INTEGRATION BETWEEN THE SOUTH AFRICAN AND INTERNATIONAL BOND MARKETS: IMPLICATIONS FOR PORTFOLIO DIVERSIFICATION

PHOMOLO RABANA

STUDENT NUMBER: 603R3081

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF

MASTERS IN COMMERCE (FINANCIAL MARKETS)

DEPARTMENT OF ECONOMICS AND ECONOMIC HISTORY
RHODES UNIVERSITY, GRAHAMSTOWN

SUPERVISOR: PROFESSOR MESHACH AZIAKPONO

CO-SUPERVISOR: PROFESSOR JEN SNOWBALL

ABSTRACT

International bond market linkages are examined using monthly bond yield data and total return indices on government bonds with ten years to maturity. The bond yield data covers a nineteen-year period from January 1990 to July 2008, while the bond total return index data covers a nine-year period from August 2000 to July 2008. The international bond markets included in the study are Australia, Canada, Germany, Japan, the United Kingdom, and the United States. The examination of international bond market linkages across these markets has important implications for the formulation of effective portfolio diversification strategies.

The empirical analysis is carried out in three phases: the preliminary analysis, the principal component analysis (PCA), and the cointegration analysis. For each analysis and for each set of data the full sample period is first analysed and subsequently a five-year rolling window approach is implemented. Accordingly, this makes it possible to capture the time-varying nature of international bond market linkages.

The preliminary analysis examines the bond market trends over the sample period, provides descriptive statistics, and reports the correlation coefficients between the selected bond markets. The PCA investigates the interrelationships among the bond markets according to their common sources of movement and identifies which markets tend to move together. The cointegration analysis is carried out using the Johansen cointegration procedure and investigates whether there is long-run comovement between South Africa and the selected bond markets. Where cointegration is found, Vector Error-Correction Models (VECMs) are estimated in order to examine the long-run equilibrium relationships in addition to their short-run adjustments over time.

The empirical analysis results were robust, and overall integration between SA and the selected major bond markets remained weak and sporadic. In addition, the results showed that even after accounting for exchange rate differentials, international bond market diversification remained beneficial for a South African investor; and since international bond market linkages remained weak with no observable trend, international bond market diversification will remain beneficial for some time to come for a South African investor.

ACKNOWLEDGEMENTS

The financial assistance from the Allan Gray Scholarship towards this research is hereby acknowledged. Opinions expressed and conclusions arrived at, are those of the author and not necessarily to be attributed to Rhodes University or the donor.

I extend my deepest gratitude to Professor Meshach Aziakpono. Without his careful supervision this research would not have been possible. You have taught me how to write a thesis, and more importantly how to think critically. Furthermore, I thank Professor Jen Snowball for her attention to detail and the valuable insights she provided in the writing of this thesis.

Thank you to my family – simply because you are. To my mother and father – you are sublime. I am eternally grateful for your support and I am thankful beyond measure for all you have done for me. May the Lord keep you all in the palm of his hand.

To all the people who helped with journal information, finding data, and/or providing me with guidance and advice: Ms. Riëtte Engelen, Ms. Susan Rionda, Mr. Maarten Ackerman, Professor Pierre Faure, Mr. Anthony Bickersteth, Mr. Birol Unal, and Mr. Brad Preston – Thank you!

To all my Rhodes friends – thank you all so much for all the memories and the support you have given me. Because of all of you, these past six years have been an absolutely amazing, crazy, fun-filled and memorable journey. Tkwa-rizzo – Thank you.

To my fellow master's students it's been a pleasure working among such great minds. I wish you all the best in your future endeavors.

I am lucky and blessed to be in this position, and for that I thank 'the Man upstairs'.

TABLE OF CONTENTS

CHAPTER FOUR

ANALYSIS OF EMPIRICAL RESULTS

CHAPTER FIVE

SUMMARY OF MAJOR FINDINGS, IMPLICATIONS FOR PORTFOLIO DIVERSIFICATION & AREAS FOR FURTHER RESEARCH

LIST OF TABLES

IN-TEXT TABLES

APPENDIX TABLES

LIST OF FIGURES

APPENDIX FIGURES

CHAPTER ONE
INTRODUCTION

1.1 CONTEXT OF THE RESEARCH

This study examines international bond market linkages and the implications they have for portfolio diversification from a South African portfolio manager's perspective. Understanding the nature of these linkages is important for a variety of investment and risk management decisions (Fleming *et al.,* 1998:112). For instance, this will make it possible for a portfolio manager to construct an efficient international portfolio, which can be classified as a combination of investments in different countries that either maximise the rate of return for a given level of risk, or minimise the risk for a given level of return (Levy and Sarnat, 1970:669).

The principal motivation behind investing in international markets is because this allows for portfolios to be diversified more completely, and as a consequence this will, on average, yield higher returns and pose a lower risk than any individual investment found within a portfolio (Siegel, 2002:168). The principle behind portfolio diversification is so highly regarded for the proper management of risk that Pension Funds, Life Offices, General Insurers and Medical Schemes are required by law to diversify their assets across a number of different asset classes (Firer *et al.,* 2003:17).

However, globalisation is believed to have led to a greater interdependence across most financial markets (Mills and Mills, 1991:273). A consequence of countries becoming more economically integrated is that they will have greater similarities in the movements of their financial markets. This will have an adverse effect on portfolio diversification as it implies that integrated markets will perform poorly at the same time. Thus, as countries become more integrated, international diversification might not provide portfolio managers with effective diversification opportunities.

To date much of the research investigating the nature and extent of international financial integration has focused on issues relating to equity market integration. In contrast, despite the perception of increased integration across bond markets, the degree of research into such markets is relatively limited (Lucey and Steeley, 2006:1).

Markowitz (1952) and Tobin (1958) pioneered the formal study of the benefits of diversification. Grubel (1968) then applied this analysis to international financial markets (Allen and

MacDonald, 1995:33). International portfolio diversification marked the emergence of a new type of welfare gain emanating from international economic relations (Grubel, 1968:1299). Accordingly, this stimulated a series of further studies including Levy and Sarnat (1970), and Lessard (1973). Overall, these studies were in favour of international portfolio diversification due to its risk-reducing ability and improved returns. For this reason, these studies can collectively be viewed to be amongst the first to advance a new pattern of thought for portfolio managers.

However, most of these earlier studies focused on equity markets with little attention being given to international bond market diversification. Nonetheless, as interest in the bond market increased, more studies emerged. Initially such studies analysed the relationship between international equity markets and international bond markets (c.f. Ibbotson *et al.*, 1982; Levy and Lerman, 1988; Solnik *et al.,* 1996; Hunter and Simon, 2005; Lim *et al.,* 1998; Cappiello *et al.,* 2006). Later on studies emerged which solely focused on the linkages among international bond markets (c.f. Cholerton *et al.,* 1986; Burik and Ennis, 1990; Mills and Mills, 1991; DeGennaro *et al.*, 1994; Clare *et al.*, 1995; Sutton, 2000; Smith, 2002; Yang, 2005; Skintzi and Refenes, 2006; Ciner, 2007). The earlier studies made use of graphic analysis and employed the mean-variance efficient frontier framework, while the more recent studies were more econometrical in approach. In general, the empirical studies offered mixed views on the nature of international bond market linkages. Furthermore, the studies generally focused on the bond markets in developed countries.

The academic literature focusing on international portfolio diversification from the perspective of an African investor is limited. The studies that do exist focus on international equity market diversification, while none specifically focuses on international bond market diversification from an African investor's point of view.

Lamba and Otchere (2001a) conducted the first comprehensive analysis of the long-term linkages among African equity markets and major global equity markets. Subsequently, Lamba and Otchere (2001b) analysed the dynamic relationships between the South African equity market and major world equity markets. Further studies were carried out by Webbstock *et al.* (2005), Alhassan (2006), and Humavindu and Floros (2006).

From a purely South African perspective, studies focusing on international portfolio diversification started to emerge following the abolishment of the Financial Rand Discount on 7

February 1983. Most of the empirical studies were in favour of international equity diversification as it provided benefits in terms of increased returns and/or reduced risk (c.f. Van den Honert and Affleck-Graves, 1985; Barr, 1986; Bhana, 1986; 1987; 1990; Patrick and Ward, 1996; Swart, 1999; Chinzara, 2007).

The South African government and corporate bond market is regulated by the Bond Exchange of South Africa (BESA) (Goodspeed, 2006:48). It is a highly developed market and plays an integral role in the country's financial system. Historically, the market has been heavily weighted in favour of government bonds (SARB, 2006). However, corporate bonds have also been growing in prominence as more corporate treasurers turn towards the bond market for corporate funding (BESA, 2005). Furthermore, the South African bond market has a long history of resident and non-resident participation. This is beneficial as it means that the country's government and corporate entities are able to borrow from non-residents in their own currency, and thus avoid exchange rate exposure (SARB, 2006).

Apart from the issue of portfolio diversification there are several other reasons for undertaking an analysis of international bond market linkages. These include monetary policy, modelling and forecasting long-term interest rates, and market efficiency. These issues will be discussed in depth in Chapter Two. Thus far, suffice to say that despite the growing importance of the South African bond market, the lack of studies examining its international linkages raises a need for such a study. In light of this, the objectives of the current study are stated.

1.2 THE OBJECTIVES OF THE RESEARCH

The purpose of this research is to identify which among the following developed bond markets: Australia, Canada, Germany, Japan, the United Kingdom, and the United States, have the strongest influence on the South African bond market. The specific objectives are to:

i. examine the time-varying nature of international bond market linkages;
ii. examine the long-run comovement between the South African and international bond markets in order to determine whether international bond market diversification would be beneficial to a South African portfolio manager;
iii. identify which countries offer the greatest diversification possibilities to a South African portfolio manager; and

iv. make recommendations on how best a South African portfolio manager can organise their portfolio in order to minimise risk.

1.3 MOTIVATION FOR THE STUDY

Lamba and Otchere (2001b:202) note that it is likely that the South African equity market has become integrated with major developed equity markets following the gradual easing and then the formal removal of Apartheid during 1989-1994. Based on the same premise, a similar argument can be extended to the South African bond market. Thus, there is a need to determine whether the South African bond market is integrated with international bond markets.

As will be shown in Chapter Two, while empirical research papers examining the linkages across African equity markets and the major global equity markets have grown in number and also become more advanced in econometric technique; the empirical literature examining international bond market linkages from a general African investor's perspective is nonexistent. In this regard, this thesis aims to contribute to the literature by providing an analysis of the linkages between the South African and the major international bond markets.

Furthermore, studies have found that international equities markets become more correlated during periods of increased market volatility and as a result the diversification benefits sought by portfolio managers investing in multiple international equity markets would be lowest when most desired. In contrast, international bond market linkages decreased during volatile periods, thus portfolio diversification benefits available to portfolio managers remained robust (c.f. Solnik *et al.,* 1996; Cappiello *et al.,* 2006; Hunter and Simon, 2005). Such an attribute makes investing across international bond markets highly appealing. In the wake of the latest financial crisis: the current sub-prime mortgage crisis, this study will be able to ascertain whether international bond markets still possess such an attribute.

1.4 ORGANISATION OF THE STUDY

The remainder of this thesis is organised as follows: Chapter Two discusses the role played by the bond market within the financial system; it presents the theoretical framework, and reviews the empirical literature. Chapter Three explains the analytical framework to be followed. Chapter Four presents the results of the empirical analysis. Chapter Five summarises the empirical results, identifies the implications they have for a South African portfolio manager, and suggests areas for further research.

CHAPTER TWO

THEORETICAL ISSUES AND LITERATURE REVIEW

2.1 INTRODUCTION

The purpose of this chapter is to review existing work in order to provide a foundation for the analysis of international bond market linkages. To this end: Section 2.2 identifies the role of the bond market within the financial system. Section 2.3 discusses the importance of understanding international bond market linkages. Section 2.4 introduces the theoretical and analytical framework. Section 2.5 presents the empirical evidence of portfolio diversification and identifies the gap in the literature. Section 2.6 concludes and indicates the contribution the current study aims to make to the existing literature.

2.2 THE BOND MARKET IN CONTEXT

Although the focus of this study is on the bond market, this section will first provide a broad overview of the financial markets and then identify the role of the bond market within this framework. The financial markets consist of the foreign exchange market, the money market, the commodities market, and the capital market (Goodspeed, 2006:2). A well developed financial market plays an integral part in furthering a country's growth prospects by improving resource allocation and increasing capital formation.

The bond market along with the equity market, form the capital market. The capital market is the market through which institutions, corporations, companies and governments obtain/raise long-term funds in order to finance capital investments and expansion projects (Goodspeed, 2006:48). Thus, the bond market represents the market through which long-term (a period exceeding twelve months) debt instruments are issued (i.e. bonds). The bond market can also be viewed as an extension of the money market. The major difference being that the money market is used to acquire short-term funds (i.e. any period not exceeding twelve months) (Botha, 2007:2).

Therefore, bearing the above in mind, a bond can be defined as a long-term debt security which constitutes a promise (debt obligation) by the issuer to pay a stated rate of interest (fixed or floating) based on the face value of the bond at specified intervals or at maturity, and to redeem the bond at its face value at the end of the stipulated period (Faure, 2006:10).

The issuers of bonds can be broadly grouped into four categories, namely: the government sector, the corporate sector, the household sector, and the foreign sector. In most countries, the government sector is the largest issuer of bonds with the other sectors playing a peripheral role (Faure, 2006:20). The bond market is of particular relevance to institutions such as pension and provident funds, and long-term insurers as their liabilities are of a long-term nature (Faure, 2006:64).

Accordingly, the bond market plays an important role within the financial system. Therefore understanding international bond market linkages is extremely important for several reasons which are discussed in the following section.

2.3 THE IMPORTANCE OF UNDERSTANDING INTERNATIONAL BOND MARKET LINKAGES

Several reasons can be identified for undertaking an analysis of the nature and extent of international bond market linkages. These include monetary policy, portfolio diversification, modelling and forecasting long-term interest rates (c.f. Yang, 2005; Ciner, 2007), and market efficiency (c.f. Smith, 2002; Allen and MacDonald, 1995).

In recent decades the ability of central banks to maintain inflation at low levels has been identified as the foundation of an effective monetary policy. In order to achieve low inflation monetary policy needs to be forward-looking. Thus, monetary policy relies to some extent on a forward-looking indicator that is able to embody a direct measure of inflation expectations such as the long bond rate[1]. For instance, significant bond rate movements are likely to influence the timing and magnitude of monetary policy actions (Goodfriend, 1998:13-18). Therefore, if bond markets are found to be internationally linked this will have implications for understanding the global conduct of monetary policy. For instance, if bond markets are internationally linked then an interest rate movement in one country could influence the interest rate movements in another country. Therefore, shocks transmitted across global bond markets, will limit the conduct of domestic monetary policy as authorities will need to take these international developments into account in addition to domestic concerns when implementing monetary policy actions (Ciner, 2007:291).

[1] For instance, the US Federal Reserve does not automatically follow longer-term rates when making monetary policy decisions. It still retains a considerable amount of discretion when influencing short-term rates as the decisions they arrive at must be interpreted in conjunction with other economic indicators (Goodfriend, 1998:13-18).

Secondly, since bond markets represent a large segment of international asset markets and are also important investment instruments for many market participants, understanding the linkages between them is vital when formulating effective **portfolio diversification** strategies (Ciner, 2007:291). A portfolio manager can adopt either a passive or an active investment strategy. A passive investment strategy takes market prices as fairly set. Therefore, instead of trying to beat the market by exploiting superior information or insight, a passive portfolio manager will act to maintain an appropriate risk-return balance given market opportunities. Conversely, an active investment strategy attempts to achieve greater returns than those proportional to the risk borne (Bodie *et al.,* 2002:482).

It is important to note that investing in international assets does not necessarily result in meaningful portfolio diversification since those international assets could merely be duplicates of those found in an investor's home country, in which case they would not represent any new opportunities for minimising risk or increasing returns (Elton and Gruber, 1995:263). The lower the correlation across international markets, the greater the opportunities for international diversification. The low correlation indicates that international diversification could decrease the risk on an investor's portfolio (Elton and Gruber, 1995:269). Accordingly, when determining whether or not international diversification ought to be an important part of an investor's portfolio the correlation between the markets, and the risk/return characteristics of each market need to be analysed.

Thirdly, understanding global bond market linkages could prove helpful for **modelling and forecasting interest rates** (Ciner, 2007:291). For instance, if it is found that the bond markets are becoming increasingly correlated this would indicate that information from one or more markets could be helpful in predicting bond returns in other markets. This is because if the markets are cointegrated, this means that they are part of a mean-reverting equilibrium system. Accordingly, they would share a common equilibrium and thus the view can be taken that each market is part of an endogenous "common" system (Smith, 2002:205). Thus, this would imply that when forecasting interest rates one needs to consider domestic fundamental factors[2] in addition to international developments.

[2] Domestic fundamental factors include: the supply of funds from savers; the demand of funds from businesses to be used in capital formation; and a government's net supply and/or demand for funds as effected through monetary policy by a country's central bank (Bodie *et al.,* 2002:133).

Lastly, the weak form of the **Efficient Market Hypothesis** (EMH) states that all relevant information of an asset's price due to its past behaviour is already incorporated into its current price (Howells and Bain, 2005:543). The implication of this is that an investor should not be able to use information from other markets to predict future bond market movements (Smith, 2002:219) as any useful information found in past trends would have already been incorporated into the security's current price (Howells and Bain, 2005:543). Accordingly, Lim *et al.* (1998:181) argue that if international markets were efficient then it would not be possible for investors to earn superior market returns by investing internationally. Hence, by investing in international markets, investors are implicitly acknowledging the inefficiency of global markets. Furthermore, if for instance, two markets are found to be cointegrated this would imply that one of the markets is able to help predict the other due to the existence of a valid error correcting representation (Allen and MacDonald, 1995:35). Similarly, Clare *et al.* (1995:316) note that if two markets are found to be cointegrated, knowledge of their short-run deviations from their long-run cointegrated path could be useful as investors could use such information to predict future changes in certain variables of interest. Thus, the finding of cointegration among markets could imply that the markets are not efficient.

Monetary policy, portfolio diversification, modelling and forecasting interest rates, and market efficiency adequately highlight the importance of studying the nature of international bond market linkages. As the title suggests, *'Integration between the South African and International bond markets: Implications for portfolio diversification,'* the focal point of this thesis will be on international bond portfolio diversification. Accordingly, this sets the context for which this study is carried out and the standpoint from which inferences regarding the other three issues can be conveyed. Having set the scene, the following section identifies and discusses theory pertaining to international interest rate movements. This is of consequence as it affects international bond market linkages, which in turn influence the nature and effectiveness of international portfolio diversification.

2.4 THE THEORETICAL AND ANALYTICAL FRAMEWORK

The following section discusses the relevant theory underpinning international financial market linkages and lays the foundation for understanding interest rate movements within the international bond market. The parity conditions: the *interest rate parity theory*, *purchasing power parity*, and the *Fisher effect* can accurately be described as "a set of equilibrium relationships which should hold between product prices, interest rates, and spot and forward exchange rates assuming a

freely floating exchange system" (Demirag and Goddard, 1994:70). These parity conditions can in a sense be viewed as representing a set of *a priori* assumptions regarding international interest rate movements.

The ***interest rate parity*** theory states that the interest rate differential between two currencies should be approximately equal to the difference between the spot and forward exchange rates (Demirag and Goddard, 1994:77). The forward exchange rate usually trades at either a premium (above) or at a discount (below) to the spot exchange rate. Accordingly, since the forward premium/discount is equal to the interest rate differential an investor is not able to make use of forward contracts in order to earn risk-free profits through arbitrage (Goodspeed, 2006:41). Thus, it stands to reason that a country which has a lower interest rate than another country would value its currency at a premium relative to the other country's currency (Demirag and Goddard, 1994:76). Following on from this, three interest rate parity conditions can be identified, namely: *covered interest parity* (CIP), *uncovered interest parity* (UIP), and *real interest parity* (RIP). The CIP represents the narrowest measure of capital mobility, while the UIP is a somewhat broader measure of financial integration, and the RIP represents the broadest of arbitrage measures as it incorporates both financial and real integration. Collectively, their purpose is to equate the rates of returns of comparable assets across markets (Cavoli *et al.*, 2004:3). Accordingly, when analysing the return linkages between international bond markets, these interest parity conditions need to be kept in mind.

Before going into more detail about the three parity conditions, it is necessary to highlight the important role arbitrage plays in the efficient functioning of capital markets. Arbitrage involves the "simultaneous purchase and sale of equivalent securities in order to profit from discrepancies in their price relationship" (Bodie *et al.,* 2002:320). Therefore, the presence of an arbitrage opportunity, which can result from the mispricing of an asset, will cause investors who are aware of the opportunity to undertake the largest position possible thereby maximising their risk-free profit. Hence, such a large volume of trades will exert enough pressure on that particular security thus restoring equilibrium (Bodie *et al.,* 2002:320). In light of this, the CIP condition implies that, where currency risk can be hedged against, the interest rate differentials between comparable assets denominated in different currencies must equal the difference between the spot and forward exchange rates (Von Furstenberg, 1998:64). If this condition does not hold, covered interest rate arbitrage will occur. In this case, investors will take advantage of the interest rate discrepancies by making use of, for example, a forward exchange market to obtain cover against

exchange rate risk and lock-in a risk-free profit (Howells and Bain, 2005:382). Therefore, arbitrage helps ensure that the CIP condition holds, although disparities from this condition may be caused by market imperfections (i.e. capital controls, transaction costs, political and sovereign risks) (Aziakpono, 2006:3).

In contrast to the CIP condition, the *uncovered interest parity* (UIP) condition does not provide for the hedging of investment yields against exchange rate risk. Therefore, the UIP condition requires that unhedged returns on comparable investments in different countries and currencies should be equal after accounting for the expected movement in the exchange rate (Von Furstenberg, 1998:64). This implies that the "rate of change in any bilateral exchange rate is expected to offset the bilateral interest-rate differential" (Von Furstenberg, 1998:64). If this condition does not hold it would provide investors with a greater incentive to speculate on future spot rates by moving capital from countries with low interest rates to countries with higher interest rates in an attempt to make a profit (Howells and Bain, 2005:382). Before introducing the last parity condition, two theories which affect its ability to hold need to be outlined; namely, the *purchasing power parity* theory and the *Fisher effect*.

The essence of the ***purchasing power parity*** **(PPP)** theory is that the exchange rate between two currencies should reflect the difference between the price levels in the two countries (Howells and Bain, 2005:588). The absolute PPP theory stems from the 'law of one price' which states that "if two countries produce an identical good, and transportation costs and trade barriers are very low, the price of the good should be the same throughout the world no matter which country produces it" (Mishkin, 2004:439). However, due to the presence of governmental and/or other barriers to the flow of capital and goods, the law of one price may not hold. Therefore, the extent to which this law holds serves as a good indication as to whether international capital markets are integrated or segmented (Ibbotson *et al.,* 1982:73). The relative PPP theory states that "any necessary adjustment in the exchange rate between two countries can be found by comparing the change in the ratio of domestic and foreign prices from the time when exchange rates were in equilibrium (Demirag and Goddard, 1994:71). Therefore, a price level change (i.e. an increase) in one country due to inflation will be compensated for by a change in its exchange rate (i.e. a currency devaluation). In general, PPP is expressed in relative terms as this shows changes from the existing PPP rates (Howells and Bain, 2005:588). Empirical research into the PPP theory finds that it tends to hold in the long-run (c.f. Balassa, 1964; Gailliot, 1970;

Frenkel, 1981; Edison, 1987) but not in the short-to-medium term (c.f. Isard, 1977; Milone, 1986; Webster, 1987).

Since most financial contracts are stated in terms of nominal interest rates, the expected inflation rate needs to be taken into account when determining the real interest rate. Accordingly, the ***Fisher Effect*** states that the nominal interest rate is a function of the real rate of return and the inflation premium which is equal to the expected inflation rate (Demirag and Goddard, 1994:75). This can be expressed mathematically as shown in equation [2.1]:

$$i = i_r + \pi^e \qquad [2.1]$$

where i is the nominal interest rate, i_r is the real rate of return, and π^e is the expected inflation rate (Mishkin, 2004:80). Hence, if expected inflation increases then interest rates will rise, and the converse will hold for a decrease in expected inflation (Mishkin, 2004:100).

The major consequence of the Fisher effect is in its corollary, the ***International Fisher Effect (IFE)*** which holds that interest rate differentials on assets between countries, which are similar in all important respects except currency of denomination, should reflect the expected movement in their spot/current exchange rate (Demirag and Goddard, 1994:76). Mathematically, this can be expressed as follows:

$$(1 + R_{ft-1})/(1+R_{dt-1}) = E_t/E_{t-1} \qquad [2.2]$$

where R_{ft-1} is the interest rate on a foreign currency-denominated security at time t-1, R_{dt-1} is the interest rate on a domestic currency-denominated security at time t-1, E_t is the exchange rate at the maturity date of the security (expressed in terms of the number of foreign currency units per domestic currency unit), and E_{t-1} is the exchange rate at the issue date of the security (expressed in terms of the number of foreign currency units per domestic currency unit) (Aliber and Stickney, 1975:54).

Hence, the principle behind the IFE is that an investor will hold an asset denominated in a currency expected to depreciate only if the interest rate earned on the asset would adequately compensate for the anticipated currency depreciation. Conversely, an investor will hold an asset which carries a lower rate of interest relative to a substitute asset in a different country, provided

that the currency in which the lower interest rate asset is denominated is expected to appreciate (Aliber and Stickney, 1975:54). Stated differently, one would expect a country with a higher interest rate to also have a higher rate of inflation and as a consequence of the higher inflation rate, that county's exchange rate will depreciate relative to a country with a lower interest rate. Similar to the PPP theory Aliber and Stickney (1975) find evidence that over the long-term the IFE tends to hold. However, Robinson and Warburton (1980) find evidence to the contrary.

Keeping the above in mind, the last parity condition can now be introduced. The *real interest parity* (RIP) condition includes elements of both financial and real market integration. It implies that capital flows will equalise real interest rates of comparable assets across economies (Cheung *et al.*, 2003:283). It is generally considered a very long-run parity condition as it will only hold if the UIP, PPP, and the Fisher hypothesis simultaneously hold (Cavoli *et al.*, 2004:3). Importantly, RIP provides a useful general condition for encapsulating trade and financial market linkages (Cavoli *et al.*, 2004:15).

The purpose of this section was to review the theoretical framework explaining interest rate movements across international financial markets. If the parity conditions do in fact hold, this would indicate the existence of an interest rate equilibrium relationship across international markets, which would imply the existence of an extremely high degree of market integration. However, due to the presence of barriers such as asymmetric information, transaction costs, differential tax treatment, political and sovereign risks and so forth, it is unlikely that such a level of integration can be practically achieved (Aziakpono, 2006:3). Hence, in reality interest rates across countries tend to deviate from international parity conditions. As a result this has prompted academics, analysts and financial market participants to undertake empirical investigations into international financial market linkages.

The extent to which interest rates across international capital markets deviate from the above parity conditions helps to justify international portfolio diversification not only in terms of decreased risk, but also in terms of increased return. The following section traces the development of portfolio diversification from its infancy to its current level and also examines international equity and bond market linkages of developed as well as emerging African markets.

2.5 EMPIRICAL STUDIES[3]

2.5.1) Early Empirical Studies

There are various approaches which have been used for studying the implications of portfolio diversification. The earliest of these approaches employed a mean-variance efficient frontier framework whereby a set of portfolios were constructed based on the premise of maximising expected return for any given level of risk (i.e. variance). In this regard, Markowitz (1952) pioneered the formal study of portfolio diversification. He argued that a well diversified portfolio is not necessarily the one with the largest number of securities but rather, one that consists of securities from industries which are not similar. The rationale is that firms within the same industry are more likely to perform poorly at the same time relative to firms in different industries. Put differently, when diversifying a portfolio it is not sufficient to squarely focus on minimising the variance by investing in many securities; one ought to also avoid investing in securities with high covariances among themselves. Hence, by investing in different industries, in particular those with different economic characteristics, an investor will be able to lower the covariance among the securities in the portfolio (Markowitz, 1952:89).

Similarly, Tobin (1958:85) used the theory of risk-avoiding behaviour to explain why an individual is more likely to hold both cash and "consols" as opposed to merely holding one or the other. Consols can be taken to represent any non-cash asset (i.e. bonds and other debt instruments varying in maturity, debtor, and other features) (Tobin, 1958:82). Accordingly, an investor is more inclined to diversify their portfolio by holding both cash and consols as this will result in reaching the highest indifference curve possible, given the initial size and quantity of both assets and the investor's willingness to assume risk (Tobin, 1958:77). Risk is measured by the standard deviation of return, which is simply the measure of dispersion of possible returns around the mean value of return (expected return). Since cash is assumed to be a riskless asset, the amount an investor holds in consols determines both expected return and risk (Tobin, 1958:85). Thus, if an investor wishes to obtain a greater expected return s/he will have to assume more risk, and conversely, by assuming less risk, a higher expected return is forfeited (Tobin, 1958:72).

Grubel (1968:1299) was among the first to apply the models developed by Markowitz (1952) and Tobin (1958) to international financial markets. The study identified international diversification

[3] A Table summary of the empirical studies discussed in this section is presented in Table-A 2.1 in the Appendix.

of portfolios as a new type of welfare gain distinct from the traditional "gains from trade" and productivity increases which result due to a migration of factors of production. The average monthly rates of return for common stocks from eleven countries[4] for the period January 1959 to December 1966 were calculated (Grubel, 1968:1304). The results revealed that diversification among the assets from the eleven countries would have, on average, resulted in investors obtaining a higher rate of return or a lower variance than they could have achieved by purchasing a portfolio consisting of only local common stocks (Grubel, 1968:1308).

In a similar study, Levy and Sarnat (1970:669) carried out an *ex post* analysis of twenty-eight countries for the period 1951 to 1967 using common stock annual returns in order to calculate a set of efficient international portfolios. An efficient international portfolio was classified as a combination of investments in different countries that either maximise the rate of return for a given level of risk, or minimise the level of risk for a given return. The study identifies the potential gains available from international portfolio diversification and also highlights the importance of investing in countries whose economies are not highly correlated with that of the investing country as this would have a greater effect on reducing the variance of a portfolio (Levy and Sarnat, 1970:674).

In contrast to the previous studies, a multivariate factor analysis was employed by Lessard (1973:621) to assess the diversification potential available in the equity markets of Argentina, Brazil, Colombia, and Chile from December 1958 to December 1968 using common stock quarterly returns. The multivariate factor analysis based on the principal component analysis was used in order to help reveal the complex patterns of association among the securities. The results revealed that there were substantial diversification possibilities among the selected developing countries despite their close geographical proximity (Lessard, 1973:630).

The studies thus far were amongst the first to analyse the issue of international diversification within a theoretical and empirical context. In general, they are in favour of international portfolio diversification due to the substantial advantages available in terms of risk reduction. Collectively, they can be viewed as advancing a new way of thinking for portfolio managers. However, their focus was on the international equity market with very little attention being given to the bond market.

[4] The countries were: Australia, Belgium, Canada, France, Italy, Japan, Netherlands, South Africa, the United Kingdom (UK), and West Germany.

As the importance of international bond markets increased, empirical studies began to analyse the relationship between international equity markets and international bond markets (c.f. Ibbotson *et al.*, 1982; Levy and Lerman, 1988; Solnik *et al.,* 1996; Hunter and Simon, 2005; Lim *et al.,* 1998; Cappiello *et al.,* 2006). Later on studies emerged which solely focused on the linkages among international bond markets (c.f. Cholerton *et al.,* 1986; Burik and Ennis, 1990; Mills and Mills, 1991; DeGennaro *et al.*, 1994; Clare *et al.*, 1995; Sutton, 2000; Smith, 2002; Yang, 2005; Skintzi and Refenes, 2006; Ciner, 2007). The earlier studies made use of graphic analysis and employed the mean-variance efficient frontier framework, while the more recent studies were more econometrical in approach.

Ibbotson *et al.* (1982) and Levy and Lerman (1988) used the same data[5] and sample period (1960-1980) to analyse the correlation and regression results of the total returns on equities and bonds for eighteen[6] and thirteen[7] countries respectively. Ibbotson *et al.* (1982) compared domestically and internationally diversified equity and bond portfolios and incorporated exchange and inflation rates as well as other macroeconomic variables into the analysis. In contrast, Levy and Lerman (1988) directly compared the performance of internationally diversified equity and bond portfolios.

Ibbotson *et al.* (1982:61) found that from a US dollar investor's perspective, an internationally diversified bond portfolio offered superior investment returns and greater risk reduction relative to a domestically diversified bond portfolio. Moreover, imperfections within international capital markets provided further profit making opportunities since the economic relationship between inflation and exchange rates held imperfectly (especially in the short-run), thus resulting in deviations in international parity theorems. They argued that most of the deviations from the international parity conditions were likely due to barriers to international capital, goods and labour flows (Ibbotson *et al.,* 1982:75). Levy and Lerman (1988:56) found that during the sample period, the international bond portfolio outperformed the international equity portfolio. This was attributed to the fact that bond correlations were zero or negative, thus provided greater risk-reduction possibilities, whilst stock correlations were mainly positive (Levy and Lerman, 1988:60-61). Furthermore, they concluded that diversification in bonds would continue to result in an increase in mean return at the price of a smaller increase in risk, relative to diversification in

[5] Dollar adjusted annual rates of return.
[6] Australia, Austria, Belgium, Canada, Denmark, France, Germany, Hong Kong, Italy, Japan, Netherlands, Norway, Singapore, Spain, Sweden, Switzerland, the UK, the United Stated (US).
[7] Belgium, Canada, Denmark, France, Germany, Holland, Italy, Japan, Spain, Sweden, Switzerland, the UK, and the US.

equities. This is because the riskiness of an asset is partly determined by correlation coefficients between the corresponding assets, which are more stable over time than rates of return (Levy and Lerman, 1988:61).

Kirchgässner and Wolters (1987:675) carried out spectral analysis, granger causality tests and estimated trivariate autoregressive models using monthly data on short-term Euro-market and long-term bond market interest rates to determine whether there was an interest rate linkage between Switzerland, the US, and West Germany. The sample period was divided into two time periods: January 1974 to December 1978 and January 1979 to December 1984. In contrast to studies by Ibbotson *et al.* (1982) and Levy and Lerman (1988) these results revealed that during the first time-period the international linkage of interest rates was only weakly pronounced for the short-term Euro-market, and nonexistent for the long-term bond market. However, highly significant interest rate linkages in both markets were found in the second time period. To an extent, this was attributed to the rapidly expanding international capital markets and the large increase in trade between industrialised countries (Kirchgässner and Wolters, 1987:682).

Solnik *et al.* (1996:7) examined whether international diversification benefits decreased over time or during periods of high market volatility. *Ex post* analysis was utilised to analyse the equity and bond market correlations for France, Germany, Japan, Switzerland, and the UK using monthly data for the period 1959 to 1995 as well as weekly data for the period 1982 to 1995 respectively. They found evidence of volatility contagion[8] across the bond and equity markets and also that international correlations fluctuated extensively across the markets. However, international risk diversification remained beneficial because international correlations were still at levels which were attractive from a risk diversification point of view (Solnik *et al.,* 1996:32).

Lim *et al.* (1998:183) used cointegration and Granger causality methodologies to examine the relationships between international equity and international bond markets for November 1988 to December 1993. The Morgan Stanley Capital International World Index was used as a proxy for international stock markets, while the Salmon Brothers World Bond Index was used as a proxy for the international bond markets. In both cases monthly observations were used. A subperiod analysis was also carried out from November 1988 to May 1991, and from June 1991 to December 1993 in order to take into account significant international changes that began in 1991 (i.e. the marked decline in global interest rates and the rapid depreciation in the US dollar) (Lim

[8] Monthly innovations/"shocks" in correlation and volatility (as measured by the standard deviation of market returns) were used to determine the link between correlation and market volatilities.

et al., 1998:185). Strong contemporaneous causality was found to exist between the markets in all three time periods; however, this could be expected when monthly returns are used given the speed at which financial markets respond (Lim *et al.,* 1998:189). Collectively, the results indicate that both international equity and bond market efficiency and integration has been increasing over time. The rise in market efficiency could be attributed to the increasing levels of activity in both markets (Lim *et al.,* 1998:189). This is in agreement with several other studies (c.f. Bennett and Kelleher, 1988; Gallo *et al.,* 1997). Consequently, as the time period progressed potential arbitrage opportunities declined (Lim *et al.,* 1998:189).

