investor's decision to include it or not in his/her portfolio. Secondly, the financial scenario of a country in terms of its liquidity, degree of debt and import-export ratios also plays an important part in an investor's decision-making process as to whether or not to invest in that market's assets. Exchange rate risk also influences the inflow of foreign capital into a market. Another factor that causes investors to hold back from diversifying their portfolios internationally is the potential differences in languages, standards, habits and the availability of information in general. Even if information is available, there may be difficulties in translating and standardising it to the domestic market data levels. The risk of such asymmetric information will also indirectly create a home bias in an investor's

portfolio decision. Sendi and Bellalah (2010) consider the impact of non-traded human capital on optimal portfolio holdings, based on empirical studies by Baxter and Jermann (1997) and Coen (2001). The authors note that the effect of human capital could partially explain home bias.

Apart from these traditional factors of home bias, Sendi and Bellalah (2010) point out various anomalies related to capital asset pricing models and investors' behaviour that could explain home bias. The authors find that the assumptions made by traditional financial theory that markets are efficient and investors are rational are inconsistent with reality, and behavioural biases of individuals also need to be accounted for in home bias regarding international diversification. The authors conclude that further advancements in the study of behavioural finance could provide detailed explanations of these factors.

The general consensus in research is that despite the presence and impact of these factors that negatively affect benefits from the international diversification of portfolios, investors can still achieve significant gains from diversification using appropriate techniques and careful selection of assets. Research has also identified that benefits similar to that from international diversification of portfolio could be attained from diversifying domestically through multinational companies. This notion may appeal to investors who are reluctant to internationally diversify their portfolios, and it is examined in the following section.

4.5 Domestic diversification and diversification without investing overseas

Benefits of international portfolio diversification can be achieved through investing in multinational corporations, which is treated as diversifying without investing abroad. However, the amount of diversification benefits from such investments will depend on the characteristics and extensiveness of the corporations' international participation. Fatemi (1984), Errunza, Hogan and Hung (1999) and Cai and Warnock (2006) have examined the diversification benefits of investing in multinational corporations. Wright and McCarthy (2002) explain the rationale of treating investment in multinational corporations as international diversification is that their returns are governed by factors that affect foreign companies and hence they are less correlated with domestic companies.

The empirical evidence on the benefits of diversification into multinational corporations is not unanimous. Hughes, Longue and Sweeney (1975) found that multinational corporations have lower systematic risk, lower unsystematic risk and hence lower total risk and therefore investing into MNCs could be beneficial. Jacquillat and Solnik (1978) studied the returns of MNCs from nine countries and showed that the equity returns of MNCs were highly influenced by the movements of the domestic equity index of the country where their head offices were located, and also that the share price behaviour of MNCs and domestic companies were indistinguishable. Senchack and Beedles (1980) analysed the risk returns of portfolios of MNCs with domestic and international investments and found that they did not accrue diversification benefits. Mikhail and Shawky

(1979) examined the performance of thirty US based MNCs and concluded that there were gains from investing in these companies. Rowland and Tesar (2004) studied the multinational companies in seven countries and provided weak evidence that the United States multinationals provided diversification benefits for two periods of their sample. Wright and McCarthy (2002) analysed the potential diversification benefits from investing in Australian MNCs using 63 Australian based MNCs and 63 domestic only firms, and concluded that no diversification benefits were accrued from investing in MNCs over the study period.

Market integration has been the most discussed factor influencing international portfolio diversification in previous research, and recent empirical findings emphasise the need to look for new avenues for diversification. Theory suggests that diversifying into segmented markets would provide higher reduction in portfolio risk for an investor, due to the potential low correlations between domestic and international assets included in the portfolio. During the past two decades, emerging markets enjoyed low correlations with the major developed markets around the world, and diversification into emerging markets was highly celebrated. With increased integration of the world capital markets, diversification benefits from emerging markets have started to decline, and frontier markets are now considered to be more segmented from the developed markets, which underlines the possible gains from diversifying into these markets. The following sections present discussions around emerging market diversification and the decline in diversification benefits from emerging markets as a result of increased market integration.

4.6 Emerging markets diversification

Over the last 25 years, the advanced capital markets of the world have become highly integrated with each other, with increasing correlations between themselves. These developed equity markets are considered to be nearly completely integrated, and as a result there are minimal gains to be exploited from diversifying across them. Therefore, investors have been interested in diversification into emerging markets, which are segmented from the developed markets, characterised by lower correlations with the major capital markets, and presenting a potential for diversification benefits. Even though the activate participation of investors from developed markets in various emerging markets can only be traced back to late 1980s and early 1990s, the actual concept of emerging market investments started with the establishment of the Foreign and Colonial Investment Trust in the UK during 1868, which was intended to invest in the American railway and trading companies. However, it took more than a century since then for emerging markets to be recognised as a separate investment category, when in 1987 the Templeton Emerging Markets Fund was created in the USA (Fifield, Lonie and Power, 1998). An extensive list of emerging market investment funds and indices has been created ever since, underlining their significance in the international diversification of portfolios.

The definition of emerging markets was subject to conflicting and overlapping classifications in the earlier years of its recognition as a separate asset class. Errunza (1983) provided one of the earliest classifications of emerging markets into three categories – old established markets, markets that rely on specific

events for their growth and development and new markets that are growing at a high rate. Markets in Latin America such as Venezuela fall under the first category and Jordan is an example of the second category, as its development was boosted by events in the Middle East. New and rapidly developing markets like Korea are included in the third group. In general, emerging markets have been defined based on the pace of economic growth, trade and their financial development (Kuczynski 1994). Over the years, the most widely accepted definition for emerging markets have been based on the World Bank's classification of high and low income economies. This study will use the definition adopted by Standard and Poor's. Emerging markets are defined by Standard and Poors (S&P) as the equity markets in those economies which are considered as low or middle income by the World Bank and have relatively low market capitalisation. Based on 2009 data, economies with a GNI per capita of $12,196 or more are classified as high income countries. The criteria used by S&P to include a market in the emerging markets category are: first, the market should fall in the low income economy as per World Bank's definition, and second, the level of market capitalisation is relatively low. In recent years, S&P have added a new criterion: that if a market exceeds the low income cut-off as per World Bank's definition for three consecutive years, the market will not be considered emerging. The S&P emerging index includes the following markets: Brazil, Chile, China, Czech Republic, Egypt, Hungary, India, Indonesia, Malaysia, Mexico, Morocco, Peru, Philippines, Poland, Russia, South Africa, Taiwan, Thailand and Turkey. Due to the dynamic nature of these markets, the list of emerging markets is frequently revised, with new markets being added and/or existing ones being

removed. This study will consider the above listed S&P Emerging Markets as emerging markets.

Previous research on emerging markets has identified their various empirical features: low correlations with developed markets, and amongst emerging markets, high volatility, high long-horizon returns, and shocks from regulatory changes, exchange rate devaluations and political crises (Bekeart, Erb, Harvey and Viskanta 1998). Gupta and Donleavy (2009) identifies several economic, structural and financial characteristics of emerging markets that distinguish them from developed capital markets. First, emerging markets are generally characterised by some form of discriminatory taxation that adversely affects the capital inflows to the market. Secondly, market regulations and capital flow restrictions are generally in place in emerging markets that restrict the capital mobility and market structure. Another distinctive feature is the relatively low level of liquidity in the emerging markets. Market activity, which is monitored using the market turnover ratio, is also usually quite low when compared to other developed markets. Finally, low market capitalisation is another major feature of the emerging markets. These distinctive characteristics make emerging markets segmented from the major capital markets and hence they provide a potential for investors in diversifying into these markets. The institutional infrastructures in emerging markets are distinctively different from developed markets, and these segment emerging markets from the rest of the world, creating potential benefits from diversification into them (Gupta 2009). Congruent to this finding, since the early 1990s there has been a tremendous increase in investor and research interest

in emerging markets, and a large number of empirical studies have been generated on emerging market diversification.

The late 1980s and early 1990s witnessed a mammoth inflow of investments into the emerging markets, referred to by Fifield et al (1998) as the "global investment stampede". The authors explore the reasons for such a massive inflow of capital and categorise the causes into two: the pull factors in developing markets and the push factors from the advanced markets. Calvo, Leiderman and Reinhart (1993) find that domestic restructuring in the emerging markets, such as economic, financial and political reforms, have attracted foreign investments. However, these pull factors alone do not completely form the basis of the tremendous capital inflow. The authors identify certain external factors that have acted as the push factors for investments to be channelled to the emerging markets: declining interest rates, ongoing economic recession and the balance of payments crisis in the USA. Chuhan, Cleassens and Maningi (1998) examined the factors influencing capital flows from the US into sixteen emerging markets in Latin America and Asia, and concluded that while external factors (declining interest rates and economic recession in the USA) account for almost half of the increase in capital inflows in Latin America, the impact of domestic and market specific factors are more important than external factors in the Asian markets. In summary, the rapid levels of economic growth and development coupled with financial and political reforms in the developing markets provide potential investors with a possibility of earning higher returns through diversification into these markets. Along with this, the segmented nature of emerging markets provides a theoretical basis for potential gains from diversification into them, and

since the developed capital markets are nearly completely integrated with each other, there are no significant diversification gains from including the advanced markets in a diversified portfolio. A combination of these pull factors and push factors have resulted in the "investment stampede" into the emerging markets during the last two decades, and generated a plethora of empirical studies into the issue of emerging market diversification, which is discussed in the following sections.

Research into the benefits of emerging market diversification has been vast. Wilcox (1992), Divecha, Drach and Stefek (1992) and Speidell and Sappenfield (1992) were among the earliest to suggest that inclusion of emerging market equities in portfolios will substantially increase returns without a significant increase in the risk. Wilcox's 'Taming Frontier Markets' (1992) is one of the earliest studies on emerging market diversification. Wilcox studied 20 markets (Argentina, Brazil, Chile, Colombia, Mexico, Venezuela, Korea, Philippines, Taiwan, India, Indonesia, Malaysia, Pakistan, Thailand, Greece, Jordan, Nigeria, Portugal, Turkey and Zimbabwe) during the late 1980s and examined various factors such as the risk and return from these markets, market capitalisation and real growth. He analysed the diversification benefits from emerging markets using PB-ROE chart which plots Price-to-Book ratio against Return on Equity for a number of securities. Wilcox (1992) was one of the earliest studies to emphasise the significance of emerging market diversification and concluded that these markets provide the greatest opportunity for diversification. He recorded that there exist high potential benefits from diversifying into the emerging markets despite the presence of various risks. Wilcox also underlined that awareness about

and adoption of appropriate diversification strategies and proper benchmarks are required to sail through the arena of emerging market diversification. The markets that were included in Wilcox's sample as frontier markets have evolved into today's emerging market giants. During the late 1980s, the emerging markets constituted about 15% of the world GDP and less than 1% of the world market capitalisation. By 2012, emerging markets accounted for more than 30% of the world GDP and around 13% of the world market capitalisation (BlackRock, 2013). Development to this great extent has provided significant benefits to investors from emerging market diversification as compared to advanced capital markets in the past two decades. Even though there has been a multi-fold increment in the GDP growth rate and market capitalisation of emerging markets over the last 25 years, these two have not converged, and there still exists a significant gap that implies emerging market diversification is still gainful (Bekeart and Harvey 2013).

Divecha, Drach and Stefek (1992) also found that even though emerging markets are much more volatile than the developed capital markets, they had low correlations with the developed markets and between themselves. As a result, inclusion of these markets in a diversified portfolio would reduce the overall risk of the portfolio. The authors noted that in the five years of their study, if an investor were to put 20% in an emerging market index, that would have reduced the overall annual risk of the portfolio by nearly 1% and increased the annual returns by nearly 2%. They also found that stock returns in emerging markets are more homogenous than developed markets, and hence movements in markets spread sooner and affect the majority of the participants.

Research has shown that emerging markets exhibit high volatile behaviour and instability (Bley 2007; Hassan, Haque and Lawrence 2006, Jotikasthira, Lundblad and Ramadorai 2012). Despite these risks, emerging market diversification has attracted significant investor attention, as these economies have produced very high average growth rates when compared to the developed economies. Individual markets are often characterised by significantly high average returns together with high volatility, but combining of securities from various emerging markets reduces the overall risk (Harvey 1995). The results from his study suggest that the addition of emerging market assets in a mean-variance efficient portfolio will provide higher expected returns and lower the total volatility of the portfolio. The issue of whether the variation in emerging market equities is systematic or not was explored by Fifield, Lonie, Power and Sinclair (2001). After examining four data sets – over time, across different markets, across various industries and using different size categories – the authors conclude that appropriate selection of the market to be included in the diversified portfolio is the most important way of reducing volatility. Another pull factor is the low correlations between the emerging markets and with the developed markets which presents a potential reduction in portfolio risk by including emerging markets equities in the portfolio. Conover, Jensen and Johnson (2002) showed that emerging market equities are a worthy addition to a US investor's portfolio. The authors found that inclusion of emerging market equities in a US portfolio resulted in approximately 1.5% rise in the returns from the portfolio. They concluded that investors should evaluate the monetary conditions of their domestic market before finalising the allocation of assets in their diversified portfolio. Girard and Biswas (2007) examined the

relationship between trading volume and volatility in developed markets compared to emerging markets, and found that emerging markets respond more to larger information stocks and have greater sensitivity to an unexpected volume of trading than the developed markets. The authors examined 22 developed markets and 27 emerging markets during the period 1985–2005 using daily prices and volume activity data. They concluded that in order to better attract foreign investors into the emerging markets, changes in local policies are warranted.

4.6.1 Declining benefits from emerging market diversification

Theoretically, market integration will result in a reduction of returns from asset holdings. Based on the capital asset pricing model (CAPM) of Sharpe (1964) and Linter (1965), a completely segmented market will have assets priced in relation to the local market returns, and the local expected return is a function of the local beta of the asset and the local market risk premium. High volatility of local returns is likely to result in high expected returns. But once the markets are integrated, the expected returns are determined by the beta and risk premium with respect to the world and expected returns will be lower. More recent empirical studies by Bekaert and Harvey (1995), Henry (2000) and Kim and Singal (2000) confirm this theoretical result.

A rise in the level of integration between world capital markets results in higher correlation between the markets, and hence brings about a decrease in the potential benefits from diversification into the developed markets. Since the correlations of emerging markets with other markets have started to increase, the benefits from investing in them will eventually decline and therefore research into

the benefits of diversifying in to frontier markets is significant. Turgultu and Ucer (2010) examine the benefits from diversification into emerging markets using a mixed copula approach. They find that these equity markets are characterised by significant levels of dependence, and hence the potential for achieving benefits from international diversification are narrower. Christoffersen, Errunza, Jacobs and Langlois (2012) examine the evolution of dependence between 17 emerging markets and 16 developed markets over the period 1973-2009 using a dynamic asymmetric copula (DAC) method. They provide evidence that the level of dependence between developed markets and emerging markets are on the upward trend. However, the dependence between the developed markets is higher than that between the emerging markets throughout the sample period and their findings imply declining benefits from portfolio diversification into these markets. Cashin, Kumar and McDermott (1995) examine the level of integration between 13 markets, seven of which are developed markets and six are emerging markets, for the period 1989 to 1995. They find that after 1990, there has been an increase in the level of integration between these markets. Chollete, Pena and Lu (2011) and Wang, Chen and Huang (2011) also present similar results of declining benefits from international portfolio diversification into emerging markets using Copula approach.

The level of integration and extent of diversification benefits between the US and South American stock markets for the period of 1995–2002 was examined by Serrano and Rivero (2003). They used Gregory Hansen's (1996) method of testing for long-run relationship between markets and found that in the later stage of their data, the potential benefits to an international investor from diversifying into the

emerging markets significantly lowered. In an earlier study, Serrano and Rivero (2001) analysed the issue of market integration between the Japanese market and Asian-Pacific markets using the Johansen method (1991) of testing for market integration. The study found more evidence of cointegration after a structural shift in the cointegration vector was allowed for. Worthington and Higgs (2004) examined three developed and six emerging markets from the Asian region and analysed the transmission of equity returns and volatility among them. The authors used a multivariate GARCH model to investigate the source and extent of spill-overs and concluded that there existed large and mainly positive mean and volatility spill-overs. This implies the increasing impact of market integration and the potential decline in diversification benefits from these markets.

As the world capital markets are being increasingly integrated with each other and with the progressive lifting of capital controls, the question of whether emerging markets still offer benefits from diversification was examined by Dunis and Shannon (2005). The study compares seven emerging markets from South-East Asia and Central Asia with the US, the UK and Japanese markets for a period of 1999–2003. The authors found the presence of one co-integrating vector between the emerging markets and each developed market. The authors found that although the level of integration between the emerging markets and the Japanese market had increased, there were some diversification benefits for the US investor during the period. The findings of the study also underline the increasing levels of market cointegration between the emerging and developed markets. More recently, Gupta and Donleavy (2009) examined the potential benefits for an

Australian investor from diversifying into seven emerging markets and found that the correlations between these markets have started to increase.

The East Asian financial crisis has raised questions about the validity of the benefits of diversifying into emerging markets owing to the higher volatility of the emerging markets and a perceived higher risk of these markets. Chiang, Jeon and Li (2007) examined daily returns data from nine Asian markets for the period 1990–2003 using a dynamic conditional correlation model. The authors find that there was a phase of increase in correlation and a second phase of continued high correlation. The study found a shift in variance during the crisis period, and the authors concluded that the benefits from diversifying into these emerging markets could be on the decline. Aloui, Aissa and Nguyen (2011) analysed the extent of GFC and contagion effects across the US and the BRIC markets (Brazil, Russia, India and China) using copula functions. The study found strong evidence of time-varying dependence between all the markets included in the study and the high dependence was evident in both bullish and bearish markets together. Similarly, Kneourgios, Samitas and Paltalidis (2011) investigated the financial contagion during five recent financial crises among the BRIC markets and the US and the UK markets. The authors found the presence of contagion effect from the crisis country to all other markets in all of the crises periods that were examined. Chittedi (2014) examined the impact of the contagion of GFC into emerging markets of the BRIC countries during the period 1996 – 2011 using daily data applying DCC and AG-DCC models. Results from the study imply that benefits from diversification into these markets are less than desirable.

The findings from these studies underline the fact that as the world capital markets are integrated more across the globe, there is a significant rise in the correlations between the markets. This in turn results in a decrease in the potential benefits from diversification into emerging equity markets, as the co-integration between the emerging markets with other developed markets has also been on the rise.

The large influx of foreign investments into emerging markets over the past two decades targeting the high diversification benefits that accrue from these markets would now start to decline as their benefits have also started to disappear. In this scenario, it is necessary to look into new avenues that could provide potential benefits from diversification. As the established capital markets become more integrated and eventually slowdown in economic growth and development, there will be an inevitable emergence of newer, more rapidly growing markets, and these could potentially provide better diversification benefits (Kuczynski, 1994). Frontier markets have been established as a relatively new asset class that is less integrated with the developed and emerging markets and hence have low correlations with these markets. However, since these are a relatively new asset class, research into the issue of benefits from frontier market diversification is limited.

4.7 Frontier market diversification

Frontier markets are defined as the pre-emerging markets in the developing world that are not large enough to be categorised as emerging markets and are characterised by low market capitalisation and low liquidity levels (Stultz, 2010). These markets are much more segmented from the developed capital markets than the emerging market currently is. The reduction in the potential gains from diversification into emerging markets, along with the recent crisis and turmoil in the East Asian emerging markets, have increased interest into a new investment class—the frontier markets.

Frontier markets are those economies that have lower market cap and lower liquidity than the emerging markets (Schultz, 2010). The definition, nature and criteria for classification of frontier markets have been presented in detail in Chapter 3. These are pre-emerging markets that are not yet large and liquid enough to be included in the category of emerging markets. Frontier markets have historically enjoyed low correlation with other emerging markets and the developed markets and they are still segmented from the world capital market. Along with these factors, the frontier markets are characterised by higher inefficiency, which increases the potential for obtaining diversification gains. The significance of frontier market diversification is underlined by the recent launch of various frontier market indices and large inflow of investments into these markets. Frontier markets have now been recognised as a separate asset class from the emerging and developed markets and hence research on frontier market diversification is warranted.

The frontier markets exhibit higher volatility and hence there is additional risk associated with investing in these markets. The political conditions and instability characterising them are other factors that have kept investors from approaching frontier markets till recently, but the higher risk-taking investors have showcased the potential high returns from frontier market diversification in recent years. Tests of economic and political side effects are beyond the scope of this thesis. However, research has found increased volatility in the frontier markets that investments are being directed to. Empirical evidence on the effect of foreign investments in emerging markets is mixed (De Roon, Nijman and Werker 2001; Divecha, Drach and Stefek 1992; Gupta and Donleavy 2009; Speidell and Sappanfield 1992). The stakeholders in domestic politics may be concerned about increased foreign portfolio investments in their markets. It is argued that portfolio investments move out on the first sign of trouble in host economies, and are commonly referred to as 'hot money' (Lee, 2004). This study recognises this factor, and in a test of robustness will apply restrictions on investments in each frontier market, based on the 'market prudence rule'. The performance of investments in emerging markets suggests that it is unlikely that investors will all of a sudden hold an optimised portfolio of frontier markets. Nevertheless, all the evidence in favour of investing into emerging markets suggests that investments in emerging markets have been underweighted.