A more recent study carried out by Hunter and Simon (2005), similar in objective to Solnik *et al.* (1996) also analysed whether international diversification benefits decreased during periods of increased market volatility. A bivariate conditional correlation GARCH model was used to examine the relationship between German, Japanese, UK and US ten-year government bonds. Weekly returns from January 1992 to September 2002 were employed. Over the sample period the correlations remained significantly low, thus indicating that the benefits of international bond diversification were not eroded. Furthermore, during extremely volatile periods, bond return correlations decreased rather than increased, which indicated that international bond diversification benefits were available when most needed. This was in stark contrast to international equity markets where evidence suggests that their diversification benefits evaporate when US equity return volatility increases dramatically or when equity markets weaken considerably (Hunter and Simon, 2005:480). The bond return correlations varied over time and were driven by changing macroeconomic and market conditions. In particular, differences in business cycles which are reflected by a greater absolute difference in yield curve slopes or absolute interest rate differentials led to lower bond return correlations. In addition, similarities in short-term interest rates across countries was likely to lead to higher correlation in international bond returns, thus indicating that international bond returns would be sensitive to similarities in monetary policies (Hunter and Simon, 2005:481).

By using a new generalised autoregressive conditionally heteroskedastic (GARCH) model, the asymmetric generalised dynamic conditional correlation (AG-DCC) model, Cappiello *et al.* (2006:537) investigated conditional asymmetries in volatilities and correlations for a collection of international equity and bond markets. Weekly data from 8 January 1987 until 7 February 2002

for the FTSE All-World Indices for twenty-one[9] countries and five-year average maturity government bond indices for thirteen[10] countries were collected (Cappiello *et al.,* 2006:546). Their findings revealed that linkages between international equity markets increased during periods of financial turmoil (i.e. the 1987 stock market crash, the beginning of Gulf war, and the Asian financial crisis). In contrast to equity returns, bond market return volatilities exhibited less apparent linkages. This finding again brings to light the issue of whether or not the diversification sought by investing in multiple markets will be present when most desired (Cappiello *et al.,* 2006:567). The introduction of the Euro in 1999 which resulted in a fixed exchange rate regime being established and the harmonisation of monetary policies, led to a near-perfect correlation among bond returns within the European Monetary Union. In addition, equity return correlations both within and outside the EMU increased (Cappiello *et al.,* 2006:537). Lastly, the conditional correlation between equity and bond returns was found to decline when stock markets were in financial turmoil, which is an indication of the "flight to quality" phenomenon, whereby investors move capital from equities to safer assets such as bonds (Cappiello *et al.,* 2006:567).

2.5.2) International Bond Market Linkages

The following empirical studies focus only on international bond market linkages. In this regard, one of the earlier studies was carried out by Cholerton *et al.* (1986:5) whereby the relationship between the bond markets of Germany, Japan, Netherlands, Switzerland, the UK, and the US were examined using monthly rates of return for the period 1971 to 1984. Graphical analyses of the risk/return trade-offs of international bond portfolios were undertaken and mean-variance efficient frontiers derived. The study found that the international bond markets were not well correlated during the sample period. Furthermore, since monetary and fiscal policies and long-term interest rates were not well synchronised, the potential for risk reduction by investing internationally would be substantial (Cholerton *et al.,* 1986:5).

Burik and Ennis (1990) carried out an *ex post* analysis for the period 1979 to 1987 in order to examine the risk-return characteristics of foreign bonds in light of their main source of risk: currency risk. Annualised quarterly returns were used. Foreign bonds were represented by the Salomon Brothers non-U.S. World Government Bond Index. The study found that investors

[9]Australia, Austria, Belgium, Canada, Denmark, France, Germany, Hong Kong, Ireland, Italy, Japan, Mexico, Netherlands, New Zealand, Norway, Singapore, Spain, Sweden, Switzerland, the UK, and the US.
[10] Austria, Belgium, Canada, Denmark, France, Germany, Ireland, Japan, Netherlands, Sweden, Switzerland, the UK, and the US.

would tend to mitigate against currency risk by hedging their foreign bond portfolios. However, although this reduced foreign exchange volatility by more than half, the additional costs incurred as a direct result of hedging were significant enough to deter many investors, in particular, small investors. Unlike small investors, larger investors were able to utilise certain economies of scale to their advantage, thus making them able to realise adequate gains from diversification in foreign bonds (Burik and Ennis, 1990:32). Hence, Burik and Ennis (1990:35) note that in order for foreign bonds to offer more compelling diversification opportunities there either needs to be a substantial decrease in currency risk, or hedging needs to become less costly. This study is important as it alludes to the possibility that even though international bond diversification does provide greater diversification benefits, it may still not be feasible for all investors.

Mills and Mills (1991:273) used high (daily) frequency data and multivariate time series techniques to investigate the international transmission of government bond market movements for Japan, the UK, the US, and West Germany, and for the period 1 April 1986 to 29 December 1989. The use of daily data made it possible for their models to capture the dynamics of globalisation during the time period. In summary, they found that the bond yields were not cointegrated and therefore in the long-run they were determined by separate domestic fundamentals (Mills and Mills, 1991:280). However, the international bond markets were regarded as being informationally efficient as innovations in one market were quickly transmitted through to other markets, thus making it difficult to earn abnormal profits by operating in a particular market based on observed developments in other markets (Mills and Mills, 1991:278).

DeGennaro *et al.* (1994:577) analysed monthly long-term bond interest rates for Canada, Germany, Japan, the UK, and the US from January 1967 to December 1990 using multivariate cointegration tests. Their results revealed little evidence of cointegration among the five long-term interest rate series, thus indicating that researchers wishing to forecast the bond yields of the different countries should assume that they are driven by a separate set of fundamentals (DeGennaro *et al.*, 1994:594).

Clare *et al.* (1995:321) employed the Engle and Granger (1987) two step methodology to analyse monthly total return bond indices of the German, Japanese, UK, and US government bond markets in order to determine whether they were integrated during the sample period: January 1978 to April 1990. This approach is proposed as a complement to the construction of the mean-variance efficient frontiers and correlation coefficient measures used by financial

economists (c.f. Levy and Lerman, 1988; Cholerton *et al.,* 1986; Burik and Ennis, 1990). Clare *et al.* (1995:313) argued that the correlation coefficient which was often used to measure the degree of integration between any two markets could be a misleading indicator as it was unable to distinguish between short-run and long-run comovements. This was likely to result in the correlation coefficient underestimating the degree to which markets were integrated since markets could diverge significantly in the short-run, while in the long-run they would actually be integrated. In contrast, cointegration analysis offered the advantage of providing more accurate measures of long-term asset market integration and the ability to separate the comovement of time-series variables into their short (or dynamic) and long-run components (Clare *et al.,* 1995:314). Their results revealed that, during the sample period, the bond markets were not well integrated, thus providing diversification benefits for (in this case) a UK investor (Clare *et al.,* 1995:322).

However, the findings from empirical studies carried out by Sutton (2000) and Smith (2002) advanced the view that the linkages among developed bond markets were in fact stronger than implied in previous studies. Sutton (2000:364) used the expectations theory of the term structure of interest rates as the base model in order to examine the historical behaviour of bond yields for Canada, the UK, and the US from 1961 to 1992, and for Germany and Japan from 1967 to 1992. Quarterly time series of the three-month and ten-year yields for each country were collected. The results of the Monte Carlo simulations indicated that over the period examined the bond yields in those markets displayed excess volatility and excess comovement relative to the base model, thus implying that bond yields were positively correlated (Sutton, 2000:374).

The findings of Sutton (2000) were supported by Smith (2002:207) who tested for the presence of cointegration by applying the Johansen (1988) and Johansen and Juselius (1990) method on monthly government bond data from February 1985 to March 1999 for the following countries: Canada, France, Germany, Japan, the UK, and the US. The cointegration tests revealed that the government bond markets were driven by the same common factors and as a result such information could be used to help better predict government bond market movements across those markets. This implies that over the long-term international bond market diversification benefits may not be present (Smith, 2002:220).

Yang (2005:40) used monthly rates of return to examine international government bond market linkages for Canada, Germany, Japan, the UK, and the US for the period January 1986 to

December 2000 by means of a vector autoregressive (VAR) framework. Cointegration tests were carried out using the Johansen (1991) procedure. Dynamic causal linkages between bond yield changes were also examined (Yang, 2005:40). The results revealed no evidence of cointegration between the five bond markets (Yang, 2005:46). Furthermore, international bond markets were found to be partially rather than completely segmented in the short-run, while no one country was found to have a distinct leadership role in terms of influencing the others (Yang, 2005:52).

Skintzi and Refenes (2006:24) investigated how local, regional, and world factors affected European bond markets by measuring the magnitude and the changing nature of volatility spillovers from the aggregate Euro area bond market and the US bond market to a number of individual European bond markets. The bivariate EGARCH model was employed in order to allow for both price and volatility spillovers and for time-varying correlation structure (Skintzi and Refenes, 2006:29). Weekly bond total return indices from eight Euro area countries[11], four non-Euro area countries[12] and the US were used. The sample period was from 1 February 1991 to 31 December 2002 which was then divided into two sub-periods in order to mark the period before and after the introduction of the Euro (1 January 1999) (Skintzi and Refenes, 2006:28). Importantly, the study showed that the introduction of the Euro had strengthened and to an extent stabilised correlation levels between individual European markets and the aggregate Euro area, and also between the European bond markets and the US. This suggested that globalisation of the bond markets had increased due to the establishment of the European Monetary Union (Skintzi and Refenes, 2006:39).

Similar to the findings in other studies (c.f. Solnik *et al.,* 1996; Hunter and Simon, 2005; Cappiello *et al.,* 2006), the study carried out by Polwitoon and Tawatnunchai (2006:2784) provides further support to the risk-reducing ability of international bond portfolios during periods of increased market volatility. They examined the diversification benefits and performance of 188 US-based global bond funds using monthly returns for the period January 1993 to December 2004 by means of conditional and unconditional Sharpe ratios. Their results indicated that a domestic investor that diversified their bond portfolio internationally would have reduced their exposure to risk during periods of increased market volatility (Polwitoon and Tawatnunchai, 2006:2778).

[11] Austria, Belgium, France, Germany, Ireland, Italy, Netherlands and Spain.
[12] Denmark, Norway, Sweden and the UK.

A study carried out by Ciner (2007) presents results which are to the most part contradictory to the results in Yang (2005). Ciner (2007:290) used the same set of countries to examine the cointegration properties between them for the period 1988 to 2005. Similarly, cointegration tests were carried out using the Johansen (1991) procedure, while a new statistical technique, the Dufour *et al.* (2006) method was used to investigate the casual dynamics between the indexes. Due to the long time period, a subperiod analysis was undertaken in order to determine whether there had been a change in market dynamics. The first subperiod was from 1 January 1988 to 12 September 1996 and the second subperiod ran from 13 September 1996 to 31 May 2005 (Ciner, 2007:298). The use of higher frequency data (i.e. daily) was opted for as it was likely that transmission in bond markets had become more rapid and as a result, daily data could detect interactions not uncovered by monthly data (Ciner, 2007:291). Similar to Yang (2005), when the full sample period was analysed the indexes were found not to be cointegrated. However, when the sample period was subdivided, the latter part of the sample showed that the international bond indexes were in fact cointegrated (Ciner, 2007:302). Thus, implying that "the benefits of international diversification may not be as significant as suggested in prior work" (Ciner, 2007:302). Furthermore, when causality between the indexes was investigated, it was found that the US market was more influential in the information transmission process since in both sample periods causality ran from the US to all other markets (Ciner, 2007:302).

In sum, although most of the empirical studies in this section indicated that international bond markets linkages across the developed markets analysed were weak, one should not automatically assume that this is still the case. This is because the major limitation of these studies[13] is that they may simply be outdated. For instance, the latest of these studies was carried out by Yang (2005), which, as mentioned, had a sample period beginning in January 1986 and ending in December 2000. However, bearing in mind that globalisation is a continual process it remains possible that bond market linkages have since then increased. This line of reasoning is supported by Ciner (2007:302) who, as shown above, found there to be a change in international bond market dynamics during this latter part of the sample period (i.e. the markets were now found to be cointegrated).

Lastly, the above studies focused on the market linkages across developed countries, so it is necessary to specifically highlight empirical literature from an African investor's perspective so as

[13] In particular, Cholerton *et al.* (1986), Burik and Ennis (1990), Mills and Mills (1991), DeGennaro *et al.* (1994), Clare *et al.* (1995), and Yang (2005).

to clearly identify the gap in the current literature, and thus indicate the contribution this thesis aims to make.

2.5.3) A South African Perspective

As briefly mentioned in Chapter One, academic literature focusing on international portfolio diversification from the perspective of an African investor is limited. The studies that do exist focus on the international equity market, while none specifically focus on the international bond market. Since the focus of this study is on the latter, this section will only briefly highlight the equity studies that have been conducted as they may still provide valuable insights regarding the linkages between the South African bond market and the major global bond markets.

Studies focusing on international portfolio diversification started to emerge following the abolishment of the Financial Rand Discount on 7 February 1983 as this marked the first step towards exchange control relaxation in South Africa. In this regard, Van den Honert and Affleck-Graves (1985) carried out one of the first South African portfolio diversification empirical studies. The results confirmed that international portfolio investments could provide additional benefits in terms of the risk-return trade-off[14]. The exchange rate was identified as having a significant effect on the performance and risk of the securities, and as a result, securities which were desirable to a South African investor may not be desirable to an American investor when the base currency used is US dollars (Van den Honert and Affleck-Graves, 1985:89). This view was reinforced by Barr (1986) who found that the substantial Rand returns which a South African investor could have earned from investing abroad[15] were mainly attributable to the dramatic depreciation of the Rand amid growing political instability, and as such, these results could not be used as an indication of future expected portfolio returns (Barr, 1986:141).

In addition, Barr (1986:141) argued that South Africa's economic performance moved countercyclically to that of the US because South Africa's economic performance depended to a large extent on the price of gold. Whereas in the US, high growth rates and low inflation were linked with a weak gold price, while low growth rates and high inflation were linked with a high gold price (Barr, 1986:141).

[14] This was for the period February 1965 to January 1980.
[15] The markets included in the analysis were the New York Stock Exchange (NYSE) and the London Stock Exchange (LSE).

Further studies carried out were in favour of international equity diversification as it provided benefits in terms of increased returns and/or reduced risk (c.f. Bhana; 1986; 1987; 1990; Patrick and Ward, 1996; Swart, 1999; Chinzara, 2007). Furthermore, similar to Van den Honert and Affleck-Graves (1985) and Barr (1986), Swart (1999:22) notes that the relatively good Rand returns obtained from international diversification were to a fair extent attributable to the Rand depreciation against most major currencies, thus indicating that future returns would also be dependent on the future movements in the exchange rates.

However, some studies have found that South Africa had become integrated with major global equity markets (c.f. Lamba and Otchere, 2001a; Lamba and Otchere, 2001b; Webbstock *et al.,* 2005) and thus indicate that from a South African investor's perspective international equity portfolios offer reduced diversification benefits.

In summary, earlier empirical studies were collectively in favour of international equity diversification as it offered South African investors ample portfolio diversification benefits in terms of both increased returns and reduced risk (c.f. Van den Honert and Affleck-Graves, 1985; Barr, 1986; Bhana, 1986, 1987, 1990; Patrick and Ward, 1996). However, contrary evidence of increased equity market linkages between the South African and the major international equity markets was presented by more recent papers (c.f. Lamba and Otchere, 2001a; Lamba and Otchere, 2001b; Webbstock *et al.* 2005; with the exception of Swart, 1999; Chinzara, 2007).

Hence, most of the studies in this section find that the South African equity market is segmented from the major global equity markets. Thus, the question that arises is whether or not the South African bond market is segmented from the major global bond markets. Or is the South African bond market becoming more integrated with these markets? By addressing these questions it will be possible to ascertain whether international bond market diversification will provide a South African investor with effective portfolio diversification opportunities.

2.6 CONCLUSION

The aim of this chapter was to provide the background for the current study. Thus, the bond market was defined and its role in the financial system was identified. Several reasons which make it important to understand international bond market linkages were then highlighted. Subsequently, the relevant theoretical and analytical framework underpinning international financial market linkages was introduced. Next, empirical studies focusing on international

market linkages were discussed in order to give practical application to the theory of portfolio diversification.

While the empirical literature examining the linkages across African equity markets and the major global equity markets have grown in number and also become more advanced in econometric technique; the empirical literature examining international bond market linkages from an African investor's perspective is nonexistent. In this regard, bearing in mind the objectives stated in Chapter One, the current study aims to address the gap in the literature by carrying out an analysis of international bond market linkages between South Africa and major international markets.

Against the background of increased globalisation, one would expect the level of integration across most international bond markets to increase. However, it is possible that South Africa will not conform to this expectation as most of the empirical studies examining international equity market linkages between South Africa and major international markets found that South Africa was still not integrated with these markets. Thus, it is plausible to expect the South African bond market to exhibit similar features. In the next chapter, the methodology and analytical framework that will be used to examine international bond market linkages is introduced and discussed.

CHAPTER THREE

METHODOLOGY AND ANALYTICAL FRAMEWORK

3.1 INTRODUCTION

In this chapter the analytical framework to be used is explained. The framework provides the platform that will allow for the realisation of the objectives stated in Chapter One. In this regard, the study will examine the long-run comovement and bond linkages between the South African and international bond markets. To this end, the empirical analysis will be carried out in three phases: the preliminary analysis, the principal component analysis (PCA), and the cointegration analysis. The preliminary analysis will provide a broad overview of bond market trends over time and serve as a useful introduction to the empirical analysis. The PCA and the cointegration analysis will allow for more econometrically rigorous analyses and thus provide greater insights. For this reason this chapter will squarely focus on these two econometric methods and their relevance in the current study.

In particular, the PCA will be utilised to study the comovements across the bond markets and to evaluate the portfolio diversification implications of these comovements. The bivariate cointegration analyses will be carried out using the Johansen cointegration procedure in order to determine whether there is long-run comovement between South Africa and the selected bond markets. It is of value to perform a PCA in conjunction with cointegration analysis as the former focuses on patterns of movements across the bond markets, whilst the latter provides a quantifiable measure of the degree of integration across the selected bond markets. Accordingly, more robust conclusions on the extent of integration across international bond markets can be provided by comparing the results from both sets of analyses (Figueira *et al.,* 2005:4).

The remainder of the chapter is organised as follows: Section 3.2 describes the principal component analysis; Section 3.3 examines the Johansen cointegration procedure; and Section 3.4 concludes.

3.2 PRINCIPAL COMPONENT ANALYSIS

Principal component analysis (PCA) is a factor analytic technique. Factor analysis is a multivariate technique used to analyse the interrelationships among a set of variables according to their common sources of movement (Ripley, 1973:359). As a result, the overall complexity of

a data set is reduced to a few factors which are constructed in a manner that takes advantage of their inherent interdependencies. Hence, a smaller number of factors will usually be able to account for approximately the same amount of information as the larger set of original observations (Reghunath *et al.*, 2002:2439).

It thus follows that the rationale behind PCA is "to reduce the dimensionality of a data set consisting of a large number of interrelated variables, while retaining as much as possible of the variation present in the data set" (Jolliffe, 2002:1). This is achieved by transforming "a given set of variables into a new set of composite variables, referred to as principle components (PCs), which are orthogonal to each other" (Figueira *et al.,* 2005:4). As explained by Nellis (1982:345), given a collection of correlation coefficients for a set of variables, this form of analysis makes it possible to detect whether there exists an underlying pattern of relationships such that it is possible to reduce the data to a set of factors less in number than the set of variables.

Accordingly, PCA will make it possible to detect bond market movements by converting a matrix of their returns into linear combinations of unobserved factors, which explain the variance of the set of market returns (Gilmore *et al.,* 2006:11). Following Aziakpono *et al.* (2007:11), mathematically, the PCA[16] framework can be expressed as follows:

$$P = AX \qquad [3.1]$$

where, in this case, X represents a vector of bond market data; P represents a vector of PCs (orthogonal factors) which are a linear combination of the original bond data series X; and A represents a matrix coefficient referred to as factor loadings. Each coefficient represents the weighting attributed to each of the respective original variables in the relevant PCs. The number of PCs and the number of original variables are equal. Since the PCs are derived in descending order of importance, this means that the main part of the variation in X is accounted for by the first PC, while the second PC would account for the main part of the variation in X after the effects of the first PC have been removed[17] (Aziakpono *et al.,* 2007:11). Put differently, the first PC, which is found by maximising the variance which it explains, can be defined as the single best summary of the linear relationships found in the data, whilst the second PC can be defined

[16] PCA makes no assumptions regarding the structure, distribution or other properties of the variables (Brooks, 2002:221), and as a result the stationarity properties of each series of the data series X do not need to be determined (Aziakpono *et al.,* 2007:12).
[17] This means that the second PC is orthogonal to the first PC (Figueira *et al.,* 2005:4).

as the second best linear combination. Subsequent PCs are defined in a similar fashion until all the variance in the data has been accounted for (Figueira *et al.,* 2005:6).

Since the factors in PCA are not directly observable, a major obstacle in PCA concerns identifying the actual cause of bond market comovements (Figueira *et al.,* 2005:5). However, since PCA makes it possible to determine the smallest number of common factors that best account for the correlation across international bond markets, the primary objective of this study will be achieved – an analysis of the nature of international bond market linkages for the purposes of bond portfolio diversification.

For instance, following Meric *et al.* (2008:159), the number of statistically significant PCs would be an indication of the diversification possibilities available to investors investing in the selected bond markets. The more diverse the bond markets are, the greater the number of statistically significant PCs. Conversely, fewer statistically significant PCs indicates that the bond markets are more closely correlated. Furthermore, bond markets with high factor loadings in the same PC would indicate that the markets move closely together and therefore would not offer good portfolio diversification opportunities to investors (i.e. bond markets that move closely would fall into the same PC). Hence, the higher the factor loading of a bond market in a PC, the greater will be its correlation with other bond markets with high factor loadings in the same PC. Conversely, bond markets with high factor loadings in different PCs do not move closely together, and therefore provide greater diversification opportunities. However, bond markets which may have high factor loadings in more than one PC would not be good prospects for effective diversification, as this would indicate that the movements in those particular bond markets would to a certain extent be similar to the movements of bond markets with high factor loadings in more than one PC (Meric *et al.,* 2008:159).

The main point being made above is that the more integrated bond markets become, the more homogenous their bond movements will be. As a result, an increasing number of factor loadings will have the same sign and size (Becker and Hall, 2007:12). Thus, bond markets that have factor loadings with the same sign in the same PC will move in the same direction. Such a pattern can help determine which group of markets would fall into the same 'convergence group' (Aziakpono *et al.,* 2007:12). Thus, from a portfolio diversification perspective, countries that form part of the same convergence group would not provide effective diversification possibilities. Therefore, a market which, for instance, diverges from a convergence group will

have a different sign and size attached to its factor loading (c.f. Becker and Hall, 2007:16; Siliverstovs *et al.,* 2005:610). Accordingly, such a market will serve as a good prospect for effective portfolio diversification. In order to conduct the PCA and identify the PCs, the data will need to first be transformed into a matrix.

A set of variables can be transformed by either using a correlation matrix or a covariance matrix (Aziakpono *et al.,* 2007:12). The use of either the correlation or covariance matrix will depend mainly on the data set being analysed as this will determine which matrix is more appropriate. A major drawback with PCA based on the covariance matrix, as opposed to the correlation matrix, is that that the structure of the PCs will depend on the unit of measurement used. It is therefore not wise to use PCs on a covariance matrix when the set of variables being analysed have been measured in different units. Using a covariance matrix in such a case is unlikely to provide very informative PCs, especially when the variables have widely differing variances[18]. Therefore, in cases where variables differ in scale the correlation matrix is extremely useful. (Jolliffe, 2002:24). For instance, Aziakpono *et al.* (2007:11) based their transformation of Southern African interest rates in levels on the correlation matrix due to differences in national inflation and exchange rates. Based on a similar premise, variable transformation in this study shall be conducted using the correlation matrix.

Furthermore, an important issue in PCA is determining how many PCs should be retained in order to account for most of the variation in a set of variables without serious information loss. To address this issue various rules have been proposed[19] (Jolliffe, 2002:112). Conventionally, the eigenvalue and the cumulative R^2 of the PC are used to determine the explanatory power of each PC (Aziakpono *et al.,* 2007:12). Accordingly, the current study will follow this approach. *Kaiser's rule*[20] will be applied and a cumulative proportion criterion established in order to determine the significance of the eigenvalues of each PC[21]. By following Kaiser's rule (Kaiser, 1960) only statistically significant PCs with variances (eigenvalues) equal to or greater than 1.0 will be retained for analysis (c.f. Nellis, 1982; Meric *et al.,* 2008). This is because these are the PCs that contribute most to the total variance of the variables and are able to describe more of the data than any single variable. On the other hand, the remaining factors (those with eigenvalues less

[18] For a detailed discussion regarding the correlation and covariance matrices see Jolliffe (2002:21-26).
[19] For a detailed discussion on this issue see Jolliffe (2002:111-131).
[20] Kaiser's rule is specifically constructed for use with correlation matrices, although it can also be adapted to suit some covariance matrices (Jolliffe, 2002:114).
[21]It must be noted that although the Kaiser and the cumulative percentage of total variation criteria can be described as ad hoc rules of thumb they have been adopted in this study because they are intuitively plausible and work well in practice (Jolliffe, 2002:112).

than 1.0) do not need to be retained for analysis as they are likely to "be obscure and more difficult to identify" (Nellis, 1982:346).

In addition to following the Kaiser rule, a cumulative percentage of total variation criteria can be established. According to Jolliffe (2002:113), a sensible cut-off is usually between 70% and 90%, but this can be higher or lower depending on the practical details of each data set. For instance, a cut-off of more than 90% may be appropriate in cases where although the most obvious and dominant sources of variation can be explained by the first one or two PCs, it is of interest to the researcher to identify the less obvious sources of variation (Jolliffe, 2002:133). Bearing not only the above recommendations in mind, but also the purpose of the current study and the approach followed, instead of imposing a predetermined cut-off level, the explanatory power of the cumulative R^2 was used rather as a guide. For instance, in some cases where a PC is not found to be statistically significant according to the Kaiser rule, it may still be considered if it has a fairly large impact on the explanatory power of the cumulative R^2 value.

Lastly, as suggested in the work carried out by Ciner (2007) the level of bond market integration between Canada, Germany, Japan, the UK, and the US has been increasing over time. Therefore, in order to determine the time-varying nature of the bond market linkages a five-year rolling window approach will be implemented. The factor loadings of the statistically significant PCs will then be graphically plotted. This will make it possible to detect whether linkages as well as the contributions to the comovement process by individual bond markets vary over time and also ascertain whether comovements are a gradual, unidirectional progression or are more of a sporadic phenomenon (Gilmore *et al.,* 2006:3).

As mentioned in the introduction, PCA focuses on identifying the patterns of movements across the bond markets, rather than providing a quantifiable measure of the degree of integration. Thus, in order to fulfill the latter objective, cointegration tests will also be carried out. As a result, this will make it possible to make inferences regarding the degree of integration between the South African bond market and the other bond markets. Furthermore, the use of two statistical methods will make it possible to provide more robust conclusions regarding the extent of integration across the bond markets (Figueira *et al.,* 2005:4).

3.3 COINTEGRATION ANALYSIS

Cointegration analysis was proposed by Engle and Granger (1987). According to Brooks (2002:388), a set of variables can be classified as being cointegrated if a linear combination of them is stationary. For instance, if two or more variables with stochastic trends are found to be cointegrated, this means that although they may not be individually stationary, one or more linear combinations of them are stationary. Thus, the cointegrated variables can be thought of as having a long-run equilibrium relationship between them, while non-cointegrated variables suggests the nonexistence of a long-run association (Brooks, 2002:388). Therefore, cointegration analysis seeks to determine whether such a relationship exists, and if so, the number and structure of the cointegrating vectors.

The first step of the analysis is to test whether the series is stationary or non-stationary. The stationarity or otherwise of the series influences its behaviour and properties and as a result has important implications for the manner in which the variables in the series should be treated. A stationary series can be described as one with "constant mean, constant variance and constant autocovariances for each given lag" (Brooks, 2002:367). In order to determine the non/stationarity of each series, the Dickey-Fuller generalised least squares (DF-GLS) and the Ng and Perron (2001) tests are used. The commonly used unit root tests – the augmented Dickey-Fuller (ADF) and the Philip-Perron (PP) statistics – will not be employed in this study as they have poor size and power properties[22]. This means that they have a tendency to "over-reject the null-hypothesis of nonstationary when it is true and under-reject it when it is false" (Aziakpono, 2008a:198). In contrast, the DF-GLS statistic, which is a modified Dickey-Fuller statistic with local GLS detrending has been shown in Elliot *et al.* (1996) to be almost uniformly most powerfully invariant (Aziakpono, 2008a:198). The Ng and Perron (2001) statistic, which is also a modification of the standard ADF statistic, is used because it has better size and power properties relative to conventional unit root tests (Rapach and Weber, 2004:412). Both statistics test for the presence of a unit root. Specifically, the null hypothesis tests the series for the presence of a unit root (i.e. a test for non-stationarity), against the alternative hypothesis of stationarity. Therefore, if the null hypothesis of a unit root is rejected this would imply that the series is stationary (DeGennaro *et al.*, 1994:580).

The second step of the analysis will be to perform bivariate cointegration tests to establish whether the South African bond market is cointegrated with each of the other bond markets.

[22] This is especially the case when the sample size is small (c.f. Masih and Masih, 2000:629; Brooks, 2002:381).

This will help to determine if there are any common forces driving the long-run movement between the South African bond market and the other bond markets or if each market is driven by its own unique set of fundamentals (DeGennaro *et al.*, 1994:586). Although it is unlikely that an investor would only consider bivariate portfolios, the bivariate analysis will provide useful insight when considering wider portfolios as it demonstrates which data series tend to move together in the long-run. Furthermore, from a practical point of view, arbitrarily selecting a portfolio and then carrying out cointegration tests can lead to mistaken inferences (Allen and MacDonald, 1995:40).

The two commonly used bivariate cointegration procedures are the *Engle-Granger (EG) two-step procedure*[23] and *Johansen's Maximum Likelihood (JML) procedure*. Compared to the EG procedure, the JML procedure has been considered to be more robust (c.f. Gonzalo, 1994:225; Masih and Masih, 1995:141; Masih and Masih, 2000:626; Figueira *et al.,* 2005:7). In contrast to the EG procedure which is sensitive[24] to the choice of the dependent variable in the cointegrating regression, the JML procedure assumes all variables are endogenous. Consequently, unlike the EG procedure, the JML procedure is able to avoid the arbitrary choice of the dependent variable and remain insensitive to the variable being normalised (Masih and Masih, 2000:630). Furthermore, the JML procedure has the advantage of being more general, by for instance, directly testing for multiple cointegrating relationships among a set of variables (Masih and Masih, 2000:626) and by also allowing for the inclusion of deterministic variables (e.g. dummies) in the cointegrating vector (Allen and MacDonald, 1995:35). Lastly, the JML procedure is able to capture long-run relationships previously unfounded by the EG procedure (Masih and Masih, 2000:626). For such reasons, cointegration tests will be carried out using only the JML procedure, in particular, Johansen (1991).

The vector autoregressive (VAR) model is the basis for the empirical analysis. In conjunction with the Johansen (1991) procedure and partly following Yang (2005:41), the error correction model (ECM) can be specified as follows:

$$\Delta X_t = \prod X_{t-1} + \sum_{i=1}^{k-1} \Gamma_i \Delta X_{t-i} + \mu + e_t \qquad (t = 1, \ldots, T) \qquad [3.2]$$

[23] The EG procedure can only be used in bivariate analysis as it does not account for the possibility of multiple cointegrating relationships (Masih, 1995:141).

[24] i.e. when running the cointegration regression using the EG procedure, one variable has to first be specified as the dependent variable and the other as the independent variable even though there may be no theoretical motivation for doing so (Brooks, 2002:394).

where, X_t denotes a column vector of the bond market series p for the selected bond markets, Γ and Π denote coefficient matrices where Π captures information regarding the long-run (cointegration) relationships among n variables, Δ is a difference operator, k represents the lag length, and μ is a constant term. If the rank of $\Pi = 0$, then the variables in X_t are non-cointegrated as no stationary linear combination can be identified. Whereas, if the rank r of $\Pi > 0$, there will exist r possible stationary linear combinations, and Π can be expressed as a product of two matrices, α and β (Masih and Masih, 2000:631), as shown in [3.3]:

$$H(r): \ \Pi = \alpha\beta' \qquad [3.3]$$

where, α and β' are n x r and $r \times n$ matrices, respectively (Brooks, 2002:407). α contains the speed-of-adjustment coefficients and β contains the coefficients of the r cointegrating vectors (Masih and Masih, 2000:631).

In order to be able to determine the number and structure of the cointegrating relations without having to impose *a priori* structural relations (Johansen, 1991:1553), the Johansen cointegration procedure uses two likelihood ratio statistics to test the rank of the Π matrix. These are the trace (λ_{trace}) and the maximum eigenvalue (λ_{max}) statistics. Mathematically they are expressed as follows:

$$\lambda_{trace}(r) = -T\sum_{i=r+1}^{N} In(1-\hat{\lambda}_i) \qquad [3.4]$$

and,

$$\lambda_{\max}(r, r+1) = -TIn(1-\hat{\lambda}_{r+1}) \qquad [3.5]$$

Where, r represents the number of cointegrating vectors under the null hypothesis, $\hat{\lambda}_i$ represents the estimated value for the ith ordered eigenvalue (characteristic root) of the Π matrix (Brooks, 2002: 405), and T represents the number of usable observations (Figueira *et al.,* 2005:4). The λ_{trace} statistic is used to determine r, where the null hypothesis is that there are at most r cointegrating vectors against an unspecified alternative, n, that there are more than r ($0 \leq r < n$) cointegrating vectors (Yang, 2005:42). The λ_{max} statistic tests for the exact number of cointegrating vectors (Kim *et al.*, 2006:46). As a result, each eigenvalue is individually tested. The

null hypothesis is that there are *r* cointegrating vectors against the alternative of $r + 1$ (Brooks, 2002:405).

As mentioned in Chapter Two, from a portfolio diversification standpoint, the finding of cointegration among international bond markets will reduce the long-term diversification benefits available to investors as it indicates that over the longer term the bond markets are being driven by the same common factors (Smith, 2002:220). This implies that the returns across the cointegrated markets will be highly correlated in the long-run and thus not provide investors with large benefits in risk-reduction in the long-term (Allen and MacDonald, 1995:34-35). However, since cointegration focuses on long-run associations this does not rule out the possibility to engage in effective portfolio diversification strategies over shorter time horizons. For instance, if investors can identify which markets are cointegrated they could use such knowledge to their advantage in order to determine in which markets to invest their funds and for how long to do so. This follows on from Clare *et al.* (1995:317) who indicated that when short-run bond market movements deviate from their long-run equilibrium path it is possible to use the lagged values of the error correction mechanism to predict future bond market movements.

If the markets are found to be cointegrated based on the λ_{trace} and/or λ_{max} test statistics, the Vector Error Correction Model (VECM) can then be formulated. Importantly, the VECM framework allows for short-run adjustment dynamics while restricting the long-run behaviour of the endogenous variables to converge to their cointegrating relationships (Chinzara, 2007:30). Furthermore, in order to determine the causal relationship between the bond markets, weak exogeneity tests will be carried out (Aziakpono, 2008b:188). Lastly, in order to determine whether the models have been correctly specified, serial correlation diagnostic tests will be conducted.

3.4 CONCLUSION

The aim of this chapter was to systematically lay out the analytical framework that will lead to the realisation of the objectives stated in Chapter One. The econometric techniques to be followed were discussed; namely, PCA and the Johansen cointegration procedure. By employing both econometric techniques a more rigorous and comprehensive analysis can be undertaken. Thus, more robust results can be provided and greater insights into international bond market linkages can be gained.

Fundamentally, the intention of this thesis is to extend the literature by examining the time-varying dynamics of bond market linkages between South Africa and the developed markets. This will shed light on whether any comovement between South Africa and the other markets is a gradual unidirectional progression resulting from increasing economic integration or is more of a sporadic phenomenon. Accordingly, determining whether the comovements are stable or unstable over time will have important implications for portfolio managers (Gilmore *et al.,* 2006:3).

CHAPTER FOUR

ANALYSIS OF EMPIRICAL RESULTS

4.1 INTRODUCTION

The objectives set out in Chapter One were to: (I) examine the time-varying nature of international bond market linkages, (II) examine the long-run comovement between the South African and international bond markets in order to determine whether international bond market diversification would be beneficial to a South African investor; (III) identify which countries offer the greatest diversification possibilities to a South African investor; and (IV) make recommendations on how best a South African investor can organise their portfolio in order to minimise risk. Thus far, the existing empirical literature has been reviewed, and the analytical framework established. In order to achieve the aforementioned objectives, the current chapter deals with the application of this analytical framework.

The remainder of the chapter is organised as follows: Section 4.2 describes the data and sources. Section 4.3, Section 4.4, and Section 4.5, present and discuss the results from the preliminary analysis, the principal component analysis (PCA), and the Johansen cointegration analysis, respectively. Section 4.6 concludes.

4.2 DATA AND SOURCES

In general, the countries included in the study were chosen because they each have well developed financial markets and play an important role in the international bond market. In addition, they collectively represent realistic investment possibilities for a South African portfolio manager.

As mentioned in Chapter One, the countries are: Australia (AU), Canada (CN), Germany (BD), Japan (JP), the United Kingdom (UK), and the United States (US)[25]. AU was chosen because like South Africa (SA) it is a small open economy, geographically isolated from major world markets, with large export-orientated resource sectors (Harcourt, 2004). Similar to SA and AU, CN is also a resource based economy. *A priori*, one would expect SA to have closer ties with such economies due to their similarities in economic structure. BD is the most economically powerful

[25] Note that in this section the United Kingdom is simply referred to as 'UK' and not 'the UK' and similarly the United States is referred to as 'US' and not 'the US'.

European Union member state (Bertelsmann Foundation, 2007) and as such, it is often used to represent the European Union (Chinzara, 2007:4). US and JP were chosen because at the time of writing their economies were respectively, the largest and second largest in the world[26] (Locke, 2004). The inclusion of UK is based on its historical importance to SA due to colonialism and the prominent role it plays in international financial markets.

It would have been beneficial to also include several emerging markets such as Brazil, China, India and Malaysia in the study. However, due to the limited availability of bond market data for these markets they were subsequently not included.

When examining whether international bond portfolio diversification would be beneficial to a South African investor, a longer time period would be ideal in order to assess whether there are in fact any linkages between SA and the international markets, and if so, to determine whether these linkages have been increasing over time, or are merely sporadic. However, bearing in mind that the total return indices for South Africa are only available from August 2000[27], from a South African investor's perspective, an examination of international bond portfolio diversification that focuses solely on the indices would provide a limited insight into international bond market linkages. Therefore, the current analysis will be carried out using redemption yields **(i.e. bond yields)** for government bonds with ten years to maturity and monthly **total return indices** on ten-year government bonds[28]. The bond yield data covers a nineteen-year period from January 1990 to July 2008 and includes 223 month-end observations, while the bond index data covers a nine-year period from August 2000 to July 2008 and includes 96 month-end observations. The bond yield data for AU, CN, BD, JP, UK and US was sourced from *Thompson DataStream* and the bond yield data for SA was sourced from the *IMF International Financial Statistics*. All bond index data was sourced from *Thompson DataStream*. The indices (which include reinvested coupon payments) were Rand adjusted in order to reflect the possible benefits to a South African investor engaging in international bond portfolio diversification. For both yields and indices the data was converted into natural logarithms before undertaking the PCA and the cointegration analysis. However, for the preliminary analysis raw data was used (i.e. the data was not converted into natural logarithms).

[26] At present Japan is the third largest economy and China is now the second largest economy in the world (Patterson, 2008).
[27] Note: the Bond Exchange of South Africa (BESA) launched the Total Return Indices in July 2000 (BESA, 2000:4). The current study chose to use these indices because the old South African bond indices, the Bond Performance Indices, made it difficult to obtain accurate performance measures (BESA, 2000:5).
[28] Hereafter simply referred to as the bond indices.

In general, Government bonds were chosen because in most countries, the government sector is the largest issuer of bonds while the other sectors play a peripheral role (Faure, 2006:20). Furthermore, most empirical studies also use government bonds when examining international bond market linkages (c.f. Mills and Mills, 1991; Clare *et al.,* 1995; Yang 2005; Ciner 2007). However, whereas Mills and Mills (1991) used bond yields to study international bond market linkages, Clare *et al.* (1995), Yang (2005), and Ciner (2007) used bond indices.

The current study differs from the existing literature in that it uses both bond yields and bond indices concurrently to examine international bond market linkages. The use of bond yield data serves to complement the analysis of bond portfolio diversification by providing greater insights into the nature of interest rate linkages across the international bond markets. Furthermore, the longer time period will make it possible to better ascertain how international bond market linkages have varied over time, and also address further issues such as: whether South Africa's readmission into the international arena has lead to a strengthening of these linkages, and also whether South Africa's adoption of an inflation targeting approach in February 2000 has had an effect on these linkages. In addition, for the latter part of the analysis (i.e. August 2000 to July 2008) by being able to compare the yield and index results, the effect exchange rate differential has on international portfolio diversification can be accounted for since the bond indices are Rand-adjusted.

Simply put, the use of bond yield data will set the background for the analysis of international bond market linkages, while the use of the bond indices will provide the detail needed to assess the opportunities available to a South African investor engaging in international bond portfolio diversification. For this reason, when discussing the results of the preliminary analysis, the PCAs, and the cointegration analysis, the yield results will first be discussed followed by the index results.

4.3 PRELIMINARY ANALYSIS

Figure 4.1 and Figure 4.3 respectively present graphical plots of bond market yields (BMYs) over time and the changes in BMYs over time. Figure 4.2 and Figure 4.4 respectively present graphical plots of bond market indices (BMIs) over time and the changes in BMIs over time. The correlation coefficients between BMYs for all countries are reported in Table 4.1, and the correlation coefficients between BMIs for all countries are reported in Table 4.2. Figure 4.5 presents a graphical plot of the BMY correlation coefficients between SA and the other bond

markets and Figure 4.6 presents a graphical plot of the BMI correlation coefficients between SA and the other bond markets

4.3.1) Bond Market Trends

Figure 4.1: Bond Market Yields

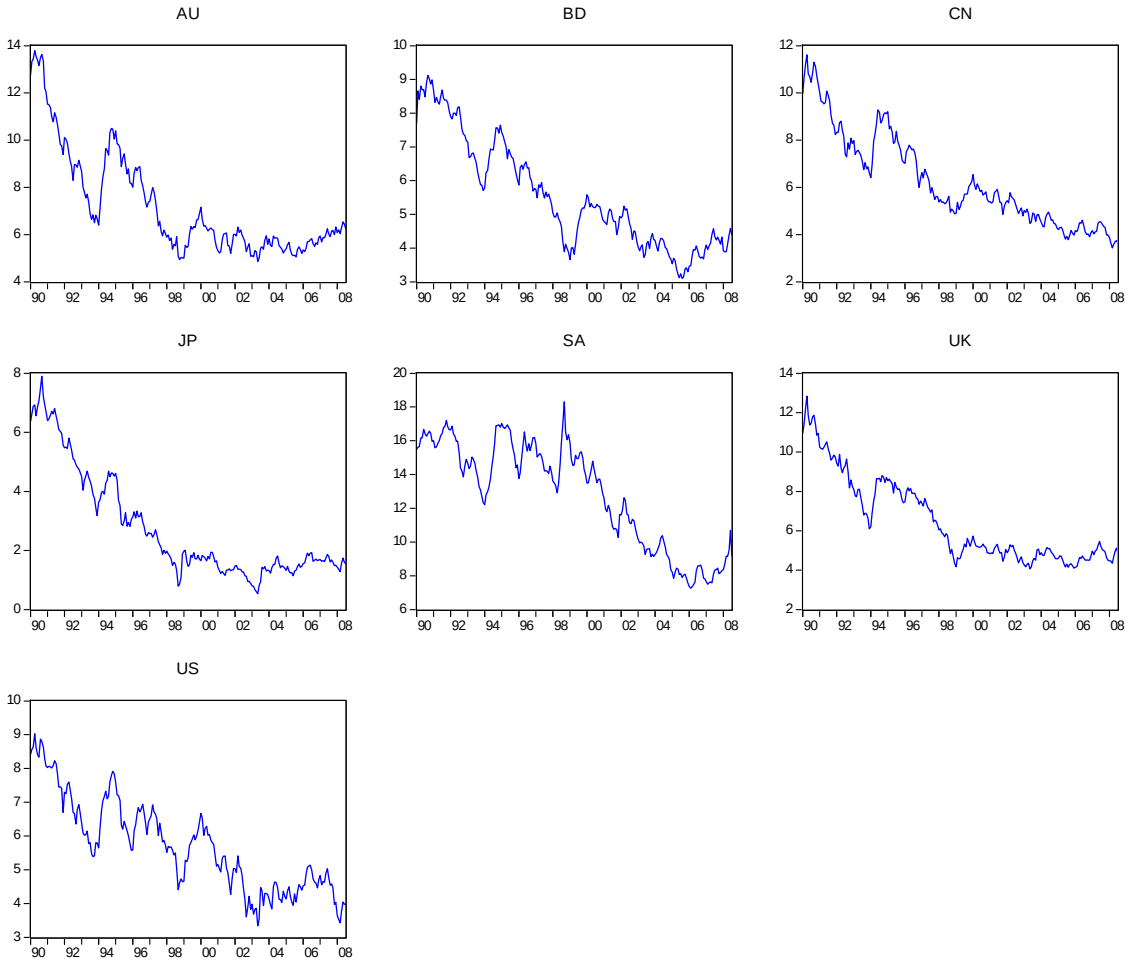
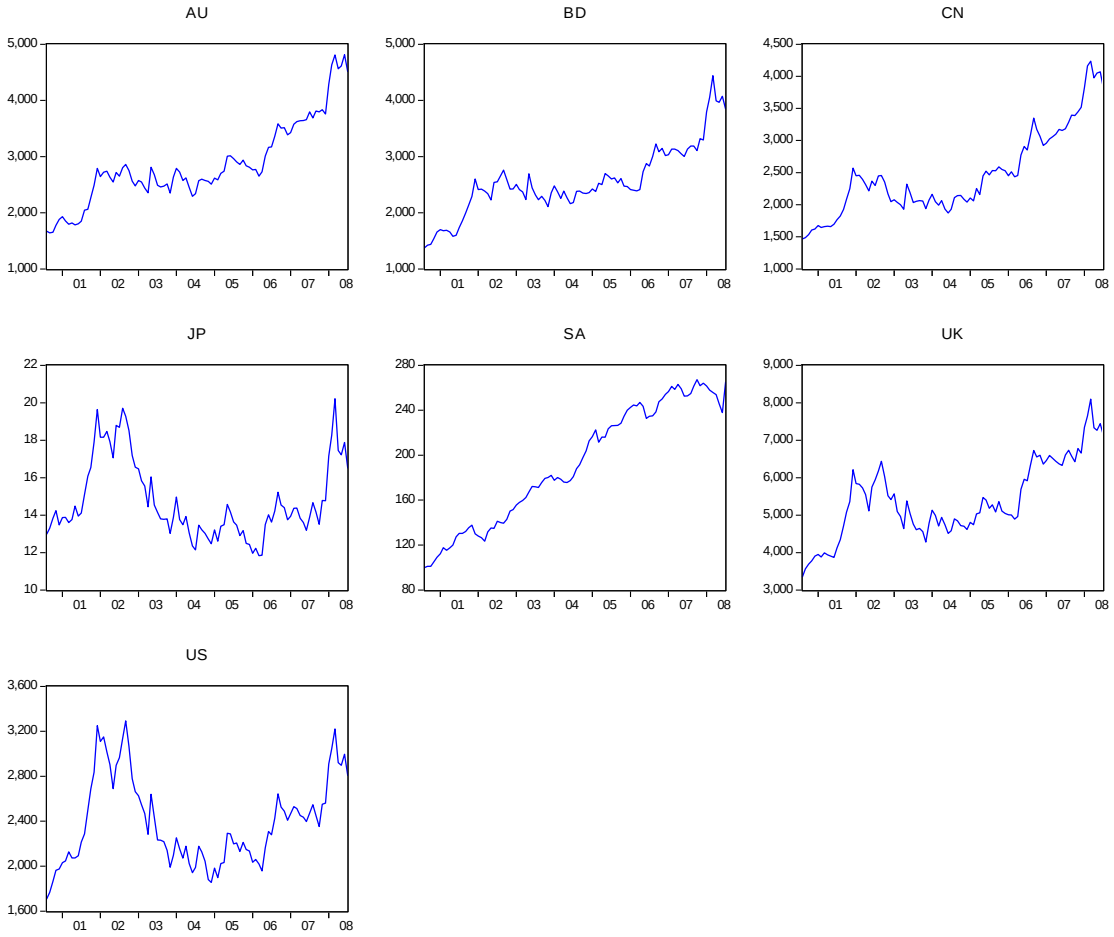


Figure 4.1 indicates a general downward trend in BMYs for all markets. This downward trend can probably be partly attributed to the fact that more and more central banks (especially in developed markets) were becoming primarily concerned with price stability (i.e. keeping inflation low). This is because, as mentioned by Goodfriend (1998), the ability of central banks to maintain low inflation levels has been identified as the foundation of an effective monetary policy. Therefore, BMYs are likely to trend downwards if inflation expectations decrease because as mentioned in Chapter Two, the long-term bond rate can be viewed to some extent as being a forward-looking indicator that embodies a direct measure of inflation expectations (Goodfriend, 2008). AU, BD, CN and UK reflect a very similar trend in BMYs, while JP and US appear to do so to a lesser extent. However, SA appears to have a fairly distinct BMY trend. Most noticeably,

in SA BMYs reached their peak in 1998 while for all other markets this occurred during the 1990 period. However, bearing in mind the relationship between the long-term bond rate and inflation expectations it is not surprising that BMYs in SA remained fairly high between 1990 to 1998, if one considers the fact that in SA inflation, according to the consumer price index (CPI), had generally fluctuated around the 15% level in the late 1980s and early 1990s. However, in 1999 inflation had declined to an average of 5.2% as, by this stage, SA had adopted an informal[29] inflation targeting approach (van der Merwe, 2004:1). The latest upward trend in SA BMYs can also be explained in light of the rising CPI inflation in SA, especially during 2008, when it reached the level of 13.6% in August (SARB, 2008), which is well above its 3%-6% target range.

Figure 4.2: Bond Market Indices



Note: The indices are all in-terms of South African Rands (i.e. Rand-adjusted).

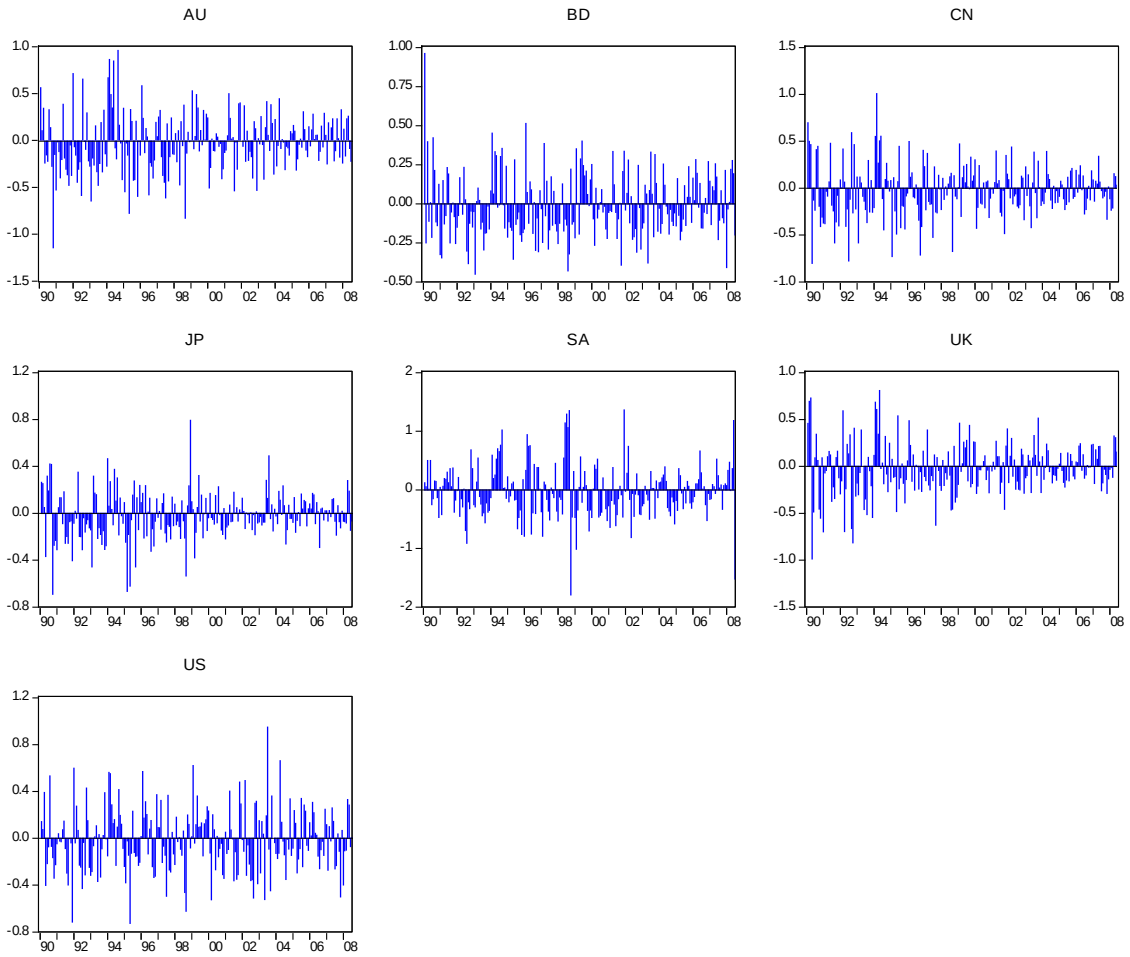
Figure 4.2 above shows that AU, BD, CN, and UK, have a very similar upward trend in BMIs, while the trend in BMIs for JP, SA, and US are somewhat different from the former countries.

[29] It was only formally announced in February 2000 that SA would be adopting inflation targeting as part of its monetary policy framework (van der Merwe, 2004:1).

However, the trend in BMIs for JP and US are nearly identical. Hence, similar to the BMY results, SA again appears to have a fairly different BMI trend relative to the other developed countries. However, what is more apparent from Figure 4.2 relative to Figure 4.1 is how closely linked the JP and US BMIs appear to be.

Figure 4.3 below shows that SA relative to the other markets has had both the greatest monthly increase and decrease in BMYs. In general, the other markets appear to have more moderate monthly changes in BMYs. However, bearing in mind that SA is an emerging market one would expect it to be more prone to extreme BMY changes relative to the developed markets.

Figure 4.3: Changes in Bond Market Yields

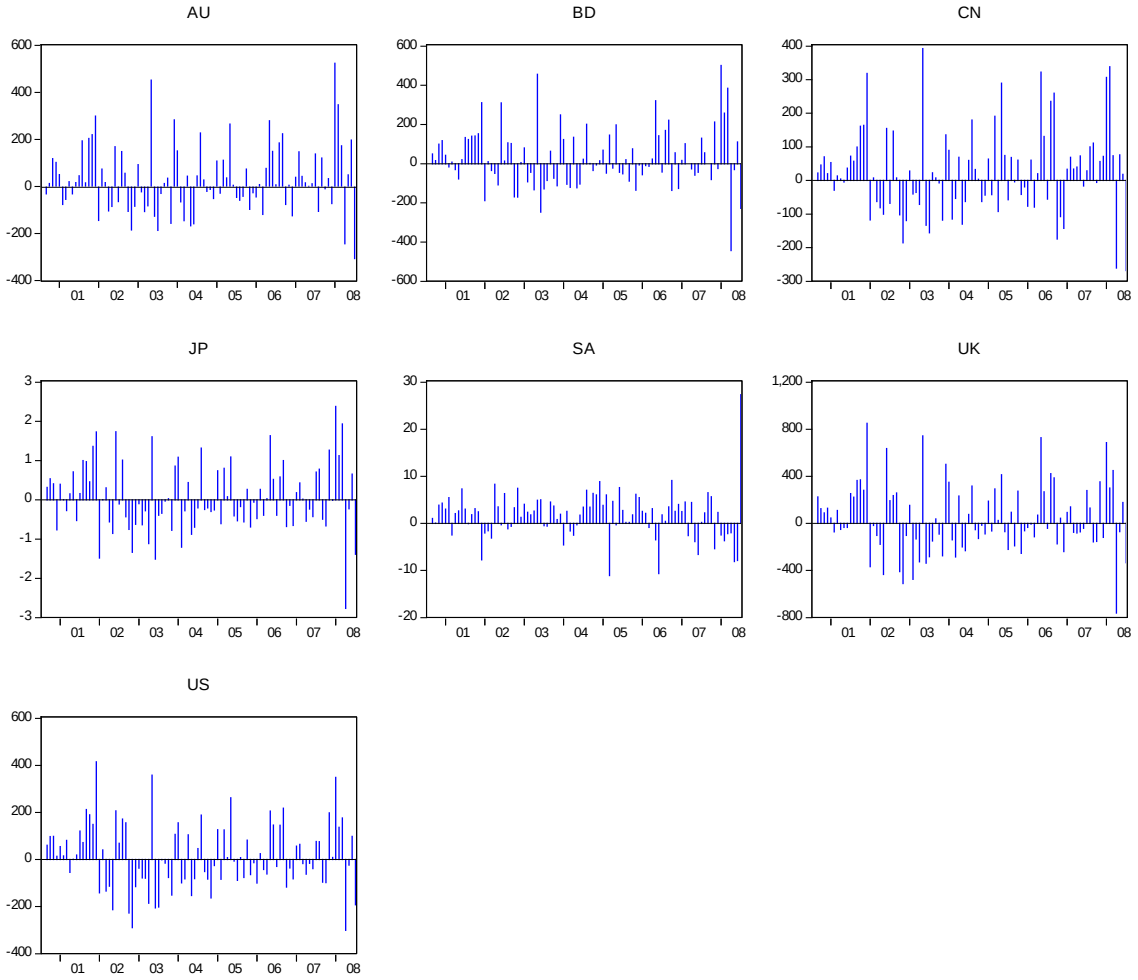


Note: The indices are all in-terms of South African Rands (i.e. Rand-adjusted).

In contrast to Figure 4.3 where the monthly changes in BMYs appeared to be more erratic relative to the developed markets, the monthly changes in BMIs for SA were more consistent and moderate in their increases over time. However, during the final few months of the sample

period there appears to be a sustained decrease in SA BMIs, which coincides with the ongoing Sub-prime Mortgage Crisis. This would imply that during such uncertain times, foreign investors are in fact withdrawing their funds from the South African bond market and placing them elsewhere. For instance, although BMIs for the developed markets also varied significantly during the final few months, none of those markets consistently experienced the sustained month-to-month decrease that is exhibited by the SA bond market. This could be because investors are opting to place their funds in investment environments which they consider to be less risky (i.e. developed markets). Attention is now turned to the descriptive statistics.

Figure 4.4: Changes in Bond Market Indices



Note: The graphs show the monthly index changes for each country from August 2000 to July 2008 (horizontal axis). The vertical axis show the monthly index changes for each country.

4.3.2) Descriptive Statistics

Table 4.1: BMY Correlation Coefficients

Market	AU	BD	CN	JP	**SA**	UK	US
AU	1.0						
BD	0.933	1.0					
CN	0.949	0.966	1.0				
JP	0.938	0.940	0.924	1.0			
SA	**0.670**	**0.780**	**0.796**	**0.646**	**1.0**		
UK	0.965	0.969	0.961	0.955	**0.741**	1.0	
US	0.907	0.927	0.944	0.883	**0.804**	0.926	1.0

Note: Correlations are calculated from January 1990 to July 2008 using actual yield values.

Table 4.1 reports the pair-wise bond yield correlations between the bond markets. Overall, correlation between all markets is positive and there is also a high level of contemporaneous correlation among the markets. However, in all cases SA appeared to be the least correlated with the other markets. Correlations between SA and the other markets averaged 74%[30]. SA was least correlated with JP followed by AU, and it was most correlated with US followed by CN. The highest correlation was found between BD and UK.

Considering that the sample period starts in January 1990 and ends in July 2008, in order to better capture the time-varying nature of the correlation coefficients across the bond markets during this period a five-year rolling window approach was subsequently implemented. Thus, fifteen rolling window samples were analysed from January 1990 to December 1994, January 1991 to December 1995, and so on until January 2004 to July 2008. The full results are reported in Table-A 4.1 in the Appendix, while Figure 4.5 presents a graphical plot of the BMY correlation coefficients for each rolling window between SA and the other bond markets.

[30] (0.669979 + 0.78039 + 0.795501 + 0.646181 + 0.741208 + 0.804205)/7 X 100 = 74%

Figure 4.5: Bond Yield Correlation Coefficients between SA and the Major Global Bond Markets

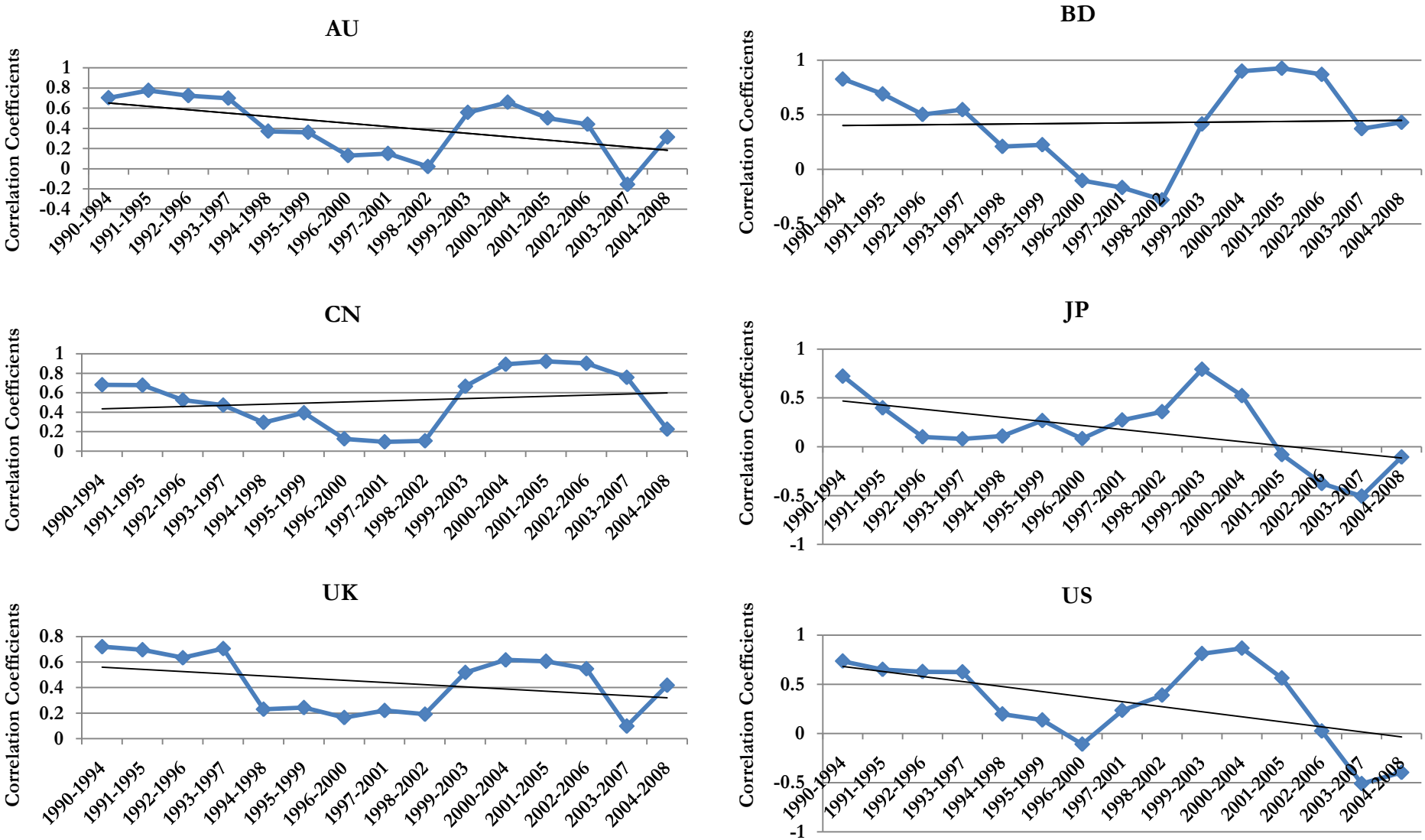


Figure 4.5 shows that the BMY correlation coefficients between SA and the other markets were fairly unstable and varied considerably over the rolling window sample period. In order to determine the general trend of the BMY correlation between SA and the other bond markets each graph also displays a trend line. The trend line simply shows whether the BMY correlations between SA and the other bond markets were, on average, increasing or decreasing during the sample period. For instance, with regards to the UK, although the trend line is negatively sloped, UK BMYs remained positively correlated with SA BMYs during the sample period. It was merely the degree of correlation between them that was decreasing. For all rolling windows SA BMYs was found to always be positively correlated with the BMYs of CN and UK. In contrast to UK, the CN trend line was positively sloped, thus indicating that BMY correlation between SA and CN was, on average, increasing during the sample period. Therefore, although in most cases SA BMYs remained predominantly positively correlated with all markets the trend line was negatively sloped for AU, JP, UK, and US and positively sloped for only BD and CN. This is an interesting finding as *a priori* one would expect that against the background of increasing economic integration, BMY correlations between SA and the major global market would also increase over time. However, the finding here is that in the majority of cases, bond market correlation between SA and the other markets were, on average, decreasing during the sample period.

Before beginning to draw conclusions on the implications that the above findings have on portfolio diversification from a South African investor's perspective, the BMIs results must first be discussed. Table 4.1 reports the pair-wise bond index correlations between the bond markets.

Table 4.1: BMI Correlation Coefficients

Market	AU	BD	CN	JP	SA	UK	US
AU	1.00						
BD	0.988	1.00					
CN	0.983	0.968	1.00				
JP	0.299	0.363	0.319	1.00			
SA	**0.808**	**0.781**	**0.787**	**-0.258**	**1.00**		
UK	0.942	0.957	0.945	0.513	**0.669**	1.00	
US	0.533	0.586	0.558	0.925	**0.035**	0.740	1.00

Note: Correlations are calculated from August 2000 to July 2008 using the actual index values.

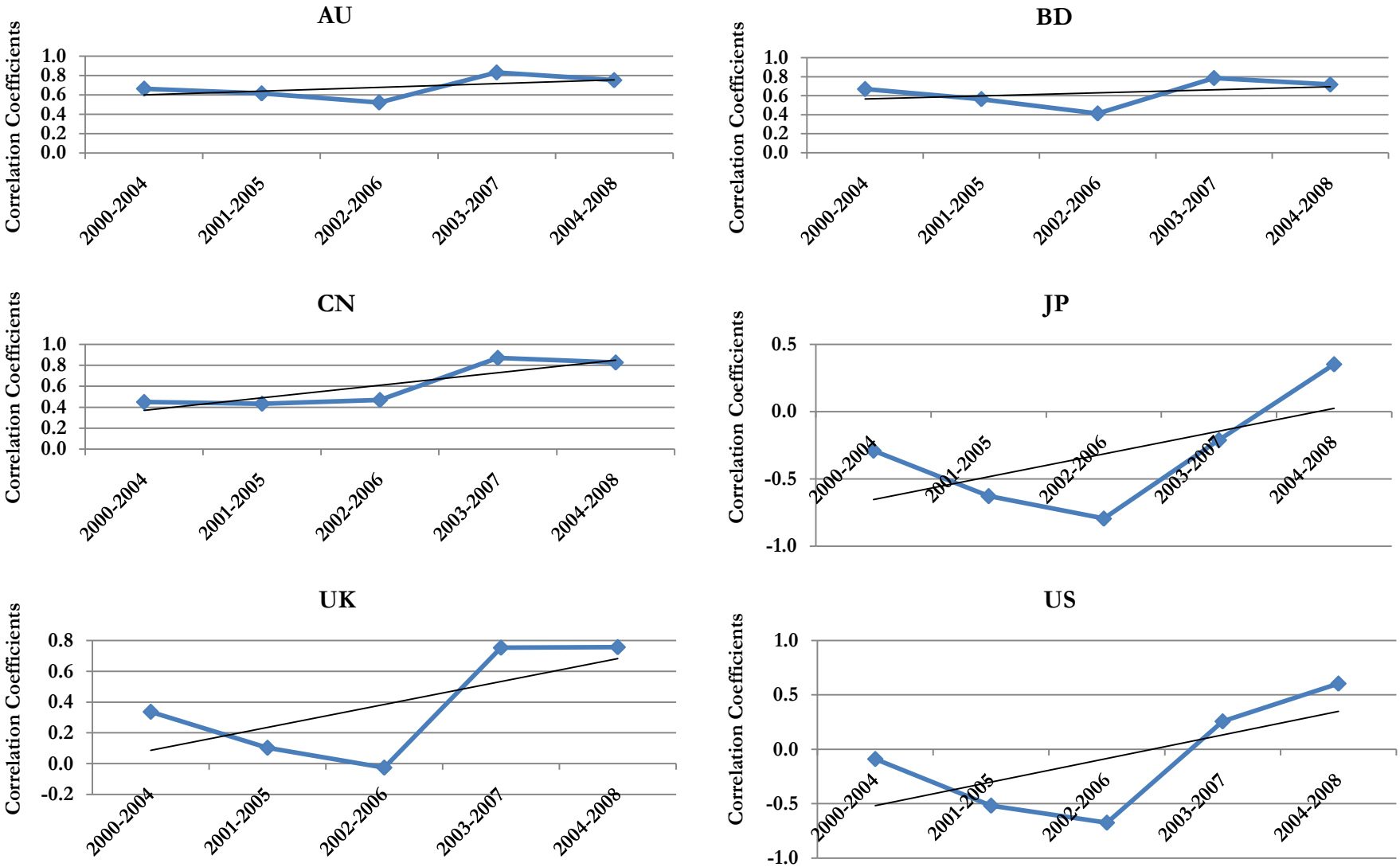
Similar to the BMY results, BMI correlation between the markets remained positive with the only exception being between SA and JP where the results indicated that the two markets were negatively correlated. In contrast to the BMY results where SA BMYs were found to be least

correlated with those of the other markets, for the BMI results JP followed by US BMIs were, on average, found to be least correlated with the BMIs of the other markets. However, JP and US did remain well correlated with each other. BMI correlations between SA and the other markets averaged 47%. In this case SA BMIs were found to be most correlated with AU BMIs and least correlated with JP BMIs.

Similarly to the previous section, a five-year rolling window approach was again implemented. However, for the bond indices there were only five rolling windows from August 2000 to December 2004, January 2001 to December 2005, and so on until January 2004 to July 2008. The full results are reported in Table-A 4.2 in the Appendix, while Figure 4.6 presents a graphical plot of the correlation coefficients for each rolling window between SA and the other bond markets.