The structural characteristics of the frontier equity markets were examined by Speidell and Krohne (2007); they analysed the returns and correlations of frontier markets with other markets, and concluded that investing in these markets may be

highly rewarding. The authors present an all-encompassing review of the structural features of frontier markets, summarised below.

Speidell and Kronhe (2007) discuss the economic characteristics of frontier markets. The median GDP percapita of frontier markets (excluding the Middle East) in 2005 was $1,337, which is a rather low mark. The average annual GDP growth rates of these markets during 2000–2005 was much higher than the US, Europe Australasia and Far East (EAFE) markets and the emerging markets. In terms of the annual GDP growth rates of all countries, the frontier markets had 15 out of the 20 fastest growing markets during 2000–2005.

The political nature of the frontier markets is described as a distinctive characteristic by Speidell and Kronhe (2007). The authors provide an analysis of the political performance of frontier markets, based on the 2005 Index of Economic Freedom, which is measured in terms of a country's government size, legal structure, trade freedom, credit regulations and restrictions on labour and business. Speidell and Kronhe find that the rankings of frontier markets are not as high as developed markets, but are almost at par with emerging markets. Interestingly, the rankings for frontier markets improved during 2000, whereas that of emerging markets dropped.

The authors also identify the levels of corruption in frontier markets as a distinctive feature of these markets. Speidell and Kronhe analyse the issue of corruption levels in frontier markets based on ratings from Transparence International. The authors report that an average 2005 rating of frontier markets in the corruption index was lower than developed markets and almost similar to

emerging markets. However, since 2000, the average corruption rating for frontier markets improved much higher than developed markets, whereas the rating for emerging markets declined. The authors conclude that improvements in the level of corruption could often result in rewarding returns.

The financial performance of frontier markets also sets them apart from other market categories. Speidell and Krohne outline the stock market structure of the frontier markets, and note that the 22 markets included in S&P/IFC Frontier Markets Composite represented a significant portion of capitalisation of their individual markets in the Composite Index. With regard to the returns from these markets, the total return from the Composite index from 1996 to 2006 was 307%, compared to much lower rates of 160% for the MSCI Emerging Market index, 126% of MSCI EAFE and 175% for S&P 500 Index.

The level of correlations between other markets and frontier markets and also amongst frontier markets themselves is another characteristic feature of frontier markets that distinguishes them from emerging markets. The authors note that frontier markets are driven mostly by their own internal economic and political dynamics and hence enjoy low correlations with the advanced markets. The correlations between frontier markets and developed markets have been consistently low over time, and correlations with emerging markets are relatively low.

The standard deviations of frontier markets are also discussed by Speidell and Krohne (2007) in their analysis of the structural characteristics of frontier markets. The authors find that even though the volatility of individual frontier markets is

quite high, low correlations amongst frontier markets create an overall low volatility for the Composite Frontier markets as a whole. The authors point out that the overall standard deviation of the Frontier Markets Composite is less than that of the MSCI Emerging Market index and slightly higher than for the MSCI EAFE and S&P 500 indexes.

The event risk in frontier markets is also an important part of the criteria provided by Speidell and Kronhe. The response of frontier markets to world events, specifically two events—the 2001 terror attacks in the US and the 2006 oil price rise—were examined by Speidell and Kronhe (2007). The authors find that during the 2001 crisis, all the major indices fell between 8% and 15%, and the frontier markets dropped only by 3.3%. Similarly, during the 2006 oil price rise, the major indices rose around 0.4%–5%, while the frontier markets rose by 6.4%. These findings highlight the low correlations of frontier markets with the advanced markets around the world.

Finally, Speidell and Kronhe (2007) list a number of structural risks in these markets which form an essential part of the nature of frontier markets. Frontier markets are characterised by some structural risks such as political instability, internal civil wars, disease outbreaks and corruption. These markets also present micro level issues such as difficulty in accessing data from companies, issues with accurate and high quality data and difficulties in smooth access of market.

Speidell and Krohne (2007) state that despite the various issues associated with frontier markets, careful, diligent and long-term security analysis and portfolio construction are absolutely warranted with these markets. The authors conclude

that frontier markets could be the final frontier for global capital and they could prove highly rewarding if approached with patience and care.

The benefits of diversifying into seven countries in the Middle East and North Africa, most of which are considered to be frontier markets, are examined by Segot and Lucey (2007), who concluded that there are substantial diversification benefits to be attained from these markets; they emphasise that these underestimated and under-investigated markets could attract more portfolio investments in the future. A recent study on frontier market diversification by Berger, Pukthuanthong and Yang (2011) examines the level of integration of frontier markets. They examine 25 frontier markets and analyse the level of integration, concluding that the frontier markets exhibit no signs of integration with the world market, and hence diversifying into these markets would be beneficial to the investors. Chen, Chen and Lee (2014) analysed the level of integration between the US market and frontier markets and the factors affecting it. They conclude that the low levels of integration suggest the possibilities for arbitrage opportunities from the frontier markets for an investor from an advanced market.

Berger, Pukthuanthong and Yang (2013) extend their previous study by using mean variance spanning tests to examine whether the benefits from frontier market diversification is realisable from a US perspective. Their study examines the Pearson's Correlations and calculate Sharpe Ratio in order to understand the benefits from including frontier markets in a diversified US portfolio and the results indicate that these markets provide significant risk reduction. However,

relying on unconditional Pearson's Correlations to estimate correlations that are varying over time will lead to inaccurate results. Sukumaran, Gupta and Jithendranathan (2015)[6] examine the time varying ADCC GARCH correlations between Australia and US with ten frontier markets and employ those correlations in the construction of optimal portfolios to determine potential benefits from frontier market diversification. The authors conduct an out-of-sample analysis as well to estimate the benefits from frontier market diversification. Their study provides evidence that including frontier markets in a developed market investor's portfolio provides major benefits, however the benefits for the Australian investor are significantly lower than that of the US investor.

One of the primary factors that hold investors back from venturing into frontier markets is the perceived high volatility of these markets, and Speidell and Kronhe (2007) demonstrate that the Composite Frontier market index is lower than the emerging markets index and marginally higher than two developed market indices. One of the seven "deadly sins" for investors, as pointed out by Kristof (2013) is being too afraid of risk and volatility, and thereby losing buying power permanently. Frontier markets could be the last frontier for international diversification gains, and come to represent the Holy Grail of benefits from diversification (BlackRock 2013; Speidell and Krohne 2007). Overcoming the major fears associated with frontier market diversification, investors should explore the theoretical rationale that segmented markets can provide high benefits

[6] One paper was published using the initial results of this thesis in the Journal of Managerial Finance in January 2015 titled "Looking at new markets for international diversification: Frontier markets".

from diversification for a developed market investor, and that frontier market diversification might be potentially beneficial for an Australia/US investor.

There has been no previous research on frontier market diversification from an Australian perspective, and this research will be the first to examine the potential benefits of diversifying into frontier markets for Australian and US investors. Benefits of diversification may be different according to the perspective of investors from different markets. This is because of the different factors prevailing between countries. This research will compare the benefits of diversifying into frontier market from the perspective of the Australian and the US investors. This will be the first study to compare two sets of frontier markets across different time periods in order to outline a pattern of growth that the present frontier markets may eventually follow, and to examine whether the diversification benefits are similar for Australian and US investors.

4.8 International diversification for an Australian investor compared to a US investor

The majority of diversification studies have been conducted from the perspective of a US investor (Chuhan et al. 1998; Eun and Shim 1989; Grubel 1968; Morse and Shive 2011; Solnik 1974). The results from these studies may not be directly applicable to other smaller developed markets such as Australia because of the significant differences in the nature and characteristics of these two markets. The Australian equity market is less than one-tenth the size of the US market and the benefits that accrue to a US investor might not hold true for an Australian investor, as the size effect on diversification benefits along with external

economies of scale differ. A further reason that an examination of the Australian scenario is highly recommended is the tremendous growth in the Australian managed funds sector in recent years, which warrants a search for better avenues to diversify available capital. The nature and characteristics of the Australian market during and after the GFC has also spurred an increased interest in the Australian perspective for investors and researchers. These reasons together substantiate the need to look into frontier market diversification from an Australian perspective. The comparison of potential benefits for the two markets will shed light on the possible impact of the size effect on diversification benefits.

Literature on international diversification for an Australian investor has been very limited and has predominantly focussed on diversification into developed markets. Australian investments to other markets have predominantly been directed towards other developed markets such as USA, UK, other European Union countries, and New Zealand (ABS 2011). It is only in recent years that a shift in this pattern of overseas Australian investments has picked up emerging markets such as Malaysia, Philippines, Thailand and India. Consistent with this structure, research on Australian portfolio diversification has been primarily focussed on developed markets. In recent years some studies have looked into the possibilities of emerging market diversification for the Australian investor. A review of research on Australian perspectives is presented in the following paragraphs.

The exchange controls on Australian investors undertaking overseas portfolio investments were partially relaxed by the Australian Government in 1972, and Watson and Dickinson (1981) examine the benefits that could have accrued to

Australian investors if they had used the opportunity fully. The authors use monthly data for 1970–1977 from Australia and seven developed markets and employ both Markowitz's (1952) model and naive diversification strategies in their analysis. The study finds that international diversification could have created benefits for the Australian investor from both ex-post and ex-ante perspectives. Allen and Macdonald (1995) studied the potential diversification benefits for an Australian investor during 1970–1992 in 15 developed capital markets using monthly data. The study finds that there were diversification gains to the Australian investor for most pairwise portfolios and there was no evidence of cointegration in those. However, three pairwise portfolios—Australia and Canada, Australia and the UK and Australia and Hong Kong—showed cointegration and hence lack of diversification benefits. Mitchell, Wapnah and Izan (1988) and Izan, Jalleh and Ong (1991) also produced similar results for the Australian investor.

The diversification benefits for an Australian investor from investing in multinational corporations was examined by Wright and McCarthy (2002), and they state that given the strong trend of home bias in Australian portfolios, diversifying through MNCs could provide an alternative for international diversification. The authors note that the rationale for MNCs acting as a proxy for international diversification is threefold. Firstly, MNCs create value for shareholders by investing in overseas projects that have a positive net present value. Secondly, the earnings of MNCs have less variability because of the fact that MNCs hold physical investments in various countries that are not perfectly correlated and hence their systematic risk is lower than that of domestic firms. Thirdly, most of the MNCs undertake across-industry and across-country

diversification, and thereby they are able to diversify away their political and foreign exchange risks. On the other hand, the primary disadvantage of diversifying through MNCs is that they are more complex international organisations than domestic firms. The study finds that there is no significant increase in returns from investing in Australian multinational corporations above investing in purely domestic firms. The authors propose that this result could be because of the relatively smaller size of the Australian MNCs which are not diversified enough to provide their investors with better diversification gains.

Research on diversification into emerging markets for an Australian investor was long ignored. Over the last two decades, with a shift in the structure of Australian investments overseas and increased attention towards emerging markets like Malaysia, India and the Philippines, some studies have been conducted in this area. Hatemi, Roca and Qui (2004) studied the diversification benefits for an Australian investor into the major trading partners including developed and emerging markets, using Markowitz's mean variance analysis, and found that there are significant benefits from diversifying into all the sample markets. Gupta and Donleavy (2009) analysed the potential benefits for an Australian investor from diversifying into seven emerging markets. They found that although the investors have restricted their investment to emerging markets to an arbitrary level, there are potential gains to be obtained from emerging market diversification. However, the study also finds that the correlations of the Australian equity returns with the emerging markets have been increasing.

The unprecedented growth in the managed funds sector in Australia has provided a wealth of capital for disposal and investors looking for better destinations for their investments. In the context of rising correlations between Australian and emerging markets, research into frontier market diversification for an Australian investor is highly relevant. Current literature on diversification does not address this issue and this study intends to fill this gap in knowledge.

4.9 Methodologies employed

This chapter has examined various studies that have been conducted on the issue of portfolio diversification. A variety of methods have been used to analyse whether there are any significant benefits from diversification and whether the benefits from diversification can be quantified. Huberman and Kandel (1987) were the first to propose a formal model to examine this issue; they developed a regression test to analyse whether the addition of a new set of assets improves the mean variance spanning of the existing assets. Since then, a large number of studies have improved on the Huberman and Kandel model with the emergence of Stochastic Discount Factor (SDF) based Generalised Method of Moments (GMM) tests and multivariate GARCH models (Beaulieu, Dufour and Khalaf 2007; Bekeart and Urias 1996; Jobson and Korkie 1989; Kan and Zhou 2001; Silli, Umlauft and Caruso 2005). A detailed discussion of the major methods used to quantify benefits from diversification and the superiority of AG-DCC GARCH are presented in Chapter 5.

The Huberman and Kandel model was followed by the wide acceptance of the SDF-based GMM tests, which were popularised by the works of DeSantis (1995),

Ferson (1993), and Bekeart and Urias (1996). In recent years multivariate GRACH models have been extensively used and accepted as a method of estimating correlations used in calculation of diversification benefits. In the earlier years of the use of GARCH models, correlation was assumed to be constant and the models were based on Bollerslev's (1990) Constant Correlation Coefficient model. Since this assumption of constant correlation is unrealistic, a modified version of GARCH models was proposed by Kroner and Ng (1998). In 2002, Engle proposed the Dynamic Conditional Correlation GARCH (DCC GARCH) model which combined the theoretical appeal of time varying correlations and the computational efficiency of univariate models. The DCC GARCH model has been used in studying the dynamics of correlation movements among equity markets by Jithendranathan (2005) and for analysing benefits of diversification by Cha and Jithendranathan (2005). The DCC GARCH model was modified by Capiello, Engle and Sheppard (2006) to include the asymmetric effects in financial data and is known as the Asymmetric Generalised Dynamic Conditional Correlation (AG-DCC) model. This model has been employed in a number of similar studies examining the benefits from diversification and is accepted as a computationally efficient and accurate estimation of time varying correlations (Capiello, Engle and Sheppard 2006; Hyde, Bredin and Nguyen 2007; Skintzi an Sisinis 2007). This study proposes to use the AG-DCC model as it has been accepted as an effective method for capturing volatility clustering and asymmetric volatility of financial time series data. A detailed analysis of the model is presented in Chapter 5.

Some of the recent models for estimating the level of dependence between stock markets and in finance research in general are the Extreme Value Theory and

Copulas. The Extreme Value Theory (EVT) which provides a fundamental basis for estimating the probability of rare and extreme events such as stock market crashes and currency crisis, has been used to estimate the tail behaviour of financial time series data and a number of recent studies have employed this method to examine market dependencies and portfolio optimisation issues (Bhattacharyya et al. 2007; DiTraglia and Gerlach 2013; Gilli and Kellezi 2006; Hyung and DeVries 2005; Ibragimov and Walden 2007; Longin 2005). The biggest criticism of EVT is the assumption that the data under study is independently and identically distributed, which is an unlikely scenario for financial time series data.

Another modelling tool that has been used in financial data is Copulas, which was introduced by Sklar in 1959. Copulas are statistical functions that join one-dimensional distributions to form multivariate distributions and is flexible in constructing a suitable joint distribution when facing non-normality in financial time series data (Liu, 2011). The unique feature of copula model is that it separates a joint distribution of returns into two parts- a marginal distribution and a dependence structure and hence enables better capturing of different patterns of dependence. There have been a variety of copula models proposed and employed in financial research to examine joint distributions – Gaussian copula, Student-*t* copula, Archimedean copula, Gumbel copula and Clayton copula are some to be named. A detailed analysis of the EVT and Copula models is beyond the scope of this thesis and hence this discussion is not extended in Chapter 5. Copula and vine copulas combined with dynamic conditional correlation models like Engle's DCC have also been recently employed in studying financial data (Basher, Nechi and

Zhu 2014; Chollette et al. 2011; Christoffersen et al. 2012; Elkamhi and Stefanova 2015; Han, Gong and Zhou 2016; Wang et al. 2011; Yang, Cai, Li and Hamori 2015).

4.10 Conclusion

This chapter provides a comprehensive review of literature in the field of international portfolio diversification; I find that on balance, there are significant benefits to investors from diversifying internationally. The inclusion of international equities in a diversified portfolio provides significant reduction in the total risk of the portfolio and also has the potential for achieving higher returns. With the opening up of newer markets for international investments and further financial reforms in place, the developing markets attracted tremendous interest from investors in the advanced world. The segmented nature of the emerging markets along with their distinctive characteristics resulted in massive gains from emerging market diversification in the 1990s and caused an "investment stampede" into these markets. The increase in globalisation of the capital markets around the world has resulted in rise in integration between markets and higher correlations between them. However, research has established that there still are benefits to be accrued from international portfolio diversification (Chittedi 2014; Turgultu and Ucer 2010; Worthington and Higgs 2004). As the potential benefits from emerging market diversification have started to decline, investors are faced with the dilemma of whether there exist alternative markets that could provide similar or better diversification benefits. This investment scenario was the primary motivation for conducting this study on

whether the inclusion of frontier market assets to the portfolio of a developed market investor could result in potential gains from diversification.

Frontier markets have emerged as the next and final frontier for attaining diversification benefits, as these markets are highly segmented from the rest of the capital markets. Investors need to cautiously search, analyse and select appropriate assets to achieve gains from international diversification. Frontier markets, being a relatively new asset class, have not been widely researched. Along with the ambiguity associated with the volatility and risks of frontier markets, the lack of reliable empirical research prevents many investors from including them in their diversified portfolios. This thesis aims to bridge the gap in literature by estimating potential benefits from frontier market diversification using computationally efficient models and out-of-sample-analysis. Another significant gap in existing research on international portfolio diversification is that the majority of empirical studies are conducted from the perspective of a US investor; the results from those studies may not be directly applicable to investors from other markets due to the differences in nature and characteristics of the domestic market. My study will fill this gap in the literature by providing a comprehensive analysis from the perspective of an Australian investor, and conducting a comparative examination of the differences between the Australian and US perspectives. This chapter has reviewed the literature on diversification of portfolios, the factors affecting potential benefits from diversification, the benefits from emerging markets, declining gains from emerging market diversification, and the need to look to frontier markets for international diversification of portfolios.

A significant amount of research has been published on the benefits from emerging markets, but recent studies have found that these benefits have started to decline (Chiang et al. 2007; Gupta and Donleavy 2009; Kneourgios et al. 2011). A review of previous literature on emerging market diversification indicates that as globalisation and financial integration of capital markets increase, the developed markets are increasingly integrated with the emerging markets, resulting in a decline in possible diversification benefits. As emerging markets grow to become the next developed markets, eventually the diversification benefits from them will decline to become nearly non-existent and this will be only in a matter of time. This scenario has given rise to the emergence of a new set of assets called frontier markets for international investors. As frontier markets are the least developed markets in the developing world, they are much more segmented from the world capital markets than the emerging markets are. The peculiar nature and characteristics of frontier markets create a potential scenario for immense diversification gains from them for developed market investors. The prominent characteristics of frontier markets were detailed in previous research by Speidell and Kronhe (2007) and are outlined in detail in section 4.7. A thorough understanding of the nature, characteristics and dynamics of frontier markets is absolutely necessary before stepping into the world of frontier market diversification. Frontier markets are intrinsically volatile, and as Speidell and Krohne state, with patience and care in examining and selecting appropriate assets, frontier markets can prove to be significantly rewarding. Since these markets have only recently been recognised as a separate category, there have not been extensive studies performed on the issue of frontier market diversification.

Since frontier markets could be "the last and final frontier" for achieving benefits from international diversification, research into this area is highly important. Acknowledging the gap in the literature that was established in the detailed review of existing research presented in this chapter, the primary question that this thesis aims to examine is whether there are any significant benefits from including frontier markets in a diversified portfolio for a developed market investor.

The literature review identifies that research on international diversification for an Australian investor has been limited (Allen and Macdonald 1995; Izan, Jalleh and Ong 1991; Mitchell, Wapnah and Izan 1988; Watson and Dickinson 1981). Australia has distinctly unique market characteristics and financial market conditions, highlighting the need for more studies to be carried out from an Australian perspective, rather than just extending the results from US based studies to the Australian case. Predominantly, Australian investments overseas have been directed towards other developed markets, and only in recent years, when a change in this pattern occurred, have emerging markets become attractive to investors. The issue of emerging market diversification for an Australian investor has been examined by studies such as Hatemi, Roca and Qui (2004) and Gupta and Donleavy (2009). In the event of declining benefits from emerging market diversification along with the unprecedented growth of managed funds sector over the past 5 years, it has become immensely important for the Australian investors to look to frontier markets as the next possible destination for attaining diversification benefits. A review of the existing literature strongly indicates that diversification into frontier markets is likely to produce significant benefits for an

Australian investor. There has been no previous research on this issue and this study intends to bridge this gap in research.

The second objective of this study is therefore to examine whether the potential benefits for an Australian investor are noticeably different from the benefits to a US investor in frontier markets, and explore the possible reasons for such differences. Such an analysis will be useful while analysing similar areas of research interest in the future.

An examination of empirical research into international portfolio diversification presented in this chapter also underlines the fact that the majority of studies have been performed in an ex-post scenario (Chen et al. 2014; Berger et al. 2013; Gupta and Donleavy 2009). The use of ex-post analyses could overstate the true level of gains from diversification and may not reveal the actual picture (Fifield et al 2002). The conditions present in the ex-post period of analysis may not hold true in subsequent periods, and hence the analysis may not be applicable to subsequent periods and thus result in discrepancies while replicating the study with other data. This study will therefore give both an ex-post analysis and an ex-ante analysis. The third and final objective of this thesis is to investigate whether the results from the in-sample analysis are consistent with those from an out-of-sample analysis. The results of such an estimation will provide reliable results for both researchers and investors in the future. To the best of my knowledge, this will be the first study to provide an ex-post and ex-ante analysis on frontier market diversification for an Australian investor and also to draw a comparison with the US investor's perspective.

The review of literature presented in this chapter presents a brief discussion of the various methods used in previous empirical studies on international portfolio diversification. The Huberman-Kandel model of testing whether the addition of a new set of assets improves the mean variance spanning of the existing assets was one of the earliest formal models proposed. Improvements over this model have given way to newer methods of estimation such as SDF based GMM tests and various multivariate GARCH models. Multivariate GARCH models – DCC GARCH and ADCC GARCH have been previously used in similar diversification studies and have been accepted as computationally efficient models of estimation. This thesis will employ AG-DCC GARCH to estimate time varying correlations between frontier markets and the developed capital market returns, in order to examine whether the inclusion of the former in the diversified portfolio of the latter could result in potential gains. A detailed examination of the various methods employed to estimate diversification benefits is presented in Chapter 5.

The review of literature on international diversification of portfolios leads to the conclusion that the issue of frontier market diversification has been insufficiently examined by previous research. The area of frontier market diversification still holds various uncertainties for potential investors, and future research is warranted so that reliable and accurate information is available for investors to make informed decisions. The declining benefits from emerging market diversification emphasise the need for researching the potential of frontier markets to be the next avenue for generating diversification gains. A review of the literature shows that there have not been any previous studies analysing the possible diversification gains from frontier markets from an Australian v/s US

investor perspective. The investment scenario in Australia calls for additional research on possible new destinations for portfolio diversifications, and frontier market diversification could be beneficial to the Australian investor. This study will bridge these major gaps in research by providing a comprehensive examination of frontier market diversification, using ex-post and ex-ante analysis from both an Australian and a US perspective.

Based on the identified gaps in the literature, this thesis will seek answers for three questions: 1) Are there any significant benefits from frontier market diversification for an investor from a developed market? 2) Are there any differences in the potential benefits to an Australian investor when compared to a US investor? and 3) Are the out-of-sample results consistent with the in-sample results? The research questions are explored by constructing diversified portfolios generated using time varying correlations estimated with the AG-DCC GARCH model. The findings of this study will emphasise the potential role of frontier markets in the future of international portfolio diversification strategies and assist in developing a practical understanding of the possible benefits. A comparison of the Australian and US investor perspectives of frontier market diversification will shed light on the intrinsic differences in the nature of the two markets and hence the possible differences in diversification benefits. The results from this comparative analysis will be significant for both academics and practitioners, and will assist in deciding whether or not extending results from a larger market study to a smaller market is to scale. Another significant contribution of this thesis is the out-of-sample analysis conducted for a period of five years. Previous studies on frontier market diversification have not used an in-sample and out-of-sample

analysis; this thesis will examine if the results from the in-sample period are consistent with that from the holding out period. The out-of-sample analysis undertaken in this study will strengthen the reliability of the results and provide a practical overview of the potential growth of investment over the holding out period. The findings of this innovative exploration of the potential benefits of frontier market diversification and its effects on investors from two types of markets will have practical and academic implications for practice and further research in this area.

A brief review of various methodologies used in estimating benefits from diversification and a detailed discussion of the model used for analysis in this study are presented in Chapter 5, following.

Chapter 5
Research Methodology

5.1 Introduction

The analysis of diversification benefits explores whether the addition of an asset will improve the portfolio returns, and if that is the case whether this change can be measured. There are different methods for testing diversification benefits. One of the ways is to look at the mean and variance of the portfolio and examine whether the addition of a new set of assets to the existing portfolio will result in any betterment in the minimum variance frontier. Huberman and Kandel (1987) conducted one of the first studies to examine this issue, and they provide a multivariate test of whether the addition of new assets to a portfolio will improve the mean variance spanned by the existing assets. Later studies provided various methods to examine mean variance spanning (DeSantis, 1993; De Roon, Nijman and Werker, 2001). Another method employed to estimate diversification benefits uses the stochastic discount factor (SDF) based GMM tests. This method is considered an improvement over the Huberman-Kandel framework, as it overcomes the drawback of the latter's assumption that returns are independently and identically normally distributed because of the use of GMM estimation (Schroder, 2000). DeSantis (1995), Bekeart and Urias (1996) and Schroder (2000) are some of the studies that have deployed SDF based GMM tests to analyse the benefits from portfolio diversification. This chapter will examine the various methods used to estimate diversification benefits and the superiority of AG-DCC GARCH model.

5.2 The need for advanced models: A review of existing methods of estimation

The selection of appropriate models for estimation and forecasting of financial data is important for generating accurate and reliable results for academia and investors alike. The use of linear models to estimate or forecast data which is intrinsically non-linear in nature will create incorrect and misleading results. During the late 1980s and through the 1990s, several empirical studies have established the presence of non-linearity in financial time series data. Hinich and Patterson (1985) examined the daily returns of fifteen US stocks and reported the presence of non-linearity. Campbell, Lo and MacKinlay (1997) identify that payoffs to options are non-linear in nature, as are the investors' willingness to trade off returns and risk. Several empirical studies have since confirmed the non-linearity of financial time series data (Abhyankar, Copeland and Wong, 1995; Bonilla, Romero and Hinich, 2006; Lim and Hinich, 2005; Scheinman and LeBaron, 1989). This evidence confirms the need for using non-linear models for estimation and forecasting of financial data.

Financial time series data are often characterised by volatility clustering, where there are periods of severe swings for a significant amount of time, followed by relatively stationary periods. This particular nature of financial time series data can be attributed to the impact of different news sources and other exogenous economic events on the nature and pattern of data, which results in large clusters of significant positive and negative units of data (Franses, 1998). Linear models of estimation are not able to explain the features of financial data such as volatility

clustering and leverage effects. Financial time series data are often characterised by "varying variance", or heteroscedasticity (Gujarati and Sangeetha, 2007). These features of financial data require careful selection of the models to be employed in measuring potential benefits from diversification for both practitioners and academics.

The primary objective of this study is to examine the potential benefits from diversification into frontier markets for an Australian investor in comparison to a US investor. In order to examine whether there are significant benefits from frontier market diversification for a developed market investor, this study will use time varying conditional correlations generated using the AG-DCC GARCH model, and create a set of efficient portfolios using these correlations. This study also presents the results from a holding out period analysis using the same methodology. The theoretical basis for selecting this methodology and a brief analysis of various other methods of measuring diversification benefits are presented in the following sections.

Since Huberman and Kandel (1987), a large number of studies have been published on various methods for estimating benefits from diversification. Mansourfar, Mohamad and Hassan (2010) state that the methodologies used to measure benefits from international diversification of portfolios can be grouped into three major categories. The first category relies on the international CAPM model as the basis for understanding market segmentation, but this implies that the level of market segmentation is constant over time. The second category focuses on the extent of market integration as the major factor affecting benefits

from international portfolio diversification, and is based on testing correlation dynamics and advanced co-integration methods. These methods were, however, unable to describe the time varying nature of the risk premiums associated with international portfolio diversification. The third category overcomes this issue by employing dynamic models for analysing market co-integration.

Li (2003) presents a comprehensive classification of various tests for diversification benefits. She categorises methods of testing for benefits from diversification into three groups—regression based mean variance spanning tests, stochastic discount factor (SDF) based GMM tests, and numeraire portfolio tests based on non-arbitrage principles. Following Li (2003), the next section presents an overview of these three categories of methods used to test diversification benefits and the reasons for employing multivariate GARCH models.

5.2.1 Regression based spanning tests

The theory of diversification developed by Markowitz (1952) analyses whether the addition of assets that are less correlated to the existing assets in the portfolio will create an expansion in the set of mean variance efficient portfolios of the investor; such expansions in the mean variance frontier can be detected using spanning tests (Silli, Umlauft and Caruso, 2005). The regression based tests of spanning have been grouped into two by Kan and Zhou (2001)—mean variance spanning and multivariate tests of mean variance spanning.

5.2.1.1 Mean variance spanning

The first model of mean variance spanning was introduced by Huberman and Kandel (1987) where they used a regression based test of the hypothesis that the introduction of new assets will expand the mean variance frontier span of the existing assets. The basic concept of mean variance spanning is that if the minimum variance frontier of an existing set of assets is identical to the minimum variance frontier of the existing plus new test assets, then it is said that the existing set of assets spans a larger set of existing plus new assets.

Kan and Zhou (2012) explain this further as follows: A set of K risky assets is said to span a larger set of N+K risky assets if the minimum variance frontier of the K assets is equivalent to that of the N+K assets. The initial set of assets K is known as the benchmark assets and the second set N+K as the test assets. In a scenario where a risk free asset exists and unlimited lending and borrowing at the risk free rate is permitted, investors will examine whether the portfolio that maximises the Sharpe ratio by using the bench mark assets is equivalent to the portfolio using the test assets. In a scenario where there is not a risk free asset and risk free lending and borrowing rates are different, investors will be interested in analysing whether the minimum variance frontiers of the benchmark and test assets are identical. Kan and Zhou note that the implication in these scenarios based on mean variance spanning is whether an investor can achieve maximisation of the Sharpe ratio by holding a smaller set of assets rather than a larger one and whether the addition of a new set of assets to the benchmark assets will result in any benefits to the investor.

The mean variance spanning method presented by Huberman and Kandel (1987) puts forth the hypothesis that the addition of test assets will expand the mean variance frontier of the benchmark assets. After specifying the expected returns and covariance of the test assets and the benchmark assets, Huberman and Kandel provide:

$$r = \alpha + \beta R + e \tag{5.1}$$

Where *r* is the NX1 return vector of test assets and *R* is the KX1 return vector of the benchmark assets. They state the necessary conditions of restrictions as:

$$\alpha = 0$$

$$\beta_x i_K = i_N \tag{5.2}$$

The mean variance spanning method presented above was subsequently developed further by adding multivariate tests to examine the restrictions presented by the model. Three of the major multivariate tests of mean variance spanning are discussed in the following section.

5.2.1.2 Multivariate tests of mean variance spanning

The necessary and sufficient conditions for spanning that were presented in the Huberman-Kandel model in equation 5.2 can be tested using the Likelihood Ratio (LR) test which compares the likelihood functions under the null hypothesis and the alternative hypothesis. There have been subsequent improvements to this method from Jobson and Korkie (1989) who provided an extension to the test by adding it to a multivariate setting, and Beaulieu et al. (2007), who provided a

simulation based method that does not assume normal distribution. Kan and Zhou (2001) critique the LR test for its lack of power. The authors suggest two other multivariate tests — the Wald test and the Lagrangian Multiplier test.

The Wald test is given as:

$$W = T\,(\lambda_1 + \delta\lambda_2) \quad \overset{A}{\sim} x^2_{2N} \tag{5.3}$$

And the Lagrangian Multiplier test is given as:

$$LM = T\ \sum_{i=1}^{2} \frac{\lambda_i}{1+\lambda_i} \quad \overset{A}{\sim} x^2_{2N} \tag{5.4}$$

where λ_1 and λ_2 are two eigenvalues where $\lambda_1 \geq \lambda_2 \geq 0$, *N* is the test assets added to the *K* benchmark assets and *T* is the length of time.

The mean variance spanning methods of estimating the benefits from diversification have been criticised by various studies. Gungor and Luger (2013) note that Huberman and Kandel's mean variance spanning tests are based on the assumption that the multivariate linear regression model disturbances are independent according to a normal distribution, and that this assumption is questionable as financial asset returns are characterised by non-normalities. They also point out that the Huberman Kandel model presents a restriction on the number of test assets — the size of the cross section should be lower than the time series in order to be computable. However, the major criticism against the Huberman Kandel mean variance spanning model is the lack of power of the LR test. Kan and Zhou (2001) point out two major mistakes in the application of the Huberman and Kandel spanning test: firstly, the test statistic is incorrectly

computed in the original paper, and secondly, the use of this test for single test asset cases is incorrect. They suggest that results from other tests such as the Wald test and the Lagrange multiplier test should be taken into consideration while using this method. They find that there is a linkage between regression based spanning tests and the SDF based GMM tests and also find evidence that regression based spanning tests can be superior to the SDF tests if the returns follow multivariate Student –*t* distribution.

5.2.2 SDF based GMM tests

The mean variance spanning concept has been remodelled in recent years by studies such as DeSantis (1993), Ferson (1995) and Bekeart and Urias (1996), and these studies provide various GMM (Generalised Method of Moments) based tests of spanning using the SDF framework. The conditional asset pricing restriction under the Hansen-Jagannathan (1991) model can be written as:

$$E\big((R_{t+1} + i)m_{t+1}\big|\phi_t\big) = i \tag{5.5}$$

Where R_{t+1} is the vector of asset returns, m_{t+1} is the stochastic discount factor, and ϕ_t is the information set at time *t* from the projection of m_{t+1} on the asset returns, the stochastic discount factor can be formed as follows:

$$m_{t+1}^{\alpha} \equiv \alpha + [R_{t+1} - E(R_{t+1})]'\beta^{(\alpha)} \tag{5.6}$$

The spanning restrictions in the Hansen-Jagannathan framework are based on $\beta_N^{(\alpha)}$ as the portion of$\beta^{(\alpha)}$:

$$\beta_N^{(\alpha)} = 0_N$$

$$E(R_{t+1}m_{t+1}^{\alpha}) + E(m_{t+1}^{\alpha}) = i \tag{5.7}$$

Bekeart and Urias (1996) show that these restrictions can be tested using a GMM test. They find that the GMM test has a lack of power when compared to the likelihood ratio test of Huberman and Kandel. Also, GMM tests do not give an accurate estimate when used in small samples.

The third category of tests of diversification benefits – the numeraire portfolio tests based on non-arbitrage principles, introduced by Long (1990) provides that when there exist restrictions on trading of assets, the non-arbitrage condition will be equal to the existence of a 'numeraire portfolio' of assets that comply to the following conditions:

$$Prob_t\left[1 + r_{N,t+1} > 0\right] = 1$$

$$E_t\left[\frac{1+r_{i,t+1}}{1+r_{N,t+1}}\right] = 1 \tag{5.8}$$

Where $r_{i,t+1}$ represents any asset return and $r_{N,t+1}$is the numeraire portfolio. Chen and Knez (1995) and Hentschel and Long (2004) have developed this concept further. Hentschel and Long (2004) provide a constant-weight numeraire portfolio as follows:

$$\frac{1}{T}\sum_{t=1}^{T}\left[\frac{1+r_t}{1+r_{N,t}} - \frac{1+r_{1m,t}}{1+r_{N,t}}\ i\right] = 0 \tag{5.9}$$

Kan and Zhou (1999) critique the SDF method and state that there are two potential problems in using this method — first, the estimated risk premium will have poor accuracy, and second, the test doesn't have sufficient power to detect

misspecified models. These drawbacks lead to the wide use of multivariate GARCH models in the estimation of diversification benefits, as these models are accepted as giving an accurate estimation of time varying correlations.

5.2.3 Multivariate GARCH Models

Financial time series data and asset returns data in particular are characterised by certain specific properties such as fat tails, volatility clustering and asymmetric volatility that require the application of advanced models to estimate and forecast accurately. Fat tails or leptokurtosis imply that there exist a large number of extreme observations having more weight in the tails than in the normal distribution. Volatility clustering denotes the presence of large (or small) changes in returns in the current period being followed by large (or small) changes in the subsequent periods. Finally, asymmetric volatility indicates the nature in which asset returns react more to negative shocks than to positive shocks of the same magnitude. The Autoregressive Conditional Heteroscedastic (ARCH) model proposed by Engle (1982) is one of the most important tools to model time varying volatilities in financial data. This model was subsequently generalised into the Generalised Autoregressive Conditional Heteroscedastic (GARCH) model by Bollerslev in 1986. These models have been widely applied and accepted by researchers as successful methods to capture volatility and estimate time varying correlations (Anderson and Bollerslev, 1998; Engle, Hong and Kane, 1990; Lamoureux and Lastrapes, 1990).

Traditional symmetric GARCH models allow capturing volatility clustering, but asymmetric responses to external shocks are not captured by these models.

Traditional models are criticised for underestimating the conditional volatility after a negative shock and overestimating it after a positive shock (Capiello, Engle and Sheppard, 2006). Portfolio management and development of appropriate diversification strategies require the estimation of the conditional covariance of returns of multiple assets, and hence univariate models need to be extended into a multivariate framework.

The early multivariate models of GARCH were based on Bollerslev's (1990) Conditional Correlation Coefficient model. The model proposes that the time-dependent conditional covariances are a product of constant correlations and time dependent conditional standard deviations. The conditional covariance matrix in this model is given by:

$$H_t = D_{H_t}^{1/2} R D_{H_t}^{1/2} \tag{5.10}$$

where D_i denotes the k x k diagonal matrix of the diagonal elements of an arbitrary matrix A; and R is the matrix of constant conditional correlations. Even though this is a simple model, the basic underlying idea of constant correlations is incorrect, as previous empirical studies have proven the time varying nature of correlations (Engle and Sheppard, 2001; Goetzmann, Li and Rouwenhorst, 2001; Longin and Solnik, 1995; Tse, 2000).

Another multivariate GARCH model is the industry standard RiskMetrics model of JP Morgan (1997) which uses exponentially weighted moving average model to examine conditional variances and covariances. The conditional covariance matrix developed by this model is:

$$H_t = (1 - \lambda)\varepsilon_{t-1}\varepsilon'_{t-1} + \lambda H_{t-1} \quad (5.11)$$

This is based on the assumption that asset returns are normally distributed, with mean zero such that the T x k matrix of returns r_t is given as $r_t = \varepsilon_t$ for t = 1, .., T where T is the number of observations and k is the number of assets and λ is the weighting factor such that $0< \lambda <1$. Higher weights are assigned to the most recent innovations and the weights decline exponentially. The value for λ that is set in the model is 0.94 for daily data and 0.97 for monthly data. However, the moving average models tend to incorrectly assign weights and may not provide accurate estimations of time varying correlations and covariances.

The Dynamic Conditional Correlation GARCH (DCC GARCH) model introduced by Engel in 2002 allows for time varying correlations, and this is a significant improvement over the previous models. Wong and Vlaar (2003) note three major practical advantages that the DCC model presents: first, it is flexible; second, it is relatively parsimonious; and finally, estimation of parameters is relatively easy as it is done in two steps. Since the model captures the time varying nature of asset returns, estimation and forecasting using the model are considered to be more accurate than older methods that were used (Wong and Vlaar 2003). Jithendranathan (2005) used this model to study the changes in correlations between US and Russian equity markets and found that it was an efficient method to analyse the dynamic nature of asset returns over time. Since the model is very flexible, it allows for specifying a different univariate specification for each asset series. Since the parameters to be estimated in each of the two steps are relatively small, it will also. reduce the computational time. Empirical studies by

Jithendranathan (2005) and Wong and Vlaar (2003) support the use of the DCC GARCH model to estimate time varying correlations. The DCC GARCH model was extended by Gupta and Donleavy (2009) as the Asymmetric DCC GARCH model, including the effects of asymmetric information, in order to analyse the correlations between Australian and emerging markets. They recommend using this model for estimating correlations over time. Capiello, Engle and Sheppard (2006) introduced the asymmetric generalised DCC (AG-DCC) model which incorporates the impact of series-specific news and allows for the effects of asymmetries in correlation dynamics. The AG-DCC model is a highly recommended method of estimation for examining the correlation dynamics among different asset types, and for analysing the issues of conditional variances and negative return correlations (Hyde, Bredin and Nguyen, 2007). Thus, the DCC GARCH and AG-DCC GARCH models are advanced enough to examine the specific features of financial data discussed earlier — volatility clustering and asymmetric volatility. The computational efficiency and practical flexibility of these models make them the most suitable methods to be applied in this study. These models have been used in similar studies that examine asset returns and potential benefits from diversification, hence the applicability of the models in similar scenarios has been previously tested and accepted. Skintzi and Sisinis (2007) examined the correlation forecasting performance of 11 models across three different asset classes, and found that DCC GARCH and AG-DCC GARCH models outperform the other models, based on all the evaluation criteria and across all the forecasting periods, and the authors concluded that AG-DCC and DCC models are the most effective forecasting models, especially for stock and

bond portfolios. Following Capiello et al. (2006), this research proposes to use the Asymmetric Generalised Dynamic Conditional Correlation (AG-DCC) GARCH model for estimating the correlations between the Australian and frontier equity markets. This study will also use the AG-DCC GARCH model as proposed by Capiello, Engle and Sheppard (2006) for comparison with the DCC GARCH results. The following section details the DCC GARCH and AG-DCC GARCH models employed in this research.

5.3 Estimation of time varying correlations using DCC and AG-DCC GARCH

Following Jithendranathan (2005) and Gupta and Donleavy (2009), conditional correlation between two random variables r_1 and r_2 that each have mean zero is defined as:

$$\rho_{12,i} = \frac{E_{t-1}(r_{1,i}r_{2,i})}{\sqrt{E_{t-1}(r_{1,i}^2)E_{t-1}(r_{2,i}^2)}} \tag{5.12}$$

This conditional correlation is based on information known for the previous period; multi-period forecasts can be obtained in a similar way. All correlations defined in this way will lie within the interval [-1, 1]. The conditional correlation satisfies this constraint for all possible realisations of past information and for all linear combinations of the variables.