As indicated by the trend lines in Figure 4.6, BMI correlation between SA and the other bond markets, on average, increases during the sample period, which suggests that the benefits of engaging in international bond portfolio diversification are diminishing. This is in contrast to the BMY correlation coefficients graph where, on average, BMY correlations for all countries were found to decrease during the same time period (see Figure-A 4.1 in the Appendix). This finding is of value because it suggests that after accounting for exchange rate differentials, the linkages across international bond markets strengthen. However, the fact that SA BMIs were not found to be perfectly correlated with those of the other markets indicates that engaging in bond portfolio diversification will remain beneficial for a South African investor because as noted by Howells and Bain (2005:176) the lower (and more negative) the correlations are across assets, the greater the opportunity for portfolio diversification, and the lower the level of risk associated with a given return. However, bond markets which are not perfectly correlated but are positively correlated will offer lower bond portfolio diversification benefits relative to those markets that are negatively correlated. For instance, Figure 4.6 suggests that since correlation between SA and JP, and SA and US remained negative for most of this sample period, these two countries would provide the greatest portfolio diversification opportunities to a South African investor.

Figure 4.6: Bond Index Correlation Coefficients between SA and the Major Global Bond Market



Lastly, the fact that the BMY and BMI correlations between SA and the other markets remained varied during the sample period suggests that international bond portfolio diversification will, at times, be beneficial for a South African portfolio manager. However, from the above analysis it still remains difficult to answer questions such as: exactly which markets have similar BMY movement patterns? Do these similarities occur throughout the entire sample period? Is SA more likely to have similar BMY/BMI movements with countries which are also predominantly resource based economies such as AU and CN? Or are BMYs/BMIs in SA largely influenced by BMY/BMI movements in some of the world's largest economies i.e. US and JP? Therefore, in order not to make mistaken inferences and better capture what appears to be a more complex portrait of BMY/BMI movement patterns further analysis is needed. This is done using PCA and cointegration analysis. These results are discussed in the following section.

4.4 PCA RESULTS

4.4.1) BMYs

Figure 4.7 presents a graphical plot of the BMY eigenvalues of the first three principal components (PCs) over time. Table 4.3 and Figure 4.8 report the number of statistically significant PCs found per rolling window for BMYs and their respective cumulative R^2 values. The BMY factor loadings for the first (PC1) and second (PC2) PCs are plotted in Figure 4.9 and Figure 4.10, respectively[31]. On average, the BMYs rolling window results indicate that SA BMYs are not well integrated with the BMYs of the selected international bond markets. Furthermore, JP BMYs are found not to be well integrated with the BMYs of the developed bond markets. Moreover, there is some evidence to suggest that, overall, international BMYs become less integrated during financial crisis periods.

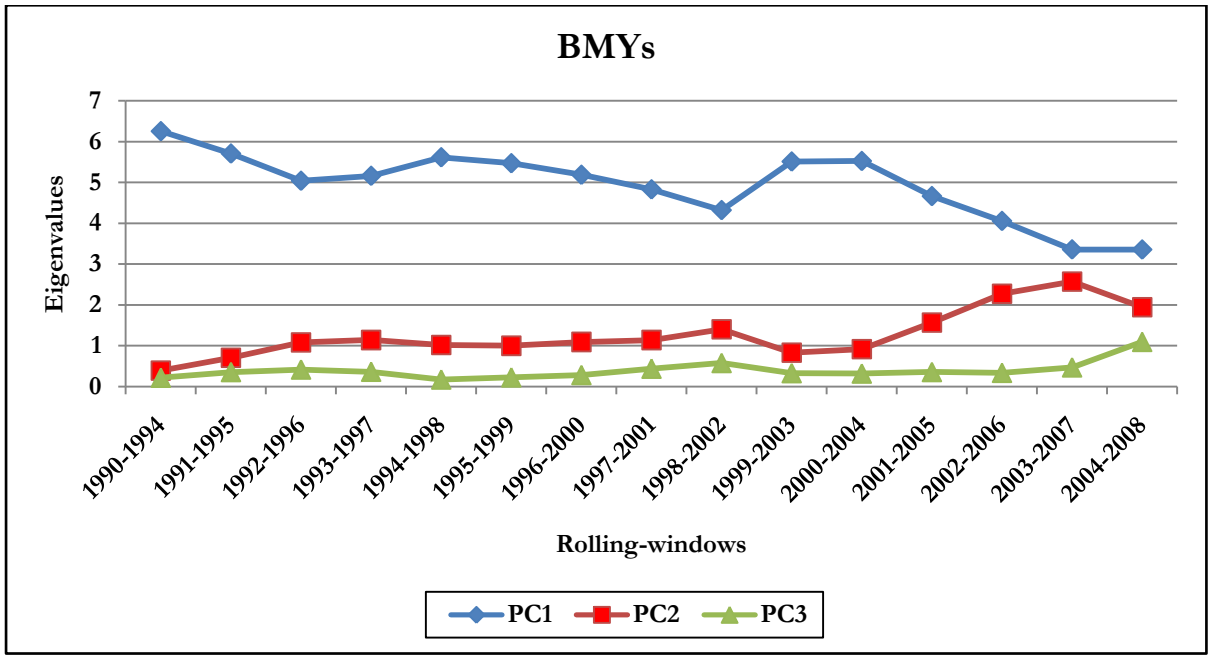
As shown in Table 4.3, when the entire sample period was analysed (i.e. January 1990 to July 2008), there emerged only one statistically significant PC of which PC1 explained 89.3% of the total variability in BMYs according to its cumulative R^2 value. Furthermore, the BMYs in all countries showed and maintained indications of comovement as their factor loadings where of similar magnitude and exhibited the same sign (i.e. systematically similar).

[31] These results are also presented in Table-A 4.3 and Table-A 4.4 in the Appendix.

Furthermore, similar to the previous section, a five-year rolling window approach was implemented in order to capture the time-varying nature of international bond market linkages. The results are reported in Figure 4.7, Figure 4.8, and Table 4.3

Figure 4.7 shows that, as the time period progressed, the ability of PC1 to adequately account for the total variability in the set of BMYs decreased. The corollary of this was an increasing ability of PC2 and PC3 to account for a greater proportion of the total variability in BMYs.

Figure 4.7: Eigenvalues of the First Three PCs per Rolling Window



Note: PC1, PC2 and PC3 represent principal component one, two and three, respectively.

The declining explanatory power of PC1 in explaining the variability in BMYs suggests that, over the entire sample period, not all bond markets had similar BMY movement patterns. Thus, it is necessary to identify which markets are diverging from the others and the reasons for their divergence. As a result, the divergence in BMYs that is captured in Figure 4.7 can be accounted for. Furthermore, by identifying the reasons for their divergence it will be possible to ascertain whether their divergence was merely sporadic or if it is likely to persist. Understanding these issues will provide valuable insights into international bond market linkages.

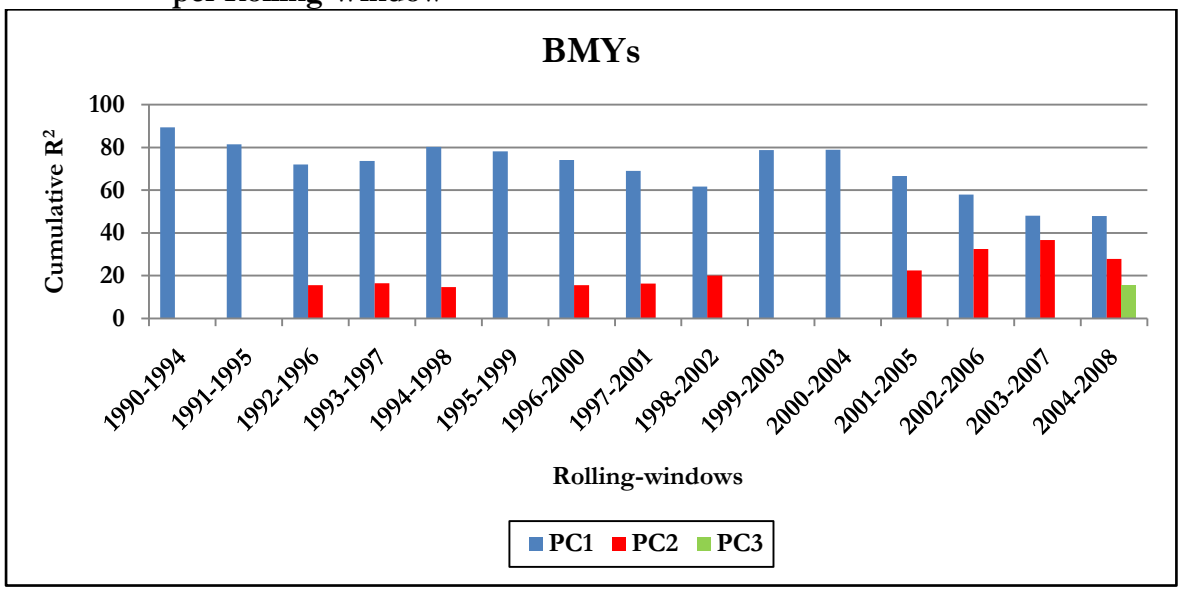
As a precursor to addressing these issues, the proportion of variability explained by the eigenvalue of each statistically significant PC during the entire sample period and also during each rolling window will first be considered. They are reported in Table 4.3.

Table 4.3: Proportion (%) of Variability Explained by each Statistically Significant PC

Period	PC1	PC2	PC3	Period	PC1	PC2	PC3
1990-2008	89.3	-	-	1997-2001	69.0	16.3	-
1990-1994	89.4	-	-	1998-2002	61.7	20.0	-
1991-1995	81.5	-	-	1999-2003	78.7	-	-
1992-1996	72.0	15.5	-	2000-2004	78.9	-	-
1993-1997	73.7	16.4	-	2001-2005	66.6	22.4	-
1994-1998	80.2	14.6	-	2002-2006	57.9	32.5	-
1995-1999	78.1	-	-	2003-2007	48.0	36.7	-
1996-2000	74.1	15.6	-	2004-2008	47.9	27.8	15.6

Note: PC1, PC2 and PC3 represent principal component one, two and three, respectively. In the cases where the eigenvalue is not statistically significant the proportion of variability it explains is not reported.

Figure 4.8: Proportion (%) of Variability Explained by each Statistically Significant PC per Rolling Window

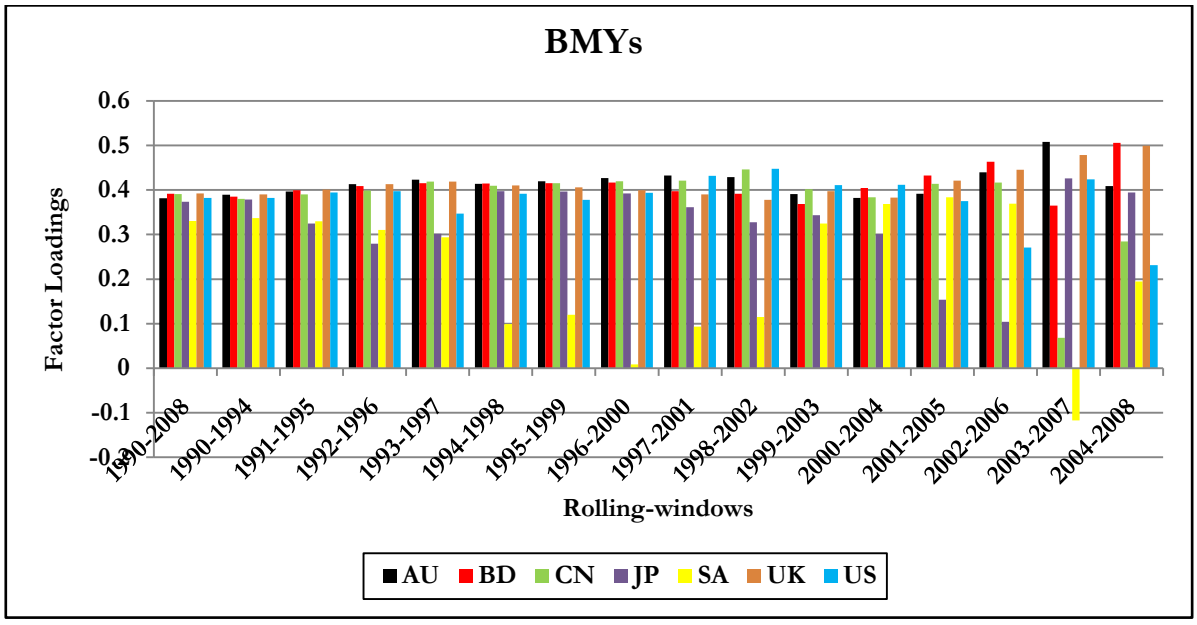


Note: PC1, PC2 and PC3 represent principal component one, two and three, respectively.

As shown in Table 4.3 and Figure 4.8, during the 1990-1994, 1991-1995, 1995-1999, 1999-2003, and 2000-2004 rolling windows, international BMYs appear to be closely correlated as only one statistically significant PC emerged according to the Kaiser Rule of eigenvalues greater than one. However, in most rolling windows at least two statistically significant PCs emerged, with the exception of the final rolling window where three statistically significant PCs emerged. Therefore, for most rolling windows, international BMYs appear to be segmented to some extent. The question arises as to whether these periods of segmentation can be attributed to specific economic phenomena, such as the 1997/98 Asian Financial Crisis – or are merely incidental occurrences.

Figure 4.9 and Figure 4.10 report the factor loadings of PC1 and PC2, respectively. Based on the results from the country factor loadings in PC1, during the earlier rolling windows (i.e. 1992-1996, 1993-1997, 1994-1998, 1996-2000, 1997-2001 and 1998-2002) the perceived segmentation across international BMYs captured by the PCA, was not in fact a divergence between most international BMYs, but rather the divergence of the BMYs in SA– and to a much lesser extent JP – with the other countries. This is because, as shown in Figure 4.9, during the earlier rolling windows BMY comovements across most countries were systematically similar as their factor loadings were of similar magnitude and exhibited the same sign, whilst the factor loadings of SA and at times JP were more varied. In fact, in most cases SA appeared to be better explained by PC2 as it had a higher factor loading in PC2 relative to PC1. SA's factor loading throughout most periods ranged from being slightly different to being completely different from the other countries' factor loadings.

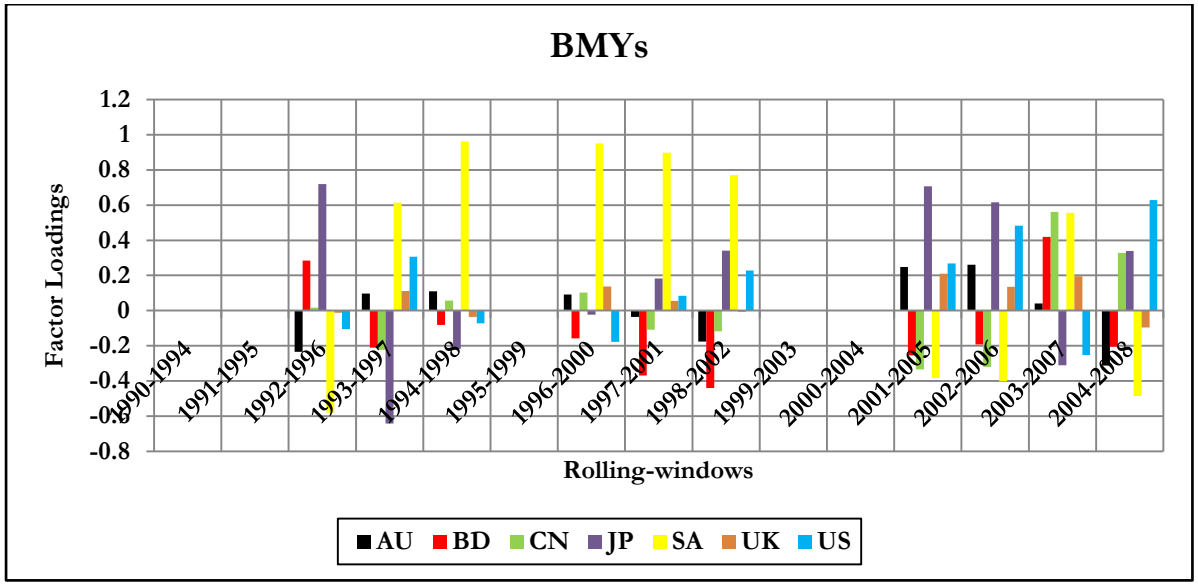
Figure 4.9: Country Factor Loadings for the First PC (PC1)



With regard to JP, it was apparent that it did not, to a large extent move, in unison with the other developed markets during the 1992-1996 and 1993-1997 rolling windows. According to Hoshi and Kashyap (2004:4), JP's economy started to underperform in 1992. In fact, the former rolling windows overlap the period during which JP was in economic stagnation. As mentioned by Kuttner and Posen (2001:100), inflation in JP had been consistently negative since 1994 with the exception of a brief respite in 1997. Consequently, JP was the first industrial country since the postwar era to undergo a period of sustained deflation. This economic phenomenon was peculiar

to JP and therefore it is likely that the actions taken by its monetary and fiscal authorities caused BMYs in JP to diverge from the other developed markets.

Figure 4.10: Country Factor Loadings for the Second PC (PC2)



Note: The factor loadings are reported for only those periods were PC2 was found to be statistically significant.

Furthermore, the fact that BMYs among the selected developed markets remained systematically similar during JP's economic stagnation indicates that BMY movements in JP had a negligible influence on the other bond markets. This is surprising considering the prominent role played by JP in the international arena.

However, it is only during the later rolling windows (i.e. 2001-2005 to 2004-2008) where there appears to be a genuine disintegration in BMYs because more countries (i.e. not only SA or JP) appear to have contrasting BMY movements. For instance, by the 2002-2006 rolling window JP, SA, and US had higher factor loadings in PC2 than in PC1. During the 2003-2007 rolling window, SA had for the first time a negative factor loading in PC1, which thus indicated that BMY movements in SA were not moving in the same direction as those in the other bond markets, while BD and CN both had higher factor loadings in PC2. By the final rolling window the emergence of three significant PCs resulted in BD, JP, and UK having their highest factor loadings in PC1, while US had its highest factor loading in PC2, and AU, CN, and SA had their highest factor loadings in PC3[32].

[32] The country factor loadings for PC3 are reported in the Table-A 4.5 in the Appendix.

During the 2002-2006 rolling window was the first time US had a higher factor loading in PC2 than in PC1. Divergence in US BMYs from those of AU, BD, CN, and UK occurred during a period when investor sentiment, especially towards the US equity market, was low. In all likelihood this can in part be attributed to the September 11 2001 terrorist attacks in the US and the US invasion of Afghanistan in March 2002. However, the burst of the telecom, media, and technology (TMT) bubble in March 2001 (MSN Encarta, 2008) appears to have played an instrumental role in investor pessimism towards the US. During 2002, the burst of the TMT bubble continued to weigh on global equity markets, as institutional investors rebalanced their portfolios away from more risky assets (i.e. equities) toward higher quality assets (i.e. government securities) (IMF, 2002:1). Market adjustments had occurred against the background of the bursting of the TMT bubble and by the end of March 2002 global financial markets had become fairly unsettled. Of consequence, the bursting of the TMT bubble exposed what can be described as "a culture of irrational exuberance" and some unsound business practices which in effect artificially boosted company share prices (IMF, 2002:1). During 2002 the dollar continued to depreciate against other major currencies, reflecting reductions in foreign capital flows into the US. The dollar's decline was exacerbated by a continuous stream of accounting irregularities in the US and the relative absences of them elsewhere. In particular, this raised numerous concerns regarding the stability of the US economy and the sustainability of the capital flows needed to finance the US current account deficit (IMF, 2002:1-2).

By the 2003-2007 and 2004-2008 rolling windows there appears to be systemic destabilization of BMY movements across all markets. This could either be attributed to – as shown in the case of JP and SA – a country specific phenomenon which caused, in this case, an increasing number of bond markets to diverge from the others, or to an economic phenomenon which had a significant impact on most markets. As it is unlikely that the divergence in BMYs in all seven markets especially during the 2003-2007 and 2004-2008 rolling windows was due to the occurrence of isolated events, because these 'isolated' events would have had to have occurred almost simultaneously in order to warrant such a divergence.

4.4.2) BMIs

Figure 4.11 presents a graphical plot of the BMI eigenvalues of the first two PCs over time. Table 4.4 and Figure 4.12 report the number of statistically significant PCs found per rolling window for BMIs and their respective cumulative R^2 values. The BMY factor loadings for PC1

and PC2 are plotted in Figure 4.13 and Figure 4.14, respectively[33]. Lastly, Table 4.5 reports the BMI results for the convergence group analysis for the entire sample period and for the five rolling windows.

On average, the BMIs rolling window results indicate that SA, JP, and to a lesser extent US are not well integrated with the other international bond markets. Furthermore, although there appeared to be an increase in the level of bond market integration according to the BMIs, effective bond portfolio diversification opportunities remained, as not all markets were found to be well integrated.

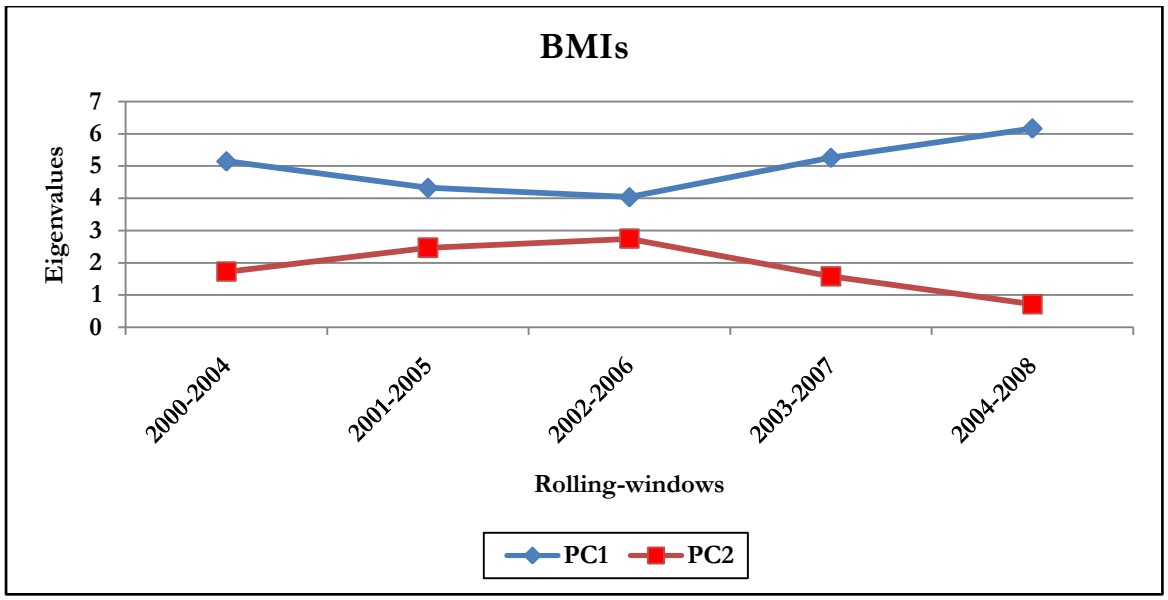
As shown in Table 4.4, when the entire sample period was analysed (i.e. August 2000 to July 2008), there emerged two statistically significant PC of which PC1 and PC2 respectively explained 72.7% and 25.4% of the total variability in BMIs. The emergence of two statistically significant PCs and the fact that not all countries (in particular, JP and US) showed indications of comovement as their factor loadings where not of similar magnitude indicated that not all the bond markets were closely correlated. This has important implications from a portfolio diversification point of view as the more statistically significant PCs there are, the more diverse the markets, and hence; the greater the portfolio diversification benefits will be from investing in these markets (Meric *et al.,* 2008:159).

Once again, a five-year rolling window approach was implemented in order to capture the time-varying nature of international bond market linkages. This will help provide valuable insights for a South African investor in order for them to ascertain whether international bond market diversification benefits are available. The results are reported in Figure 4.11, Figure 4.12, and Table 4.4.

Figure 4.11 shows that as the time period progressed, the ability of PC1 to adequately account for the total variability in the set of BMIs decreased up until the 2002-2006 rolling window, after which it begun to increase again. Although the capability of PC1 to explain BMI variability is increasing, it may still not affect international bond markets in the same manner or to the same extent. In this regard, one would have to assess country factor loadings and the signs attached to them. This issue is further discussed below and also in Section 4.4.3.

[33] These results are also presented in Table-A 4.6 and Table-A 4.7 in the Appendix.

Figure 4.11: Eigenvalues of the First Two PCs per Rolling Window



Note: PC1, and PC2 represent principal component one and two, respectively.

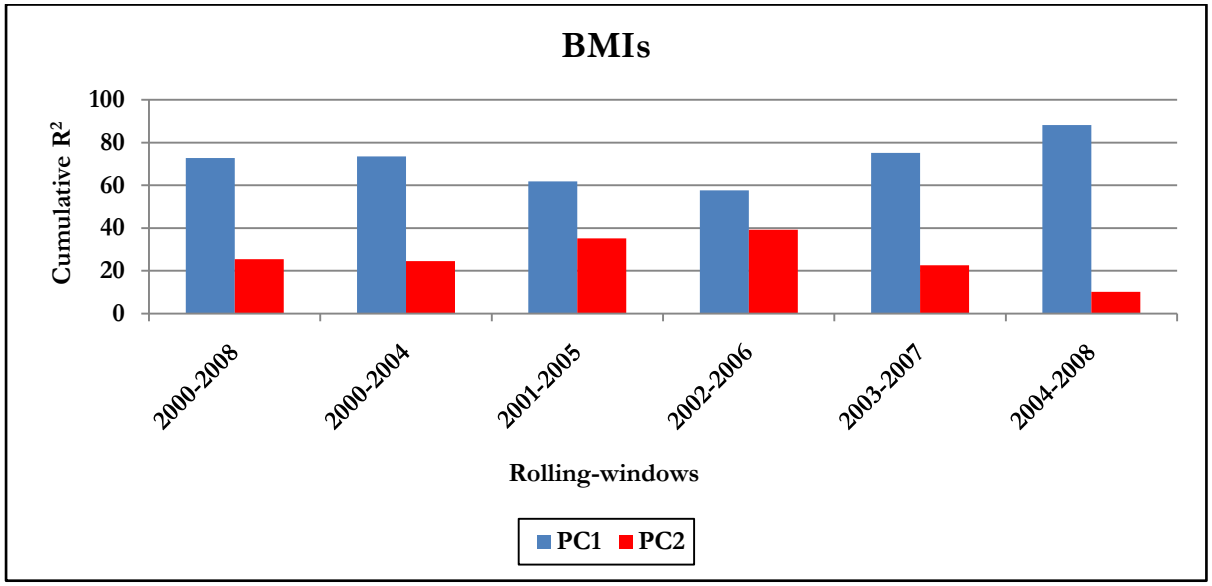
Table 4.4 and Figure 4.12 report the proportion of variability explained by the eigenvalue of each statistically significant PC during the entire sample period and during each rolling window. For all periods, except for the final rolling window, there emerged two statistically significant PCs. Therefore, it appears that for the most part international BMIs have to an extent been segmented. Given the objective of this study it is important to identify in which PC SA belongs, and also to identify which countries have 'caused' the divergence in international BMIs. In order to address these matters the country factor loadings will need to be analysed.

Table 4.4: Proportion of Variability Explained by each Statistically Significant PC

Period	PC1	PC2
2000-2008	72.7	25.4
2000-2004	73.5	24.6
2001-2005	61.8	35.2
2002-2006	57.7	39.2
2003-2007	75.1	22.6
2004-2008	88.1	10.2

Note: PC1 and PC2 represent principal component one and two, respectively. Although the second principal component for the 2004-2008 rolling window was not statistically significant it was still included due to its ability to capture the variability in the BMIs of JP and SA.

Figure 4.12: Proportion (%) of Variability Explained by each Statistically Significant PC



Note: PC1 and PC2 represent principal component one and two, respectively. Although the second principal component for the 2004-2008 rolling window was not statistically significant it was still included due to its ability to capture the variability in the BMIs of JP and SA.

Figure 4.13 and Figure 4.14 report the country factor loadings for PC1 and PC2, respectively. Given that numerous studies have found that SA, which is an emerging market, is not well integrated with the developed markets[34] (c.f. Chang *et al.,* 2006; Alhassan, 2006; Chinzara, 2007) it would not be surprising to also find that SA BMIs do not tend to move in tandem with the other markets. Furthermore, given the results arrived at when BMYs were considered, one would expect to observe a similar trend when analysing BMIs. From Figure 4.13 and Figure 4.14, SA is again for most periods found to be better explained by the PC2 relative to PC1. Thus, for most rolling windows, on average, SA BMIs are not well integrated with most of the international BMIs. However, what is also evident, and also rather surprising considering that JP and US are both developed markets, is that JP BMIs, and to a lesser extent US BMIs, also do not move in unison with the rest of the international BMIs.

According to the country factor loadings of PC1 all bond markets appear to be moving in the same direction as their factor loadings are all positive. However, the magnitude of the factor loadings for JP and SA, and in some instances US, remain lower, which suggests that these bond markets contribute less to the integration process.

[34] The focus of these studies was however on the stock market.

Figure 4.13: Country Factor Loadings for PC1

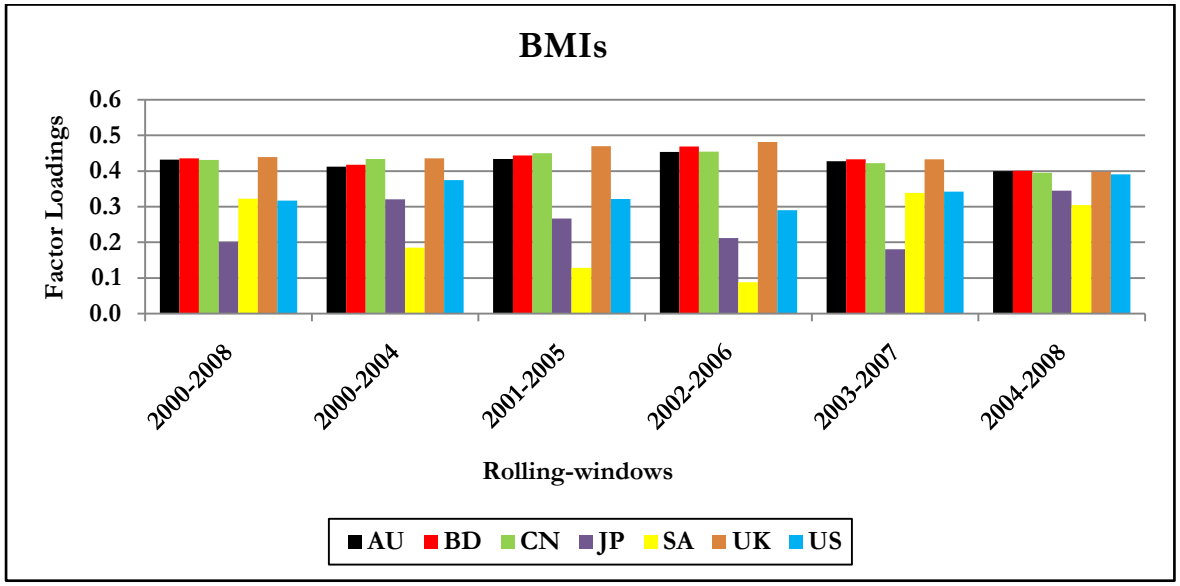
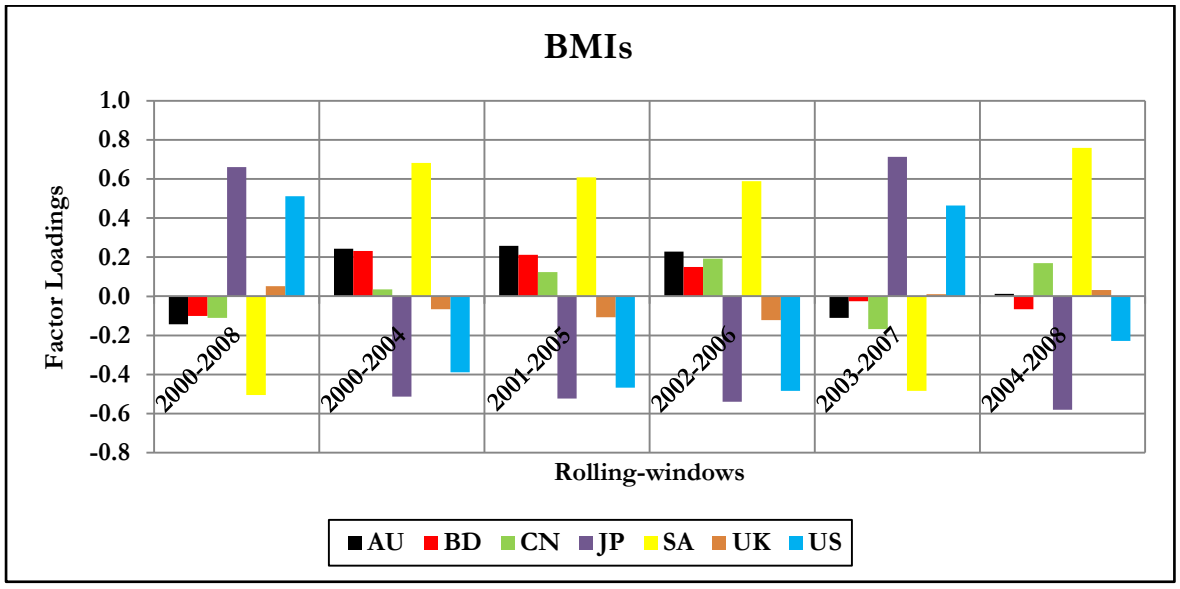


Figure 4.14: Country Factor Loadings for PC2



Although country factor loadings have become less varied by the final rolling window (Figure 4.13), JP and SA still remain better explained by PC2 as they both have higher factor loadings in this PC (see Figure 4.14). Therefore, although international bond market linkages, according to the BMIs, appears to have increased, JP and SA remain not well integrated with the other international bond markets.

Lastly, identifying which markets tend to move together has important implications for bond portfolio diversification. Thus, the next section identifies which markets form 'convergence groups' and which markets are independent. As the primary focus for the following section is on

portfolio diversification and since investors generally only look at total return indices when evaluating the performance of their investments, a convergence group analysis using BMYs will not be included in this section[35]. Thus, only the BMIs will be used in order to identify which markets will provide an SA investor with effective bond portfolio diversification benefits.

4.4.3) Convergence Groups

A convergence group (CG) can be classified as a group of countries that have similar movement patterns (Meric *et al.*, 2008:159). For example, countries with a high factor loading with the same sign in the same PC would have similar movement patterns, and thus form a single CG (Aziakpono *et al.*, 2007:11). Due to their similarities in movement, such countries would not provide good prospects for successful international bond portfolio diversification. In order for a portfolio manager to effectively diversify their bond portfolio across international markets they would need to invest across CGs and independent markets.

In order to ascertain which countries fell into the same CG an iterative selection approach was followed. As explained in Chapter Three, the Kaiser Rule in addition to the explanatory power of the cumulative R^2 were used to identify CGs. For a group of countries to be truly integrated, only one significant PC, which is capable of explaining most of the variation in BMYs, should emerge. In addition, those countries would need to have factor loadings of similar magnitude with the same sign. In cases where more than one significant PC is found, further analyses are carried out until there emerges a single dominant PC which is capable of explaining most of the variation in BMIs (Aziakpono *et al.,* 2007:19). The results of the iterative selection approach are reported in Table 4.5 with more detailed results available in Table-A 4.10 in the Appendix. Table 4.5 identifies which CG each country falls into and also reports the proportion of variation (cumulative R^2) explained by the dominant PC for each CG.

As shown in Table 4.5, over the full sample period SA was found to fall into the same CG as AU, BD, CN, and UK, while JP and US fell into the second CG. However, the rolling window results revealed that for most of the periods BMIs in SA were largely segmented from most of the other developed countries included in the study. Thus, international bond market diversification would be somewhat beneficial for an SA investor.