To clarify the relationship between conditional correlations and conditional variances, we can write the returns as the conditional standardised disturbance:

$$h_{i,t} = E_{t-1}\left(r_{i,t}^2\right) \; and \; r_{i,t} = \sqrt{h_{i,t}\varepsilon_{i,t}} \text{ for i=1,2.}$$

where εi,t is a standardised disturbance that has zero mean and variance of one; εi,t = $D_t^{-1} r_t$

Substituting the above in equation (5.12) we can get:

$$\rho_{12,t} = \frac{E_{t-1}(\varepsilon_{1,i}\varepsilon_{2,i})}{\sqrt{E_{t-1}(\varepsilon_{1,i}^2)E_{t-1}(\varepsilon_{2,i}^2)}} = E_{t-1}(\varepsilon_{1,t}\varepsilon_{2,t}) \tag{5.13}$$

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

$$q_{12,t} = \bar{\rho}_{12} + \alpha\left(\varepsilon_{1,t-1}\varepsilon_{2,t-1} - \bar{\rho}_{12}\right) + \beta\left(q_{12,t-1} - \bar{\rho}_{12}\right) \tag{5.14}$$

The unconditional expectation of the cross product is $\bar{\rho}_{12}$, while for the variances $\bar{\rho}_{12}$= 1.

The correlation estimator can be written as:

$$\rho_{12,t} \frac{q_{12,t}}{\sqrt{q_{11,t}q_{22,t}}} \tag{5.15}$$

This model will be mean reverting if α + β < 1. The matrix version of this model then can be written as:

$$Q_t = S(1 - \alpha - \beta) + \alpha(\varepsilon_{t-1}\acute{\varepsilon}_{t-1}) + \beta Q_{t-1} \tag{5.16}$$

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

$$L = -\frac{1}{2}\sum_{t=1}^{T}(n\log(2\pi) + 2\log\left|\ D_t\ \right| + \log R_t + \varepsilon_t' R_t^{-1}\varepsilon_t \qquad (5.17)$$

Where $D_t = diag\left(\sqrt{h_{i,t}}\right)$ and Rt is the time varying correlation matrix.

The relationship suggested by Bekaert and Wu and further adopted by Jithendranathan is as follows:

> …. negative shock at the market level produces two effects: (1) revision of conditional variance expectations upwards, as this increase in conditional volatility at the market level is compensated by increased returns, current market value will drop, and (2) declines in market-wide prices will result in the increase in leverage at the market level and therefore higher stock volatility. (Jithendranathan, 2005)

This study will use AG-DCC GARCH model as stated above to estimate time varying correlations and present these time varying correlations in the portfolio optimisation process.

Since the DCC GARCH model does not allow for asymmetries, Capiello, Engle and Sheppard (2006) introduce a modified version incorporating the symmetric effect and asset-specific new impact in the AG-DCC model as follows.

$$Q_t = (\bar{Q} - A'\bar{Q}A - B'\bar{Q}B - G'\bar{N}G) + A'\varepsilon_{t-1}\varepsilon_{t-1}'A + B'Q_{t-1}B + G'n_{t-1}n_{t-1}'G \qquad (5.18)$$

Where A, B and G are diagonal parameter matrices, n_t= I($\varepsilon_t < 0$), $\bar{N} = E[n_t, n_t']$. For $\bar{Q} and\ \bar{N}$, 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. $Q_t^* = \left[q_{ii,t}^*\right]=\left[\sqrt{q_{ii,t}}\right]$ is a diagonal matrix with the square root of the ith diagonal element of Qt on its *i*th diagonal position.

This study will use the AG-DCC GARCH model presented above for comparison with the results from the DCC GARCH model. Once the time varying correlations have been estimated, the next step is to construct efficient portfolios using these correlations. Australia-only and US-only portfolios are also constructed. The results from these portfolios are used to estimate whether there are any benefits to the developed market investor from diversifying into frontier markets, and whether these benefits are different for the Australian and US investors. The following section presents the methodology for construction of efficient portfolios.

5.4 Constructing efficient portfolios

This study will trace the ex-post efficient frontier in order to quantify the returns to an Australian investor. An efficient frontier can be described as the set of portfolios that exhibit the minimum amount of risk for a given level of risk or the highest return for a given level of risk, and lies above the global minimum variance portfolio. There are two approaches to selecting an optimal portfolio – the Markowitz mean-variance optimisation method and the single index model of estimating the variance-covariance structure.

Elton, Gruber and Padberg (1976) propose that by assuming that a risk free asset exists, one can use a simple decision criterion to reach an optimal solution to the

portfolio problem, so that either the single index model adequately describes the variance-covariance structure, or a good estimate of all pairwise correlation coefficients is a single figure. This will allow one to determine which stocks to include in the portfolio and also how much to invest in each. Gupta and Donleavy (2009), in a study similar to this, used this model for estimation of diversification benefits. First, the study uses an approach utilising the single-index model to construct optimal portfolios. Where returns are determined as follows:

$$R_i = \alpha_i + \beta_i R_m + \varepsilon_i \tag{5.19}$$

Where R_i is the return on security i,

α_i is the return on security i that is dependent of the market's performance,

β_i is a constant that measures the expected change in Ri given a change in Rm and

ε_i is the random error term with mean zero and variance of $\sigma_{\varepsilon_i}^2$

Based on the assumption that short selling is possible, the unconstrained vector of relative weights for each security which maximises the Sharpe-ratio is to be established. That is:

The relative weights, Xi's of each security can be found by maximising the Sharpe ratio

$$\theta = \frac{\overline{R}_p - R_f}{\sigma_p} \tag{5.20}$$

Where

- $\overline{R}_p$ is the mean return on portfolio and
- σ_p is the standard deviation of the return on portfolio.

Given that

$$\overline{R}_p - R_f = \sum_{i=1}^{N} X_i(\overline{R}_p - R_f) \tag{5.21}$$

and

$$\sigma_p^2 = E\left(\sum_{i=1}^{N} X_i R_i - \sum_{i=1}^{N} X_i \overline{R}_i\right)^2$$

$$\sigma_p^2 = \left[\sum_{i=1}^{N} X_i^2 \beta_i^2 \sigma_m^2 + \sum_{i=1}^{N} \sum_{j=1}^{N} X_i X_j \beta_i \beta_j \sigma_m^2 + \sum X_i^2 \sigma_{\varepsilon_i}^2\right] \tag{5.22}$$

Substituting these equations in 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:

$$X_i^0 = \frac{\frac{(\overline{R}_i - R_f) - C_0 \beta_i}{\sigma_{\varepsilon_i}^2}}{\sum_{j=1}^{N} \left| \frac{(\overline{R}_j - R_f) - C_0 \beta_j}{\sigma_{\varepsilon_j}^2} \right|} \tag{5.23}$$

where

$$C_0 = \sigma_m^2 \frac{\sum_{j=1}^{N} \left[\frac{\overline{R}_j - R_f}{\sigma_{\varepsilon_j}^2} \beta_j \right]}{1 + \sigma_m^2 \sum_{j=1}^{N} \frac{\beta_j^2}{\sigma_{\varepsilon_j}^2}} \tag{5.24}$$

The above equation will determine the respective weightings for each security within a portfolio and also find the optimal portfolio's risk and return measures. Here, risk and returns can be obtained by substituting the respective weights found for each security into the returns and variance formula given in equations 5.21 and 5.22.

The single index model by Elton et.al (1976) is based on the assumption that the only source of joint movement of two securities is caused by a common response to market index. This assumption creates problems for using the single index model in an international diversification study since there are multiple markets involved instead of multiple securities from one market. Hence, the use of the single index model in this thesis is unrealistic. The second approach of constructing optimal portfolios is the Markowitz mean-variance method which minimises the portfolio variance and maximises returns. The main criticism against this method is that it requires the estimation of a large number of correlation pairs. While the single index model reduces the computational difficulties, the significant increase in computing power since the 1970s has made it easier to compute correlation matrices and hence use of the Markowitz mean-variance method is an efficient approach for this study as follows:

A portfolio with *N* assets has the return[7]:

$$\bar{r}_P = \sum_{i=1}^{N} X_i \bar{r}_i \qquad (5.25)$$

[7] A standard restriction to equation 5.25 is placed as $\sum_{i=1}^{N} w_i = 1$. Other restrictions that are used in this research are based on the "prudent man rule" which is commonly practiced in the U.S. based on this practice, we place arbitrary restrictions such as a maximum of 20% investment in frontier markets and a minimum of 50% in the Australian (or the U.S) market.

Where X_i is the weight of the *i*th security in the portfolio and $\bar{r}_i$ is the expected return of that asset.

Mathematically, the optimisation problem can be stated as:

$$Max\bar{r}_P = \sum_{i=1}^{N} X_i \bar{r}_i \text{ subject to:}$$

$$\sigma_P^2 = \sum_{i=1}^{N} \sum_{k=1}^{N} X_i X_j \sigma_{i,k} \leq \hat{\sigma}^2 \quad (5.26a)$$

$$Min\sigma_P^2 = \sum_{i=1}^{N} \sum_{k=1}^{N} X_i X_j \sigma_{i,k} \text{ subject to:}$$

$$\bar{r}_P = \sum_{i=1}^{N} X_i \bar{r}_i = \hat{\bar{r}} \quad (5.26b)$$

The Markowitz mean-variance optimisation method has been widely used in diversification studies and this thesis will employ the model stated as above to construct optimal portfolios. The detailed discussion of the Markowitz model was presented in Chapter 2.

5.5 Conclusion

A review of the literature on the various methodologies used to estimate diversification benefits indicates that multivariate GARCH models have been widely accepted as an accurate estimation method for time varying correlations. The major categories of methods used to test for benefits from diversification are presented in this chapter and the superiority of multivariate GARCH models is established. Li (2003) concludes that there are four major issues associated with the use of regression based mean variance spanning methods and SDF based GMM tests to examine diversification benefits. Firstly, these two types of

methods do not present any information on the extent of efficiency improvement that could result from the addition of test assets to the benchmark assets. Secondly, the assumptions of normally distributed asset returns and quadratic utility of investors are unrealistic. Thirdly, neither of these methods considers the impact of investors' attitudes towards risk to affect the benefits from diversification. Finally, these two methods do not allow for the inclusion of constraints such as transaction costs and short sale constraints.

Multivariate GARCH models have been considered an accurate estimation tool for data such as stock market data that is proven to be non-linear with volatility clusters. Traditional GARCH models were, however, unable to account for the asymmetric responses to positive and negative shocks. This drawback was rectified with the introduction of multivariate GARCH models such as DCC GARCH and AG-DCC GARCH. This study uses AG-DCC GARCH to estimate time varying correlations and then constructs efficient portfolios to examine the benefits from diversifying into frontier markets for an Australian investor in comparison to a US investor. A holding out period analysis is also undertaken in this research, as most of the diversification studies do not perform out-of-sample analysis. Chapter 6 provides data and results from the analysis conducted using the computationally efficient AG-DCC GARCH model.

DECLARATION OF CO-AUTHORSHIP AND CONTRIBUTION

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Nature of Candidate's Contribution

Primary author

Nature of Co-Authors' Contributions

Supervision of the analysis and results and guidance of the general structure of the article.

Candidate's Declaration

I declare that the publication above meets the requirements to be included in the thesis as outlined in the Publication of Research Higher Degree Work for Inclusion in the Thesis Procedures

Signature 

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Chapter 6
Analysis and Results of Frontier Market Diversification for Australian and US investors

6.1 Introduction

The theoretical basis of portfolio diversification and the current significance of looking into frontier markets for international portfolio diversification have been discussed in the preceding chapters. While there have been studies on whether the inclusion of frontier markets in a diversified portfolio will be beneficial for a US investor, no research has been conducted as to whether the results apply to the Australian counterpart as well. This comparison is significant, as the particular characteristics of the Australian market and the current financial environment call for an in-depth analysis of Australia as a standalone market. A mere extension of the results from US-based studies to the Australian scenario creates discrepancies in actual results because of the vast differences in the two markets. A review of the existing literature points to the lack of a comparative analysis of potential benefits from frontier market diversification from Australian and US investor perspectives, and the results from this study will bridge this important gap. This chapter will outline the data analysis and results from my study on the potential benefits from diversification into frontier markets for the Australian investor as compared to the US investor. The analysis and results are presented in four sections. The first section will examine the time varying correlations between Australia and USA with that of the ten frontier markets. I have used AG-DCC GARCH correlations to measure the time varying nature of correlations and also compared this to DCC correlations. The second section will present results from optimal portfolios constructed from the perspectives of the Australian and US investor. As outlined in the methodology chapter, I have constructed and compared an Australia only portfolio and several optimal portfolios with various

restrictions and the same methodology has been followed for the US investor. The third section will present a detailed comparison of the results for the Australian investor against those for a US investor. The fourth section will outline the results from a holding out period analysis that this research has undertaken.

6.2 Time varying correlations

The primary objective of this research is to examine whether there are potential benefits in holding a diversified portfolio of frontier market equities from an Australian investor's perspective in comparison to a US investor's perspective. Earlier studies on diversification were conducted based on the notion that correlations are constant over time. Research has established that contrary to this notion, correlations are time varying (Login and Solnik 1995). The use of unconditional constant correlation models to estimate and forecast diversification benefits will result in misleading conclusions; hence the use of advanced techniques to model the dynamic nature of asset returns is required. Multivariate GARCH models have been used in many studies to estimate time varying correlations (Capiello, Engle and Sheppard, 2006; Gupta and Donleavy, 2009; Jithendranathan, 2005). The earliest of the multivariate GARCH models were based on Bollerslev's (1990) Conditional Correlation Coefficient model, which later gave way to Engle's (2002) Dynamic Conditional Correlation Coefficient (DCC) model. Gupta and Donleavy (2009) use an Asymmetric DCC model incorporating the asymmetric factor. This study uses the AG-DCC GARCH model and compares the results with those from a DCC GARCH model. The matrix version of the DCC GARCH model is given by:

$$Q_t = S(1 - \alpha - \beta) + \alpha(\varepsilon_{t-1}\acute{\varepsilon}_{t-1}) + \beta Q_{t-1} \quad (6.1)$$

where S denotes the unconditional correlation matrix of the disturbance terms and

$$Q_t = \left| q_{1,2,t} \right|$$

The AG-DCC GARCH model is stated as:

$$Q_t = (\bar{Q} - A'\bar{Q}A - B'\bar{Q}B - G'\bar{N}G) + A'\varepsilon_{t-1}\varepsilon'_{t-1}A + B'Q_{t-1}B + G'n_{t-1}n'_{t-1}G \quad (6.2)$$

where A,B and G are diagonal parameter matrices, n_t= I($\varepsilon_t < 0$), $\bar{N} = E[n_t, n'_t]$.

The models and their detailed review were presented in section 5.3 of Chapter 5. This study looks at the frontier markets that are a new investment avenue from the perspectives of the Australian investor in comparison to the US investor. This comparison will help to shed light on the effects of differences in the nature of the domestic market of the investor. Congruent with the conclusions of previous studies by Speidell and Kronhe (2007), Segot and Lucey (2007), and Berger, Pukthuanthong and Yang (2011), the findings of this thesis record very low levels of time varying correlations between frontier markets and the developed capital markets. This strongly indicates that frontier markets are highly segmented from the developed markets and hence the potential benefits from diversifying into them could be significant. The conclusions from this analysis are supported by the theoretical rationale suggested by the modern portfolio theory that the addition of less correlated assets could improve the portfolio returns (Markowitz, 1952). The

detailed discussion of results from the estimation of time varying correlations is presented in section 6.2.2.

6.2.1 Data

This research has used weekly return data for 12 markets—Australia and USA against 10 frontier markets. The frontier markets included in this study are Jordan, Kenya, Nigeria, Colombia, Ecuador, Estonia, Lithuania, Romania, Pakistan and Sri Lanka. The Australian ASX300 index and S&P100 index have been used for the Australian and US markets respectively. Data for frontier markets have been taken from the respective individual market indices through DataStream. All the frontier market index values were collected in US Dollar terms in order to eliminate problems of exchange rate differences. The data covers the period from September 1997 to August 2014. This research also uses a holding out period from June 2009 to June 2014. Weekly price information for these indices was obtained from Griffith University DataStream.

There are over 60 frontier markets in the world, but not all of them are open to international investors. Many of the frontier markets have only recently opened to foreign investors and availability of data from such markets is limited. Due to these constraints, this study incorporates 10 frontier markets. A number of previous studies on international diversification have used a similar number of markets (Gupta and Donleavy, 2009; Grubel, 1968; Segot and Lucy, 2007; Solnik, 1974). The reason this research limits the number of frontier markets to 10 is the inconsistency and non-continuity of data available for a large number of frontier markets, which makes those markets unsuitable for my analysis. For example,

frontier markets such as Croatia, Ghana, Jamaica, Kuwait, Latvia, Mauritius, Namibia, Slovakia, Slovenia, Trinidad and Tobago, Tunisia, UAE and Zambia either have inconsistent data or have data starting from a much later date or both. Namibia, for instance, has data available from February 2000 and UAE has data from January 2005. There are also several inconsistencies in data in these excluded markets that could have been caused by the backdating of data from a certain available date. These issues in data availability and consistency have therefore limited the number of frontier markets used in this study to 10.

I have used some criteria for the selection of frontier markets for this study. Firstly, the market should be listed in the S&P Frontier BMI, MSCI Frontier Market Index or the Russell Frontier Markets. All frontier markets included in this study except for Colombia and Ecuador are listed in at least two of the above mentioned indices. Colombia and Ecuador are included only in S&P frontier markets list, whereas Colombia is included in the MSCI frontier emerging markets index on the rationale that smaller emerging markets resemble frontier markets in nature. Another criterion used is geographical diversity. Out of the 10 frontier markets included in this study, two are from Africa (Kenya, Nigeria), two from South America (Colombia, Ecuador), three from Eastern Europe (Estonia, Lithuania, Romania) and three from the Middle East and Asia (Jordan, Pakistan, Sri Lanka). This sample is consistent with the global distribution of frontier markets discussed by Speidell and Kronhe (2007); they outlined 60 markets spread out across Europe, the Middle East, Latin America, Asia and Africa.

The weekly returns data from all the markets have been calculated in US Dollars. This would avoid the problem of exchange rate affecting the portfolio returns. Investors from the developed capital markets can access the emerging/frontier market indices through Exchange Traded Funds that are presented in the local currency of the investor. The issue of exchange rate volatility between the Australian Dollar and the US Dollar may also influence the potential benefits from diversification. The use of US Dollar for all the markets in this study will aid consistency of comparison between Australian and the US results.

Table 6.1 presents the macroeconomic variables and the equity market structures of the 12 markets included in the study. Among the 10 frontier markets, Estonia had the highest per capita GDP of US$13,934 in 2010. Kenya had the lowest per capita GDP of US$769. The market capitalisations of the frontier markets are relatively small. Estonia had the lowest market capitalisation of US$2.3 billion, and Colombia had the highest at US$208 billion. The number of listed firms is also relatively small in most of these frontier markets. For instance, there are only 15 listed companies in Estonia and 39 in Lithuania. The lack of internal diversification in a country can also add to the risk for an investor, and a small number of listed companies is an indicator for this. Another potential problem for an international investor is the lack of liquidity in the market, and this can be gauged by the stock market turnover ratio. The turnover ratio is the lowest for Ecuador at 3.8%, and markets such as Romania, Lithuania and Kenya have turnover ratios of less than 10%. The level of foreign direct investments into these markets is also relatively low. Many of these frontier markets except for Estonia and Lithuania have low levels of exports of goods and services, which can

potentially shield them from global contagion. A comparison of the Australian and the US markets shows that the Australian market is less than one-tenth of the US market.

Table 6.2 presents the summary statistics of weekly returns of all the selected markets for the sample period. All countries had positive average returns for the period. Australia had mean returns of 0.19% and minimum of -19.97%. Colombia and Sri Lanka had mean returns of 0.28% and 0.17% and minimum of -24.31% and -19.14% respectively. The frontier markets in the sample generally have higher standard deviations, in particular Romania, Estonia and Lithuania. This is consistent with the findings from previous studies by Speidell and Kronhe (2007) and Alexakis (2010) that frontier markets are more volatile than other advanced markets, but with the appropriate tools for estimation, investors could sail through the high gains and potential high losses pattern. Markets such as Australia, USA, Pakistan, Ecuador and Romania have negative skewness, which is an indication that these markets have had more negative shocks than positive shocks, indicating the presence of asymmetric volatility. Such asymmetric volatility, where markets react more to negative shocks than to positive shocks, underlines the need to use advanced models that capture such phenomena like DCC GARCH and AG-DCC GARCH.

The next section presents and discusses the results from the time varying correlations analysis.

Table 6.1 Market structure of Australia and the frontier markets

Country	Per capita GDP	Market capitalisation (in millions)	Number of listed companies	Stock market turnover ratio	Foreign direct investments (in millions)	Export of goods and services % of GDP
Australia	42,279	1,454,546	1,913	90.1%	30,580	20%
USA	47,240	17,138,978	4,279	189.1%	270,986	13%
Kenya	769	14,460	53	8.6%	130	39%
Nigeria	1,224	50,882	215	12.5%	6,050	26%
Colombia	6,224	208,501	84	13.4%	6,760	16%
Ecuador	4,277	5,262	40	3.8%	160	31%
Estonia	13,934	2,260	15	13.1%	1,540	78%
Lithuania	10,939	5,660	39	5.8%	620	68%
Romania	7,535	32,384	1,383	5.4%	3,450	23%
Jordan	4,525	30,864	277	30.1%	1,700	45%
Pakistan	1,008	38,168	644	36.2%	2,020	13%
Sri Lanka	2,423	19,923	241	23.6%	480	19%

Source: World Bank Data for 2010; all figures are in US dollars.

Table 6.2 Summary statistics of weekly returns

Country	Mean	Standard Deviation	Kurtosis	Skewness	Minimum	Maximum
Australia	0.0019	0.0359	6.0099	-0.1938	-0.1997	0.2401
USA	0.0020	0.0296	8.4653	-0.5370	-0.2062	0.2170
Colombia	0.0028	0.0373	15.5914	0.4532	-0.2431	0.3773
Jordan	0.0014	0.0271	3.8919	0.4684	-0.1289	0.1387
Nigeria	0.0022	0.0362	2.2519	0.0724	-0.1505	0.1488
Pakistan	0.0016	0.0405	3.3198	-0.7171	-0.1910	0.1489
Sri Lanka	0.0017	0.0340	6.9280	0.6442	-0.1914	0.2315
Ecuador	-0.0001	0.0313	34.7696	-0.1725	-0.3269	0.3296
Estonia	0.0015	0.0485	21.2472	0.4750	-0.3299	0.4803
Lithuania	0.0025	0.0457	293.5748	12.8416	-0.2110	1.0319
Romania	0.0017	0.0473	2.7340	-0.1119	-0.1957	0.2495
Kenya	0.0005	0.0312	17.0880	1.6154	-0.1308	0.3222

Note: Weekly returns have been calculated from primary indices of each market as Ri=Ri/(Ri-1–1). Summary statistics have been derived from returns data for the 12 markets in the study.

6.2.2 Results and Discussion

In order to construct optimal portfolios, it is required to derive time varying correlations as the first step. Optimal portfolios could be constructed using unconditional correlations as well, but unconditional correlations fail to capture their time varying nature. This study uses the AG-DCC GARCH model to estimate time varying correlations. I also test this against DCC GARCH correlations to check whether the results are model specific.

Table 6.3 shows the unconditional Pearson's Correlations between Australia and the 10 frontier markets. Australia has relatively low correlations with most of the frontier markets. One of the markets, Nigeria, has negative correlations with the Australian market (-0.002). The more developed countries of Eastern Europe, Lithuania and Romania have slightly higher correlations. This indicates that the bigger markets in the frontier market category are less segmented with a developed capital market than the smaller markets in the category. However, even the bigger frontier markets are relatively less correlated with Australia —Romania has the highest correlation value with Australia at 0.37, followed by Colombia at 0.29. These values are still significantly lower than the high correlations between developed capital markets, and do not hinder the argument that frontier markets are highly segmented from developed capital markets. In general, the unconditional correlations between frontier markets are relatively low. The only exceptions are the Eastern European markets, which have higher correlations amongst them, which could be attributed to the geographical concentration and similarities in economic and financial environments.

Table 6.3 Unconditional correlations of weekly returns

	Australia	Colombia	Jordan	Nigeria	Pakistan	Sri Lanka	Ecuador	Estonia	Lithuania	Romania	Kenya
Australia	1										
Colombia	0.2907	1									
Jordan	0.1472	0.0900	1								
Nigeria	-0.0027	0.0551	0.1053	1							
Pakistan	0.0975	0.1603	0.0612	0.0557	1						
Sri Lanka	0.1158	0.0694	0.1341	0.1141	0.1263	1					
Ecuador	0.0215	0.0177	-0.0146	-0.0226	0.0138	0.0624	1				
Estonia	0.0643	0.0707	0.0744	0.0869	0.1085	0.0718	0.0170	1			
Lithuania	0.0976	0.0704	0.1226	0.0794	0.0540	0.0653	-0.0197	0.5244	1		
Romania	0.3741	0.2746	0.1362	0.0876	0.1486	0.1358	0.0222	0.1655	0.1292	1	
Kenya	0.1185	0.0873	0.0957	0.0077	0.0894	0.1378	0.0123	0.0912	0.0930	0.1555	1

Note: The unconditional correlations presented here are the Pearson's correlations of weekly returns between Australia and the ten frontier markets.

The results presented in table 6.3 are unconditional Pearson's correlations which are constant in nature. Previous research has established that correlations vary over time, and hence the use of constant correlations to estimate diversification benefits will create inaccurate results. The Pearson's correlations have been presented in this section for comparison only to the time varying correlations discussed in the following sections. The review in Chapter 5 of existing literature on various models for estimating diversification benefits summarises that multivariate GARCH models are a better tool for accurately estimating the benefits. Engle (2002) introduced the Dynamic Conditional Correlation (DCC) GARCH model and Gupta and Donleavy (2009) used an extended Asymmetric Dynamic Conditional Correlation (ADCC) GARCH model. The DCC GARCH model allows us to capture the dynamic nature of time varying correlations and the AG-DCC GARCH model incorporates the effects of asymmetric information effect in asset returns data. Wong and Vlaar (2003) conclude that these models are efficient methods of estimating diversification benefits in the long run. Following previous studies (Capiello et al., 2006; Hyde et al., 2007; Skintzi et al., 2007), this study uses the AG-DCC GARCH model to estimate correlations and to construct optimal portfolios, and also estimates DCC GARCH correlations in order to test if the results are model specific. The AG-DCC GARCH and DCC GARCH models are detailed in Chapter 5.

The DCC GARCH model that was used is stated below in matrix version as:

$$Q_t = S(1 - \alpha - \beta) + \alpha(\varepsilon_{t-1}\acute{\varepsilon}_{t-1}) + \beta Q_{t-1} \quad (6.1)$$

Where S denotes the unconditional correlation matrix of the disturbance terms, and

$$Q_t = \left| q_{1,2,t} \right|.$$

The log likelihood of this estimator can be written as:

$$L = -\frac{1}{2}\sum_{t=1}^{T}(n\log(2\pi) + 2\log\left| D_t \right| + \log R_t + \varepsilon_t' R_t^{-1}\varepsilon_t \quad (6.2)$$

Where $D_t = diag\left(\sqrt{h_{i,t}}\right)$ and Rt is the time varying correlation matrix.

The AG-DCC GARCH model can be stated as:

$$Q_t = (\bar{Q} - A'\bar{Q}A - B'\bar{Q}B - G'\bar{N}G) + A'\varepsilon_{t-1}\varepsilon_{t-1}'A + B'Q_{t-1}B + G'n_{t-1}n_{t-1}'G \quad (6.3)$$

Where A,B and G are diagonal parameter matrices, n_t= I($\varepsilon_t < 0$), $\bar{N} = E[n_t, n_t']$. For $\bar{Q} and\ \bar{N}$, 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. $Q_t^* = \left[q_{ii,t}^*\right]$=$\left[\sqrt{q_{ii,t}}\right]$ is a diagonal matrix with the square root of the ith diagonal element of Qt on its ith diagonal position.

Table 6.4 presents the AG-DCC GARCH correlations for Australia and the frontier markets[8]. Similar to the results from the unconditional correlation estimates, ADCC GARCH estimates also present very low correlations between Australia and the frontier markets. Estonia and Kenya have negative correlations with Australia at -0.006 and -0.016 respectively. The highest correlation with

[8] The correlations presented in table 6.4 are the full sample estimates for August, 2014. The AG-DCC GARCH estimates for the in-sample period ending May, 2009 are presented in Appendix A.

Australia is for Romania (0.44) and Colombia (0.36). The correlations amongst the frontier markets are also on the lower side except for some of the Eastern European markets. The more developed frontier markets in the European region have greater levels of integration with the Australian market and hence record higher levels of correlations. However, the levels of correlation are comparably smaller in even the larger frontier markets in this data set, and thus provide a potential for attaining diversification benefits from these markets for the Australian investor. Nigeria, Pakistan, Estonia, Lithuania and Kenya present correlations lower than 0.1, while Colombia, Jordan, Sri Lanka and Ecuador have less than 0.3. In general, the ADCC GARCH correlations reveal the low levels of correlations that exist between frontier markets and Australia. These figures are consistent with results from previous research that have concluded that less segmented frontier markets provide low correlations with developed capital markets. This is the first study to examine the impact of frontier market diversification for an Australian investor and I find that similar to results from US based frontier market studies, Australia also records quite low levels of correlation with frontier markets.

The conditional correlations between Australia and frontier markets using the DCC GARCH model are also examined in this study, and these results are presented in Table 6.5. The results from the DCC GARCH estimation are presented in Table 6.5 along with the AG-DCC GARCH correlations for comparison. The study finds no significant deviation from AG-DCC GARCH correlations and thus rules out the possibility of results being model specific. The least amount of variations in results is found in six market pairs – Colombia, Sri

Lanka, Ecuador, Estonia, Romania and Kenya. For instance, during at the end of the in-sample period in May 2009, Australia and Colombia had correlation of 0.33 (AG-DCC) and 0.31 (DCC); Australia and Ecuador had -0.12(AG-DCC) and -0.10(DCC). The comparison of conditional correlations from the two models for the other four markets — Jordan, Nigeria, Pakistan and Lithuania— present low levels of differences. These differences can be accounted to the capturing of the impact of asymmetric volatility phenomenon in the frontier markets that was not accounted for in the DCC model. In general, these models are considered to be efficient ways to estimate time varying correlations, and in the further analysis of portfolio optimisation and holding out period analysis, I have used AG-DCC GARCH correlations.

Table 6.4 Conditional correlations (AG-DCC GARCH) of weekly returns between Australia and the frontier markets

	Australia	Colombia	Jordan	Nigeria	Pakistan	Sri Lanka	Ecuador	Estonia	Lithuania	Romania	Kenya
Australia	1										
Colombia	0.3647	1									
Jordan	0.2068	0.2552	1								
Nigeria	0.0426	0.1496	0.1732	1							
Pakistan	0.0808	0.2851	0.2542	0.2313	1						
Sri Lanka	0.1286	0.0104	0.1540	0.2860	0.2238	1					
Ecuador	0.1071	-0.0091	0.1165	-0.0668	-0.1815	0.0282	1				
Estonia	-0.0065	0.0054	-0.0312	0.0379	0.0622	0.0360	0.0040	1			
Lithuania	0.0171	-0.0341	0.0438	0.0238	0.0663	0.0296	-0.0704	0.7165	1		
Romania	0.4475	0.3383	0.0726	0.0717	0.2200	0.2796	0.0199	0.0159	0.0058	1	
Kenya	-0.0165	0.0810	0.0502	0.1395	0.1526	0.0857	0.0584	0.0154	0.0176	0.1732	1

Note: Conditional correlations presented here are the AG-DCC GARCH correlations at the end of the full sample period of August 2014 for weekly returns for Australia and the ten frontier markets.

Table 6.5 Conditional correlations (AG-DCC v/s DCC GARCH) of weekly returns between Australia and the frontier markets

Country	Australia	
	AG-DCC	DCC
Australia	1	1
Colombia	0.3391	0.3189
Jordon	0.1756	0.0502
Nigeria	0.1378	0.0252
Pakistan	0.0922	0.1698
Sri Lanka	0.0956	0.0923
Ecuador	-0.1223	-0.1004
Estonia	0.0371	0.0301
Lithuania	0.0728	0.2485
Romania	0.4503	0.4332
Kenya	0.0032	0.0390

Note: The conditional correlations derived from AG-DCC GARCH and DCC GARCH models presented are at the end of the in-sample period in May 2009 for weekly returns data.

The conditional correlations between Australia and Ecuador, Jordan and Sri Lanka which are derived using the AG-DCC GARCH model are presented in a graphic representation below in Figures 6.1–6.3.[9] The correlations between Australia and Jordan are presented in Figure 6.2, which shows considerably low levels of correlation – staying mostly between the -0.1 and 0.2. In Figure 6.3, which maps the correlation dynamics with Sri Lanka, correlations generally stay near 0.2, but during the 2009-2010 period of financial crisis, there is a significant spike in correlations. These indicate that even though the frontier markets are highly segmented from developed capital markets, there were some spill-over effects from the crisis to these markets. However, the smaller and less integrated frontier markets such as Ecuador and Jordan record smaller correlations and shorter time of increase in them, pointing towards the fact that these markets are

[9] The graphical representations of all the pairwise AG_DCC GARCH correlations for Australia and all the ten frontier markets are presented in Appendix C.

less integrated, so they were less affected by the rise in correlations during the crisis.

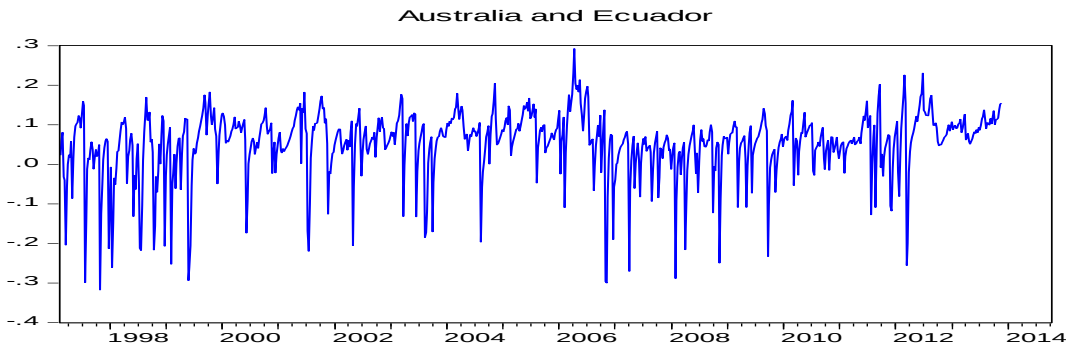

Figure 6-1 AG-DCC GARCH correlations between Australia and Ecuador

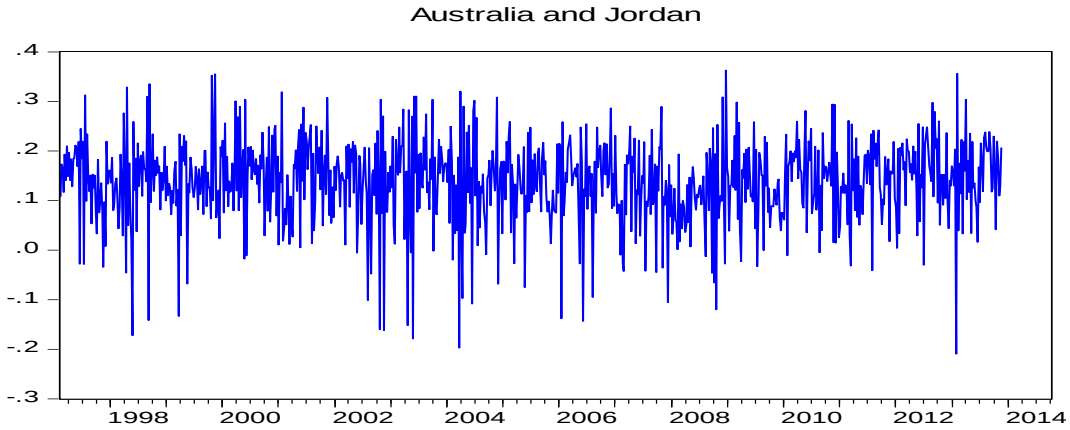

Figure 6-2 AG-DCC GARCH correlations between Australia and Jordan

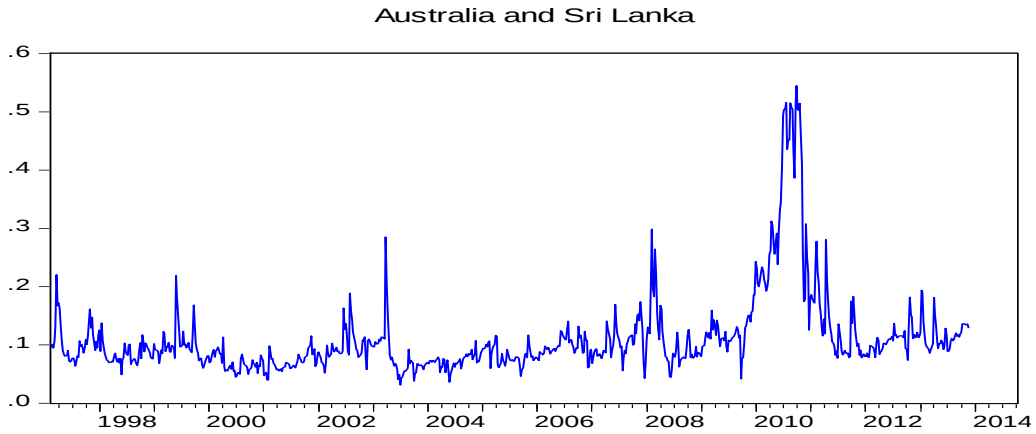

Figure 6-3 AG-DCC GARCH correlations between Australia and Sri Lanka

The next step in examining whether there are potential benefits from frontier market diversification for an Australian investor is to incorporate the time varying correlations obtained from this analysis in the construction of a number of diversified optimal portfolios subjected to various restrictions. This analysis is outlined in the following section. The same steps of analysis are followed for the US investor and those findings are presented in section 6.4.

6.3 Optimal Portfolios

Time varying correlations estimated using the AG-DCC GARCH model are used in the portfolio optimisation process in order to determine if there are any potential benefits for the Australian investor from diversifying into the frontier markets. This analysis is performed in two steps. First, an Australia-only portfolio is constructed. Second, various optimal diversified portfolios are constructed with several restrictions. We compare the Sharpe ratio, mean returns and standard deviation of these optimal portfolios with the Australia-only portfolio to determine whether there are any benefits from diversification.

6.3.1 Results and Discussion

An Australia-only portfolio represents the undiversified portfolio of an Australian investor who holds all their assets in the domestic market. It is constructed using the 3-month Treasury Bills rate, and it is 2.65% in this case. Table 6.6 shows the Australia-only portfolio. The mean return of the Australia-only portfolio is 9.85%, with a standard deviation of 25.91%. The Sharpe ratio of this portfolio is 0.278, and it was constructed with the risk free rate of 2.65%. The undiversified portfolio

will theoretically provide lower returns than a diversified portfolio, or might present higher total risk. In order to examine this, the next section will construct various diversified portfolios and compare the returns and standard deviations of these two sets to arrive at conclusions.

Table 6.6 Australia-only portfolio

Mean annual returns	9.85%
Standard deviation	25.91%
Sharpe ratio	0.278
Probability of achieving mean returns	49.76%

Note: Sharpe ratio Australia is calculated using the risk free rate of 2.65%. Weekly returns annualised as Annualised returns = Weekly returns X 52 and standard deviations annualised as Annualised SD = Weekly Standard deviation X 52^0.5

The next step is to construct optimal portfolios with various restrictions based on the AG-DCC GARCH correlations between the markets. One unrestricted portfolio and four portfolios with the following restrictions are constructed: a maximum of 10% investment in frontier markets; a maximum of 20% investment in frontier markets; a minimum of 50% in Australian/US market and a maximum of 10% in frontier markets; and a minimum of 50% in Australian/US markets and a maximum of 20% in frontier markets. These restrictions showcase different scenarios that could be presented in front of an investor whereby the diversification strategy is affected.

The results from the optimisation are presented in Table 6.7. The unrestricted Australian portfolio provides an optimal return of 10.71% with a Sharpe ratio of

0.600. The weights allocated to different markets in the unrestricted portfolio vary from Colombia (25.10%), Nigeria (21.56%), Romania (10.23%) and Lithuania (8.74%) on the higher end to Kenya (1.61%) and Pakistan (1.80%) on the lower end. The unrestricted diversified portfolio presents a significant improvement over the Australia-only portfolio, as the mean returns and Sharpe ratio are much higher. Similarly, all the diversified portfolios with various restrictions also performed better, with higher Sharpe ratios and lower standard deviations. The portfolio with at least 50% in Australia and a maximum of 10% in frontier market yields 10.30% mean returns and 0.455 Sharpe ratio with a standard deviation of 16.81%. All of the diversified portfolios produce a much higher Sharpe ratio and significantly lower standard deviations along with almost the same level of mean returns as the Australia-only portfolio. The weights allocated to the markets in these portfolios differ according to the restrictions applied. Colombia, Jordan and Nigeria are allocated 10% or more of the total portfolio weight in at least three of the five diversified portfolios. The results from the diversified portfolios are presented in the table below, and an examination of the figures provided here clearly outlines the improvement of diversified portfolios over an undiversified Australian portfolio.

While the mean returns of the diversified portfolios provide a slight improvement over the undiversified portfolio, there is tremendous decline in the standard deviations of the diversified portfolios over the Australia-only portfolio. The standard deviation of the Australia-only portfolio is 25.91%, whereas that of all the diversified portfolios are much lower: 13.44% for the unrestricted portfolio; 13% for the portfolio with a maximum of 10% investment in frontier markets;

13.41% for the portfolio with a maximum of 20% investment in frontier markets; 16.58% and 16.81% for the portfolios with a minimum of 50% investment in Australia and 10% or 20% respectively in the frontier markets. If a diversified portfolio of the same level of standard deviation as the Australia-only portfolio were to be constructed, it would theoretically provide a much higher mean return than those presented in the table below. But on a practical level, investors aim at reducing the level of risk and hence the results presented from the diversified portfolios in Table 6.7 are significant, since there is an increase in mean returns paired with a tremendous decline in standard deviations.