[35] However, for interest, the BMY convergence group analysis is available in Table-A 4.9 in the Appendix.

Although during the 2002-2006 rolling window JP, US, and SA fell into the same convergence group (i.e. one statistically significant PC was found which was capable of explaining most of the variation in their BMIs), SA had an opposite sign factor loading to that of JP and US. Thus, although the countries were being driven by the same underlying force, that force had an opposite effect on SA, which meant that bond market returns in SA during this period were diverging from those in JP and US. Hence, SA BMIs were not integrated with JP and US BMIs. For all the other CGs, the countries that formed those CGs all had factor loadings of similar magnitude with the same sign, and as a result this indicated that these markets were well integrated.

During the final rolling window all countries fell into the same CG. As mentioned earlier, JP and SA remained better explained by PC2 as they both had higher factor loadings in PC2. Although PC2 was not found to be statistically significant according to the Kaiser rule, the collective exclusion of these two countries resulted in a marked improvement in the cumulative R^2 value of PC1 from 88.1% to 97.4%. Hence, their exclusion from CG1 was warranted as they appeared to be outliers in this group and were not well integrated with the other bond markets. Thus, they would still provide some opportunity for effective bond portfolio diversification. Further analysis revealed that JP and SA were also not moving in tandem, and as a result they were treated as independent markets, while AU, BD, CN, UK, and US formed CG1[36].

Table 4.5: Convergence Group Analysis

	Convergence Groups			Cumulative R^2 Values (%)		
	CG1	**CG2**	**CG3**	**CG1**	**CG2**	**CG3**
Period						
2000-2008	OTHERS	JP & US		91.4	95.4	
2000-2004	OTHERS	SA		83.4	+	
2001-2005	OTHERS	JP, SA & US		91.2	80.9	
2002-2006	OTHERS	JP, SA & US		90.7	87.4	
2003-2007	OTHERS	JP & US		92.7	91.1	
2004-2008	OTHERS	JP	SA	97.4	+	+

Note: CG1, and CG2 represent convergence groups (CG) one and two, respectively. + indicates an independent market. AU, BD, CN, JP, UK, and US represent the bond markets of Australia, Germany, Canada, Japan, the United Kingdom, and the United States, respectively. OTHERS refers to the countries not explicitly stated (i.e. for the 2000-2008 rolling window, OTHERS would be AU, BD, CN, SA, and UK).

[36] Detailed results of each stage of the CG analyses are available in Table-A 4.10 in the Appendix.

Overall, JP and US appear to provide an SA investor with the greatest possibilities to effectively diversify their bond portfolio because for most of the rolling windows, bond market returns across these countries were not well correlated. It was only during the 2001-2005 rolling window where BMIs in JP, SA, and US appeared to move in unison, as not only did they fall into the same convergence group, but their factor loadings were also of similar magnitude and exhibited the same sign.

In the next section, the cointegration analysis results are presented and discussed. This will make it possible to specifically test the strength of the bond market linkages between SA and each of the other bond markets. For instance, the following section will address issues such as: specifically which markets SA is most and least integrated with, and whether these linkages have been increasing over time.

4.5 COINTEGRATION ANALYSIS RESULTS

The unit root test results for BMYs and BMIs are reported in Table-A 4.11 and in Table-A 4.12 respectively in the Appendix. The cointegration results and the VECM results for BMYs are reported in Table 4.6 and Table 4.7, respectively, while Figure 4.15 provides a graphical plot of the β coefficients for each country. The cointegration results and the VECM results for BMIs are reported in Table 4.8 and Table 4.9, respectively, while Figure 4.16 provides a graphical plot of the β coefficients for each country.

4.5.1) Unit Root Results

The first step in cointegration analysis involves testing for a unit root in the time series data being used. As mentioned in Chapter Three, DF-GLS and Ng and Perron (NP) (2001) tests were used to determine the order of integration for each series. For both tests the null hypothesis was that the series contained a unit root. The data generating process (DGP) of each series was determined by carrying out each test at level and at first difference. In both cases, the assumption of intercept with no trend and intercept with a trend were tested (Aziakpono, 2008:184). The DF-GLS and NP unit root tests were largely in agreement. In most cases the series for BMYs were first difference stationary[37]. With regard to the BMIs, the series were also found to be first difference stationary. However, for both BMYs and BMIs there were a few instances were a

[37] For example, an exception was UK during the 1994-1998 rolling-window where neither the DF-GLS nor the NP test statistics found a unit root at first difference. However, the analysis was still carried out since one of the two variables was stationary (i.e. SA).

series was found to be stationary at level. For instance, when the whole sample period for BMYs (January 1990 to July 2008) was tested for a unit root under the intercept and trend assumption, CN and US were found to be level stationary at the 5% level. While for BMIs, according to the DF-GLS statistic, SA was found to be level stationary at the 10% level of significance under the intercept without trend assumption when the entire sample period (August 2000 to July 2008) was tested, and also during the 2000-2004 and 2001-2005 rolling windows. Based on the results of the unit root test, the next step was to determine whether SA BMYs and BMIs were cointegrated with the other international bond markets.

4.5.2) Cointegration Test Results

Before reporting the cointegration results, it is first necessary to explain how the actual cointegration procedure was carried out. First, since monthly data was utilised for both BMYs and BMIs, following Brooks (2002:380) the initial number of lags specified was twelve. In selecting the optimal number of lags, all five information criteria supported by *Eviews 6* were utilised in order to indentify the range within which to test for cointegration[38]. The cointegration tests began with the minimum lag selected by any of the five information criteria. In cases where the results produced were not economically meaningful with white noise residuals, the lag was increased sequentially until a maximum of four lags. Following the practice in the literature (c.f. Kleimeier and Sander, 2006:1847; Sander and Kleimeier, 2006:218; Aziakpono *et al.,* 2007:13; Aziakpono, 2008b:182), if cointegration was not detected after testing the fourth lag, the test was ended and it was concluded that the series were not cointegrated. The BMY and BMI cointegration results will now be discussed.

4.5.3) BMYs

When the entire sample period for BMYs was analysed the results showed no evidence of cointegration between SA BMYs and those of the other countries. Similar to the PCA section, a five-year rolling window approach was implemented. During these sub-periods some evidence of cointegration across international BMYs was found in several instances. Where cointegration was found, the next step involved determining whether the results confirmed the *a priori* expectation that SA was endogenous[39]. Subsequently, weak exogeneity tests were carried out, and the results are reported in the final two columns in Table 4.6. The weak exogeneity test made it possible to

[38] The information criteria are: the Sequential Modified Likelihood Ratio, the Final Prediction Error, the Akaike Information Criterion, the Schwarz Information Criterion, and the Hannan-Quinn Information Criterion.

[39] Following Chinzara and Aziakpono (2008:16), given the size of the SA economy relative to the other countries' economies one would expect the direction of influence to run from the larger economies to the smaller economy (i.e. SA).

determine the causal relationship between the variables in the model (Aziakpono, 2008b:188). In most cases, SA was found to be endogenous. During the 1993-1997 rolling window, AU and SA were both endogenous and during the 1997-2001 rolling window JP and SA were also both endogenous. In cases where both countries are found to be endogenous it means that two-way causality exits between them (Chinzara and Aziakpono, 2008:16).

Table 4.6 reports the results of only those rolling windows in which cointegration was found. Furthermore, the results reported are only for those models that produced good diagnostic results according to the serial correlation test. SA BMYs were not found to be cointegrated at the same time with the BMYs of all the other international bond markets; however, it was found to be most cointegrated with the greatest number of international BMYs during the 2002-2006 rolling window. Furthermore, SA BMYs were not found to be cointegrated with the BMYs of any individual bond market for all fifteen rolling window samples analysed. In fact, SA BMYs were found to be most cointegrated with AU BMYs as there was cointegration between the two countries six times out of the fifteen rolling windows. SA BMYs were found to be cointegrated with JP BMYs five times out of the fifteen rolling windows, while SA BMYs were found to be cointegrated with US BMYs four times out of the fifteen rolling windows. On the lower end of the scale, SA BMYs were found to be cointegrated with BD and CN BMYs only three times each out of the fifteen rolling windows. SA BMYs were found to be least cointegrated with UK BMYs, as cointegration between them was only found two times out of the fifteen rolling windows.

In the final step, the model was normalised on the endogenous variable, which in most cases was SA. In cases were SA was found to be exogenous and one of the other countries was found to be endogenous, the normalisation restriction was not placed on the latter country. The VECM results are reported in Table 4.7. Since all variables are in logarithms, the parameters thus represent elasticities.

Table 4.6: BMY Cointegration Results for Bi-variate Models

	k	A	Trace		Max		Exogeneity	
			r = 0	r ≤ 0	r = 0	r = 1	SA	Other
1990-1994								
AU	2	3	16.14[0.04]	4.55[0.03]	11.59[0.13]	4.55[0.03]	3.93[0.05]	3.36[0.07]
BD	4	2	20.73[0.04]	3.47[0.50]	17.25[0.03]	3.47[0.50]	6.46[0.01]	0.02[0.90]
US	2	3	16.89[0.03]	3.17[0.08]	13.72[0.06]	3.17[0.08]	5.90[0.02]	1.08[0.30]
1991-1995								
AU	2	2	29.92[0.00]	7.63[0.10]	22.29[0.00]	7.63[0.10]	11.8[0.00]	0.42[0.52]
CN	2	2	27.77[0.00]	8.54[0.07]	19.23[0.01]	8.54[0.07]	10.6[0.00]	0.00[0.98]
1992-1996								
AU	2	3	18.54[0.02]	3.29[0.07]	15.25[0.03]	3.29[0.07]	10.3[0.00]	5.22[0.02]
JP	2	2	26.49[0.04]	9.21[0.17]	17.28[0.10]	9.21[0.17]	5.04[0.02]	0.61[0.43]
UK	2	4	27.26[0.03]	7.90[0.26]	19.36[0.05]	7.80[0.26]	7.93[0.00]	0.05[0.82]
1993-1997								
AU	2	3	16.63[0.03]	2.17[0.14]	14.45[0.05]	2.17[0.14]	13.0[0.00]	4.36[0.04]
JP	2	4	27.78[0.03]	7.71[0.28]	20.07[0.04]	7.71[0.28]	3.19[0.07]	2.33[0.13]
US	2	4	26.95[0.04]	10.22[0.12]	16.73[0.12]	10.22[0.12]	7.11[0.01]	0.01[0.94]
1994-1998								
JP	2	4	27.53[0.03]	7.58[0.29]	19.94[0.04]	7.58[0.29]	0.04[0.83]	9.60[0.00]
UK	2	2	20.72[0.04]	6.97[0.13]	13.75[0.11]	6.97[0.13]	2.41[0.12]	8.63[0.00]
1995-1999								
JP	2	3	16.75[0.03]	3.81[0.05]	12.95[0.08]	3.81[0.05]	3.77[0.05]	1.22[0.27]
1997-2001								
JP	4	3	16.41[0.04]	1.20[0.27]	15.21[0.04]	1.20[0.27]	3.77[0.05]	8.25[0.00]
1999-2003								
AU	3	4	15.86[0.04]	0.31[0.58]	15.56[0.03]	0.31[0.58]	0.22[0.64]	10.78[0.00]
2002-2006								
AU	4	4	32.36[0.01]	12.21[0.06]	20.15[0.04]	12.21[0.06]	7.17[0.01]	0.37[0.54]
BD	2	2	21.80[0.03]	5.31[0.25]	16.49[0.04]	5.31[0.25]	3.68[0.06]	0.00[0.95]
CN	2	2	23.85[0.02]	8.48[0.07]	15.37[0.06]	8.48[0.07]	3.44[0.06]	1.93[0.16]
US	2	3	17.31[0.03]	2.64[0.10]	14.67[0.04]	2.64[0.10]	0.19[0.67]	7.53[0.01]
2003-2007								
BD	4	4	26.84[0.04]	2.19[0.96]	24.65[0.01]	2.19[0.96]	13.4[0.00]	0.65[0.42]
CN	3	2	20.84[0.04]	4.47[0.35]	16.37[0.04]	4.47[0.35]	2.84[0.09]	1.04[0.31]
US	4	3	16.39[0.04]	3.69[0.05]	12.70[0.09]	3.69[0.05]	0.94[0.33]	6.81[0.01]

Note: Parentheses [ ] are used to denote probability value. AU, BD, CN, JP, UK and US represent the bond markets of Australia, Germany, Canada, Japan, the United Kingdom, and the United States, respectively. The VAR order, k, is selected by an appropriate information criterion following the procedure discussed above.
A is the deterministic trend assumption: (2) The level data *X* has no deterministic trend and the cointegration equations have intercepts; (3) The level data X has linear trends, but the cointegrating equations have only intercepts; (4) Both the level data and the cointegration equations have linear trends (Aziakpono, 2008b:145).
Source: Computed by author.

An Error Correction Model (ECM) describes how variables which are cointegrated respond to deviations from the long-run equilibrium relationship (Hu and Lin, 2008:2346). The higher the value of the ECM the faster the speed of adjustment to the long-run equation. In all cases the coefficients of adjustment had negative signs, and on average they were either significant at the 1% or 5% level of significance[40]. β* provides the long-run parameter results and makes it possible to determine whether SA BMYs are negatively or positively related to those in other bond markets. Furthermore, the lower the β coefficient, the lower the level of BMY integration between the markets being analysed (Aziakpono, 2008a:197). The t-value** parameter shows whether β coefficients are statistically different from one (Aziakpono, 2008a:203). By testing the null hypothesis of $\beta = 1$, this makes it possible to determine whether SA BMYs are predominantly influenced by domestic factors. According to the t-statistics, all of the β coefficients, with the exception of JP in the 1995-1999 rolling window, were significantly different from zero. However, far fewer β coefficients were found to be significantly different from one. This suggests that SA BMYs are to a large extent influenced by domestic factors (Aziakpono, 2008a:198). The values of the statistically significant β coefficients ranged from 24% to 151% with a total average of 74.3%.

In all rolling windows, the long-run parameters were positive and in most cases they were statistically significant at the 1% level of significance. This suggests a positive long-run relationship between SA BMYs and the BMYs of the other bond markets which SA was cointegrated with.

A plot of the β coefficients from Table 4.7 is provided in Figure 4.15. The values of the β coefficient between SA and AU ranged from 24% to 103%; with BD they ranged from 51% to 104%; with CN they ranged from 94% and 151%; and with JP they ranged from 9% to 101%. For UK it was only possible to normalise on SA during the 1992-1996 rolling window, and the value of the β coefficient on this occasion was 79%. For US it was possible to normalise on SA during the 1990-1994 and 1993-1997 rolling windows, and the values of the β coefficient were 52% and 100%, respectively.

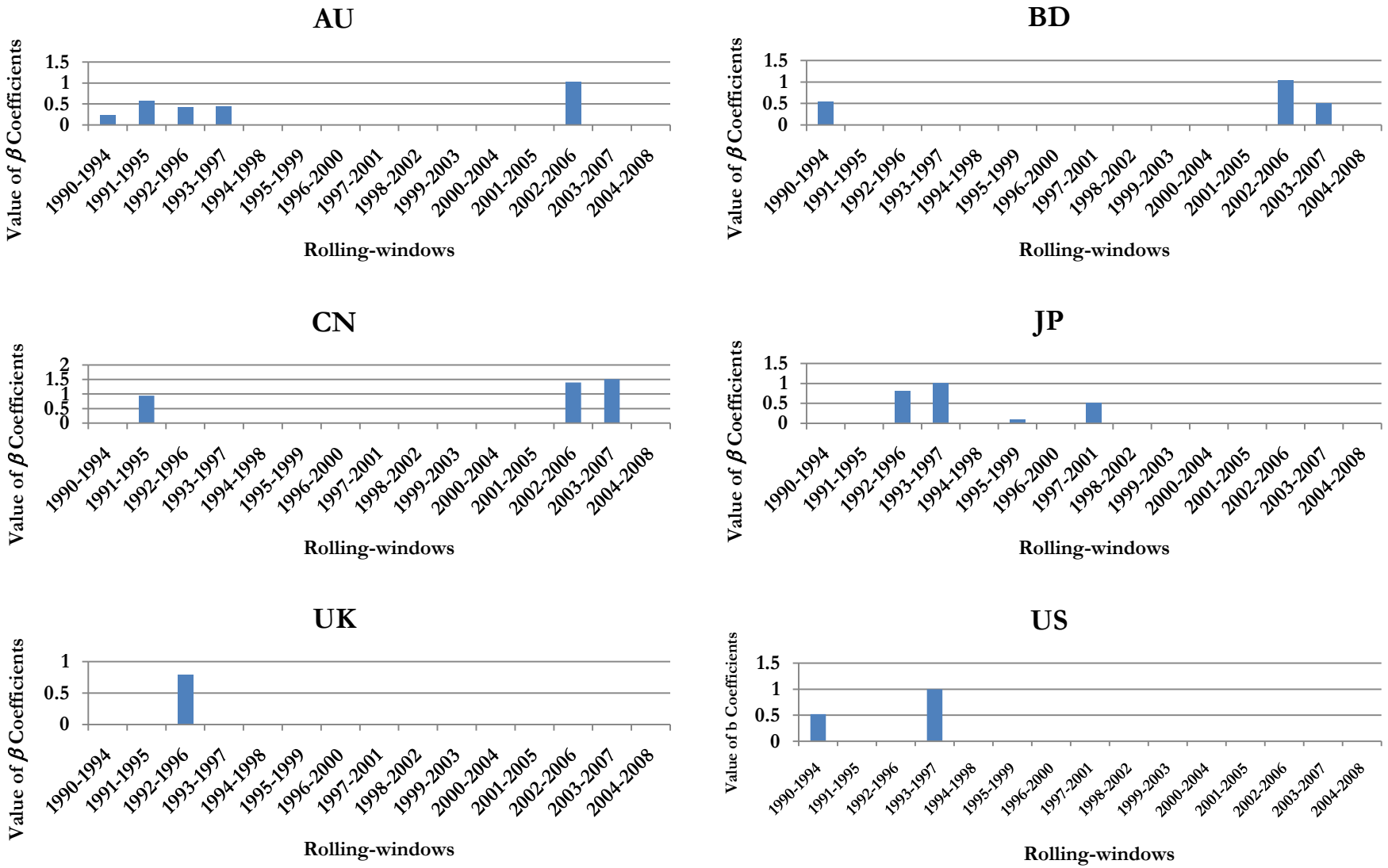
[40] Exceptions occurred during the 1997-2001 (JP), 2002-2006 (CN), 2003-2007 (CN) rolling-windows.

Table 4.7: BMY VECM Results

	Intercept	β*	t-value**	ECM	R^2	S.Cor
1990-1994						
AU	2.18	0.24(2.95)[b]	9.35[a]	-0.13(-2.62)[c]	0.36	0.87[0.93]
BD	1.62	0.54(6.30)[a]	5.32[a]	-0.25(-3.01)[b]	0.40	4.08[0.40]
US	1.71	0.52(4.22)[a]	3.92[a]	-0.16(-3.22)[b]	0.39	3.47[0.48]
1991-1995						
AU	1.47	0.57(7.74)[a]	5.8[a]	-0.24(-4.72)[a]	0.49	2.50[0.65]
CN	0.74	0.94(7.04)[a]	0.45	-0.18(-4.40)[a]	0.46	1.13[0.89]
1992-1996						
AU	1.78	0.43(4.39)[a]	5.75[a]	-0.25(-3.77)[a]	0.35	3.53[0.47]
JP	1.26	0.80(3.98)[a]	0.99	-0.15(-3.37)[a]	0.35	4.62[0.33]
UK	0.97	0.79(5.90)[a]	1.57	-0.25(-3.60)[a]	0.35	6.30[0.18]
1993-1997						
AU	1.77	0.45(4.69)[a]	5.72[a]	-0.23(-4.07)[a]	0.36	2.62[0.62]
JP	1.06	1.01(4.70)[a]	0.05	-0.10(-2.48)[c]	0.25	6.52[0.16]
US	0.83	1.00(5.05)[a]	0.02	-0.18(-3.66)[a]	0.33	4.82[0.31]
1995-1999						
JP	2.65	0.09(1.40)	13.49[a]	-0.18(-2.87)[b]	0.23	3.81[0.43]
1997-2001						
JP	2.37	0.51(3.02)[b]	2.89[b]	-0.09(-1.97)	0.23	6.80[0.15]
2002-2006						
AU	-0.66	1.03(4.53)[a]	0.13	-0.33(-3.62)[a]	0.38	3.07[0.55]
BD	0.76	1.04(5.20)[a]	0.2	-0.14(-2.84)[b]	0.24	5.82[0.21]
CN	0.09	1.40(8.45)[a]	2.41[c]	-0.14(-2.21)	0.18	4.70[0.32]
2003-2007						
BD	1.58	0.51(5.20)[a]	4.97[a]	-0.39(-4.11)[a]	0.43	5.09[0.28]
CN	-0.07	1.51(5.58)[a]	1.89	-0.14(-2.31)	0.27	4.52[0.34]

Note: Only the results where SA was normalised on are reported. Parentheses [ ] are used to denote probability value. a, b, c indicate whether the variable is significant at the 1%, 5%, or 10% level of significance, respectively. AU, BD, CN, JP, UK and US are explained in Table 4.5. The t-values are represented by ( ). The null hypothesis of $\beta = 0$ and $\beta = 1$ are represented by β * and t-value**, respectively.
Source: Computed by Author.

Figure 4.15: A Plot of the BMY β Coefficients from Table 4.7



Note: the β coefficients are reported only for those periods where cointegration was found and it was possible to normalise the equation on SA (i.e. SA was endogenous).

As shown in Figure 4.15, the fact that there was no evidence of consistent cointegration throughout all rolling windows and because the level of cointegration between SA and most of the other countries remained extremely varied, indicates that BMY integration between SA and the other markets is more of a sporadic phenomenon as opposed to a gradual progression resulting from increasing economic ties. Thus, at this stage there is no strong evidence to indicate that SA BMYs are becoming more integrated with the BMYs of the other markets.

It is thus fair to say that SA BMYs are to a large extent not integrated with the BMYs of the other international bond markets. In the context of these results, this implies that despite SA's return into the international arena, BMYs remain strongly driven by domestic factors. This is not to say that SA BMYs are not influenced by international developments, but rather that domestic factors tend to dominate the international influence. This finding is in agreement with other studies based on stock markets which, as mentioned earlier, find there to be little long-run comovement between developed and emerging markets (c.f. Chang *et al.,* 2006; Alhassan, 2006; Chinzara, 2007).

4.5.4) BMIs

When the entire sample period for BMIs was analysed SA BMIs were found to be cointegrated with all international BMIs except for AU BMIs. During the five-year rolling windows, evidence of intermittent cointegration was found between SA BMIs and international BMIs. Similarly to the BMYs section, where cointegration was found weak, exogeneity tests were carried out. The results are reported in the final two columns in Table 4.8. Similar to the BMY results, SA was again found to be endogenous in most cases.

Table 4.8 also shows that only during the 2002-2006 rolling window were SA BMIs found to be simultaneously cointegrated with all the other markets, while no evidence of BMI cointegration was found between SA and the other countries during the 2003-2007 rolling window. SA BMIs were found to be most cointegrated with those of BD and US as cointegration was found three times out of the five rolling windows. For AU, JP, and UK cointegration in BMIs between them and SA was found twice out of the five rolling windows, while BMI cointegration between SA and CN was only found once out of the five rolling windows.

Table 4.8: BMI Cointegration Results for Bi-variate Models

	k	A	Trace		Max		Exogeniety	
			r = 0	r ≤ 0	r = 0	r ≤ 0	SA	Other
2000-2008								
BD	4	2	24.44[0.01]	4.77[0.31]	19.67[0.01]	4.77[0.31]	16.38[0.00]	0.84[0.36]
JP	2	2	21.37[0.04]	2.95[0.59]	18.42[0.02]	2.95[0.59]	11.01[0.00]	0.47[0.49]
US	2	2	24.44[0.01]	3.29[0.53]	21.15[0.01]	3.29[0.53]	10.39[0.00]	1.55[0.21]
2000-2004								
US	2	2	21.32[0.04]	4.51[0.34]	16.80[0.04]	4.51[0.34]	7.75[0.01]	1.57[0.21]
2002-2006								
AU	2	2	22.93[0.02]	5.74[0.21]	17.18[0.03]	5.74[0.21]	7.38[0.01]	0.00[0.99]
BD	2	2	21.81[0.03]	3.55[0.48]	18.26[0.02]	3.55[0.48]	9.34[0.00]	0.01[0.94]
CN	2	2	24.62[0.01]	6.71[0.14]	17.90[0.02]	6.71[0.14]	8.30[0.00]	0.18[0.67]
JP	2	2	19.56[0.06]	3.10[0.56]	16.46[0.04]	3.10[0.56]	10.6[0.00]	0.96[0.33]
UK	2	2	22.33[0.03]	3.61[0.47]	18.72[0.02]	3.61[0.47]	9.94[0.00]	0.00[0.99]
US	2	2	20.89[0.04]	3.34[0.52]	17.55[0.03]	3.34[0.52]	10.2[0.00]	0.78[0.38]
2004-2008								
BD	4	2	21.45[0.03]	4.96[0.29]	16.49[0.04]	4.96[0.29]	6.31[0.01]	0.01[0.94]
JP	4	2	21.34[0.04]	5.59[0.22]	15.74[0.05]	5.59[0.22]	5.63[0.02]	0.81[0.37]

Note: Parenthesis [ ] are used to denote probability value. AU, BD, CN, JP, UK, and US represent the bond markets of Australia, Germany, Canada, Japan, the United Kingdom, and the United States, respectively. The VAR order, k, is selected by an appropriate information criterion following the procedure discussed above.
A is the deterministic trend assumption: (2) The level data X has no deterministic trend and the cointegration linear equations have intercepts; (3) The level data X has linear trends, but the cointegrating equations have only intercepts; Both the level data and the cointegration equations have linear trends (Aziakpono, 2008b:145).
Source: Computed by author.

Where SA was endogenous, the model was again normalised on SA. If cases arose where SA was found to be exogenous and one of the other countries was found to be endogenous, the normalisation restriction would not be placed on the latter country as the purpose of this study was to determine potential portfolio diversification possibilities from a South African investor's perspective. The VECM results are reported in Table 4.9.

In all cases the coefficients of adjustment had negative signs, and were significant at the 1% level of significance. According to β^*, which provides the long-run parameter results, over the entire sample period (August 2000 to July 2008) SA BMIs were found to be negatively correlated with the BMIs of BD, JP, and US. During the 2000-2004 rolling window SA BMIs were found to be negatively correlated with US BMIs. However, during the 2002-2006 and 2004-2008 rolling windows, SA BMIs became positively correlated with those international BMIs which SA was cointegrated with. According to the t-statistics, all the β coefficients were not statistically different from zero. Furthermore, none of the β coefficients were found to be significantly

different from one. This suggests that SA BMIs are to a large extent influenced by domestic factors (Aziakpono, 2008a:198).

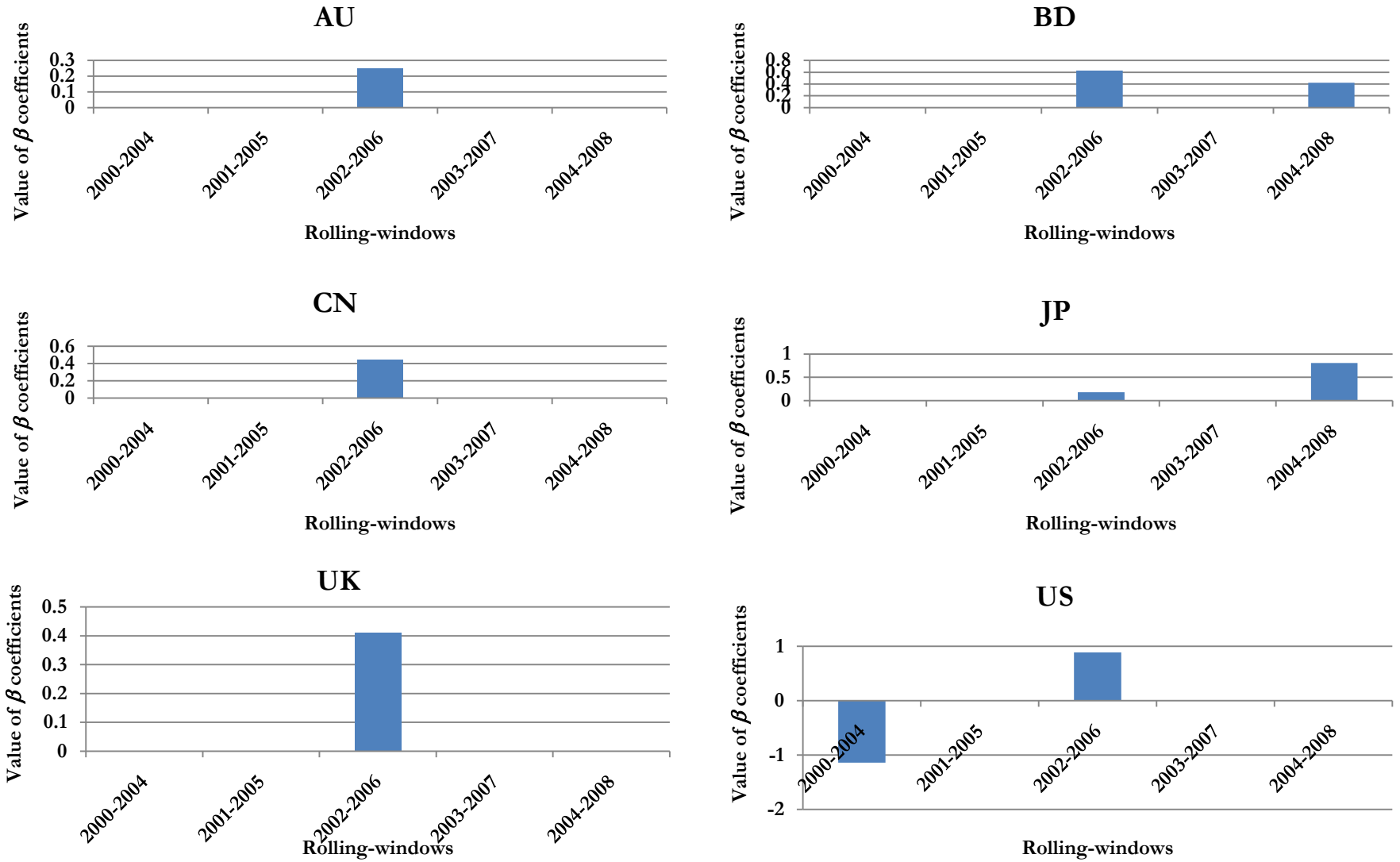
Table 4.9: BMI VECM Results

	Intercept	β*	t-value**	ECM	R (squared)	S.Cor
2000-2008						
BD	12.3	-0.78(-0.97)	0.27	-0.01(-4.49)[a]	0.18	3.37[0.50]
JP	10.1	-1.64(-1.95)	0.76	-0.02(-3.70)[a]	0.06	1.28[0.86]
US	19.9	-1.81(-2.10)	0.94	-0.02(-3.57)[a]	0.05	2.31[0.68]
2000-2004						
US	14.2	-1.14(2.25)	0.28	-0.03(-3.28)[a]	0.03	4.44[0.35]
2002-2006						
AU	3.87	0.25(0.17)	0.51	-0.02(-3.86)[a]	0.05	4.42[0.35]
BD	0.89	0.63(0.41)	0.24	-0.02(-3.88)[a]	0.06	3.71[0.45]
CN	2.27	0.44(0.51)	0.64	-0.02(-3.88)[a]	0.06	2.80[0.59]
JP	5.34	0.18(0.17)	0.78	-0.02(-3.90)[a]	0.05	1.07[0.90]
UK	2.50	0.41(0.25)	0.37	-0.02(-3.90)[a]	0.05	3.45[0.49]
US	-0.93	0.89(0.71)	0.09	-0.01(-3.96)[a]	0.06	3.06[0.55]
2004-2008						
BD	2.30	0.42(1.36)	1.89	-0.07(3.52)[a]	0.24	3.74[0.44]
JP	3.43	0.81(1.42)	0.33	-0.07(3.41)[a]	0.27	3.81[0.43]

Note: Only the results where SA was normalised on are reported. Parentheses [ ] are used to denote probability value. a, b, and c indicate whether the variable is significant at the 1%, 5%, or 10% level of significance, respectively. AU, BD, CN, JP, UK, and US are explained in Table 4.8. The t-values are represented by ( ). The null hypothesis of $\beta = 0$ and $\beta = 1$ are represented by β* and t-value**, respectively.
Source: Computed by author.

Similar to the BMY results and as shown by a plot of the β coefficients from Table 4.9 (see Figure 4.16), BMI cointegration between SA and the other countries remained intermittent with no discernable trend. Thus, SA BMIs are to a large extent not cointegrated with the BMIs of the other international bond markets. As mentioned in Chapter Two, the finding of cointegration – or the lack thereof – has important implications for investors. Of consequence, this implies that it remains possible for a South African investor to successfully engage in pair-wise bond portfolio diversification between SA and the other international bond markets.

Figure 4.16: A Plot of the BMI β Coefficients from Table 4.9



Note: the β coefficients are reported only for those periods where cointegration was found and it was possible to normalise the equation on SA (i.e. SA was endogenous).

4.6 CONCLUSION

In this chapter the estimation results regarding the linkages between SA and the selected bond markets were presented and discussed from the perspective of a South African investor. The current study differed from the existing literature in that it concurrently used bond yields and bond indices to examine international bond market linkages. The use of bond yield data provided greater insights into the nature of interest rate linkages across the international bond markets as a longer time period analysis was possible. The use of bond indices made it possible to determine which countries would provide an SA investor with effective bond market portfolio diversification opportunities, and a comparison of the BMY results to the BMI results made it possible to capture the effect exchange rate differential had on international bond market linkages. Subsequently, the results from the preliminary analysis were presented and discussed. There appeared to be a general downward trend in BMYs for all markets, although SA appeared to have a somewhat distinct BMY trend. There was a general upward trend in BMIs, with SA again exhibiting a fairly distinct BMI trend relative to the other countries.

The PCA followed by the cointegration analysis were subsequently carried out. These results were consistent with those reached in the preliminary analysis and provided a more in-depth analysis of international bond market linkages. The PCA made it possible to determine whether international bond markets were largely driven by the same underlying force. This analysis provided a broad overview of how the bond markets were moving over time in relation to each other. The Johansen cointegration analysis had a much narrower scope and the added advantage of being able to determine in a more precise manner the extent to which SA was cointegrated with each of the selected international bond markets.

In summary, both the PCA and cointegration analysis results support the view that for the most part, SA BMYs and BMIs do not move in unison with the developed markets. In fact, the majority of the results indicate that bond market linkages between SA and the international markets remain weak and sporadic. There is thus currently not enough evidence to suggest that these linkages are strengthening. Hence, the robustness of these results suggests that, for a South African investor, international bond market diversification remains beneficial and that even after accounting for exchange rate differentials, the benefit of diversification remains.

CHAPTER FIVE

SUMMARY OF MAJOR FINDINGS, IMPLICATIONS FOR PORTFOLIO DIVERSIFICATION & AREAS FOR FURTHER RESEARCH

5.1 SUMMARY OF MAJOR FINDINGS

This study examined international bond market linkages using monthly bond yield data and Rand-adjusted total return indices on government bonds with ten years to maturity. The bond yield data covers a nineteen-year period from January 1990 to July 2008, while the bond total return index data covers a nine-year period from August 2000 to July 2008. The primary focus was to determine whether investing in international bond markets offered a South African investor effective diversification opportunities. In order to address this issue it needed to be established whether the SA bond market was integrated with international bond markets. The international bond markets included in the study were those of Australia (AU), Germany (BD), Canada (CN), Japan (JP), the United Kingdom (UK), and the United States (US).