Table 6.7 Australian portfolio with different restrictions on frontier market investments with conditional correlations

	No restrictions	max 10% in frontier	max 20% in frontier	50% in Aus, 20% frontier	50% in Aus, 10% frontier
Australia	6.11%	25.11%	15.40%	52.12%	54.92%
Colombia	25.10%	10.00%	18.34%	10.09%	7.82%
Jordan	13.14%	10.00%	10.89%	1.19%	4.06%
Nigeria	21.56%	10.00%	20.00%	11.51%	10.00%
Pakistan	1.80%	10.00%	1.29%	2.48%	0.55%
Sri Lanka	1.87%	10.00%	8.40%	10.06%	8.17%
Ecuador	6.85%	2.81%	1.53%	1.06%	0.05%
Estonia	1.99%	6.04%	1.36%	3.72%	2.43%
Lithuania	8.74%	4.00%	9.87%	2.41%	2.00%
Romania	10.23%	8.09%	10.54%	4.82%	8.15%
Kenya	1.61%	3.95%	2.38%	0.54%	1.85%
Optimal Return	10.71%	9.58%	10.90%	10.30%	10.30%
Standard Deviation	13.44%	13.00%	13.41%	16.58%	16.81%
Sharpe Ratio	0.600	0.533	0.615	0.461	0.455
Probability	52.10%	48.70%	52.67%	50.72%	50.71

Note: The portfolio weight allocations for each market along with optimal return, standard deviation, Sharpe ratio and probability of achieving mean returns for the optimal Australian portfolio constructed using various restrictions are presented in this table. Restrictions are based on the "prudent man's rule" as commonly practiced in the USA. Rows 5 and 6 denote a minimum of 50% in Australia and maximum of 10% and 20% in frontier markets respectively. Risk free rate of 2.65% has been used. The diversified portfolios are constructed using the time varying correlations derived from AG-DCC GARCH model.

6.4 Comparison of the Australian and US Investor Perspectives

One of the objectives of this research is to compare the potential benefits from frontier market diversification for an Australian investor with those for a US investor. While there have been no previous studies on frontier market diversification from an Australian perspective, some work has been published from the point of view of a US investor (Segot and Lucey 2007). The fundamental differences in the nature and characteristics of these two markets imply that the results from a US based study may not be exactly applicable to the Australian scenario. Even though Australia is a developed capital market, it is less than one-tenth the size of the US market. A comparative analysis of the potential benefits to both Australian and US investors from frontier market diversification will provide evidence on whether there exist significant differences in the two cases. This analysis will provide an interesting insight into the nature of differences between the two markets. All the analysis conducted from the Australian perspective discussed in the previous section was carried out for the US market and the 10 frontier markets. The next two sections present the data and results from this analysis.

6.4.1 Data

The data for US market is obtained from the S&P100 and ranges from the period September 1997 to August 2014. The data for the ten frontier markets — Jordan, Kenya, Nigeria, Colombia, Ecuador, Estonia, Lithuania, Romania, Pakistan and

Sri Lanka — as presented in the previous analysis was used in the US investor perspective as well, and all the indices are expressed in US dollars. Weekly price information has been used and the data is collected from Griffith DataStream. The holding out period for the US investor perspective spans between June 2009 and June 2014.

6.4.2 Results and Discussion

The market structure of the US market and the frontier markets included in the sample is presented in Table 6.1. The US market is the largest capital market in the world and the frontier markets are quite small in comparison to the US market with regard to market capitalisation, turnover ratio, FDI and per capita GDP. The per capita GDP of the USA is $47,240 while the highest per capita GDP among the ten frontier markets is $13,934 in Estonia. Eight of the ten frontier markets have per capita GDP of less than $10,000. The market capitalisation figures are tremendously polarised – the frontier markets are almost insignificant in size compared to the US market. This is consistent with the characteristic feature of the frontier markets as examined by Speidell and Kronhe (2007). The frontier markets are relatively new capital markets that have recently opened up to international investors, and in due course they are expected to ripen into emerging markets and eventually into the developed markets category.

Table 6.8 presents the unconditional Pearson's correlations between the USA and the frontier markets. All the frontier markets provide very low correlations with the US market – eight of the markets have values of less than 0.2 with the US market. The frontier markets also have very low correlations amongst themselves.

Colombia has the highest correlation value at 0.28. Ecuador has a negative correlation with the US market of -0.019. The low correlations with the US market are consistent with the findings from previous studies by Speidell and Kronhe (2007) and Segot and Lucey (2007). The smaller developed markets in the Latin American and European regions, Colombia and Romania, have relatively higher correlations with the US market. The similarities in the European markets with regard to economic, political and financial policies and general environment could be considered as responsible for the slightly higher correlations. With regard to the Colombian market, geographical proximity might explain the high correlation.

Since unconditional correlations do not capture the true nature of correlations, we use AG-DCC GARCH model to estimate correlations. The results for the AG-DCC GARCH correlations between USA and the frontier markets are presented in Table 6.9[10]. The correlation estimates from the AG-DCC GARCH model are different from the unconditional correlations. The standard deviations and minimum-maximum range of the correlations depict the time-varying nature of the correlations. The highest correlation value from the AG-DCC GARCH model is with Colombia at 0.35; followed by Romania at 0.29. The lower values of correlations for USA are with Ecuador, Lithuania and Kenya at 0.01, 0.008 and 0.10 respectively. Sri Lanka has a negative correlation with the USA at -0.105.

[10] The correlations presented in table 6.9 are values at the end of the full sample period in August, 2014. The AG-DCC GARCH estimates for the in-sample period ending May 2009 are presented in Appendix B.

This study also estimates DCC GARCH correlations in order to examine whether the results are model specific. A comparison of the AG-DCC GARCH and DCC GARCH correlations for the USA and frontier markets are presented in Table 6.10. This comparison did not find any significant variations in the correlations estimated using the two models. For instance, the correlation for the pair of USA and Sri Lanka at the end of the in-sample period in May 2009 is 0.104 in AG-DCC GARCH modelling, and 0.107 in DCC GARCH modelling, and for the USA-Ecuador pair it is -0.04 and -0.03 respectively. The minor variations in correlation values derived from the two models can be attributed to the capturing of asymmetric effects by the AG-DCC model which the DCC model does not incorporate. The lack of major disparities in the time varying correlations derived from the two models provide that the results are not model specific.

Table 6.8 Unconditional correlations of weekly returns between USA and the frontier markets

	USA	Colombia	Jordan	Nigeria	Pakistan	Sri Lanka	Ecuador	Estonia	Lithuania	Romania	Kenya
USA	1										
Colombia	0.2834	1									
Jordan	0.1232	0.0900	1								
Nigeria	0.0411	0.0551	0.1053	1							
Pakistan	0.0497	0.1603	0.0612	0.0557	1						
Sri Lanka	0.0686	0.0694	0.1341	0.1141	0.1263	1					
Ecuador	-0.0195	0.0177	-0.0146	-0.0226	0.0138	0.0624	1				
Estonia	0.0389	0.0707	0.0744	0.0869	0.1085	0.0718	0.0170	1			
Lithuania	0.0790	0.0704	0.1226	0.0794	0.0540	0.0653	-0.0197	0.5244	1		
Romania	0.2847	0.2746	0.1362	0.0876	0.1486	0.1358	0.0222	0.1655	0.1292	1	
Kenya	0.0684	0.0873	0.0957	0.0077	0.0894	0.1378	0.0123	0.0912	0.0930	0.1555	1

Note: The unconditional correlations presented here are the Pearson's correlations of weekly returns between USA and the ten frontier markets.

Table 6.9 Conditional correlations (AG-DCC GARCH) of weekly returns between USA and the frontier markets

	USA	Colombia	Jordan	Nigeria	Pakistan	Sri Lanka	Ecuador	Estonia	Lithuania	Romania	Kenya
USA	1										
Colombia	0.3564	1									
Jordan	0.0966	0.2552	1								
Nigeria	0.0324	0.1496	0.1733	1							
Pakistan	0.0792	0.2852	0.2543	0.2314	1						
Sri Lanka	-0.1053	0.0105	0.1540	0.2860	0.2238	1					
Ecuador	0.0178	-0.0091	0.1166	-0.0668	-0.1816	0.0282	1				
Estonia	0.0916	0.0054	-0.0312	0.0380	0.0622	0.0361	0.0041	1			
Lithuania	0.0086	-0.0342	0.0438	0.0238	0.0664	0.0297	-0.0705	0.7165	1		
Romania	0.2973	0.3384	0.0727	0.0717	0.2200	0.2796	0.0199	0.0160	0.0058	1	
Kenya	0.1062	0.0811	0.0502	0.1396	0.1526	0.0858	0.0585	0.0155	0.0176	0.1733	1

Note: Conditional correlations presented here are the AG-DCC GARCH correlations at the end of the full sample period in August 2014 for weekly returns of USA and the ten frontier markets.

Table 6.10 Conditional correlations (AG-DCC vs DCC GARCH) of weekly returns between USA and the frontier markets

Country	USA	
	AG-DCC	DCC
USA	1	1
Colombia	0.2640	0.3474
Jordon	0.0897	0.1001
Nigeria	0.0476	0.0184
Pakistan	0.0838	0.1124
Sri Lanka	0.1040	0.1074
Ecuador	-0.0481	-0.0341
Estonia	0.1913	0.1792
Lithuania	0.1196	0.2019
Romania	0.3374	0.3177
Kenya	0.0631	0.0844

Note: The conditional correlations derived from AG-DCC GARCH and DCC GARCH models presented are for the end of the in-sample period in May 2009 for weekly returns data.

Figures 6.4–6.6 below present the graphic representation of conditional correlations (AG-DCC GARCH) between USA and the frontier markets of Sri Lanka, Nigeria and Romania.[11] The lower correlations between these markets are evident and an increase in correlation values are seen during the Global Financial Crisis period. While Romania has generally higher correlations with the US markets, possibly since these are smaller developed markets, there has been a significant rise in correlations during the 2007-09 period as shown in Figures 6.4

[11] The graphical representations of all the pairwise AG_DCC GARCH correlations for USA and all the ten frontier markets are presented in Appendix D.

and 6.6. Sri Lanka and Nigeria, on the other hand, have considerably low correlations throughout the period with a slight increase during the crisis period.

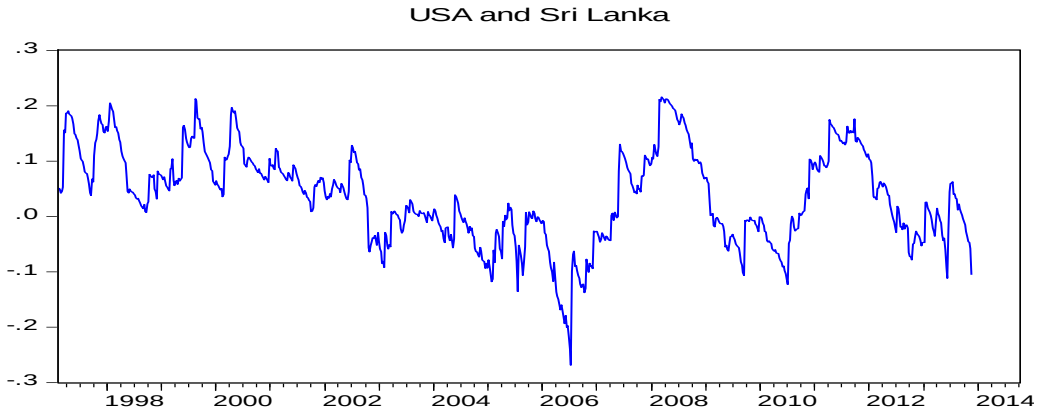

Figure 6-4 AG-DCC GARCH correlations between USA and Sri Lanka

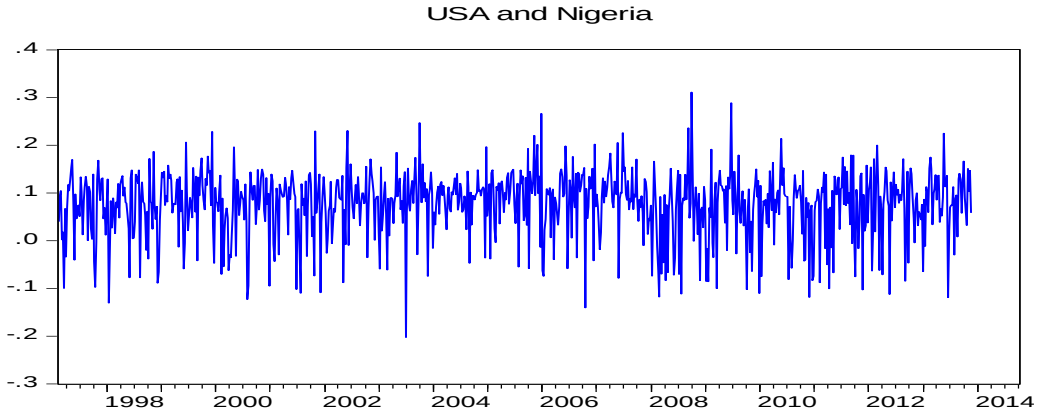

Figure 6-5 AG-DCC GARCH correlations between USA and Nigeria

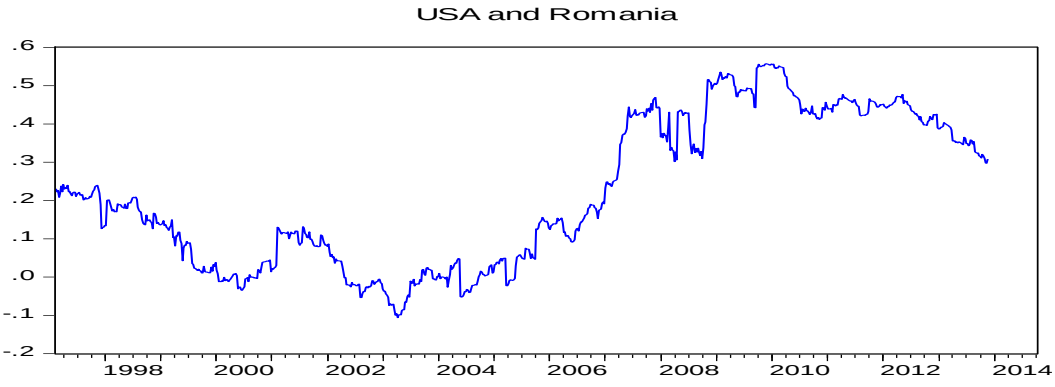

Figure 6-6 AG-DCC GARCH correlations between USA and Romania

In order to analyse whether there are any potential benefits for a US investor from diversifying into the ten frontier markets considered in this study, the next step is to construct a US-only portfolio. The US-only portfolio represents an undiversified portfolio which is held as domestic assets only by the US investor. The three-month Treasury Bill rate of 0.05% is used to construct the Sharpe ratio of this undiversified portfolio and mean returns and standard deviations are calculated. The intention is to examine whether an undiversified portfolio provides higher mean returns or lower standard deviation and a higher Sharpe ratio than any diversified portfolios for the US investor. The mean annual returns for the US-only portfolio is 10.45%, the standard deviation is 21.33% and the Sharpe ratio is 0.488.

Table 6.11 US-only portfolio

Mean annual returns	**10.45%**
Standard deviation	21.33%
Sharpe ratio	0.488
Probability of achieving mean returns	50.85%

Note: Sharpe ratio for USA is calculated using the risk-free rate of 0.05%. Weekly returns annualised as Annualised returns = Weekly returns X 52 and standard deviations annualised as Annualised SD = Weekly Standard deviation X 52^0.5

The next procedure involves constructing various diversified portfolios for the US investor by including frontier market assets in the portfolio. Five diversified portfolios were constructed using various restrictions that imply the existence of home bias and other factors. The first one is an unrestricted portfolio and the others are with the following restrictions: maximum 10% investment in frontier markets; maximum 20% investment in frontier markets; minimum 50% investment in the domestic market and a maximum of 10% in frontier markets; and a minimum 50% investment in the domestic market and a maximum of 20% in frontier markets. These restrictions will allow for various cases in which the investor may wish to hold a majority of the portfolio in the domestic market due to home bias, or may be willing to venture into the new area with a heavier weighting on frontier markets. The results from the optimal diversified portfolio are presented in Table 6.12.

The potential benefits from diversified portfolios for a US investor appear to be significantly higher than for an Australian investor. The Sharpe ratios from 3 of the 5 portfolios were more than 0.8: the unrestricted portfolio achieved a Sharpe ratio of 0.827, the maximum 10% in frontier markets portfolio achieved 0.805, and the maximum 20% in frontier markets portfolio achieved 0.836. These are immense improvements over the US-only portfolio's Sharpe ratio of 0.488. The mean returns of the constructed portfolios are similar to the US-only portfolio, while the standard deviations are significantly lower. In all of the diversified portfolios, the mean returns are marginally higher than the US-only portfolio. However, all the diversified portfolios present a highly significant reduction in the standard deviations of the undiversified US-only portfolio. The US-only portfolio

presented a 21.33% standard deviation, whereas all the diversified portfolios have standard deviations of 13% or lower. The unrestricted portfolio and the portfolios with a maximum of 10% and 20% investment in frontier markets provide standard deviations of 12.38%, 11.99% and 12.80% respectively. The portfolios with the restriction of a minimum of 50% investment in the domestic market are characterised by slightly higher standard deviation than the other three diversified portfolios. The portfolio of minimum 50% in US market with a maximum of 10% in frontier market has the highest standard deviation amongst all the five diversified portfolios that are examined in this study – 13.81%. Even the highest standard deviation of the diversified portfolios presented in Table 6.12 is much lower than the standard deviation of the US-only portfolio –21.33%. This represents a significant reduction in the portfolio risk, which is one of the most significant pointers for practitioners, as the diversified portfolios provide tremendous reduction in risk combined with an increase in return. These results indicate that the inclusion of frontier markets in a US investor's portfolio, be it in any ratio, is extremely beneficial to the investor. The Sharpe ratios of the optimal portfolios for the US investor are much higher than for the Australian portfolios. The interesting observation from a comparison of the diversified Australian and US portfolios is that the latter have performed much better than the former in each of the three areas – increase in mean returns, decline in standard deviations and improvement in Sharpe ratios. This indicates there are potentially higher benefits from frontier market diversification for the US investor than for the Australian investor. The vast differences in the nature and characteristics of the two markets and the size effect on diversification benefits could account for this discrepancy.

Table 6.12 USA portfolio with different restrictions on frontier market investments with conditional correlations

	No Restrictions	Max10%Frontier	Max20%Frontier	50% in USA, 10%Frontier	50% in USA, 20%Frontier
USA	14.68%	31.22%	19.51%	50.39%	51.69%
Colombia	15.66%	10.00%	18.98%	6.44%	4.84%
Jordan	9.28%	10.00%	10.74%	7.51%	1.84%
Nigeria	13.18%	9.69%	9.38%	8.25%	11.85%
Pakistan	6.97%	7.04%	1.49%	2.01%	2.21%
Sri Lanka	12.79%	10.00%	15.39%	9.40%	8.46%
Ecuador	3.29%	6.37%	1.82%	0.64%	2.65%
Estonia	1.83%	3.35%	1.38%	2.96%	1.59%
Lithuania	6.86%	4.00%	6.18%	3.68%	5.19%
Romania	10.98%	7.10%	14.21%	7.09%	7.63%
Kenya	3.51%	1.24%	0.91%	1.63%	2.04%
Optimal Return	10.29%	9.70%	10.74%	10.24%	10.29%
Standard Deviation	12.38%	11.99%	12.80%	13.81%	13.79%
Sharpe Ratio	0.827	0.805	0.836	0.738	0.742
Probability	50.94%	49.01%	52.32%	50.70%	50.83%

Note: The portfolio weight allocations for each market along with optimal return, standard deviation, Sharpe ratio and probability of achieving mean returns for the optimal US portfolio constructed using various restrictions are presented in this table. Restrictions are based on the "prudent man's rule" as commonly practiced in the USA. Rows 5 and 6 denote a minimum of 50% in USA and maximum of 10% and 20% in frontier markets respectively. Risk-free rate of 0.05% has been used in the calculation of optimal portfolios. The diversified portfolios are constructed using the time varying correlations derived from AG-DCC GARCH model.

6.5 Holding out period analysis

Most of the diversification studies carried out previously are ex-ante studies, and there has not been any research on the potential benefits from frontier market diversification with an ex-post analysis. One of the significant contributions of this study is the inclusion of an out-of-sample analysis incorporating frontier markets in a diversified portfolio. In this section I examine the holding out period return of a portfolio which is rebalanced at the end of each quarter, using new weights calculated from the optimisation model that was used in the previous sections.

6.5.1 Data

The holding out period used for this analysis is from June 2009 to June 2014. Portfolio returns from a selected optimal portfolio are applied and rebalanced at the end of every quarter to find the total return from the portfolio at the end of the holding out period. From the portfolio optimisation process conducted in the previous section, the optimal portfolio, constructed using the restriction of maximum investment of 20% in frontier markets, is selected for the holding out period analysis. This portfolio is chosen as it provides a higher Sharpe ratio with lower standard deviation and higher mean returns. The portfolio is rebalanced at the end of each quarter for the entire holding out period data using the weights allocated for each market in that particular quarter. The portfolio weights for the end of each quarter are estimated and these weights are used to establish if there are any benefits from frontier market diversification during this period. This strategy is applied to find out if an investment of US$100 in June 2009 would

change significantly by June 2014. This analysis is conducted for the Australia-only portfolio and the diversified Australian portfolio and the US-only portfolio and the diversified US portfolio. The next section presents the results from this analysis.