In Chapter One the objectives of the research and the motivation behind the research were set out. A survey of the relevant theoretical and empirical literature was conducted in Chapter Two. This set the background against which the current study was carried out. The general belief is that globalisation has led to a greater interdependence across financial markets. There is thus a plethora of literature focused on determining whether this is in fact the case. Numerous empirical studies specifically relevant to this study have found that international financial market linkages have been increasing (c.f. Kirchgässner and Wolters, 1987; Lim *et al.,* 1998; Sutton, 2000; Smith, 2002; Ciner, 2007), while others have found evidence to the contrary (c.f. Mills and Mills, 1991; DeGennaro *et al.,* 1994; Clare *et al.,* 1995; Yang, 2005). This is an extremely important issue to address as the finding of integration – or the lack thereof – has important implications for portfolio diversification. Simply put, the more integrated financial markets are, the fewer opportunities available for successfully diversifying an investment portfolio.

In Chapter Three, the analytical framework for examining international bond market linkages was presented. The principal component analysis (PCA) and the Johansen cointegration analysis were adopted. In order to accommodate the possibility that bond market linkages may be time-varying, a five-year rolling window approach was also adopted. Thus, with regard to bond market yields (BMYs), fifteen rolling window samples were analysed from January 1990 to December 1994, January 1991 to December 1995, and so on until January 2004 to July 2008. For bond

market indices (BMIs), five rolling window samples were analysed from August 2000 to December 2004, January 2001 to December 2005, and so on until January 2004 to July 2008.

The empirical results were presented and discussed in Chapter Four. The preliminary analysis provided a broad overview of BMY and BMI trends and the descriptive statistics provided some insight into the characteristics of each bond market. Subsequently, the PCA results were presented and discussed. BMY and BMI integration between SA and the other markets appeared to be more of a sporadic phenomenon as opposed to a gradual progression resulting from increasing ties with other economies. Moreover, there was little evidence to indicate that SA was becoming more integrated with the other markets. Although, to a lesser extent, JP also exhibited similar attributes. The consistency and robustness of the results arrived at in the preliminary analysis, the PCA and the cointegration analysis show that it remains possible to successfully engage in pair-wise portfolio diversification between SA and the other international bond markets.

5.2 IMPLICATIONS FOR PORTFOLIO DIVERSIFICATION

The findings in this study have important implications specifically for South African portfolio managers investing in international bond markets. Firstly, the fact that integration between the SA bond market and the other bond markets remained fairly weak even after accounting for exchange rate differentials and on the whole did not appear to be increasing, indicates that long-term bond portfolio diversification remains worthwhile for SA portfolio managers. Specifically, the lack of integration implies that SA portfolio managers investing in international bond markets will be able to further decrease portfolio risk for a given rate of return. As a result, their portfolios will be diversified 'more' completely and allow them to attain an efficient international portfolio.

Lastly, the lack of bond market integration shows that bond market developments in the other countries will not automatically impact on the SA bond market. Thus, bond yield movements in international markets do not provide an investor with a reliable indicator for predicting future bond yield movements in the SA market.

5.3 AREAS FOR FURTHER RESEARCH

With regards to the econometric techniques, a multivariate cointegration analysis could be carried out as an extension to the current research. However, given the robustness of the results arrived at in this research (in the sense that SA was for the most part found to be independent of the other markets) the insights a multivariate analysis would provide will be limited. This is because, even though the non-existence of bivariate cointegration does not automatically invalidate the existence of multivariate cointegration, the finding of multivariate cointegration in cases where no bivariate cointegration was found between SA and the other bond markets, would thus imply that the multivariate analysis is simply picking up the cointegration between some of the other countries included in the set of countries being analysed (i.e. the developed markets). Thus, from a South African investor's perspective, investing in international bond markets will still provide effective portfolio diversification opportunities.

Future studies could also examine the linkages in international bond market volatility and returns. Due to time constraints this was beyond the scope of this thesis. Furthermore, subject to data availability, future studies could examine the linkages between the SA bond market and other emerging bond markets such as: Argentina, Brazil, China, India, and Russia. For instance, it could be that although SA is not well integrated with the developed markets, as found in this study, it may however have stronger linkages with other emerging markets.

APPENDIX

Table-A 2.1: Summary of Empirical Studies

Author(s) and Publication Year	Countries	Study period	Data frequency	(Econometric) Method	Main findings/General consensus
Early Empirical Studies					
Markowitz (1952)	n/a	n/a	n/a	Mean-variance efficient frontier framework.	A well diversified portfolio is not necessarily the one with the most number of securities but rather, one that consists of securities from dissimilar industries.
Tobin (1958)	n/a	n/a	n/a	Mean-variance efficient frontier framework.	Diversification between cash and consols will result in obtaining the highest possible indifference curve.
Grubel (1968)	Australia, Belgium, Canada, France, Italy, Japan, Netherlands, South Africa (SA), United Kingdom (UK), and West Germany.	January 1959 - December 1966	Monthly (Equities)	Markowitz (1952) mean-variance efficient frontier framework.	Diversification among the assets from the eleven countries would have, on average, resulted in investors obtaining a higher rate of return or a lower variance than could have been achieved by purchasing a portfolio consisting of only local common stocks.
Levy and Sarnat (1970)	Australia, Austria, Belgium, Canada, Ceylon, Chile, Denmark, Finland, France, Germany, India, Israel, Italy, Japan, Mexico, Netherlands, New Zealand, Norway, Peru, Philippines, Portugal, SA, Spain, Sweden, Switzerland, UK, United States (US), and Venezuela.	1951-1967	Annual (Equities)	Mean-variance efficient frontier framework.	Provided that the economies are not highly correlated potentially greater gains are available from international portfolio diversification in terms or increased return/decreased risk.

Lessard (1973)	Argentina, Brazil, Chile, and Colombia.	December 1958 - December 1968	Quarterly (Equities)	Multivariate factor analysis.	There were substantial diversification possibilities among the selected developing countries despite their close geographical proximity.
Ibbotson *et al.* (1982)	Australia, Austria, Belgium, Canada, Denmark, France, Germany, Hong Kong, Italy, Japan, Netherlands, Norway, Singapore, Spain, Sweden, Switzerland, UK, and US.	1960-1980	Annual (Equities and Bonds)	Mean-variance efficient frontier framework.	An internationally diversified bond portfolio offered superior investment returns and greater risk reduction relative to a domestically diversified bond portfolio.
Levy and Lerman (1988)	Belgium, Canada, Denmark, France, Germany, Holland, Italy, Japan, Spain, Sweden, Switzerland, UK, and US.	1960-1980	Annual (Equities and Bonds)	Mean-variance efficient frontier framework.	The international bond portfolio outperformed the international equity portfolio. Bond correlations were zero or negative, thus providing greater risk-reduction possibilities, whilst stock correlations were mainly positive.
Kirchgässner and Wolters (1987)	US, Switzerland, and West Germany.	January 1974 - December 1978 and January 1979 - December 1984	Monthly (Money market and Bonds)	Spectral analysis and granger causality tests.	During the first time-period international interest rate linkages were only weakly pronounced for the short-term Euro-market, and nonexistent for the long-term bond market. However, highly significant interest rate linkages in both markets were found in the second time period.
Solnik *et al.* (1996)	France, Germany, Japan, Switzerland, and UK.	1959-1995	Monthly (Equities and Bonds)	Mean-variance efficient frontier framework.	However, international risk diver-sification remained beneficial because international correlations were still at levels which were attractive from a risk diversification point of view.
Lim *et al.* (1998)	Morgan Stanley Capital International World Index (MSCI)	November 1988 - May 1991 and	Monthly (Equities and Bonds)	Cointegration and Granger causality.	International equity and bond market efficiency and integration has been

	was a proxy of international stock markets, and Salmon Brothers World Bond Index was a proxy for international bond markets.	June 1991-December 1993			increasing over time. The rise in market efficiency could be attributed to the increasing levels of activity in both markets.
Hunter and Simon (2005)	Germany, Japan, UK, and US.	January 1992 - September 2002	Weekly (Equities and Bonds)	Bivariate conditional correlation GARCH model.	Correlations remained significantly low. During volatile periods, bond return correlations decreased. Therefore, international bond diversification benefits were available when most needed. In contrast international equity markets became more correlated.
Cappiello *et al.* (2006)	Australia, Austria, Belgium, Canada, Denmark, France, Germany, Honk Kong, Ireland, Italy, Japan, Mexico, Netherlands, New Zealand, Norway, Singapore, Spain, Sweden, Switzerland, UK, and US (Equity markets). Austria, Belgium, Canada, Denmark, France, Germany, Ireland, Japan, Netherlands, Sweden, Switzerland, UK, and US (Bond markets).	8 January 1987 - 7 February 2002	Weekly (Equities and Bonds)	New generalised autoregressive conditionally heteroskedastic (GARCH) model.	Opposite to equity returns, bond market return volatilities had less apparent linkages during periods of financial turmoil. Correlation between equity and bond returns declined when stock markets were in financial turmoil, therefore indicating "flight to quality" phenomenon.
INTERNATIONAL BOND LINKAGES					
Cholerton *et al.* (1986)	Germany, Japan, Netherlands, Switzerland, UK, and US.	1971-1984	Monthly (Bonds)	Mean-variance efficient frontier framework.	International bond markets were not well correlated. Therefore, the potential for risk reduction by investing internationally would be substantial.
Burik and Ennis	Salomon Brothers non-U.S. World	1978-1987	Annualised	Mean-variance	For foreign bonds to offer more com-

(1990)	Government Bond Index represented foreign bonds.		quarterly returns (Bonds)	efficient frontier framework.	pelling diversification opportunities there either needs to be a substantial decrease in currency risk, or hedging needs to become less costly.
Mills and Mills (1991)	Japan, West Germany, UK, and US.	1 April 1986 - 29 December 1989	Daily (Bonds)	Multivariate analysis.	International bond markets were not cointegrated but were informationally efficient.
DeGennaro *et al.* (1994)	Canada, Germany, Japan, UK, and US.	January 1967 - December 1990	Monthly (Bonds)	Multivariate cointegration tests.	Little evidence of cointegration. Therefore, bond yields driven by a separate set of fundamentals.
Clare *et al.* (1995)	Germany, Japan, UK, and US.	January 1978 - April 1990	Monthly (Bonds)	Engle and Granger (1987) two step methodology.	The bond markets were not well integrated thus provided diversification benefits.
Sutton (2000)	Canada, Germany, Japan, UK, and US.	1961/7-1992	Quarterly (Bonds)	Monte Carlo simulations (Expectations theory of the term structure of interest rates).	Bond yields displayed excess volatility and excess comovement relative to the base model, thus implying that bond yields were positively correlated.
Smith (2002)	Canada, France, Germany, Japan, UK, and US.	February 1985 - March 1999	Monthly (Bonds)	Johansen (1988) and Johansen and Juselius (1990).	Bond markets were driven by the same common factors. Therefore, long-term international bond market diversification benefits may not be present.
Yang (2005)	Canada, Germany, Japan, UK, and US.	January 1986 - December 2000	Monthly (Bonds)	Vector autoregressive (VAR) framework and Johansen (1991).	No evidence of cointegration. The bond markets were partially rather than completely segmented in the short-run.
Skintzi and Refenes (2006)	Austria, Belgium, France, Germany, Ireland, Italy, Netherlands, and Spain (Euro area). Denmark, Norway, Sweden,	1 February 1991 - 31 December 2002	Weekly (Bonds)	Bivariate EGARCH model.	Globalisation of the bond markets had increased due to the establishment of the European Monetary Union.

	and UK (Non-Euro area).				
Polwitoon and Tawatnunchai (2006)	188 US-based global bond funds.	January 1993 - December 2004	Monthly (Bonds)	Conditional and unconditional Sharpe ratios.	A domestic investor that diversified their bond portfolio internationally would reduce their exposure to risk during periods of increased market volatility.
Ciner (2007)	Canada, Germany, Japan, UK, and US.	1 January 1988 - 12 September 1996 and 13 September 1996 - 31 May 2005	Daily (Bonds)	Johansen (1991) procedure and Dufour *et al.* (2006).	During the second subperiod of the sample, international bond indexes were found to be cointegrated. Furthermore, causality ran from the US to all other markets.
A SOUTH AFRICAN PERSPECTIVE					
Van den Honert and Affleck-Graves (1985)	The Johannesburg Stock Exchange (JSE), the London Stock Exchange (LSE), and the New York Stock Exchange (NYSE).	February 1965 - January 1980	Annual (Equities)	Multidimensional scaling.	International portfolio investments provide additional benefits in terms of the risk-return trade-off. The exchange rate was identified as having a significant effect on the performance and risk of securities.
Barr (1986)	JSE, LSE, and NYSE.	1973-1985	Annual (Equities)	Mean-variance efficient frontier framework.	Substantial rand returns (which were mainly attributable) to the Rand depreciation could be earned from holdings in the NYSE or LSE.
Bhana (1986)	Australia, Austria, Canada, Denmark, Finland, France, Germany, Italy, Japan, Netherlands, New Zealand, Norway, SA, Spain, Sweden, Switzerland, UK, and US.	1969-1983	Annual (Equities)	Markowitz (1952) mean-variance efficient frontier framework.	An SA investor would earn superior portfolio returns and realise significant risk-reduction relative to an investor only investing in the SA equity market.
Bhana (1987)	Australia, Austria, Canada,	1969-1983	Annual	Mean-variance	Large gains from international

	Denmark, Finland, France, Germany, Italy, Japan, Netherlands, New Zealand, Norway, SA, Spain, Sweden, Switzerland, UK, and US.		(Equities)	efficient frontier framework.	diversification were achievable, although; smaller than those achieved through *ex post* optimum portfolios.
Bhana (1990)	Australia, Austria, Canada, Denmark, Finland, France, Germany, Italy, Japan, Netherlands, New Zealand, Norway, SA, Spain, Sweden, Switzerland, UK, and US.	1969-1983	Annual (Equities)	Mean-variance efficient frontier framework..	Portfolio managers should use a mean-variance model for medium to long-term investment horizons as benefits accruing from international diversification were highly correlated with the length of the investment horizon.
Patrick and Ward (1996)	Argentina, Australia, Austria, Belgium, Brazil, Canada, Chile, Colombia, Denmark, France, Germany, Greece, Hong Kong, India, Italy, Japan, Jordan, Korea, Malaysia, Mexico, Netherlands, Norway, Pakistan, Philippines, Singapore, Spain, Sweden, Switzerland, Taiwan, Thailand, UK, US, and Venezuela.	1976-1994	Monthly and Annual (Equities)	Mean-variance efficient frontier framework.	International investment improved risk reduction. Certain country pairs exhibited a greater degree of correlation when compound annual returns instead of monthly returns were used.
Swart (1999)	Germany, Japan, SA, UK, and US.	1973-1997	Monthly (Equities)	Modern Portfolio Theory framework.	Correlation coefficients between the JSE and international capital markets increased during volatile periods. But gains in risk-adjusted performance remained.
Lamba and Otchere (2001a)	Botswana, Ghana, Kenya, Mauritius, Namibia, SA, and Zimbabwe (African equity markets). Australia, Belgium, Canada, France, Germany, Japan,	January 1988 - May 2000	Weekly (Equities)	VAR framework.	Apart from SA and Namibia there was a very low degree of international comovement among African and global equity markets, thus indicating a lack of integration.

	the Netherlands, UK, and US (Major global equity markets).				
Lamba and Otchere (2001b)	Australia, Canada, France, Germany, Japan, SA, UK, and US.	May 1988 - May 2000	Daily (Equities)	Multivariate cointegration framework and a vector error-correction model (VECM).	A long-run relationship between the SA and world equity markets existed. US, Canada and Australia exerted the most influence on the SA market, while the influence of Japan was minimal.
Webbstock *et al.* (2005)	Australia and SA.	September 2000 - September 2003	Weekly (Equities)	Wagner Lau (1971) method.	No clear portfolio diversification advantage to either an SA or an Australian investor holding a combination of JSE or Australian Stock Exchange (ASX) stocks.
Alhassan (2006)	Canada, France, Germany, Ghana, Honk Kong, Japan, Singapore, UK, and US.	November 1990 - April 2003	Weekly (Equities)	Co-integration and error correction analyses.	The Ghanaian equity market was not integrated with the equity markets examined, thus offered increased diversification possibilities.
Humavindu and Floros (2006)	Namibia and SA	4 January 1999 to 20 March 2003	Daily (Equities)	VAR and GARCH *(p,q)* models.	The correlation between the two markets was very low and no long-run cointegration relationship existed.
Chinzara (2007)	Australia, China, Germany, Japan, UK, and US.	1995-2007	Daily (Equities)	Bivariate and multivariate cointegration analysis, GARCH, EGARCH, and GJR GARCH models.	There was no evidence of bivariate cointegration between SA and the foreign equity markets. Thus, indicating that pairwise portfolio diversification would be beneficial to a South African equity portfolio manager. However, multivariate cointegration was found to exist for some portfolios.

Table-A 4.1: Five-year Rolling Window Correlation Coefficients for BMYs

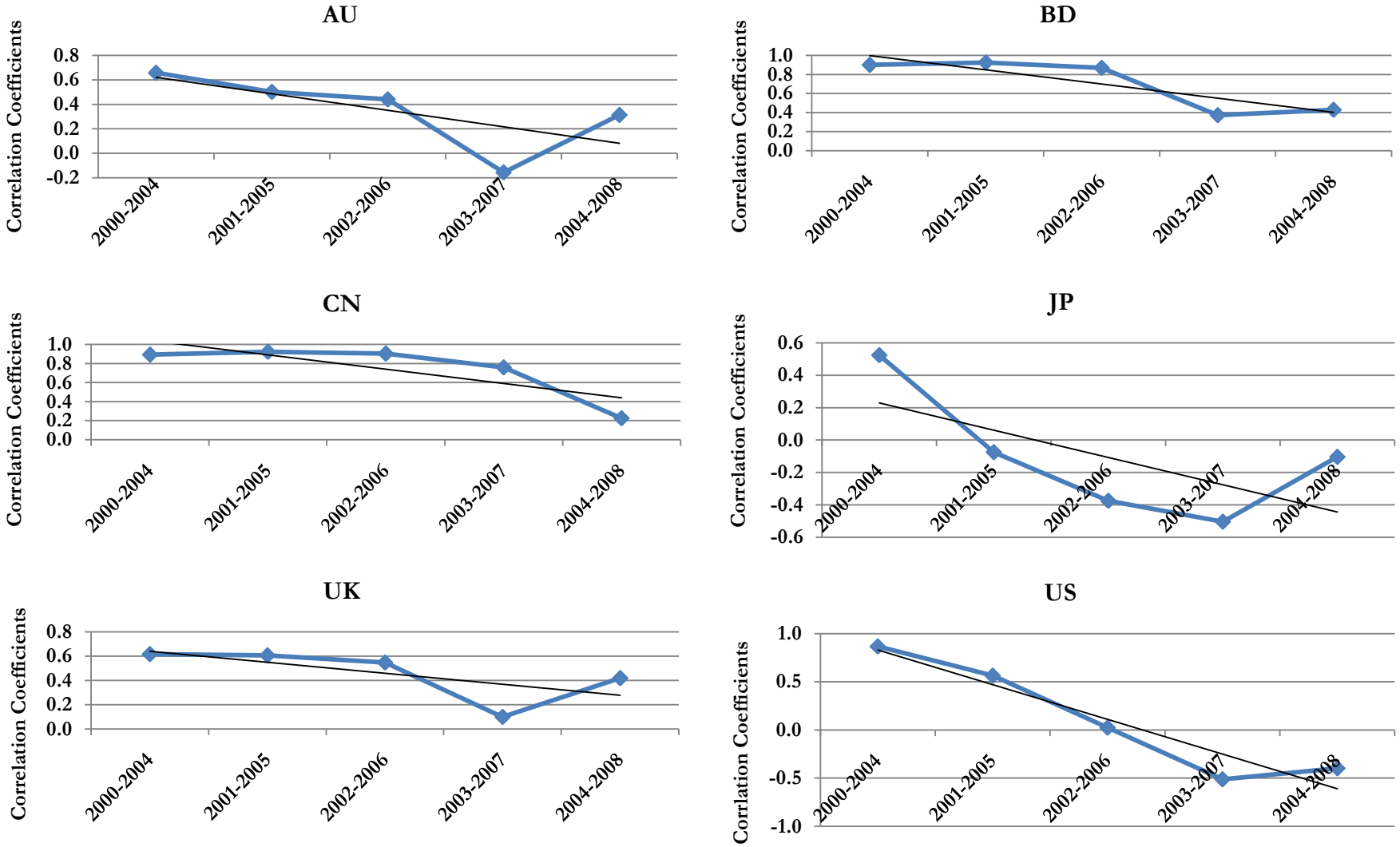
1990-1994	AU	BD	CN	JP	**SA**	UK	US
AU	1.0						
BD	0.878	1.0					
CN	0.971	0.846	1.0				
JP	0.895	0.941	0.871	1.0			
SA	**0.703**	**0.827**	**0.683**	**0.724**	**1.0**		
UK	0.955	0.933	0.925	0.940	**0.721**	1.0	
US	0.961	0.878	0.960	0.862	**0.736**	0.916	1.0
1991-1995							
AU	1.0						
BD	0.838	1.0					
CN	0.936	0.790	1.0				
JP	0.644	0.884	0.680	1.0			
SA	**0.776**	**0.691**	**0.679**	**0.399**	**1.0**		
UK	0.882	0.960	0.833	0.823	**0.697**	1.0	
US	0.919	0.850	0.941	0.745	**0.651**	0.844	1.0
1992-1996							
AU	1.0						
BD	0.747	1.0					
CN	0.886	0.721	1.0				
JP	0.401	0.826	0.523	1.0			
SA	**0.724**	**0.503**	**0.526**	**0.102**	**1.0**		
UK	0.824	0.901	0.720	0.617	**0.634**	1.0	
US	0.840	0.727	0.834	0.500	**0.629**	0.750	1.0
1993-1997							
AU	1.0						
BD	0.871	1.0					
CN	0.921	0.933	1.0				
JP	0.528	0.795	0.751	1.0			
SA	**0.699**	**0.547**	**0.474**	**0.081**	**1.0**		
UK	0.927	0.872	0.885	0.546	**0.706**	1.0	
US	0.778	0.652	0.710	0.365	**0.626**	0.733	1.0
1994-1998							
AU	1.0						
BD	0.958	1.0					
CN	0.970	0.947	1.0				
JP	0.895	0.921	0.932	1.0			
SA	**0.372**	**0.210**	**0.296**	**0.110**	**1.0**		
UK	0.953	0.965	0.922	0.860	**0.231**	1.0	
US	0.859	0.895	0.854	0.862	**0.198**	0.884	1.0
1995-1999							
AU	1.0						
BD	0.946	1.0					

CN	0.988	0.940	1.0				
JP	0.931	0.900	0.924	1.0			
SA	**0.361**	**0.226**	**0.395**	**0.269**	**1.0**		
UK	0.916	0.964	0.900	0.880	**0.244**	1.0	
US	0.815	0.844	0.791	0.794	**0.137**	0.800	1.0
1996-2000							
AU	1.0						
BD	0.893	1.0					
CN	0.976	0.892	1.0				
JP	0.898	0.826	0.873	1.0			
SA	**0.130**	**-0.102**	**0.128**	**0.084**	**1.0**		
UK	0.870	0.881	0.837	0.871	**0.166**	1.0	
US	0.833	0.862	0.811	0.700	**-0.109**	0.725	1.0
1997-2001							
AU	1.0						
BD	0.795	1.0					
CN	0.944	0.832	1.0				
JP	0.738	0.611	0.625	1.0			
SA	**0.151**	**-0.166**	**0.097**	**0.275**	**1.0**		
UK	0.753	0.769	0.692	0.746	**0.221**	1.0	
US	0.901	0.802	0.891	0.751	**0.235**	0.728	1.0
1998-2002							
AU	1.0						
BD	0.780	1.0					
CN	0.896	0.813	1.0				
JP	0.478	0.332	0.444	1.0			
SA	**0.022**	**-0.279**	**0.107**	**0.360**	**1.0**		
UK	0.553	0.645	0.588	0.398	**0.192**	1.0	
US	0.774	0.640	0.852	0.717	**0.389**	0.671	1.0
1999-2003							
AU	1.0						
BD	0.821	1.0					
CN	0.869	0.881	1.0				
JP	0.637	0.517	0.611	1.0			
SA	**0.558**	**0.416**	**0.667**	**0.795**	**1.0**		
UK	0.917	0.896	0.866	0.642	**0.519**	1.0	
US	0.850	0.764	0.913	0.813	**0.812**	0.850	1.0
2000-2004							
AU	1.0						
BD	0.808	1.0					
CN	0.759	0.952	1.0				
JP	0.668	0.536	0.419	1.0			
SA	**0.659**	**0.900**	**0.893**	**0.524**	**1.0**		
UK	0.910	0.793	0.708	0.765	**0.617**	1.0	
US	0.835	0.907	0.900	0.706	**0.867**	0.841	1.0

2001-2005							
AU	1.0						
BD	0.699	1.0					
CN	0.618	0.966	1.0				
JP	0.445	0.046	-0.075	1.0			
SA	**0.503**	**0.926**	**0.923**	**-0.080**	**1.0**		
UK	0.880	0.775	0.690	0.493	**0.607**	1.0	
US	0.699	0.671	0.663	0.465	**0.564**	0.738	1.0
2002-2006							
AU	1.0						
BD	0.725	1.0					
CN	0.548	0.936	1.0				
JP	0.487	-0.080	-0.282	1.0			
SA	**0.441**	**0.870**	**0.903**	**-0.376**	**1.0**		
UK	0.885	0.751	0.608	0.352	**0.548**	1.0	
US	0.747	0.350	0.212	0.713	**0.025**	0.513	1.0
2003-2007							
AU	1.0						
BD	0.717	1.0					
CN	0.066	0.636	1.0				
JP	0.651	0.191	-0.298	1.0			
SA	**-0.155**	**0.373**	**0.759**	**-0.505**	**1.0**		
UK	0.814	0.766	0.314	0.537	**0.099**	1.0	
US	0.579	0.214	-0.108	0.839	**-0.510**	0.461	1.0
2004-2008							
AU	1.0						
BD	0.859	1.0					
CN	-0.089	0.306	1.0				
JP	0.430	0.525	0.350	1.0			
SA	**0.314**	**0.431**	**0.227**	**-0.104**	**1.0**		
UK	0.641	0.867	0.522	0.463	**0.419**	1.0	
US	-0.043	0.136	0.552	0.740	**-0.396**	0.277	1.0

Note: Correlations are calculated based on a five-year rolling window from January 1990 to July 2008 using actual yield values.

Figure-A 4.1: Bond Yield Correlation Coefficients between SA and the Major Global Bond Markets



Note: For each graph the horizontal axis represents the rolling window periods.

Table-A 4.2: Five-year Rolling Window Correlation Coefficients for BMIs

2000-2004	AU	BD	CN	JP	SA	UK	US
AU	1.0						
BD	0.982	1.0					
CN	0.938	0.933	1.0				
JP	0.464	0.485	0.678	1.0			
SA	**0.664**	**0.670**	**0.449**	**-0.290**	**1.0**		
UK	0.894	0.915	0.961	0.776	**0.337**	1.0	
US	0.619	0.651	0.809	0.957	**-0.089**	0.882	1.0
2001-2005							
AU	1.0						
BD	0.973	1.0					
CN	0.911	0.880	1.0				
JP	0.173	0.248	0.344	1.0			
SA	**0.616**	**0.565**	**0.433**	**-0.628**	**1.0**		
UK	0.809	0.855	0.864	0.678	**0.103**	1.0	
US	0.300	0.369	0.492	0.965	**-0.517**	0.771	1.0
2002-2006							
AU	1.0						
BD	0.948	1.0					
CN	0.946	0.890	1.0				
JP	0.054	0.190	0.089	1.0			
SA	**0.521**	**0.414**	**0.468**	**-0.795**	**1.0**		
UK	0.793	0.865	0.808	0.587	**-0.026**	1.0	
US	0.221	0.335	0.294	0.954	**-0.674**	0.720	1.0
2003-2007							
AU	1.0						
BD	0.980	1.0					
CN	0.976	0.962	1.0				
JP	0.282	0.390	0.208	1.0			
SA	**0.832**	**0.786**	**0.872**	**-0.212**	**1.0**		
UK	0.969	0.989	0.950	0.418	**0.753**	1.0	
US	0.679	0.746	0.644	0.821	**0.258**	0.782	1.0
2004-2008							
AU	1.0						
BD	0.989	1.0					
CN	0.979	0.967	1.0				
JP	0.840	0.885	0.765	1.0			
SA	**0.753**	**0.718**	**0.828**	**0.352**	**1.0**		
UK	0.980	0.978	0.971	0.820	**0.757**	1.0	
US	0.957	0.966	0.927	0.913	**0.605**	0.959	1.0

Note: Correlations are calculated based on a five-year rolling window from January 1990 to July 2008 using actual the actual index values.

Table-A 4.3: Country Factor Loadings for PC1 (BMYs)

	AU	BD	CN	JP	SA	UK	US
1990-2008	0.381	0.391	0.391	0.374	0.331	0.392	0.382
1990-1994	0.389	0.385	0.380	0.379	0.337	0.390	0.382
1991-1995	0.397	0.400	0.390	0.325	0.329	0.401	0.394
1992-1996	0.413	0.409	0.399	0.279	0.310	0.413	0.397
1993-1997	0.423	0.415	0.419	0.302	0.294	0.419	0.347
1994-1998	0.414	0.415	0.409	0.397	0.099	0.410	0.392
1995-1999	0.420	0.415	0.415	0.397	0.120	0.406	0.378
1996-2000	0.427	0.416	0.419	0.392	0.008	0.400	0.393
1997-2001	0.433	0.397	0.421	0.361	0.093	0.390	0.432
1998-2002	0.429	0.391	0.447	0.327	0.115	0.378	0.448
1999-2003	0.391	0.369	0.401	0.343	0.325	0.397	0.411
2000-2004	0.382	0.404	0.384	0.301	0.369	0.383	0.412
2001-2005	0.392	0.432	0.414	0.154	0.384	0.421	0.375
2002-2006	0.440	0.464	0.416	0.104	0.369	0.445	0.271
2003-2007	0.508	0.365	0.068	0.426	-0.118	0.479	0.424
2004-2008	0.409	0.506	0.285	0.394	0.194	0.499	0.231

Table-A 4.4: Country Factor Loadings for PC2 (BMYs)

	AU	BD	CN	JP	SA	UK	US
1990-1994							
1991-1995							
1992-1996	-0.234	0.284	0.016	0.719	-0.580	-0.012	-0.105
1993-1997	0.097	-0.211	-0.224	-0.642	0.614	0.112	0.307
1994-1998	0.109	-0.081	0.057	-0.218	0.961	-0.036	-0.072
1995-1999							
1996-2000	0.092	-0.159	0.102	-0.023	0.951	0.137	-0.178
1997-2001	-0.036	-0.369	-0.109	0.183	0.899	0.056	0.084
1998-2002	-0.176	-0.439	-0.118	0.342	0.770	-0.006	0.228
1999-2003							
2000-2004							
2001-2005	0.247	-0.253	-0.335	0.707	-0.383	0.211	0.268
2002-2006	0.262	-0.192	-0.319	0.616	-0.402	0.136	0.483
2003-2007	0.041	0.419	0.561	-0.311	0.557	0.195	-0.253
2004-2008	-0.312	-0.204	0.327	0.340	-0.485	-0.095	0.628

Note: The factor loadings are reported for only those periods were PC2 was found to be statistically significant.

Table-A 4.5: Country Factor Loadings for PC3 (BMYs)

	AU	BD	CN	JP	SA	UK	US
2004-2008	-0.433	-0.109	0.655	-0.314	0.500	0.152	-0.01

Note: The factor loadings are reported for only the period were PC3 was found to be statistically significant.

Table-A 4.6: Country Factor Loadings for PC1 (BMIs)

	AU	BD	CN	JP	SA	UK	US
2000-2004	0.412	0.418	0.434	0.321	0.185	0.436	0.374
2001-2005	0.434	0.444	0.450	0.267	0.129	0.470	0.321
2002-2006	0.453	0.469	0.454	0.212	0.088	0.482	0.290
2003-2007	0.428	0.433	0.422	0.180	0.338	0.433	0.343
2004-2008	0.400	0.401	0.396	0.345	0.305	0.398	0.391

Table-A 4.7: Country Factor Loadings for PC2 (BMIs)

	AU	BD	CN	JP	SA	UK	US
2000-2008	-0.144	-0.101	-0.111	0.661	-0.505	0.052	0.511
2000-2004	0.244	0.232	0.035	-0.514	0.683	-0.066	-0.388
2001-2005	0.257	0.212	0.124	-0.523	0.608	-0.106	-0.468
2002-2006	0.229	0.150	0.193	-0.540	0.590	-0.122	-0.483
2003-2007	-0.110	-0.025	-0.167	0.713	-0.485	0.011	0.464
2004-2008							

Note: The factor loadings are reported for only those periods were PC2 was found to be statistically significant.

Table-A 4.8: Convergence Groups (BMYs)

ROUND OF TESTS			R^2	COUNTRY FACTOR LOADINGS						
	1990-1994			**AU**	**BD**	**CN**	**JP**	**SA**	**UK**	**US**
Round 1	EV PC1	6.254918	89.4	0.389411	0.38521	0.38009	0.37865	0.337041	0.39034	0.382318
(ALL)	EV PC2	0.389520	5.60							
	1991-1995									
Round 1	EV PC1	5.707310	81.5	0.396943	0.399506	0.390207	0.324833	0.329474	0.401122	0.394463
(ALL)	EV PC2	0.703549	10.1							
	1992-1996									
Round 1	EV PC1	5.039703	72.0	0.41336	0.408981	0.398519	0.279091	0.310223	0.413446	0.39747
(ALL)	EV PC2	1.082453	15.5	-0.23412	0.283965	0.01621	0.719137	-0.57955	-0.01170	-0.10541
	EV PC3	0.416765	6.00							
Round 2	EV PC1	4.200727	84.0	0.460365	0.439204	0.445231	n/a	n/a	0.450854	0.440073
(AU, BD, CN, UK & US)	EV PC2	0.385388	7.70							
JP and SA were excluded from CG1 as they had higher factor loadings (HFLs) in the second principal component (PC2). This improved the capability of the first principal component (PC1) to explain the variability in bond market yields (BMYs) (i.e. the R^2 value increased from 72% to 84%).										
Round 3	EV PC1	4.613612	76.9	0.42198	0.435256	0.421014	0.32113	n/a	0.427569	0.411452
(AU, BD, CN, JP, UK & US)	EV PC2	0.787519	13.1							
Round 4	EV PC1	4.702813	78.4	0.439127	0.40548	0.410924	n/a	0.345773	0.426853	0.414888
(AU, BD, CN, SA, UK & US)	EV PC2	0.560837	9.40							
Hence, although their individual re-inclusion into CG1 resulted in the emergence of only one statistically significant PC, they were both excluded from CG1 as their collective inclusion had resulted in the emergence of two statistically significant PCs.										
Round 5	EV PC1	1.056953	52.85	n/a	n/a	n/a	0.707107	0.707107	n/a	n/a
(JP & SA)	EV PC2	0.943047	47.15							
Although only PC1 was statistically significant its R^2 value was 52.85%, while that of PC2 was 47.15%. Therefore, each market was merely accounting for its own variation in BMYs. Hence, JP and SA were both treated as independent markets, while AU, BD, CN, UK and US formed convergence group one (CG1).										

	1993-1997									
Round 1	EV PC1	5.161493	73.7	0.423058	0.415384	0.418732	0.301598	0.294088	0.418669	0.346999
(ALL)	EV PC2	1.139479	16.3	0.096867	-0.21106	-0.22365	-0.6420	0.614227	0.112046	0.306687
	EV PC3	0.362862	5.20							
Round 2	EV PC1	4.277417	85.6	0.468522	0.450429	0.46216	n/a	n/a	0.46055	0.389748
(AU, BD, CN, UK & US)	EV PC2	0.444343	8.90							
Round 3	EV PC1	4.771947	79.5	0.433851	0.437535	0.445871	0.341357	n/a	0.427111	0.350123
(AU, BD, CN, JP, UK & US)	EV PC2	0.770597	12.8							
Round 4	EV PC1	4.750843	79.2	0.445484	0.418374	0.423094	n/a	0.335221	0.440743	0.375329
(AU, BD, CN, SA, UK & US)	EV PC2	0.676264	11.3							
Round 5	EV PC1	1.061372	53.1	n/a	n/a	n/a	0.707107	0.707107	n/a	n/a
(JP & SA)	EV PC2	0.938628	46.9							
Similarly see explanations for 1992-1993 rolling window.										
	1994-1998									
Round 1	EV PC1	5.615499	80.2	0.414103	0.414729	0.409169	0.397246	0.098774	0.410018	0.391694
(ALL)	EV PC2	1.018442	14.6	0.109482	-0.08148	0.057317	-0.21843	0.96116	-0.03609	-0.07242
	EV PC3	0.172573	2.47							
SA was markedly much better explained by PC2; therefore it was removed from CG1.										
Round 2	EV PC1	5.570127	92.8	0.413607	0.417506	0.409601	0.402216	n/a	0.412054	0.394055
(AU, BD, CN, JP, UK & US)	EV PC2	0.182539	3.04							
This resulted in the emergence of one statistically significant PC and noticeably improved the capability of PC1 to explain the variability in BMYs. Hence, SA was treated as an independent market, while AU, BD, CN, JP, UK and US formed CG1.										
	1995-1999									
Round 1	EV PC1	5.469988	78.1	0.419500	0.415383	0.414991	0.39663	0.119533	0.405816	0.378112
(ALL)	EV PC2	0.998106	14.3	0.064786	-0.10509	0.121268	-0.1201	0.956087	-0.06899	-0.19175
	EV PC3	0.224272	3.20							

Round 2	EV PC1	5.405333	90.1	0.420327	0.419629	0.414659	0.40105	n/a	0.409217	0.383399
(AU, BD, CN, JP, UK & US)	EV PC2	0.250282	4.17							
Similarly see explanations for 1994-1998 rolling window.										
	1996-2000									
Round 1	EV PC1	5.186950	74.1	0.427056	0.416412	0.419441	0.392229	0.008225	0.399537	0.393387
(ALL)	EV PC2	1.091715	15.6	0.092195	-0.15850	0.102408	-0.02336	0.951306	0.13728	-0.17752
	EV PC3	0.282431	4.03							
Round 2	EV PC1	5.186668	86.4	0.426917	0.416678	0.419287	0.392292	n/a	0.399338	0.393643
(AU, BD, CN, JP, UK & US)	EV PC2	0.303992	5.07							
Similarly see explanations for 1994-1998 rolling window.										
	1997-2001									
Round 1	EV PC1	4.829330	70.0	0.432786	0.397015	0.421027	0.361469	0.09316	0.390191	0.431536
(ALL)	EV PC2	1.138508	16.3	-0.03615	-0.3686	-0.10854	0.182504	0.898653	0.05581	0.083934
	EV PC3	0.437909	6.26							
Round 2	EV PC1	4.796068	79.9	0.434588	0.405081	0.423714	0.360239	n/a	0.389965	0.430887
(AU, BD, CN, JP, UK & US)	EV PC2	0.500006	8.33							
Similarly see explanations for 1994-1998 rolling window.										
	1998-2002									
Round 1	EV PC1	4.321219	61.7	0.428876	0.391349	0.446528	0.327399	0.114714	0.378005	0.447534
(ALL)	EV PC2	1.402153	20.0	-0.17640	-0.43888	-0.11779	0.341907	0.770401	-0.00612	0.227912
	EV PC3	0.576317	8.23							
Initially, BD, JP and SA were excluded from CG1 (AU, CN, UK and US) as they had higher factor loadings (HFLs) in PC2. As shown below in Round 2a, their exclusion resulted in there being only one statistically significant PC, which explained 80% of the variability in BMYs.										
Round 2a	EV PC1	3.199968	80.0	0.506665	n/a	0.52897	n/a	n/a	0.445855	0.514485
(AU, CN, UK & US)	EV PC2	0.485660	12.1							
Round 2b	EV PC1	3.902575	78.1	0.460659	0.441757	0.480236	n/a	n/a	0.403544	0.446284

(AU, BD, CN, UK & US)	EV PC2	0.487257	9.80							
Round 2c	EV PC1	3.632298	72.7	0.465202	n/a	0.480896	0.376361	n/a	0.404567	0.496995
(AU, CN, JP, UK & US)	EV PC2	0.660929	13.2							
Round 2d	EV PC1	3.281025	65.6	0.486798	n/a	0.514486	n/a	0.186372	0.440654	0.519058
(AU, CN, SA, UK & US)	EV PC2	1.034844	20.7	-0.32062	n/a	-0.20467	n/a	0.910570	0.018746	0.160697
	EV PC3	0.461114	9.22							
From Round 2b, when BD was re-included in CG1 the ability of PC1 to explain BMY variability decreased by only 1.9%. In contrast, when either JP or SA were re-included in CG1 the ability of PC1 to explain BMY variability decreased by 7.3% and 14.4%, respectively. Hence, BD was re-included in CG1 as its inclusion did not appear to distort the capability of PC1 to capture the variability in BMYs.										
Round 3	EV PC1	1.35343	67.7	n/a	n/a	n/a	0.707107	0.707107	n/a	n/a
(JP & SA)	EV PC2	0.64657	32.3							
Similarly to the 1992-1996 rolling window, JP and SA were both treated as independent markets, while AU, BD, CN, UK and US formed CG1.										
	1999-2003									
Round 1	EV PC1	5.511772	78.7	0.390597	0.368733	0.401337	0.343362	0.324775	0.397498	0.411118
(ALL)	EV PC2	0.830941	11.9	-0.24056	-0.45451	-0.13440	0.454129	0.628943	-0.29231	0.173897
	2000-2004									
Round 1	EV PC1	5.524555	78.9	0.382366	0.404363	0.383771	0.301013	0.36874	0.383149	0.411856
(ALL)	EV PC2	0.914000	13.1	0.213168	-0.25363	-0.41622	0.651121	-0.40429	0.359848	-0.00974
	2001-2005									
Round 1	EV PC1	4.664811	66.6	0.391811	0.432172	0.41369	0.153818	0.383695	0.421025	0.374736
(ALL)	EV PC2	1.567765	22.4	0.247380	-0.253170	-0.33481	0.707331	-0.38250	0.210510	0.267723
	EV PC3	0.355735	5.08							
Round 2	EV PC1	4.578910	76.3	0.385799	0.445352	0.430883	n/a	0.401039	0.415049	0.366146
(AU, BD, CN, SA, UK & US)	EV PC2	0.880307	14.7							
Similarly to SA during the 1994-1998 rolling window, JP was treated as an independent market, while AU, BD, CN, SA, UK and US formed CG1.										

	2002-2006									
Round 1	EV PC1	4.055708	57.9	0.439641	0.463636	0.416436	0.103925	0.368972	0.445202	0.270542
(ALL)	EV PC2	2.272319	32.5	0.261832	-0.19228	-0.31889	0.615989	-0.402170	0.13611	0.482776
	EV PC3	0.336407	4.80							
JP and US were excluded from CG1 as they had HFLs in PC2. This resulted in there being only one statistically significant PC and markedly improved the capability of the PC1 to explain the variability in BMYs (i.e. the R^2 value increased from 57.9% to 76.8%).										
Round 2a	EV PC1	3.840128	76.8	0.405298	0.495164	0.463647	n/a	0.431694	0.434992	n/a
(AU, BD, CN, SA & UK)	EV PC2	0.887458	17.8							
Round 2b	EV PC1	3.841641	64.0	0.409141	0.494199	0.46104	0.023991	0.428379	0.437868	n/a
(AU, BD, CN, JP, SA & UK)	EV PC2	1.739476	29.0	0.40824	-0.09788	-0.26908	0.73109	-0.34643	0.311210	n/a
	EV PC3	0.153541	2.6							
Round 2c	EV PC1	4.026812	67.1	0.426308	0.474458	0.434356	n/a	0.390521	0.437774	0.245629
(AU, BD, CN, SA, UK & US)	EV PC2	1.456833	24.3	0.388532	-0.183333	-0.33559	n/a	-0.472174	0.202884	0.662345
	EV PC3	0.314899	5.30							
When either JP or US were re-introduced into CG1, two statistically significant PCs emerged. Hence, they were both excluded from CG1.										
Round 3	EV PC1	1.71996	86.0	n/a	n/a	n/a	0.707107	n/a	n/a	0.707107
(JP & US)	EV PC2	0.28004	14.0							
An analysis of only JP and US revealed that PC1 was able to explain 86.0% of the BMY variability between the two countries. Hence, AU, BD, CN, SA and UK formed CG1, while JP and US formed CG2.										
	2003-2007									
Round 1	EV PC1	3.358333	48.0	0.508008	0.364656	0.067927	0.426367	-0.11767	0.478525	0.423932
(ALL)	EV PC2	2.571372	36.7	0.041358	0.418851	0.560849	-0.31053	0.556688	0.194941	-0.25292
	EV PC3	0.469270	6.70							
Similarly, to the 2002-2006 rolling window, BD, CN and SA were excluded from CG1 and then individually re-included into CG1. From the Round 2 results it was evident BD, CN and SA did not belong in CG1 as their individual re-inclusion resulted in the emergence of two statistically significant PCs.										
Round 2a	EV PC1	2.935502	73.4	0.522047	n/a	n/a	0.507714	n/a	0.479782	0.48939
(AU, JP, UK & US)	EV PC2	0.711318	17.8							
Round 2b	EV PC1	3.302753	66.1	0.515199	0.378466	n/a	0.422768	n/a	0.490172	0.41513

(AU, BD, JP, UK, & US)	EV PC2	1.194516	23.9	-0.12175	-0.61942	n/a	0.524761	n/a	-0.27175	0.502269
	EV PC3	0.243935	4.88							
Round 2c	EV PC1	2.935774	58.7	0.521424	n/a	-0.01217	0.509287	n/a	0.477986	0.490025
(AU, CN, JP, UK, & US)	EV PC2	1.337247	26.7	0.170513	n/a	0.813836	-0.33307	n/a	0.396263	-0.20159
	EV PC3	0.452532	9.05							
Round 2c	EV PC1	3.084315	61.7	0.486715	n/a	n/a	0.514662	-0.26442	0.422672	0.499665
(AU, JP, SA, UK, & US)	EV PC2	1.282153	25.6	0.329583	n/a	n/a	-0.17057	0.724238	0.538791	-0.21787
	EV PC3	0.306499	6.13							
Round 3a	EV PC1	2.189894	73.0	n/a	0.526072	0.637738	n/a	0.562617	n/a	n/a
(BD, CN & SA)	EV PC2	0.629292	21.0							
Round 3b	EV PC1	1.740355	87.0	n/a	n/a	0.707107	n/a	0.707107	n/a	n/a
(CN & SA)	EV PC2	0.259645	13.0							
Round 3c	EV PC1	1.375048	68.8	n/a	0.707107	n/a	n/a	0.707107	n/a	n/a
(BD & SA)	EV PC2	0.624952	31.3							
Round 3d	EV PC1	1.650678	82.5	n/a	0.707107	0.707107	n/a	n/a	n/a	n/a
(BD & CN)	EV PC2	0.349322	17.5							
The results in Round 3 were peculiar as transitivity did not hold (i.e. although BD and SA appeared not to move well together, they both appeared to move extremely well with CN – as they both had high R^2 values with CN). Therefore, BD, CN & SA were not separated. Hence, AU, JP, UK and US formed CG1, while BD, CN and SA formed CG2.										
	2004-2008									
Round 1	EV PC1	3.355554	47.9	0.408784	0.505794	0.284582	0.394319	0.194371	0.499344	0.231235
(ALL)	EV PC2	1.943333	27.8	-0.31195	-0.20407	0.327491	0.339642	-0.48461	-0.09500	0.628141
	EV PC3	1.092108	15.6	-0.43319	-0.10907	0.654986	-0.31403	0.499599	0.15176	-0.01387
	EV PC4	0.345092	4.93							
Similarly, to the 2002-2006 rolling window, CN, JP, SA and US were excluded from CG1 and then individually re-included into CG1.										

Round 2a	EV PC1	2.590050	86.3	0.560332	0.608752	n/a	n/a	n/a	0.561648	n/a
(AU, BD & UK)	EV PC2	0.346135	11.5							
Round 2b	EV PC1	2.696670	67.4	0.508356	0.593205	0.248277	n/a	n/a	0.572748	n/a
(AU, CN, BD & UK)	EV PC2	1.117279	27.9	-0.48396	-0.10995	0.850373	n/a	n/a	0.174808	n/a
	EV PC3	0.132115	3.30							
Round 2c	EV PC1	2.953713	73.8	0.511485	0.562630	n/a	0.396175	n/a	0.514661	n/a
(AU, BD, JP & UK)	EV PC2	0.638349	16.0							
Round 2d	EV PC1	2.829776	70.7	0.518494	0.574094	n/a	n/a	0.34053	0.534434	n/a
(AU, BD, SA & UK)	EV PC2	0.772880	19.3							
Round 2e	EV PC1	2.615424	65.4	0.547003	0.604142	n/a	n/a	n/a	0.565797	0.125194
(AU, BD, UK & US)	EV PC2	1.045680	26.1	-0.28596	-0.07003	n/a	n/a	n/a	0.142124	0.945053
	EV PC3	0.275098	6.88							
Round 2f	EV PC1	3.107598	62.2	0.496259	0.552437	n/a	0.34560	0.264006	0.509316	n/a
(AU, BD, JP, SA & UK)	EV PC2	1.117602	22.4	-0.03536	0.004876	n/a	-0.63469	0.769533	0.060947	n/a
	EV PC3	0.409952	8.20							
CN and US were excluded from CG1 as their individual re-inclusion resulted in the emergence of two statistically significant PCs. The individual re-inclusion of JP and SA into CG1 did not result in the emergence of more than one statistically significant PC. However, they both markedly decreased the ability of PC1 to capture the variability in BMYs. Furthermore, their collective inclusion in CG1 resulted in the emergence of two statistically significant PCs. As a result, they were also excluded from CG1.										
Round 3	EV PC1	2.152392	53.8	n/a	n/a	0.459332	0.561623	-0.21516	n/a	0.653682
(CN, JP, SA & US)	EV PC2	1.171508	29.3	n/a	n/a	0.536118	0.016191	0.836055	n/a	-0.11544
	EV PC3	0.570200	14.3							
Round 4a	EV PC1	1.71259	85.6	n/a	n/a	n/a	0.707107	n/a	n/a	0.707107
(JP & US)	EV PC2	0.28741	14.4							
CN and SA had HFLs in PC2, therefore were excluded from CG2 (JP and US). Similarly to the 2002-2006 rolling window, they were then individually re-included.										

Round 4b	EV PC1	2.100822	70.0	n/a	n/a	0.512716	0.572619	n/a	n/a	0.639711
(CN, JP & US)	EV PC2	0.669656	22.3							
Round 4c	EV PC1	1.874745	62.5	n/a	n/a	n/a	0.610276	-0.40011	n/a	0.683719
(JP, SA & US)	EV PC2	0.900052	30.0							
Round 5	EV PC1	1.183148	59.2	n/a	n/a	0.707107	n/a	0.707107	n/a	n/a
(CN & SA)	EV PC2	0.816852	40.8							

Hence, CN and SA were not moving in tandem therefore they were classified as independent markets, while AU, BD and UK formed CG1, and JP and US formed CG2.

Note: Explanations for 1990-1994, 1991-1995, 1995-1999, 1999-2003 and 2000-2004 rolling windows are provided in-text (Section 4.4). n/a means not applicable. CG1 and CG2, refers to convergence group one and convergence group two, respectively. HFLs means higher factor loadings. BMYs means bond market yields. EV PC1, EV PC2, EV PC3, and EV PC4 means eigenvalue of the first principal component, eigenvalue of the second principal component, eigenvalue of the third principal component, eigenvalue of the fourth principal component, respectively. ALL refers to all the bond markets selected in the study. AU, BD, CN, JP, SA, UK and US refers to Australia, Germany, Canada, Japan, South Africa, the United Kingdom, and the United States.

Table-A 4.9: Convergence Group Analysis (BMYs)

Convergence Groups					Cumulative R^2 Values (%)			
	CG1	**CG2**	**CG3**	**CG4**	**CG1**	**CG2**	**CG3**	**CG 4**
Period								
1990-2008	All				89.3			
1990-1994	All				89.4			
1991-1995	All				81.5			
1992-1996	Others	JP	SA		84.0	+	+	
1993-1997	Others	JP	SA		85.6	+	+	
1994-1998	Others	SA			92.8	+		
1995-1999	Others	SA			90.0	+		
1996-2000	Others	SA			86.4	+		
1997-2001	Others	SA			79.9	+		
1998-2002	Others	JP	SA		78.0	+	+	
1999-2003	All				78.7			
2000-2004	All				78.9			
2001-2005	Others	JP			76.3	+		
2002-2006	Others	JP, US			76.8	86.0		
2003-2007	Others	BD, CN, SA			73.4	73.0		
2004-2008	Others	JP, US	CN	SA	86.3	85.6	+	+

Note: CG1, CG2, CG3, and CG4 represent convergence group (CG) one, two, three, and four, respectively. + indicates an independent market. AU, BD, CN, JP, UK and US represent the bond markets of Australia, Germany, Canada, Japan, the United Kingdom, and the United States, respectively. ALL means all countries fell into the same convergence group. OTHERS refers to the countries not explicitly stated (i.e. for the 1992-1996 rolling window, OTHERS would be AU, CN, BD, UK, and US).

Table-A 4.10: Convergence Groups (BMIs)

ROUND OF TESTS		R^2		COUNTRY FACTOR LOADINGS						
	2000-2008			**AU**	**BD**	**CN**	**JP**	**SA**	**UK**	**US**
Round 1	EV PC1	5.086	72.7	0.432	0.436	0.431	0.200	0.323	0.439	0.317
(ALL)	EV PC2	1.781	25.4	-0.144	-0.101	-0.111	0.661	-0.505	0.052	0.511
	EV PC3	0.051								
Round 2	EV PC1	3.890	97.3	0.503	0.502	0.500	n/a	n/a	0.495	n/a
(AU, BD, CN & UK)	EV PC2	0.062	1.56							
JP, SA, and US were excluded from CG1 as they had higher factor loadings (HFLs) in the second principal component (PC2). This improved the capability of the first principal component (PC1) to explain the variability in bond market indices (BMIs) (i.e. the R^2 value increased from 72.7% to 97.3%).										
Round 3a	EV PC1	4.053	81.1	0.485	0.488	0.484	0.225	n/a	0.491	n/a
(AU, BD, CN, JP & UK)	EV PC2	0.874	17.5							
Round 3b	EV PC1	4.567	91.4	0.465	0.463	0.460	n/a	0.400	0.445	n/a
(AU, BD, CN, SA & UK)	EV PC2	0.360	7.21							
Round 3c	EV PC1	4.359	87.2	0.465	0.468	0.465	n/a	n/a	0.475	0.350
(AU, BD, CN, UK & US)	EV PC2	0.576	11.5							
SA was retained in CG1 as the capability of PC1 to explain the variability in BMIs remained extremely high after its re-inclusion.										
Round 4	EV PC1	1.908	95.4	n/a	n/a	n/a	0.707	n/a	n/a	0.707
(JP & US)	EV PC2	0.092	4.61	n/a	n/a	n/a	-0.707	n/a	n/a	0.707
As a result, AU, BD, CN, SA and UK formed CG1 and JP and US formed CG2.										
	2000-2004									
Round 1	EV PC1	5.148	73.5	0.412	0.418	0.434	0.321	0.185	0.436	0.374
(ALL)	EV PC2	1.724	24.6	0.244	0.232	0.035	-0.514	0.683	-0.066	-0.388
	EV PC3	0.052	0.75							
Similarly, JP, SA and US were again excluded from CG1.										
Round 2	EV PC1	3.811	95.3	0.500	0.502	0.503	n/a	n/a	0.494	n/a
(AU, BD, CN & UK)	EV PC2	0.137	3.42							

Round 3a	EV PC1	4.256	85.1	0.458	0.461	0.478	0.347	n/a	0.479	n/a
(AU, BD, CN, JP & UK)	EV PC2	0.674	13.5	-0.380	-0.348	-0.042	0.847	n/a	0.126	n/a
Round 3b	EV PC1	4.169	83.4	0.485	0.487	0.469	n/a	0.319	0.453	n/a
(AU, BD, CN, SA & UK)	EV PC2	0.758	15.2	0.039	0.036	-0.272	n/a	0.869	-0.411	n/a
Round 3c	EV PC1	4.448	89.0	0.448	0.453	0.468	n/a	n/a	0.468	0.395
(AU, BD, CN, UK & US)	EV PC2	0.486	9.72	-0.448	-0.388	-0.025	n/a	n/a	0.165	0.788
Round 4a	EV PC1	4.491	74.9	0.459	0.463	0.463	0.295	0.255	0.456	n/a
(AU, BD, CN, JP, SA & UK)	EV PC2	1.407	23.5	0.152	0.142	-0.078	-0.650	0.702	-0.190	n/a
	EV PC3	0.047	0.78							
Round 4b	EV PC1	5.006	83.4	0.404	0.409	0.436	0.351	n/a	0.444	0.399
(AU, BD, CN, JP, UK & US)	EV PC2	0.904	15.1	-0.437	-0.405	-0.148	0.641	n/a	-0.004	0.461
Round 4c	EV PC1	4.690	78.2	0.449	0.453	0.453	n/a	0.250	0.447	0.355
(AU, BD, CN, SA, UK & US)	EV PC2	1.205	20.1	0.168	0.153	-0.088	n/a	0.758	-0.206	-0.569
	EV PC3	0.051	0.85							
JP, and US were re-included in CG1 as they did not appear to distort the capability of PC1 to explain the variability in BMIs. In contrast, if SA was re-included in CG1 with either JP or US, there would emerge two statistically significant PCs. Hence, it was treated as independent.										
	2001-2005									
Round 1	EV PC1	4.326	61.8	0.434	0.444	0.450	0.267	0.129	0.470	0.321
(ALL)	EV PC2	2.465	35.2	0.257	0.212	0.124	-0.523	0.608	-0.106	-0.468
	EV PC3	0.126	1.80							
Round 2	EV PC1	3.647	91.2	0.507	0.509	0.501	n/a	n/a	0.483	n/a
(AU, BD, CN & UK)	EV PC2	0.218	5.45							

Round 3a	EV PC1	3.830	76.6	0.478	0.485	0.484	0.248	n/a	0.490	n/a
(AU, BD, CN, JP & UK)	EV PC2	1.009	20.2	-0.328	-0.246	-0.127	0.868	n/a	0.250	n/a
	EV PC3	0.123	2.46							
Round 3b	EV PC1	3.909	78.2	0.499	0.497	0.479	n/a	0.289	0.437	n/a
(AU, BD, CN, SA & UK)	EV PC2	0.929	18.6							
Round 3c	EV PC1	3.962	79.2	0.466	0.473	0.477	n/a	n/a	0.484	0.311
(AU, BD, CN, UK & US)	EV PC2	0.884	17.7							
Round 4	EV PC1	2.426	80.9	n/a	n/a	n/a	0.626	-0.494	n/a	0.603
(JP, SA & US)	EV PC2	0.549	18.3							
JP, SA and US were all excluded from CG1 as they all had a marked influence on the capability of PC1 to explain the variability in BMIs. When analysed collectively, one statistically significant PC emerged with a high R^2. Hence, they formed CG2.										
	2002-2006									
Round 1	EV PC1	4.038	57.7	0.453	0.469	0.454	0.212	0.088	0.482	0.290
(ALL)	EV PC2	2.746	39.2	0.229	0.150	0.193	-0.540	0.590	-0.122	-0.483
	EV PC3	0.119	1.70							
Round 2	EV PC1	3.628	90.7	0.509	0.511	0.503	n/a	n/a	0.476	n/a
(AU, BD, CN & UK)	EV PC2	0.246	6.16							
Round 3a	EV PC1	3.704	74.1	0.493	0.502	0.489	0.167	n/a	0.488	n/a
(AU, BD, CN, JP & UK)	EV PC2	1.133	22.7	-0.258	-0.115	-0.219	0.886	n/a	0.295	n/a
	EV PC3	0.105	2.10							
Round 3b	EV PC1	3.806	76.1	0.505	0.499	0.495	n/a	0.246	0.437	n/a
(AU, BD, CN, SA & UK)	EV PC2	1.031	20.6	0.066	-0.067	0.015	n/a	0.860	-0.501	n/a
	EV PC3	0.109	2.18							

Round 3c	EV PC1	3.842	76.9	0.477	0.488	0.477	n/a	n/a	0.485	0.267
(AU, BD, CN, UK & US)	EV PC2	0.993	19.9							
Round 4	EV PC1	2.621	87.4	n/a	n/a	n/a	0.608	-0.540	n/a	0.582
(JP, SA & US)	EV PC2	0.351	11.7							
Similarly, JP, SA and US again formed CG2, while AU, BD, CN, and UK, formed CG1.										
	2003-2007									
Round 1	EV PC1	5.258	75.1	0.428	0.433	0.422	0.180	0.338	0.433	0.343
(ALL)	EV PC2	1.578	22.6	-0.110	-0.025	-0.167	0.713	-0.485	0.011	0.464
	EV PC3	0.071	1.01							
Round 2	EV PC1	3.913	97.8	0.501	0.502	0.497	n/a	n/a	0.499	n/a
(AU, BD, CN & UK)	EV PC2	0.059	1.47							
Round 3a	EV PC1	4.051	81.0	0.488	0.495	0.480	0.209	n/a	0.493	n/a
(AU, BD, CN, JP & UK)	EV PC2	0.894	17.9							
Round 3b	EV PC1	4.636	92.7	0.460	0.456	0.460	n/a	0.407	0.451	n/a
(AU, BD, CN, SA & UK)	EV PC2	0.307	6.13							
Round 3c	EV PC1	4.495	89.9	0.461	0.468	0.454	n/a	n/a	0.468	0.378
(AU, BD, CN, UK & US)	EV PC2	0.443	8.86							
Round 4a	EV PC1	4.706	78.4	0.457	0.457	0.454	0.137	0.390	0.453	n/a
(AU, BD, CN, JP, SA & UK)	EV PC2	1.195	19.9	-0.007	0.094	-0.081	0.869	-0.461	0.129	n/a
	EV PC3	0.046	0.77							
Round 4b	EV PC1	4.723	78.7	0.439	0.451	0.429	0.242	n/a	0.454	0.393
(AU, BD, CN, JP, UK & US)	EV PC2	1.157	19.3	-0.252	-0.150	-0.313	0.780	n/a	-0.111	0.442

	EV PC3	0.071	1.18							
Round 4c	EV PC1	5.120	85.3	0.437	0.438	0.434	n/a	0.364	0.436	0.325
(AU, BD, CN, SA, UK & US)	EV PC2	0.773	12.9							
SA was retained in CG1 as the capability of PC1 to explain the variability in BMIs remained extremely high after its re-inclusion. JP and US formed CG2, while AU, BD, CN, and UK formed CG1.										
Round 5	EV PC1	1.821	91.1	n/a	n/a	n/a	0.707	n/a	n/a	0.707
(JP & US)	EV PC2	0.179	8.90							
	2004-2008									
Round 1	EV PC1	6.167	88.1	0.400	0.401	0.396	0.345	0.305	0.398	0.391
(ALL)	EV PC2	0.715	10.2	0.012	-0.067	0.169	-0.580	0.760	0.032	-0.229
Although only one statistically significant PC emerged, further analysis was warranted because it appeared that JP and SA were still not well explained by PC1 as they both maintained higher factor loadings in PC2.										
Round 2	EV PC1	4.870	97.4	0.450	0.450	0.445	n/a	n/a	0.449	0.442
(AU, BD, CN, UK & US)	EV PC2	0.076	1.5	-0.158	0.056	-0.603	n/a	n/a	-0.064	0.777
Round 3a	EV PC1	5.639	94.0	0.416	0.419	0.407	0.377	n/a	0.414	0.414
(AU, BD, CN, JP, UK & US)	EV PC2	0.287	4.78	-0.199	-0.041	-0.439	0.824	n/a	-0.245	0.166
Round 3b	EV PC1	5.470	91.2	0.424	0.421	0.424	n/a	0.344	0.423	0.407
(AU, BD, CN, SA, UK & US)	EV PC2	0.457	7.60	-0.109	-0.186	0.082	n/a	0.874	-0.100	-0.415
Their collective exclusion from CG1 resulted in a noticeable increase in the capability of PC1 to explain the variability in BMIs. Thus, both these markets were still considered outliers in CG1, and therefore although initially only one statistically significant PC was found, these two markets would still present effective bond diversification opportunities as they are still not well integrated with the bond markets of AU, BD, CN, UK, and US.										
Round 4	EV PC1	1.352	67.6	n/a	n/a	n/a	0.707	0.707	n/a	n/a
(JP & SA)	EV PC2	0.648	32.4	n/a	n/a	n/a	-0.707	0.707	n/a	n/a
Although only PC1 was statistically significant its R^2 value was 67.6, while that of PC2 was 32.4%. This suggests that each market was more or less accounting for its own variation in BMIs. Hence, JP and SA were both treated as independent markets, while AU, BD, CN, UK and US formed convergence group one (CG1).										

Note: n/a means not applicable. CG1 and CG2, refers to convergence group one and two respectively. HFLs means higher factor loadings. EV PC1, EV PC2, and EV PC3 means eigenvalue of the first principle component, eigenvalue of the second principle component, and eigenvalue of the third principle component, respectively. ALL refers to all the bond markets selected in the study.

Table-A 4.11: BMY Unit Root Test Results

1990-2008			AU	BD	CN	JP	SA	UK	US
DF-GLS	Level	Intercept	-0.12	-0.24	0.65	-0.11	-0.43	0.16	-0.28
		Intercept & Trend	-1.41	-2.15	-3.30[b]	-1.80	-2.29	-1.91	-3.35[b]
	1st Diff	Intercept	-3.93[a]	-1.28	-1.04	-8.67[a]	-10.9[a]	-3.32[a]	-13.0[a]
		Intercept & Trend	-5.4[a]	-2.83[c]	-4.86[a]	-9.77[a]	-9.56[a]	-11.0[a]	-13.8[a]
NP	Level	Intercept	-0.11	-0.32	0.86	-0.13	-1.17	0.20	-0.51
		Intercept & Trend	-4.89	-9.86	-19.9[b]	-7.35	-10.6	-8.14	-20.5[b]
	1st Diff	Intercept	-39.1[a]	-3.95	-1.72	-192[a]	-102[a]	-12.5[b]	-103[a]
		Intercept & Trend	-54.4[a]	-22.4[b]	-40.2[a]	-291[a]	-93.7[a]	-109[a]	-108[a]
1990-1994									
DF-GLS	Level	Intercept	-0.72	-1.25	-1.02	-0.52	-1.81[c]	-0.81	-0.98
		Intercept & Trend	-0.53	-1.12	-1.07	-1.53	-1.92	-1.37	-0.81
	1st Diff	Intercept	-5.13[a]	-0.86	-4.30[a]	-5.68[a]	-4.37[a]	-4.97[a]	-6.44[a]
		Intercept & Trend	-5.55[a]	-1.66	-5.30[a]	-6.29[a]	-4.39[a]	-5.69[a]	-6.64[a]
NP	Level	Intercept	-0.82	-1.83	-1.91	-0.70	-7.34[c]	-1.27	-1.66
		Intercept & Trend	-1.26	-2.96	-3.09	-4.69	-9.41	-4.45	-2.27
	1st Diff	Intercept	-22.7[a]	-2.09	-19.6[a]	-26.6[a]	-22.1[a]	-26.3[a]	-28.0[a]
		Intercept & Trend	-24.7[a]	-5.66[b]	-24.1[a]	-28.0[a]	-22.2[b]	-27.6[a]	-28.4[a]
1991-1995									
DF-GLS	Level	Intercept	-0.73	-0.17	-0.72	0.10	-1.91[c]	-0.68	-0.44
		Intercept & Trend	-1.23	-1.64	-1.55	-2.12	-2.01	-1.54	-1.37
	1st Diff	Intercept	-6.69[a]	-4.44[a]	-5.88[a]	-6.69[a]	-3.75[a]	-6.46[a]	-6.30[a]
		Intercept & Trend	-6.74[a]	-5.35[a]	-6.40[a]	-6.94[a]	-4.05[a]	-6.46[a]	-6.31[a]
NP	Level	Intercept	-1.12	-0.53	-1.38	0.42	-7.81[c]	-1.18	-0.77
		Intercept & Trend	-2.66	-5.61	-4.25	-7.88	-8.28	-4.41	-3.71
	1st Diff	Intercept	-29.1[a]	-19.7[a]	-25.2[a]	-30.4[a]	-17.6[a]	-28.8[a]	-28.4[a]
		Intercept & Trend	-29.0[a]	-24.7[a]	-27.9[a]	-29.5[a]	-19.7[b]	-28.8[a]	-28.5[a]
1992-1996									
DF-GLS	Level	Intercept	-0.85	-0.24	-1.80[c]	0.00	-1.89[c]	-1.17	-2.00[b]
		Intercept & Trend	-1.31	-1.43	-2.10	-2.25	-2.14	-1.97	-2.19
	1st Diff	Intercept	-6.40[a]	-6.13[a]	-6.15[a]	-7.17[a]	-4.67[a]	-6.47[a]	-5.41[a]
		Intercept & Trend	-6.39[a]	-6.10[a]	-6.16[a]	-7.32[a]	-4.79[a]	-6.53[a]	-5.4[a]
NP	Level	Intercept	-1.83	-0.21	-8.58[b]	0.28	-6.94[c]	-2.81	-8.10[c]
		Intercept & Trend	-3.15	-3.91	-9.64	-8.80	-8.57	-7.76	-9.85[b]
	1st Diff	Intercept	-28.8[a]	-31.1[a]	-33.4[a]	-28.9[a]	-24.1[a]	-35.6[a]	-29.6[a]
		Intercept & Trend	-28.8[a]	-28.6[a]	-29.1[a]	-29.4[a]	-23.5[b]	-30.9[a]	-27.0[a]
1993-1997									
DF-GLS	Level	Intercept	-0.46	-0.35	-0.42	0.41	-2.01[b]	-0.91	-2.00[b]
		Intercept & Trend	-0.97	-1.51	-1.77	-2.01	-2.02	-1.39	-2.02[b]
	1st Diff	Intercept	-1.76[c]	-1.76[c]	-4.48[a]	-2.95[a]	-4.52[a]	-5.49[a]	-21.8[a]
		Intercept & Trend	-5.55[a]	-5.93[a]	-5.49[a]	-6.72[a]	-4.82[a]	-6.12[a]	-25.6[a]
NP	Level	Intercept	-1.08	-0.64	-1.00	1.08	-8.62[b]	-2.85	-8.68[b]
		Intercept & Trend	-2.37	-4.64	-6.08	-7.70	-9.26	-4.40	-8.69
	1st Diff	Intercept	-6.51[c]	-7.36[c]	-18.0[a]	-11.6[b]	-21.8[a]	-23.8[a]	-21.8[a]
		Intercept & Trend	-23.7[b]	-22.6[b]	-22.7[b]	-26.3[a]	-23.7[b]	-26.8[a]	-25.6[a]