6.5.2 Results and Discussion

Using the strategy described in the previous section, an investment of US$100 in June 2009 would have grown into US$248.66 for an Australian investor by the end of June 2014, using the criterion of a maximum of 20% in frontier markets, and into US$304.02 for a US investor using the same criterion. If the investment were to be made in the Australian index alone, the holding period return would have been only US$209.23. On the other hand, a US-only portfolio would have given US$248.76 at the end of the holding period.

Tables 6.13 and 6.14 present the rebalanced portfolio weights for Australia and USA in the frontier markets. The rebalanced portfolio weights for each quarter of the holding out period were used to calculate the cumulative gains from diversification at the end of the period. For an Australian investor with a diversified portfolio in the first quarter, Nigeria (20%), Colombia (17.10%) and Sri Lanka (10.04%) have the higher portfolio weights allocated, and Estonia and Ecuador have the lower, with 2.09% and 0.79% respectively. In the first quarter, the weight allocated for Australia is 7.82%. The weights allocated to each market in the first quarter are used to rebalance the portfolio and new weights are derived for the following quarter. Employing this method, the weights for the second quarter of the out-of-sample period ending in September 2009 were calculated. In

the second quarter, the majority of weighting goes to Nigeria (20%), Jordan (19.09%) and Colombia (17.70%), while Ecuador (1.98%), Kenya (2.01%) and Estonia (3.01%) have a meagre share. This process of rebalancing the portfolio weights is repeated for the entire holding out period, and the weights are presented in Table 6.13. In the last quarter of the holding out period (June 2014), the higher portfolio weights were allocated to Jordan and Nigeria at 20% and 17.04% respectively, while the minimum weight went to Ecuador at 1.58%. At the end of each quarter, the portfolio is rebalanced using new weights for each market, and that process provides the new weights to be used for the next quarter's rebalancing. Employing these weights for each market in the diversified portfolio for an Australian investor, the accumulated wealth from an investment of US$100 at the start of the holding out period in June 2009 is calculated to be US$248.66. This is compared with the corresponding accumulated wealth from an Australia-only portfolio for the same period, which is calculated to be US$209.23. The results from the out-of-sample data point towards a significant improvement from the inclusion of frontier markets in the Australian diversified portfolio. The weights for each market derived from this analysis are presented in Tables 6.13, and the growth in accumulated value from this analysis provide a more practical overview of the benefits from including frontier markets in an Australian portfolio.

The quarterly rebalanced weights for the diversified US portfolio are calculated using the same method as employed in the previous section, and are presented in Table 6.14. In the first quarter of the holding out period, the maximum allocated weight is for Nigeria at 16.90% and the minimum is for Estonia at 0.76%. Sri

Lanka, Colombia and Jordan were allocated high portfolio weights at 16.40% 12.31% and 10.05% respectively. The weights allocated in the last quarter give Jordan, Romania and USA the higher weightings of 17.40%, 17.02% and 13.59% respectively, while Estonia and Kenya have the lower at 1.12% and 0.92% respectively. Using these weights, the accumulated value of a US$100 investment is calculated and it is found that an investment of US$100 in June 2009 would have increased to US$304.02 by June 2014, whereas a US-only portfolio would yield just US$248.76 by June 2014.

Table 6.13 Out of sample analysis: Quarterly rebalancing between Australia and the frontier markets

Rebalancing period	Portfolio weights (%)										
	AUST	COLO	JORD	NIGE	PAKI	SRIL	ECUA	ESTO	LITH	ROMA	KENY
Jun-09	7.82	17.10	9.87	20.00	6.86	10.04	0.79	2.09	12.55	6.65	6.23
Sep-09	15.54	17.70	19.09	20.00	3.57	6.45	1.98	3.01	5.85	4.80	2.01
Dec-09	2.66	20.00	19.00	20.00	1.66	11.59	1.21	0.26	10.20	11.20	2.22
Mar-10	11.57	15.47	18.42	15.71	4.23	7.85	4.48	4.93	6.78	8.40	2.16
Jun-10	17.13	20.00	16.94	20.00	1.17	16.19	1.30	2.77	0.44	1.89	2.17
Sep-10	18.22	17.50	17.14	19.52	5.20	15.44	0.72	0.44	0.98	1.92	2.92
Dec-10	23.07	19.26	4.93	10.54	3.86	20.00	1.35	0.90	3.38	12.67	0.04
Mar-11	15.69	18.45	12.54	20.00	3.49	20.00	0.41	5.50	0.03	1.93	1.96
Jun-11	4.58	19.56	15.42	12.03	4.71	19.10	2.38	1.33	4.79	11.08	5.02
Sep-11	2.77	20.00	20.00	20.00	1.02	20.00	0.24	4.70	6.24	4.32	0.71
Dec-11	9.06	20.00	20.00	0.36	5.19	18.28	2.08	1.93	10.00	11.67	1.43
Mar-12	0.59	17.99	19.45	13.55	10.53	14.68	3.52	1.83	5.57	10.44	1.85
Jun-12	13.20	19.76	11.09	18.11	3.69	3.96	5.68	2.43	10.10	11.30	0.68
Sep-12	14.09	15.88	12.99	12.90	1.60	16.64	0.66	1.65	8.17	12.77	2.65
Dec-12	7.76	20.00	16.21	20.00	5.42	3.07	0.09	3.05	14.01	10.23	0.16
Mar-13	4.85	20.00	10.81	20.00	0.82	12.55	1.23	0.76	9.01	14.1	5.87
Jun-13	13.03	20.00	11.17	12.50	8.47	8.01	2.30	2.12	10.14	12.13	0.13
Sep-13	12.32	19.24	12.75	20.00	0.53	12.20	2.96	2.19	7.38	9.17	1.26
Dec-13	7.16	19.11	4.89	19.98	11.83	17.50	0.16	2.01	5.84	8.71	2.81
Mar-14	5.96	20.00	12.51	20.00	3.56	7.88	1.69	5.45	9.53	12.13	1.29
Jun-14	11.26	10.49	20.00	17.04	6.50	11.40	1.58	5.46	2.41	10.66	3.20

Note: The portfolio weights for the diversified Australian portfolio (restriction of a maximum of 20% in frontier markets) that is rebalanced at the end of each quarter for the holding out period June 2009–June 2014 is presented here. Using these weights, the accumulated value of US$100 over the holding out period is calculated. In the Australian investor's case, a $100 investment at the start of June 2009 would have grown to US$248.66 by the end of June 2014.

Table 6.14 Out of sample analysis: Quarterly rebalancing between USA and the frontier markets

Rebalancing period	Portfolio weights (%)										
	USA	COLO	JORD	NIGE	PAKI	SRIL	ECUA	ESTO	LITH	ROMA	KENY
Jun-09	8.89	12.31	10.05	16.90	11.06	16.40	6.87	0.76	8.95	1.42	6.39
Sep-09	9.76	14.94	13.17	18.08	12.75	13.31	0.57	0.74	6.36	5.39	4.93
Dec-09	14.53	10.04	17.23	17.97	12.70	13.28	0.29	2.08	4.81	3.66	3.41
Mar-10	11.79	15.66	15.54	13.58	6.20	14.52	1.10	0.36	5.83	6.21	9.21
Jun-10	10.38	14.96	17.58	18.53	9.42	16.43	1.14	1.53	2.22	4.19	3.62
Sep-10	16.80	19.58	14.35	15.07	2.68	20	0.73	1.06	1.73	3.80	4.20
Dec-10	7.75	16.34	18.08	14.95	6.72	17.30	6.42	0.43	1.58	1.91	8.52
Mar-11	9.96	20	20	9.29	8.19	19.65	2.40	1.52	1.32	5.62	2.05
Jun-11	10.50	20.00	11.08	15.36	2.44	13.00	3.02	1.06	8.91	11.57	3.06
Sep-11	18.12	15.33	17.23	9.10	3.22	16.15	4.58	0.55	4.45	6.69	4.58
Dec-11	21.89	18.93	15.36	10.16	0.11	6.77	4.30	3.50	5.83	12.17	0.98
Mar-12	14.91	15.69	17.63	4.74	4.27	13.03	4.00	3.39	10.02	12.30	0.02
Jun-12	19.05	13.02	16.76	10.54	2.43	16.58	3.38	1.13	6.67	10.09	0.35
Sep-12	4.41	20.00	15.08	12.47	3.50	20.00	1.13	0.38	10.00	12.41	0.62
Dec-12	16.25	13.56	16.21	12.20	5.52	14.58	2.58	2.61	6.88	9.33	0.28
Mar-13	15.08	17.96	14.44	18.27	1.21	8.92	2.01	2.31	7.21	12.41	0.18
Jun-13	28.28	10.96	10.84	10.00	1.63	7.47	0.10	4.14	12.70	10.02	3.86
Sep-13	14.83	14.81	14.30	12.76	10.24	11.18	4.02	2.78	6.92	7.07	1.09
Dec-13	15.99	14.35	15.88	15.42	3.18	7.62	3.66	0.71	4.50	10.23	8.46
Mar-14	13.50	18.59	14.67	14.71	1.59	17.71	0.33	0.64	7.24	10.06	0.96
Jun-14	13.59	7.03	17.40	10.21	6.74	8.02	7.18	1.12	10.77	17.02	0.92

Note: The portfolio weights for the diversified USA portfolio (restriction of a maximum of 20% in frontier markets) that is rebalanced at the end of each quarter for the holding out period June 2009–June 2014 is presented here. Using these weights, the accumulated value of a US$100 over this period is calculated. In the US investor's case, a US$100 investment at the start of June 2009 would grow into US$304.02 by the end of June 2014.

The results from the accumulated value calculated using the weights presented in Tables 6.13 and 6.14 clearly demonstrate that a diversified portfolio is better than an Australia-only portfolio, and a diversified US portfolio is much more profitable than a US-only portfolio. The benefits presented to the Australian investor appear to be lower than that of the US counterpart. One reason for the less vibrant results is the differences in the level of risk of the diversified and non-diversified portfolios in comparison. The standard deviation of the diversified Australian portfolio is significantly lower than the Australia-only portfolio. The standard deviation of the optimal diversified portfolio with the restriction of maximum 20% investment in frontier markets is 13.41%, while the standard deviation of the Australia-only portfolio is 25.91%. If the diversified portfolio chosen is one with standard deviation similar to that of the Australia-only portfolio, the increase in returns in the holding out period would be more pronounced.

It is evident that the benefits for a US investor from diversifying into frontier markets are significantly higher than for an Australian investor. These differences could be attributed to the vast differences in the nature and size of the two domestic markets under consideration. The Australian market is less than one-tenth the size of the US market. The economies of scale applicable to a large market investor may not be available for an investor from a smaller market such as Australia. None the less, the inclusion of frontier markets in an Australian portfolio still presents significant benefits over a non-diversified portfolio. The out-of-sample analysis also confirms the presence of significant diversification benefits from frontier markets for a developed market investor, irrespective of the size of the domestic market. The results from this analysis emphasise the

significance of frontier market diversification for Australian and US investors alike. The findings of this analysis conform to the standard that a developed market investor will benefit from diversifying into less developed markets. While it will be interesting to understand the economic and political side effects of investing in frontier markets, it is beyond the scope of this thesis. Even though there are a number of structural risks associated with frontier markets such as political instability, corruption and disease outbreaks, careful and patient approach towards frontier market diversification is highly rewarding (Speidell and Kronhe, 2007).

6.6 Summary

Investors look for diversification benefits all over the world, and in this study we demonstrate that Australian investors can increase their returns considerably by diversifying into frontier markets. The benefits of international diversification depend on the relative economic structures of the home market and the potential foreign markets. The Australian economy is vastly different in its structure from that of other developed markets, and as such, the benefits for an Australian investor are found to be different, as expected. The finding of different benefits for Australian investor may also have been influenced by the size effect. Investing in frontier markets is not free of risks, but with the right investment strategy, it can result in considerable positive returns. This study finds that investors from developed markets can benefit from investing into frontier markets and earn significantly higher returns without considerable increase in risk. Results of the study are robust and economically and statistically significant.

With the increasing effects of globalisation, frontier markets are emerging as a viable investment class, whereas the benefits of emerging market diversification are eroding. This issue has not been extensively researched previously, and the lack of reliable empirical studies on frontier market diversification negatively affects investor confidence. Therefore, this research makes important contributions to the existing literature by showing the benefits of considering frontier markets in an optimised portfolio using computationally efficient models. The results from this study show that a developed market investor can attain large diversification benefits from including frontier markets assets in his/her diversified portfolio. Similar to findings by Speidell and Kronhe (2007), Segot and Lucey (2007) and Berger et. al (2011), this thesis posits that frontier markets are less integrated with developed capital markets and could provide benefits from diversification, and the results of these computations support such a conclusion. Previous studies have not examined frontier market diversification using computationally efficient models to estimate time varying correlations, and also have failed to provide ex-ante analysis. My thesis bridges these gaps in literature and provides theoretical and empirical contributions to the research. Based on previous empirical and theoretical evidence from research such as that of Markowitz (1952), Wilcox (1992), and Speidell and Kronhe (2007), this study tests the hypothesis that there are potential benefits from frontier market diversification to investors from Australia and the USA. The null hypothesis was implicitly tested by analysing if the benefits from a diversified portfolio constructed using time varying correlations are significantly higher than from a non-diversified portfolio in the case of two developed market investors –

Australian and US. The study finds that for both markets there are large benefits to be gained from including frontier markets in a diversified portfolio.

The potential benefits from diversification among the frontier markets would also differ from market to market based on a large number of factors(Kiviaho, Nikkinen, Piljak and Rothovius 2012). All of the previous studies on frontier market diversification have been from the perspective of a US investor. The results from such studies may not be directly applicable to investors from other developed countries which may be smaller in size than the US market. This study presents the case for an Australian investor framed by the peculiar characteristics of the Australian market, for the financial scenario in Australia warrants a separate study. The comparative analysis of the Australian and US case studies has been very informative and provides insight into the significant differences in benefits based on the domestic market of the investor.

The study also presents out-of-sample results by using a holding out period of June 2009 to June 2014, with quarterly rebalancing of the portfolio weights to calculate the accumulated value of an investment of US$100 during this period. Studies in the past have relied on ex-post analysis, and the literature has criticised this approach because of the risk that the in-sample results may not hold in an out-of-sample scenario. This thesis provides an in-sample analysis and an out-of-sample comparison of the dollar value of investment for an investor who holds an Australia-only portfolio, and compares this with a portfolio that is dynamically rebalanced by including frontier markets, using a time-varying correlation approach. The benefits of investing into frontier markets in this study have been

looked at only from a portfolio optimisation perspective within Markowitz's mean variance framework. However, in terms of investing, an investor may have to consider a country specific analysis in terms of market characteristics such as market efficiency, liquidity, size, market impact costs and market micro-structure. Examining the impact of these factors are outside the scope of this thesis, however various restrictions have been employed while constructing diversified portfolios instead. This study further contributes to existing literature by using a computationally efficient method of estimating time-varying correlations and quadratic optimisation for estimation of efficient portfolios.

Results of the study are based on the Australian market, which is similar in structure and maturity to other developed markets, and as such these results can be applied to the perspective of investors from other developed markets of similar structure and size. Based on the current scenario in the Australian managed funds sector, which is facing tremendous growth and significant incentive for fund managers and investors to search for avenues that provide better risk adjusted returns, this study provides significant results. The new asset class of frontier markets can become a potential investment pocket for Australian investors, with significant benefits from diversifying into them.

This study also compares the benefits to an Australian investor with those for a US investor. We find that the benefits to a US investor are higher than for an Australian investor. This result highlights the significant differences in market characteristics and the effect of the size of the market on investor benefits. These differences in diversification benefits could be attributed to the vast disparity in

the nature, size and characteristics of the Australian and the US markets. Examining the reasons behind this disparity would be interesting but is beyond the scope of this paper. Our study has used a computationally efficient method of estimating time-varying correlation, and the results are significant. From a practical standpoint, this study can be further extended by adding more frontier markets as and when data for these markets are available, and also can be applied to other developed market investors.

Chapter 7
Conclusion

The issue of international diversification of portfolio has been a focus of research since the early 1900s. The earliest methods of diversification were based on Lowenfeld's (1909) theory of geographic diversification, and gradually wider acceptance and evidence in favour of Markowitz's (1952) theory of diversification and more advanced versions were produced. Investors and academics were also keen to understand which assets provided better diversification benefits while included in a portfolio, and what factors influence these gains from diversification. A majority of the early research on international diversification has been focussed on the benefits for a developed market investor from diversifying into other developed markets. It has only been in the last two decades that there has been a growth in research studies on the benefits for an investor from an advanced market of including less developed markets in a diversified portfolio. However, the majority of these studies have emphasised the benefits from emerging market diversification. Recent studies have showed that as a result of increased globalisation and integration between world capital markets, the benefits from diversification into emerging markets have started to decline. It is in this scenario that the significance of this research is highlighted, responding to investors' search for any alternative avenues that can provide greater gains from diversification.

Academics and practitioners have identified frontier markets as potentially the next best opportunity for current and future international diversification. However, since these are a newly recognised asset class, there has not been a significant amount of research into the potential benefits from these markets. My research bridges this gap in the literature and offers a number of

contributions to knowledge of this subject that will be useful to both researchers and investors. This chapter will outline the conclusions drawn from analysis of the data and present the contributions of this research along with the major limitations of the study.

7.1 Summary of findings

The benefits of international portfolio diversification have been well established by research. The majority of earlier empirical studies conducted have been from the perspective of a developed market investor diversifying into other advanced equity markets. However, studies during the 1980s and 1990s have found that diversifying into markets that are less integrated with the world capital markets provides better benefits to the investor. This approach is based on Markowitz's (1952) theory that the addition of assets that are less correlated with each other will reduce the total risk of the portfolio and thus provide better gains from diversification. During the 1990s and thenceforth, there has been a rapid increase in investor interest in emerging markets around the world, and various studies have quantified the benefits from including these markets in a diversified portfolio. With the increase in the level of globalisation and the merging of world capital markets, emerging markets have become more integrated with the developed capital markets and this has resulted in higher correlations between the two. Since the benefits from emerging market diversification have started to decline, investors are searching for new avenues for better risk adjusted returns.

During the late 1990s and early 2000s, investors and market participants have identified pre-emerging markets as a separate asset class and termed these as

frontier markets. Frontier markets, being less integrated with the world capital markets than emerging markets, provide a potential for higher diversification benefits. Since frontier markets are a relatively new asset class, there has not been much research in this area. There is considerable ambiguity around the classification of markets as frontier, and a lack of sufficient reliable empirical studies to support the case for frontier market diversification. The absence of sufficient research into frontier markets is an important factor that creates a lack of investor confidence in frontier market diversification to achieve portfolio diversification benefits. This study bridges the gap in the existing literature by providing an analysis of frontier market diversification using a computationally efficient model and also by providing an out-of-sample analysis to confirm the results.

The significance of frontier markets and increase in investor interest in them are evident in the establishment of a number of frontier market indices in the past decade. An examination of these indices outlines a major overlap in country listings. This could be a serious issue for investors, because if they use more than one index while choosing their portfolio, there is the risk of duplication of markets that are included. The lack of a clear definition and criteria for classification have been major barrier to frontier markets being considered as a separate asset class, and has hindered investor confidence in entering this new territory. In order to overcome this limitation, this research provides a detailed examination of three major indices and the markets included in those indices. An analysis of the major economic and financial indicators of the markets included is provided, and a proposed list of frontier markets is presented.

A review of existing literature reveals that research on international diversification for an Australian investor has been limited. The specific case of the Australian investor needs to be investigated for a number of reasons; most of the diversification studies are conducted from a US investor's perspective, and generalising the results of such studies to the Australian scenario might not hold true. Australia, though classified as a developed market, is less than one-tenth the size of the US equity market. The economies of scale that apply to a US investor will be vastly different from that of an Australian investor. Hence extending the findings from other studies based on a US perspective to the Australian case can be unfavourable for an Australian investor. Another important factor that motivated an examination of the Australian investor perspective is the current investment and economic scenario in Australia. There has been an unprecedented growth in the managed funds industry in Australia, and it is estimated to grow even faster through 2015. As the Australian market deteriorated during end of 2014 and early 2015 and the rate of growth in Australia is likely to be under pressure compared to other markets, it is highly recommended to hold an increasing proportion of international markets in an Australian portfolio (Peak Investment, 2015). This scenario warrants a close watch on markets that will provide better benefits for the Australian investor through diversification. Earlier Australian studies were focussed on diversifying into other developed markets such as the US and European markets. An examination of the flow of investments from Australia in recent years shows that there has been a major shift in its composition to a focus on emerging markets. In the last decade there have been a few studies that have looked into the benefits of emerging market diversification

for the Australian investor. Since research has identified that the benefits from emerging market diversification is diminishing, coupled with the tremendous growth of managed funds in Australia, it is timely to examine whether frontier markets could be a positive addition to an Australian portfolio. There have not been any studies that have looked into this issue and my study bridges the gap in existing literature by using the AG-DCC GARCH model to examine the potential benefits to an Australian investor from frontier market diversification.

Research has established that the benefits from diversification differ according to the nature of the domestic market of the investor. Majority of research on international diversification of portfolio is discussed from a US investor point of view. The Australian market and economy are significantly distinct from that of the US counter parts. The effects of these differences between the US and Australian markets are evident from the impact of the GFC on the two markets; even though the Australian economy slowed down, it avoided plummeting down into depression. Since the Australian financial market is significantly smaller in size than the US market, the benefits for the investors from these two markets of diversifying into frontier markets are significantly different. Therefore, this study examines the potential benefits of investing in frontier markets for both Australian and US investors and compares the two.

A review of past research into portfolio diversification indicates that the majority of studies are conducted in an in-sample position alone. This is one of the major limitations of diversification studies. Providing an out-of-sample analysis is important in many ways: it will assist in validating the results of the in-sample

analysis; it will eliminate any data specific bias that could have been present in the in-sample period; and more importantly, an out-of-sample analysis will offer practitioners a detailed insight into how the portfolio performs out-of-sample. The results from an in-sample analysis might overstate the true returns that are achievable, and the optimal portfolios produced in the in-sample period may not hold true in the subsequent periods. Investors who rely entirely on reports based on in-sample analysis might find the reality of portfolio diversification quite different from expected, and hence it is important to provide an out-of-sample analysis so that the results can be validated. There has not been any previous research on frontier market diversification that has conducted an out-of-sample analysis from an Australian investor's perspective in comparison with a US investor's perspective. For this study, an out-of-sample analysis was conducted for a period of five years, wherein the returns from a portfolio that was rebalanced with new weights every quarter were calculated. This analysis provides a more practical implication of frontier market diversification for investors.

Research has established that correlations between markets vary over time, and multivariate GARCH models have been recognised as an effective method to accurately estimate time varying correlations. An efficient model for estimating time varying correlations is employed in diversification analysis where in the correlation estimates generated by the model are used to construct optimal portfolios and determine the potential benefits from diversification. Using this method, the time varying nature of correlations of equity returns are incorporated into a diversified portfolio optimisation model. Previous studies have employed ADCC GARCH model to estimate benefits from diversification over time, and

have found that it is an accurate way to forecast benefits. However, there have not been any studies using such computationally efficient models to investigate frontier market diversification from an Australian perspective. This study uses the AG-DCC GARCH model to estimate correlations between the Australian/US market and the frontier markets.

Based on a review of the existing literature, this study identified certain gaps in research: firstly, the potential benefits from frontier market diversification need to be extensively researched, as these are a relatively new asset class, and investors require reliable reports to form an informed strategy; secondly, research needs to present the case of an Australian investor since the current economic and financial environment demands a separate study; thirdly, the differences in Australian and US perspectives on frontier market diversification have not been examined, and are relevant for investors; fourthly, results from an in-sample analysis alone are not comprehensive and reliable, so an out-of-sample analysis is called for; and finally, due to the lack of clear-cut definition and criteria for frontier markets, there is significant vagueness and overlap in the major frontier market indices, therefore a detailed examination of the nature and characteristics of frontier markets is also required. Based on the gaps in existing research that were identified after a review of the literature, the research questions that this study answers are:

1. Are there any significant benefits from including frontier markets in a diversified portfolio for a developed market investor?

2. Are these potential benefits different for an Australian investor when compared to a US investor?

3. Are the results from the in-sample analysis consistent with the outcomes of the out-of-sample analysis?

The examination of the first question requires the estimation of correlations between market pairs and then the construction of optimal diversified portfolios using these correlation estimates. Previous research has established that correlations between markets are time varying and their estimation requires computationally efficient models that are capable of capturing their dynamic nature. Research Question 1 was examined by constructing optimal diversified portfolios using time varying correlations estimated using AG-DCC GARCH correlations for an Australian and a US investor. The diversified portfolios constituted from the 10 frontier markets included in the study provided better risk adjusted returns than the Australia-only and US-only portfolios. The diversified portfolios were constructed using several restrictions, such as a limit of maximum 10% of the portfolio in frontier markets, and a minimum of 50% in the domestic market with a maximum of 10% in frontier markets. These restrictions have been placed based on previous evidence regarding investors' home bias characteristics, and each one of the diversified portfolios performed better than the domestic market-only portfolios. There was a significant improvement in the Sharpe ratio along with a reduction in standard deviation in all the diversified portfolios. The study thus finds that a developed market investor can significantly improve his risk adjusted returns by diversifying into these frontier markets.

Research Question 2 was analysed through a comparative study of the diversified portfolios of the Australian and the US investors. This study constructed optimal diversified portfolios using time varying correlations for an Australian investor and for a US investor by including 10 frontier markets. An Australia-only portfolio and a US-only portfolio were constructed so that the results from these two portfolios with their diversified portfolios could be compared. The results show that the benefits for a US investor from frontier market diversification are much higher than for an Australian investor. The Sharpe ratios of the diversified US portfolios are significantly higher than those of the Australian diversified portfolios. The results of the comparison show that the diversified US portfolio with all the different restrictions employed performed many times higher than the corresponding Australian diversified portfolios.

Research Question 3 was answered by running an out-of-sample analysis using a five-year period from June 2009 to June 2014. For this analysis, an optimal portfolio was rebalanced every quarter using new weights from the portfolio analysis in order to calculate the end of period returns. The quarterly rebalanced weights from the portfolio were used to calculate the accumulated value of an investment of US$100 made in the first quarter of the holding-out period up to its growth by the final quarter of the holding-out period. The results of the out-of-sample analysis show that a diversified Australian portfolio performed better than an Australia-only portfolio from the same period. Similarly, a diversified US portfolio provided higher end of period returns than a US only portfolio during the five-year period. However, the increase in returns for a US investor was much higher than for the Australian investor. These results underline the effect of

differences in the nature and characteristics of the domestic market of the investor on the variations in benefits from diversification.

This study provides a comparison of results obtained from the use of two multivariate GARCH models. Research has previously established that correlations are time varying and multivariate GARCH models are an accurate method of estimating time varying correlations. This study uses the AG-DCC GARCH model to estimate correlations between Australia and the 10 frontier markets and the USA and 10 frontier markets. The results from AG-DCC GARCH correlations are compared with the correlations estimated using the DCC GARCH model. A comparison of these correlations shows that there are no significant deviations in the final results, which eliminates the possibility of the results being model-specific.

The study has thus answered the three research questions stated at the beginning of this thesis. The conclusion from this study is that based on the results from the out-of-sample analysis, inclusion of frontier markets in an Australian portfolio is beneficial to the investor. The analysis also finds that the benefits for a US investor are much more than that for an Australian investor. The overall finding is that there are significant benefits from frontier market diversification for a developed market investor, be it an Australian or a US investor. For both the developed market investors, the diversified portfolios provided higher returns than did an undiversified domestic portfolio.

The results from this study are statistically and economically significant. A holding out period analysis found that there are potential benefits for an

Australian investor and a US investor from diversifying into frontier markets. The results from the out-of-sample analysis indicate that the positive benefits from frontier market diversification are not model specific or data specific. The model used for estimation is a computationally efficient and accurate method. The DCC GARCH model's results were not significantly different from the AG-DCC GARCH results.

The findings of this thesis conform to the standard theory that an investor from a developed market will benefit from diversifying into a less developed market. The benefits that this study identified from ten frontier markets for Australian and US investors are similar to the results presented by Segot and Lucy (2007) and Berger et al. (2013). These two previous studies have been conducted from a US investor perspective. This thesis presents the case for an investor from a smaller developed markets and the results underline the vast differences in benefits to a small market investor compared to a dominant market investor.

7.2 Contributions of the study

A comparative investigation into frontier market diversification from the perspectives of a larger and a smaller developed market investor is important for both academics and investors. Extensive studies have been conducted on the benefits of international diversification from the perspective of developed capital markets. Recent literature on emerging market diversification has been limited to the perspective of the larger developed markets like the USA. It is of great importance to present results from the point of view of smaller markets, as this will shed light on the dynamics of market specific characteristics for an investor

who seeks to diversify internationally. For instance, the results from a study that is based on a US perspective might not hold true for an investor from a smaller market like Australia because of the vast differences in the nature and characteristics of the markets and the economies of scale in operation.

The significance of examining the Australian perspective is underlined by the increased interest from international academia as well as the investor community after the performance of the economy during and after the GFC, when the Australian economy avoided a steep recession. Further, the recent tremendous growth in the managed funds sector in Australia opens up a wide array of potential investment; the Reserve Bank of Australia estimates that the managed funds sector will grow to an enormous $2.5 trillion by the end of 2015. Peak Investments suggest that as the rate of growth of the Australian economy during 2014-2015 has been under pressure relative to other economies combined with the slow deterioration of the short and medium term outlook of the Australian market, which calls for increasing the international diversification of Australian portfolios. In this scenario, it is essential to investigate whether there are better destinations for channelling the enormous potential funds so as to attain higher diversification benefits. The findings of the study are important because they point to the next possible destination for Australian investments. This research contributes to existing literature by providing an extensive investigation into the Australian case for frontier market diversification. The findings from this study provide empirical evidence from an out-of-sample framework and conclude that there are significant benefits for the Australian investor from including assets from the 10 frontier markets considered in the study.

Recent studies have reported that as a result of the increased levels of globalisation and market integration, the benefits from emerging market diversification have started to decline. Investors, who are in a continuous search for avenues that provide better gains, have lately been attracted to the new asset class called frontier markets. Research into the benefits of frontier market diversification has been very limited, and no studies from the perspective of an Australian investor have been done previously. There have not been any previous studies which compare the potential benefits from frontier market diversification to investors from a larger developed market to benefits for those from a smaller developed market. This research bridges these gaps in the existing literature by studying the potential benefits from diversifying into frontier markets from the perspective of Australian and US investors. The findings of this study are that inclusion of the ten frontier markets examined is beneficial for the Australian diversified portfolio as well as for the diversified US portfolio; however, the benefits to the US investor are much higher than those for the Australian counterpart. This result indicates the underlying economies of scale available for an investor in a larger market compared to one in a smaller market. The conclusions from this analysis highlight the significance of domestic market characteristics in the diversification benefits attainable for investors. These results also point to the potential trouble an investor from a smaller market could encounter by relying completely on studies based on larger dominant markets. The conclusions from the comparative analysis presented in this research contribute to literature by providing further empirical results that emphasise the size effect of domestic market on an investor's gains from diversification.

Diversification studies have mostly failed to present out-of-sample analyses, and this is a significant limitation to the validity of results from those studies. Investors cannot completely rely on results from an in-sample analysis to develop diversification strategies, because the outcomes from such analysis may overstate the actual gains that are attainable in the subsequent periods. Providing an out-of-sample analysis will assist in determining whether the results are specific to the data from the in-sample period or whether there are abnormalities in results from the in-sample period. Investors are able to get a detailed insight into the performance of a portfolio over time in an out-of-sample study. This is a major contribution of this research, as I have conducted an out-of-sample analysis for a period of five years, and the results establish that benefits from frontier market diversification are significant for both the Australian and the US investors. The benefits to the US investor in the out-of-sample period are much higher than those attained by the Australian investor. This study has used a computationally efficient model for estimation of correlations, and has also compared the results with a second model in order to test whether the results are model specific. The findings from the out-of-sample analysis are a significant empirical contribution to the literature, as they outline that the benefits from frontier market diversification are not model or data specific, and the findings of the in-sample analysis are not an over-statement of the actual attainable benefits in the succeeding periods.

Frontier markets are a recent addition to the asset class and there is much vagueness and ambiguity regarding the definition and classification of markets as frontier versus emerging. The concept of frontier markets is essentially vague and

conflicted. This vagueness is evident in the overlap in the country listings of emerging and frontier market indices of the major index lists – S&P, MSCI and FTSE. On a practical note, if an investor uses S&P's emerging index and MSCI's frontier index while choosing his diversified portfolio, there is the risk of duplication of markets. Such overlap and vagueness is due to the lack of research into the area, and as future studies emerge, a clearer definition and criteria for classification will be achieved. I have presented a detailed examination of the basic characteristics of the economic and financial indicators of frontier markets in comparison to the Australian and the US markets, and a proposed list of frontier markets is presented. This is an important step towards overcoming the perceived risk of duplication and lack of definite criteria for classification of frontier markets. As there is further progress in the field of frontier market research, a clear cut definition and criteria for categorisation will be outlined by authorities responsible and the current overlap will be erased. The contributions of this thesis to establishing common criteria and a clear classification of markets in the frontier category are significant.

In summary, this research creates empirical evidence in support of the theoretical understanding regarding the potential benefits of diversifying into frontier markets and compares the differences in potential benefits for Australian and US investors. There has been no previous study that analyses the potential benefits for Australian and US investors from frontier market diversification, despite the fact that frontier markets are the next available vehicles for gaining benefits from international diversification. This analysis provides knowledge of the nature of diversification benefits based on the nature of the domestic market of the investor.

The in-sample and out-of-sample analysis provide a better view of the benefits of frontier market diversification. The comparison of the potential diversification benefits for the Australian and the US investor will indicate if there are any differences in the extent of diversification benefits available for the investor according to the nature of the investor's domestic market. The results of this analysis will add to the literature on the impact of market size on diversification benefits from frontier market diversification.

The absence of research into frontier markets diversification and its gains is a significant deterrent to investing into frontier equity markets. This study establishes the theoretical justification of frontier market diversification and provides empirical evidence on potential gains from investing in frontier markets from the perspective of Australian and US investors. The results from this research contribute to current knowledge by providing empirical evidence in favour of frontier market diversification from an Australian perspective. The findings from the US investor perspective in this thesis, add to the current understanding of benefits of frontier market diversification. The out-of-sample results provide a clear distinction in the extent of differences in diversification benefits for investors from different markets and the evidence from this analysis adds further empirical evidence to the theory that smaller, less integrated markets provide diversification benefits.

7.3 Limitations

Research into the less developed markets of the world is limited by several factors, such as unavailability of data, lack of transparency, illiquidity of markets and the small size of markets. The biggest limitation of this study is the problems associated with the availability and consistency of data from the frontier markets. Frontier markets are newly opened markets for international investors, and availability of data is poor. There are over 60 markets recognised as frontier markets, and I could use only 10 markets in this study because of unavailability and inconsistencies in data. For many of these markets, data is only available from dates as late as 2005. In many markets, data has been back-dated and hence present several inconsistencies till a recent date from which they have been back-dated. These reasons have made it impossible to use data from several markets. In the future, as better quality data becomes available for research, this study could be extended using a larger number of markets and a longer period of time. Future research on frontier market diversification could be conducted using advanced models of estimation and could examine the impacts of increasing market integration on the diversification benefits from these markets.

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Appendices

Appendix A

Conditional correlations (AG-DCC GARCH) of weekly returns between Australia and the frontier markets (in-sample period estimates)

	Australia	Colombia	Jordan	Nigeria	Pakistan	Sri Lanka	Ecuador	Estonia	Lithuania	Romania	Kenya
Australia	1										
Colombia	0.3391	1									
Jordan	0.1756	-0.0358	1								
Nigeria	0.1378	0.0897	-0.0108	1							
Pakistan	0.0922	0.1494	0.0908	0.0445	1						
Sri Lanka	0.0956	0.2127	-0.2984	0.1567	0.0323	1					
Ecuador	-0.1223	-0.0611	0.0557	-0.0707	-0.0565	0.0162	1				
Estonia	0.0371	0.0946	0.2407	0.0702	0.0705	0.0396	0.0212	1			
Lithuania	0.0728	-0.0137	-0.0717	0.0117	0.0947	-0.4723	-0.1771	0.2197	1		
Romania	0.4503	0.2583	0.0887	0.0501	0.1505	0.2262	0.1325	-0.0688	0.1483	1	
Kenya	0.0032	0.0572	0.2356	0.0713	0.1167	0.1147	0.0135	0.0194	0.0532	0.1373	1

Note: Conditional correlations presented here are the AG-DCC GARCH correlations at the end of the in-sample period of May 2009 for weekly returns of Australia and the ten frontier markets.

Appendix B

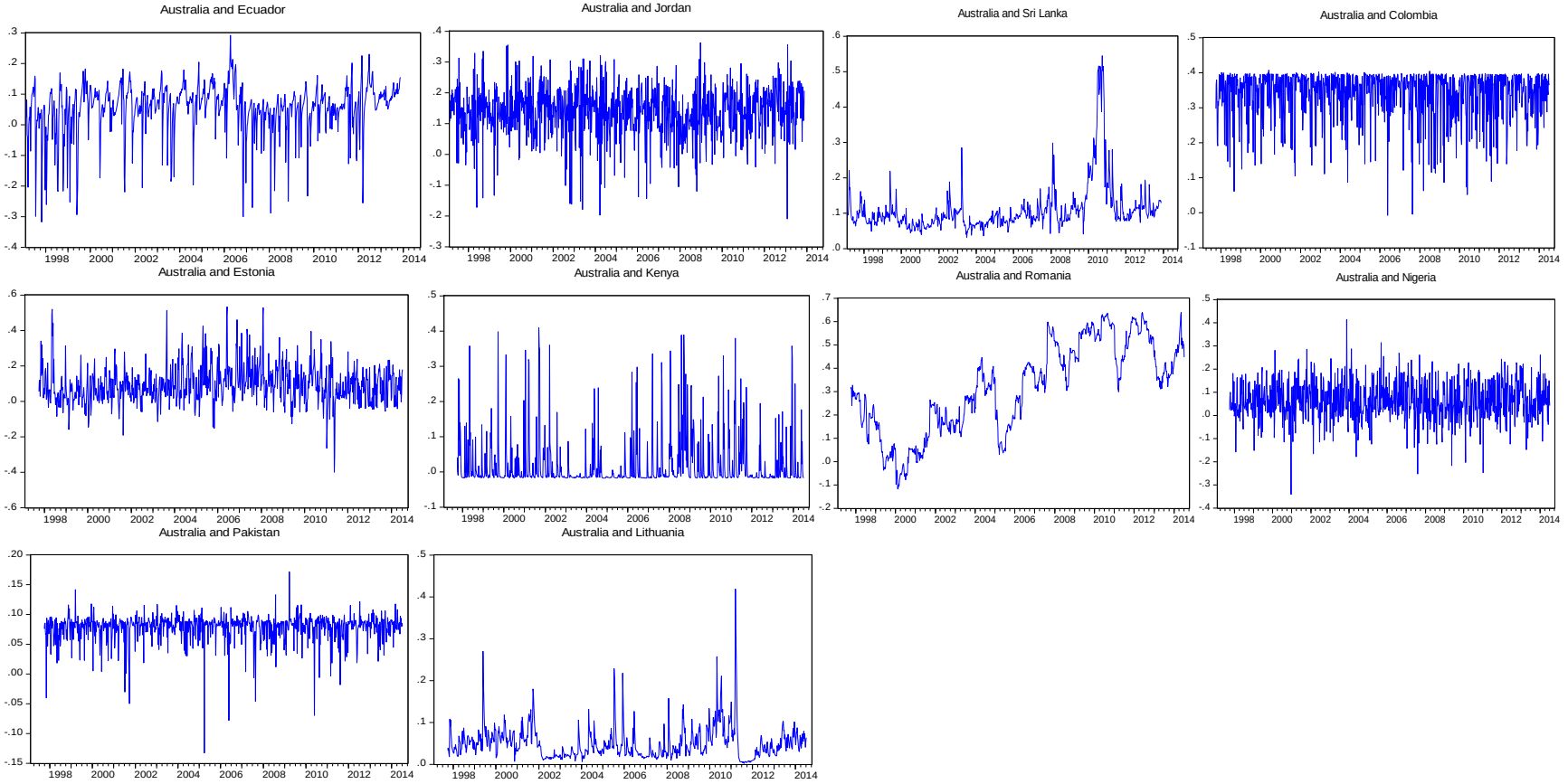
Conditional correlations (AG-DCC GARCH) of weekly returns between USA and the frontier markets (in-sample period estimates)

	USA	Colombia	Jordan	Nigeria	Pakistan	Sri Lanka	Ecuador	Estonia	Lithuania	Romania	Kenya
USA	1										
Colombia	0.2640	1									
Jordan	0.0897	-0.0358	1								
Nigeria	0.0476	0.0897	-0.0108	1							
Pakistan	0.0838	0.1494	0.0908	0.0445	1						
Sri Lanka	0.1040	0.2127	-0.2984	0.1567	0.0323	1					
Ecuador	-0.0481	-0.0611	0.0557	-0.0707	-0.0565	0.0162	1				
Estonia	0.1913	0.0946	0.2407	0.0702	0.0705	0.0396	0.0212	1			
Lithuania	0.1196	-0.0137	-0.0717	0.0117	0.0947	-0.4723	-0.1771	0.2197	1		
Romania	0.3374	0.2583	0.0887	0.0501	0.1505	0.2262	0.1325	-0.0688	0.1483	1	
Kenya	0.0631	0.0572	0.2356	0.0713	0.1167	0.1147	0.0135	0.0194	0.0532	0.1373	1

Note: Conditional correlations presented here are the AG-DCC GARCH correlations at the end of the in-sample period of May 2009 for weekly returns of USA and the ten frontier markets.

Appendix C

AGDCC Correlations of the Australian stock market with Frontier Markets



Appendix D

AGDCC correlations of the US market with the frontier markets