1994-1998									
DF-GLS	Level	Intercept	-0.35	0.72	-0.33	0.48	-1.31	0.45	-0.67
		Intercept & Trend	-1.42	-1.05	-1.74	-1.56	-2.07	-0.64	-1.48
	1st Diff	Intercept	-1.50	-1.37	-1.66[c]	-3.99[a]	-4.20[a]	-0.24	-1.50
		Intercept & Trend	-6.63[a]	-6.65[a]	-6.10[a]	-4.03[a]	-4.93[a]	-1.72	-5.30
NP	Level	Intercept	-0.55	1.24	-0.60	-0.23	-4.60	0.78	-1.55
		Intercept & Trend	-2.14	-1.73	-3.61	-6.12	-8.52	-0.30	-3.58
	1st Diff	Intercept	-3.58	-6.38[c]	-3.97	-25.7[a]	-19.0[a]	0.42	-3.83
		Intercept & Trend	-29.4[a]	-23.6[b]	-30.9[a]	-23.5[b]	-23.9[a]	-3.77	-24.7[a]
1995-1999									
DF-GLS	Level	Intercept	-0.64	-0.63	-0.65	-0.13	-2.11[b]	-0.23	-1.13
		Intercept & Trend	-0.91	-0.93	-1.17	-1.72	-3.01[c]	-1.67	-1.39
	1st Diff	Intercept	-6.57[a]	-6.68[a]	-1.60	-6.85[a]	-5.33[a]	-7.50[a]	-5.50[a]
		Intercept & Trend	-7.96[a]	-6.99[a]	-7.38	-7.39[a]	-5.40[a]	-7.93[a]	-6.47[a]
NP	Level	Intercept	-0.56	-0.61	-0.58	-0.16	-11.0[b]	-0.12	-2.03
		Intercept & Trend	-2.88	-3.01	-3.96	-6.41	-18.1[b]	-5.77	-4.51
	1st Diff	Intercept	-24.5[a]	-29.4[a]	-8.46[b]	-90.8[a]	-26.0[a]	-27.2[a]	-23.3[a]
		Intercept & Trend	-28.6[a]	-29.3[a]	-26.2[a]	-1209[a]	-26.4[a]	-29.0[a]	-27.9[a]
1996-2000									
DF-GLS	Level	Intercept	-0.54	-0.88	-0.90	-0.79	-2.43[b]	-0.19	-1.38
		Intercept & Trend	-1.44	-1.21	-1.62	-1.42	-2.89[c]	-1.56	-1.62
	1st Diff	Intercept	-2.68[a]	-0.85	-1.58	-6.51[a]	-4.84[a]	-0.88	-1.01
		Intercept & Trend	-6.00[a]	-5.11[a]	-2.51	-7.17[a]	-5.16[a]	-1.73	-2.08
NP	Level	Intercept	-0.85	-1.62	-1.82	-0.95	-13.8[a]	-0.11	-4.01
		Intercept & Trend	-3.90	-2.92	-4.90	-4.29	-19.1[b]	-4.61	-4.83
	1st Diff	Intercept	-14.1[a]	-2.79	-6.92[c]	-3981[a]	-27.8[a]	-1.99	-3.75
		Intercept & Trend	-24.5[a]	-20.4[b]	-10.6	-3671[a]	-26.6[a]	-3.53	-7.63
1997-2001									
DF-GLS	Level	Intercept	-1.26	-1.18	-1.34	-0.81	-1.38	-0.67	-1.13
		Intercept & Trend	-1.72	-1.38	-2.02	-1.85	-2.50	-1.53	-1.77
	1st Diff	Intercept	-5.96[a]	-5.65[a]	-8.07[a]	-7.04[a]	-4.40[a]	-7.47[a]	-6.35[a]
		Intercept & Trend	-6.78[a]	-6.06[a]	-8.76[a]	-7.12[a]	-4.37[a]	-7.45[a]	-6.63[a]
NP	Level	Intercept	-2.80	-2.52	-3.45	-1.66	-4.58	-0.81	-2.82
		Intercept & Trend	-5.30	-3.50	-6.72	-6.62	-12.5	-4.52	-5.64
	1st Diff	Intercept	-28.9[a]	-31.3[a]	-37.8[a]	-2742[a]	-23.2[a]	-40.0[a]	-33.1[a]
		Intercept & Trend	-29.1[a]	-28.6[a]	-31.8[a]	-41978[a]	-21.7[b]	-32.2[a]	-30.1[a]
1998-2002									
DF-GLS	Level	Intercept	-2.01[b]	-1.35	-1.99[b]	-0.55	-0.51	-1.05	-0.71
		Intercept & Trend	-2.05	-1.47	-2.08	-1.84	-1.83	-2.21	-1.50
	1st Diff	Intercept	-7.45[a]	-5.79[a]	-8.44[a]	-5.99[a]	-5.72[a]	-7.34[a]	-6.24[a]
		Intercept & Trend	-7.23[a]	-6.17[a]	-8.47[a]	-6.11[a]	-5.84[a]	-7.21[a]	-6.50[a]
NP	Level	Intercept	-8.13[b]	-4.15	-8.13[b]	-1.09	-1.16	-2.81	-2.24
		Intercept & Trend	-8.15	-4.46	-8.50	-7.12	-5.49	-8.23	-5.00
	1st Diff	Intercept	-35.0[a]	-25.9[a]	-31.7[a]	-27.7[a]	-27.5[a]	-32.6[a]	-27.3[a]
		Intercept & Trend	-29.9[a]	-28.0[a]	-29.0[a]	-28.1[a]	-27.7[a]	-29.3[a]	-28.4[a]
1999-2003									

DF-GLS	Level	Intercept	-1.63[c]	-1.13	-1.52	-1.25	0.63	-1.56	-1.36
		Intercept & Trend	-2.13	-1.53	-2.20	-3.56[b]	-2.56	-2.12	-2.20
	1st Diff	Intercept	-1.75[c]	-1.60	-1.55	-4.75[a]	-4.51[a]	-1.41	-1.70[c]
		Intercept & Trend	-5.59[a]	-2.77	-6.94[a]	-4.78[a]	-5.93[a]	-2.31	-6.46[a]
NP	Level	Intercept	-4.61	-1.98	-4.54	-2.88	1.18	-4.22	-3.68
		Intercept & Trend	-6.65	-3.07	-7.28	-45.7[a]	-10.8	-6.42	-7.10
	1st Diff	Intercept	-12.0[b]	-6.02[c]	-4.06	-20.1[a]	-16.9[a]	-5.92[c]	-12.3[b]
		Intercept & Trend	-21.8[b]	-12.3	-24.9[a]	-32.7[a]	-23.9[a]	-12.5	-23.5[b]
2000-2004									
DF-GLS	Level	Intercept	-1.12	-0.19	-0.38	-1.45	0.52	-1.27	-0.96
		Intercept & Trend	-2.41	-2.88[c]	-3.62[b]	-2.53	-2.17	-2.32	-2.50
	1st Diff	Intercept	-5.12[a]	-7.08[a]	-5.31[a]	-3.17[a]	-6.28[a]	-2.32[b]	-7.20[a]
		Intercept & Trend	-6.61[a]	-6.77[a]	-7.07[a]	-3.54[b]	-6.19[a]	-6.87[a]	-7.45[a]
NP	Level	Intercept	-2.45	-0.08	-0.42	-3.84	1.13	-3.15	-1.82
		Intercept & Trend	-8.83	-13.0	-17.2[c]	-16.6[c]	-8.38	-8.62	-10.5
	1st Diff	Intercept	-21.1[a]	-34.4[a]	-20.4[a]	-14.5[a]	-32.4[a]	-8.34[b]	-40.5[a]
		Intercept & Trend	-26.4[a]	-46.6[a]	-26.0[a]	-16.3[c]	-29.8[a]	-28.0[a]	-51.8[a]
2001-2005									
DF-GLS	Level	Intercept	-2.67[a]	-0.33	-0.67	-1.70[c]	0.53	-1.72[c]	-2.00[b]
		Intercept & Trend	-2.96[c]	-2.54	-3.52[b]	-2.64	-2.32	-2.35	-2.77
	1st Diff	Intercept	-7.18[a]	-7.10[a]	-7.72[a]	-3.40[a]	-4.99[a]	-7.29[a]	-7.63[a]
		Intercept & Trend	-7.56[a]	-7.14[a]	-7.77[a]	-6.70	-6.20[a]	-7.36[a]	-7.41[a]
NP	Level	Intercept	-11.6[b]	-0.57	-1.58	-5.30	1.20	-6.75[c]	-6.92[c]
		Intercept & Trend	-13.2	-10.4	-16.8[c]	-18.3[b]	-9.36	-9.69	-12.4
	1st Diff	Intercept	-27.6[a]	-29.5[a]	-30.1[a]	-14.7[a]	-19.8[a]	-29.3[a]	-29.1[a]
		Intercept & Trend	-28.9[a]	-29.4[a]	-29.6[a]	-28.9[a]	-25.8[a]	-29.4[a]	-55.5[a]
2002-2006									
DF-GLS	Level	Intercept	-2.15[b]	-1.00[b]	-0.84	-1.45	-0.61	-1.87[c]	-2.12[b]
		Intercept & Trend	-2.56	-1.62	-2.98[c]	-1.84	-2.88[c]	-2.08	-2.51
	1st Diff	Intercept	-8.24[a]	-6.31[a]	-7.48[a]	-6.73[a]	-4.67[a]	-5.97[a]	-7.24[a]
		Intercept & Trend	-8.25[a]	-6.74[a]	-7.41[a]	-6.78[a]	-5.15[a]	-6.52[a]	-7.56[a]
NP	Level	Intercept	-7.82[c]	-1.75	-1.68	-4.12	-0.95	-6.19[c]	-7.57[c]
		Intercept & Trend	-11.1	-5.69	-13.71	-5.56	-16.3[c]	-7.97	-9.90
	1st Diff	Intercept	-43.0[a]	-34.9[a]	-43.4[a]	-32.0[a]	-26.7[a]	-33.7[a]	-35.3[a]
		Intercept & Trend	-33.6[a]	-31.3[a]	-33.9[a]	-29.5[a]	-26.9[a]	-31.1[a]	-43.9[a]
2003-2007									
DF-GLS	Level	Intercept	-0.33	-1.50	-1.25	-1.03	-1.13	-1.68[c]	-2.40[b]
		Intercept & Trend	-1.62	-1.52	-2.59	-1.89	-2.34	-1.89	-3.31[b]
	1st Diff	Intercept	-5.41[a]	-6.42[a]	-6.81[a]	-6.62[a]	-5.13[a]	-6.01[a]	-5.95[a]
		Intercept & Trend	-4.87[a]	-6.81[a]	-6.91[a]	-6.80[a]	-5.47[a]	-6.56[a]	-7.01[a]
NP	Level	Intercept	0.16	-4.54	-3.42	-1.90	-2.85	-5.01	-9.59[b]
		Intercept & Trend	-5.41	-4.69	-10.8	-6.72	-12.8	-6.61	-17.0[c]
	1st Diff	Intercept	-10.8[b]	-29.6[a]	-31.9[a]	-34.7[a]	-24.7[a]	-27.0[a]	-23.1[a]
		Intercept & Trend	-48.9[a]	-29.0[a]	-30.0[a]	-31.4[a]	-26.5[a]	-28.2[a]	-25.5[a]
2004-2008									
DF-GLS	Level	Intercept	-1.65[c]	-1.30	-1.07	-2.00[b]	-1.42	-1.73[c]	-1.95[c]

		Intercept & Trend	-2.40	-1.55	-2.09	-2.45	-1.42	-2.39	-2.01
	1st Diff	Intercept	-5.09[a]	-4.99[a]	-5.21[a]	-5.95[a]	-5.45[a]	-4.58[a]	-6.18[a]
		Intercept & Trend	-7.17[a]	-6.20[a]	-5.82[a]	-6.78[a]	-4.83[a]	-5.23[a]	-6.67[a]
NP	Level	Intercept	-5.51	-3.31	-3.25	-6.86[c]	-3.67	-5.35	-6.84[c]
		Intercept & Trend	-8.82	-4.08	-7.89	-9.92	-4.26	-11.7	-7.28
	1st Diff	Intercept	-16.9[a]	-21.9[a]	-21.7[a]	-28.7[a]	-26.4[a]	-20.1[a]	-25.1[a]
		Intercept & Trend	-23.6[b]	-25.8[a]	-24.7[a]	-27.4[a]	-24.9[a]	-24.4[a]	-26.0[a]

Note: a, b, c indicate whether the variable is significant at the 1%, 5%, or 10% level of significance, respectively. DF-GLS and NP refer to the Dickey-Fuller Generalised Least Squares and the Ng and Perron (2001) tests, respectively.
Source: Computed by author.

Table-A 4.12: BMI Unit Root Test Results

2000-2008			AU	BD	CN	JP	SA	UK	US
DF-GLS	Level	Intercept	0.84	0.57	0.74	-1.59	1.65[c]	0.05	-0.66
		Intercept & Trend	-2.09	-1.93	-1.90	-1.86	-1.13	-1.82	-1.55
	1st Diff	Intercept	-7.53[a]	-9.37[a]	-9.17[a]	-9.89[a]	-7.63[a]	-7.06[a]	-8.41[a]
		Intercept & Trend	-8.41[a]	-9.56[a]	-8.96[a]	-9.75[a]	-6.88[a]	-8.53[a]	-8.69[a]
NP	Level	Intercept	1.28	0.93	1.14	-5.41	1.08	0.25	-1.30
		Intercept & Trend	-8.07	-6.65	-6.74	-6.58	-3.22	-5.95	-4.34
	1st Diff	Intercept	-39.4[a]	-45.3[a]	-48.8[a]	-51.5[a]	-45.4[a]	-35.8[a]	-51.3[a]
		Intercept & Trend	-45.4[a]	-46.6[a]	-48.0[a]	-49.0[a]	-45.2[a]	-43.4[a]	-48.6[a]
2000-2004									
DF-GLS	Level	Intercept	-0.85	-0.71	-0.98	-1.12	1.94[c]	-1.03	-0.99
		Intercept & Trend	-1.54	-1.49	-1.44	-1.30	-1.97	-1.34	-1.02
	1st Diff	Intercept	-6.17[a]	-6.93[a]	-6.63[a]	-7.29[a]	-5.95[a]	-5.76[a]	-5.86[a]
		Intercept & Trend	-6.54[a]	-7.47[a]	-6.88[a]	-7.98[a]	-5.87[a]	-6.90[a]	-6.76[a]
NP	Level	Intercept	-1.16	-0.71	-1.45	-2.46	2.01	-1.50	-1.50
		Intercept & Trend	-4.42	-3.72	-3.49	-2.94	-6.57	-2.95	-1.68
	1st Diff	Intercept	-24.1[a]	-25.1[a]	-26.5[a]	-27.5[a]	-26.0[a]	-22.2[a]	-26.2[a]
		Intercept & Trend	-24.9[a]	-26.1[a]	-26.0[a]	-25.9[a]	-25.6[a]	-25.3[a]	-26.1[a]
2001-2005									
DF-GLS	Level	Intercept	-0.89	-0.98	-0.81	-1.22	1.94[c]	-1.31	-1.31
		Intercept & Trend	-1.97	-1.91	-1.84	-1.70	-2.52	-1.76	-1.59
	1st Diff	Intercept	-6.08[a]	-7.93[a]	-7.33[a]	-8.42[a]	-3.13[a]	-7.31[a]	-7.15[a]
		Intercept & Trend	-6.83[a]	-8.12[a]	-7.65[a]	-8.58[a]	-6.37[a]	-7.57[a]	-7.26[a]
NP	Level	Intercept	-1.71	-1.82	-1.72	-3.23	1.80	-3.09	-3.17
		Intercept & Trend	-6.78	-6.32	-5.85	-4.79	-10.5	-5.20	-3.99
	1st Diff	Intercept	-26.6[a]	-28.7[a]	-27.8[a]	-30.2[a]	-14.2[a]	-29.1[a]	-31.6[a]
		Intercept & Trend	-28.3[a]	-28.8[a]	-28.9[a]	-29.7[a]	-26.7[a]	-28.8[a]	-29.7[a]
2002-2006									
DF-GLS	Level	Intercept	-1.34	-1.85[c]	-1.14	-1.03	1.48	-1.52	-1.10
		Intercept & Trend	-2.28	-2.55	-1.67	-1.93	-1.80	-1.63	-1.52
	1st Diff	Intercept	-7.18[a]	-8.77[a]	-8.01[a]	-8.76[a]	-3.68[a]	-7.80[a]	-7.50[a]
		Intercept & Trend	-7.21[a]	-8.76[a]	-8.09[a]	-8.71[a]	-6.49[a]	-7.97[a]	-7.59[a]
NP	Level	Intercept	-4.97	-7.77[c]	-3.19	-1.99	1.35	-4.68	-1.99
		Intercept & Trend	-9.31	-11.2	-4.96	-7.11	-6.24	-5.45	-4.79
	1st Diff	Intercept	-28.4[a]	-30.4[a]	-32.2[a]	-29.7[a]	-13.4[a]	-30.6[a]	-32.3[a]
		Intercept & Trend	-28.5[a]	-28.7[a]	-29.0[a]	-29.6[a]	-30.1[a]	-29.2[a]	-28.6[a]
2003-2007									
DF-GLS	Level	Intercept	-0.15	-0.75	0.45	-1.65[c]	1.08	-0.88	-1.60
		Intercept & Trend	-2.23	-2.47	-2.15	-2.34	-1.94	-2.03	-2.01
	1st Diff	Intercept	-7.23[a]	-7.57[a]	-7.54[a]	-7.61[a]	-6.65[a]	-1.20	-7.62[a]
		Intercept & Trend	-7.58[a]	-8.98[a]	-8.11[a]	-9.17[a]	-6.73[a]	-7.01[a]	-8.60[a]
NP	Level	Intercept	-0.20	-2.10	1.00	-4.48	1.17	-2.22	-4.53
		Intercept & Trend	-8.23	-9.69	-8.02	-8.80	-7.19	-6.21	-6.51
	1st Diff	Intercept	-34.2[a]	-25.8[a]	-29.1[a]	-24.9[a]	-28.9[a]	-3.14	-29.3[a]

		Intercept & Trend	-30.4[a]	-27.7[a]	-29.3[a]	-27.4[a]	-29.2[a]	-24.1[a]	-29.0[a]
2004-2008									
DF-GLS	Level	Intercept	0.31	-0.07	0.23	-1.60	0.13	-0.41	-1.08
		Intercept & Trend	-2.09	-2.29	-2.72[c]	-2.27	-1.51	-2.45	-2.51
	1st Diff	Intercept	-5.17[a]	-3.37[a]	-4.60[a]	-2.94[a]	-4.81[a]	-6.32[a]	-5.78[a]
		Intercept & Trend	-6.00[a]	-7.07[a]	-6.14[a]	-6.85[a]	-4.87[a]	-7.28[a]	-6.99[a]
NP	Level	Intercept	0.61	-0.02	0.51	-5.16	0.53	-0.71	-3.03
		Intercept & Trend	-6.39	-8.08	-10.53	-7.89	-4.28	-8.83	-9.30
	1st Diff	Intercept	-27.4[a]	-13.6[b]	-19.2[a]	-14.9[a]	-22.5[a]	-31.3[a]	-24.8[a]
		Intercept & Trend	-27.0[a]	-26.9[a]	-24.5[a]	-24.2[a]	-26.2[a]	-28.3[a]	-26.5[a]

Note: a, b, and c indicate whether the variable is significant at the 1%, 5%, or 10% level of significance, respectively. DF-GLS and NP refer to the Dickey-Fuller Generalised Least Squares and the Ng and Perron (2001) tests, respectively. Source:
Computed by author.

LIST OF REFERENCES

ALHASSAN, A., 2006. Prospects for International Portfolio Diversification: Linkages between the Ghanaian Equity Market and the World's Major Markets. *The African Finance Journal.* 8, 1: 1-13.

ALIBER, R.Z., and C.P., STICKNEY., 1975. Accounting Measures of Foreign Exchange Exposure: The Long and short of it. *The Accounting Review*. 50, 1: 44-57.

ALLEN, D.E., and MACDONALD, G., 1995. The Long-run Gains from International Equity Diversification: Australian Evidence from Cointegration Tests. *Journal of Applied Financial Economics.* 5: 33-42.

AZIAKPONO, M.J., 2006. Financial Integration amongst the SACU Countries: Evidence from Interest Rate Pass-Through Analysis. *Studies in Economics and Econometrics.* 30, 2: 1-23.

AZIAKPONO, M.J., KLEIMEIER, S., and SANDER, H., 2007. Banking Market Integration in the SADC Countries: Evidence from Interest Rate Analyses. Discussion paper. METEOR Version: November 2007.

AZIAKPONO, M.J., 2008a. Financial and Monetary Autonomy and Interdependence between South Africa and the Other SACU Countries. *South African Journal of Economics*. 76, 2: 189-211.

AZIAKPONO, M.J., 2008b. The Depth of Financial Integration and its Effects on the Financial Development and Economic Performance of the SACU Countries. Unpublished Doctoral thesis. Free State: Department of Economics, University of the Free Sate.

BALA, L., and PREMARATNE, G., 2004. Stock Market Volatility: Examining North America, Europe and Asia. National University of Singapore, Department of Economics. [Online]. Available: http://repec.org/esFEAM04/up.17856.1076663719.pdf [Accessed 12 October 2008].

BALASSA, B., 1964. The Purchasing Power Doctrine: A Reappraisal. *Journal of Political Economy*. 72: 584-596.

BARR, G.D.I., 1986. International Diversification After 1985 – The Argument Becomes Stronger. *South African Journal of Business Management*. 17, 3: 139-142.

BERTELSMANN FOUNDATION, 2007. *Social Policy, Labour Market Policy and Industrial Relations.* [Online]. Available: http://www.reformmonitor.org/httpd-cache/doc_news-3370.html [Accessed 1 May 2007].

BECKER, B., and HALL, S.G., 2007. A New Look at Economic Convergence in Europe: A Common Factor Approach. Loughborough University, Department of Economics, Discussion Paper Series 2007_09. [Online]. Available: https://dspace.lboro.ac.uk:8443/dspace/bitstream/2134/2747/3/Becker_Hall.pdf [Accessed 22 May 2008].

BENNETT, P., and KELLEHER, J., 1988. The International Transmission of Stock Price Disruption in October 1987. *Federal Reserve Bank of New York - Quarterly Review.* 3, 2: 17-33.

BHANA, N., 1986. International Share Portfolio Diversification: Possible Benefits for South African Investors. *South African Journal of Business Management*. 17, 3: 162-168.

BHANA, N., 1987. The Benefits to South African Investors from International Portfolio Diversification using An *Ex Ante* Investment Strategy. *South African Journal of Business Management*. 18, 2: 74-78.

BHANA, N., 1990. The use of Ex Post Inter-country Correlation Coefficients to Predict Gains From International Portfolio Diversification from the Stand Point of a South African Investor. *Investment Analysts Journal.* 32: 7-11.

BODIE, Z., KANE, A., and MARCUS, A.J., 2002. *Investments* (5e). McGraw-Hill Irwin: New York.

BOND EXCHANGE OF SOUTH AFRICA (BESA), 2000. BEASSA Total Return Indices 2000. Working Paper 0.1. [Online]. Available: http://www.bondexchange.co.za/besa/view/besa/en/page44998 [Accessed 4 February 2009 2008].

BOND EXCHANGE OF SOUTH AFRICA, 2005. *Market Performance* [Online]. Available: http://www.bondexchange.co.za/besa/view/besa/en/page12950[Accessed 20 March 2007]

BOTHA, Z., 2007. The South African Money Market.. *South African Institute of Financial Markets.* 1-137.

BROOKS, C., 2002. *Introductory Econometrics for Finance*. Cambridge: Cambridge University Press.

BURIK, P., and ENNIS, R.M., 1990. Foreign Bonds in Diversified Portfolios: A Limited Advantage. *Financial Analysts Journal.* 46, 2: 31-40.

CAPPIELLO, L., ENGLE, R.F., SHEPPARD, K.., 2006. Asymmetric Dynamics in the Correlations of Global Equity and Bond Returns. *Journal of Financial Econometrics.* 4, 4: 537-572.

CAVOLI, T., RAMKISHEN, S.R., and SIREGAR, R., 2004. A Survey of Financial Integration in East Asia; How Far? How Much Further to Go? Centre for International Economic Studies - Discussion Paper No. 0401. [Online]. Available: http://www.adelaide.edu.au/cies/papers/0401.pdf [Accessed 2 May 2008].

CHEUNG, Y., CHINN, M.D, and FUJII, E., 2003. China, Hong Kong, and Taiwan: A Quantitative Assessment of Real and Financial Integration. *China Economic Review.* 14, 3: 281-303.

CHANG, T., NIEH, C., and WEI, C., 2006. Analysis of Long-run Benefits from International Equity Diversification between Taiwan and its Major European Trading Partners: An Empirical Note. *Applied Economics.* 38, 19: 2277-2283.

CHINZARA, Z., 2007. *An Empirical Analysis of the Long-run Comovement, Dynamic Returns Linkages and Volatility Transmission between the World Major and the South African Stock Markets.* Unpublished Master of Commerce thesis. Grahamstown: Department of Economics, Rhodes University.

CHINZARA, Z., and AZIAKPONO, M.J., 2008. Integration of the South African Equity Market into the World Major Stock Markets: Implication for Portfolio Diversification. Unpublished working Paper. Grahamstown: Department of Economics, Rhodes University.

CHOLERTON, K.., PIERAERTS, P., and SOLNIK, B., 1986. Why Invest in Foreign Currency Bonds? *Journal of Portfolio Management.* 12, 4: 4-8.

CINER, C., 2007. Dynamic Linkages between International Bond Markets. *Journal of Multinational Financial Management.* 17, 4: 290-303.

CLARE, A.D, MARAS, M., and THOMAS, S.H., 1995. The Integration and Efficiency of International Bond Markets. *Journal of Business Finance and Accounting.* 22, 2: 313-322.

DEGENNARO, R., KUNKEL, R., and LEE, J., 1994. Modeling International Long-term Interest Rates. *The Financial Review*. 29, 4: 577-597.

DEMIRAG, I., and GODDARD, S., 1994. *Financial Management for International Business*. McGraw-Hill: New York.

DUFOUR, J.M., PELLETIER, D., RENAULT, E., 2006. Short Run and Long Run Causality in Time Series: Inference. *Journal of Econometrics*. 132, 2: 337-362.

EDISON, H.J., 1987. Purchasing Power Parity in the Long-run: A Test of the Dollar/Pound Exchange Rate (1890-1978). *Journal of Money, Credit and Banking*. 19, 3: 376-387.

ELLIOT, G., ROTHENBERG, T.J., and STOCK, J.H., 1996. Efficient Tests for an Autoregressive Unit Root. *Econometrica*. 64, 4: 813-836.

ENGLE, R.F., and GRANGER, C.W.J., 1987. Cointegration and Error Correction: Representation, Estimation, and Testing. *Econometrica*. 55, 2: 251-276.

ELTON, E., and GRUBER, J., 1995. *Modern Portfolio Theory and Investment Analysis* (5e). New York: John Wiley & Sons, INC.

FAURE, A.P., 2006. The Bond Market. *South African Institute of Financial Markets*. 1-167.

FIGUEIRA, C., NELLIS, J.G., and PARKER, D., 2005. Testing for International Financial Markets Integration. The Cranfield School of Management - Working Paper Series SWP 2/05. [Online]. Available: http://dspace.lib.cranfield.ac.uk:8080/bitstream/1826/852/2/SWP0205.pdf [Accessed 10 May 2008].

FLEMING, J., KIRBY, C., and OSTDIEK, B., 1998. Information and Volatility in the Stock, Bond, and Money Markets. *Journal of Financial Economics*. 49, 1: 111-137.

FRENKEL, J.A., 1981. The Collapse of Purchasing Power Parity During the 1970s. *European Economic Review*. 16, 145-165.

GAILLIOT, H.J., 1970. Purchasing Power Parity as An Explanation of Long-term Changes in the Exchange Rates. *Journal of Money, Credit and Banking*. 2, 3: 348-357.

GALLO, J.G., LOCKWOOD, L.J., and SWANSON, P.E., 1997. The Performance of International Bond Funds. *International Review of Economics and Finance*. 6, 1: 17-35.

GILMORE, C.G., LUCEY, B.M., and MCMANUS, G.M., 2006. The Dynamics of Central European Equity Market Comovements. *The Quarterly Review of Economics and Finance*. (Article in Press).

GONZALO, J., 1994. Five Alternative Methods of Estimating Long-run Equilibrium Relationships. *Journal of Econometrics*. 60, 1-2: 203-233.

GOODFRIEND, M., 1998. Using the Term Structure of Interest Rates for Monetary Policy. *Federal Reserve Bank of Richmond Economic Quarterly*. 84, 3: 13-18.

GOODSPEED, I., 2006. Introduction to Financial Markets. *South African Institute of Financial Markets*. 1-92.

GRUBEL, H.G., 1968. Internationally Diversified Portfolios: Welfare Gains and Capital Flows. *American Economic Review*. 58, 5: 1299-1314.

HARCOURT, T., 2004. *Essays on Australia and the Global Economy.* [Online]. Available: http://www.austrade.gov.au/Beyond-Our-Shores/default.aspx [Accessed 1 May 2007].

HOSHI, T., and KASHYAP, A.K., 2004. Japan's Financial Crisis and Economic Stagnation. *Journal of Economic Perspectives.* 18, 1: 3-26.

HOWELLS, P., and BAIN, K., 2005. *The Economics of Money, Banking and Finance* (3e). New York: Prentice Hall.

HU, J., and LIN, C., 2008. Disaggregated Energy Consumption and GDP in Taiwan: A Threshold Co-integration analysis. *Energy Economics.* 30, 5: 2342-2358.

HUMAVINDU, M.N., and FLOROS, C., 2006. Integration and Volatility Spillovers in African Equity Markets: Evidence from Namibia and South Africa. *The African Journal of Finance.* 8, 2: 31-50.

HUNTER, D.M. and SIMON, D.P., 2005. A Conditional Assessment of the Major World Bond Markets. *European Financial Management.* 11, 4: 463-482.

IBBOTSON, R.G., CARR, R.C., and ROBINSON, A.W., 1982. International Equity and Bond Returns. *Financial Analysts Journal.* 38, 4: 61-83.

INTERNATIONAL MONETARY FUND (IMF), 2001. *Prospects and Policy Challenges.* [Online]. Available: http://www.imf.org/external/pubs/ft/weo/2001/02/pdf/chapter1.pdf [Accessed 15 November].

INTERNATIONAL MONETARY FUND (IMF), 2002. *Overview: Key Developments and Sources of Financial Market Risks.* [Online]. Available: http://www.imf.org/External/Pubs/FT/GFSR/2002/03/pdf/chp1.pdf [Accessed 5 November 2008].

INTERNATIONAL MONETARY FUND (IMF), 2003. *World Economic Outlook April 2003: Growth and Institutions.* [Online]. Available: http://www.imf.org/external/pubs/ft/weo/2003/01/pdf/chapter1.pdf [Accessed 15 November].

INTERNATIONAL MONETARY FUND (IMF), 2008. *Navigating the Financial Storm: The Financial Crisis and the Global Economic Outlook-lessons and Policy Challenges.* [Online]. Available: http://www.imf.org/external/np/speeches/2008/030708.htm [Accessed 22 October 2008].

ISARD, P., 1977. How Far can we Push the "Law of One Price"? *American Economic Review.* 67, 5: 942-948.

JOHANSEN, S., 1988. Statistical Analysis of Cointegration Vectors. *Journal of Economic Dynamics and Control.* 12, 231-254.

JOHANSEN, S., 1991. Estimation and Hypothesis Testing of Cointegration Vectors in Gaussian Vector Autoregressive Models. *Econometrica.* 59, 1551-1580.

JOHANSEN, S. and JUSELIUS, K., 1990. The Full Information Maximum Likelihood Procedure for Inference on Cointegration – with Applications to the Demand for Money. *Oxford Bulletin of Economics and Statistics.* 52, 169-210.

JOLLIFFE, I.T., 2002. *Principal Component Analysis* (2e). New York: Springer.

KAISER, H.F., 1960. The Application of Electronic Computers to Factor Analysis. *Educational and Psychological Measurement.* 20: 141-151.

KAPETANIOS, G., 2001. Incorporating Lag Order Selection Uncertainty in Parameter Inference for AR Models. *Economic Letters.* 72, 2: 137-144.

KIM, S.J., LUCEY, B.M., and WU, E., 2006. Dynamics of Bond Market Integration Between Established and Accession European Union Countries. *Journal of International Financial Markets, Institutions & Money.* 16, 1: 41-56.

KIRCHGÄSSNER, G., and WOLTERS, J., 1987. US-European Interest Rate Linkages: A Time Series Analysis for West Germany, Switzerland, and the United States. *The Review of Economics and Statistics.* 69, 4: 675-684.

KLEIMEIER, S., and SANDER, H., 2006. Expected versus Unexpected Monetary Policy Impulses and Interest rate Pass-through in Euro-zone Retail Banking Markets. *Journal of Banking & Finance.* 30, 7:1839-1870.

KUTTNER, K.N., and POSEN, A.S., 2001. The Great Recession: Lessons for Macroeconomic Policy from Japan. *Brookings Papers on Economic Activity.* 2001, 2: 93-160.

LAMBA, A.S., and OTCHERE, I., 2001a. An Analysis of the Linkages among African and World Equity Markets. *The African Finance Journal.* 3, 2: 1-25.

LAMBA, A.S., and OTCHERE I., 2001b. An Analyses of the Dynamic Relationships between the South African Equity Market and Major World Equity Markets. *Multinational Finance Journal.* 5, 3: 201-224.

LESSARD, D.R., 1973. International Portfolio Diversification: A Multivariate Analysis for a Group of Latin American Countries. 28, 3: 619-633.

LEVY, H., and LERMAN, Z., 1988. The Benefits of International Diversification in Bonds. *Financial Analysts Journal.* 44, 5: 56-64.

LEVY, H., and SARNAT, M., 1970. International Diversification of Investment Portfolios. *The American Economic Review.* 60, 4: 668-675.

LIM, E.S., GALLO, J.G., and SWANSON, P.E., 1998. The Relationship between International Bond Markets and International Stock Markets. *International Review of Financial Analysis.* 7, 2: 181-190.

LOCKE, R., 2004. Japan, Refutation of Neoliberalism. *Post-Autistic Economics Review.* 23, 5.

LUCEY, B.M., and STEELEY, J., 2006. Measuring and Assessing the Effects and Extent of International Bond Market Integration. *Journal of International Financial Markets, Institutions & Money.* 16, 1: 1-3.

MARKOWITZ, H., 1952. Portfolio Selection. *The Journal of Finance.* 7, 1: 77-91.

MASIH, A.M.M, and MASIH, R., 1995. Investigating the Robustness of Tests of the Market Efficiency Hypothesis: Contributions from Cointegration Techniques on the Canadian Dollar. *Applied Financial Economics.* 5, 3:139-150.

MASIH, R., and MASIH, A.M.M, 2000. A Reassessment of Long-run Elasticities of Japanese Import Demand. *Journal of Policy Modelling.* 22, 2:625-639.

MERIC, I., RATNER, M., and MERIC, G., 2008. Co-movements of Sector Index Returns in the World's Major Stock Markets in Bull and Bear Markets: Portfolio Diversification Implications. *International Review of Financial Analysis.* 17, 1: 156-177.

MILLS, T.C., and MILLS, A.G., 1991. The International Transmission of Bond Market movements. *Bulletin of Economic Research.* 43, 3: 273-281.

MILONE, L.M., 1986. Law of One Price: Further Empirical Evidence concerning Italy and the UK. *Applied Economics.* 18, 6: 645-661.

MISHKIN, F.S., 2004. *The Economics of Money, Banking, and Financial Markets* (7e). New York: Pearson Addison Wesley.

MSN ENCARTA, 2008. *The Internet Bubble.* [Online]. Available: http://encarta.msn.com/media_701610607/the_internet_bubble.html [Accessed 19 October 2008].

NELLIS, J.G., 1982. A Principal Components Analysis of International Financial Integration under Fixed and Floating Exchange Rate Regimes. *Applied Economics.* 14, 4: 339-354.

NG, S., and PERRON, P., 2001. Lag Length Selection and the Construction of Unit Root Tests with Good Size and Power. *Econometrica.* 69, 6: 1519-1554.

PATRICK, I.D., and WARD, M.J.D., 1996. International Diversification and the Portfolio Investor. *Transactions of the Actuarial Society of South Africa.* 11**:** 334-417.

PATTERSON, A., 2008. Overview of the World's Ten Largest Economies. [Online]. Available: http://ezinearticles.com/?Overview-of-the-Worlds-Ten-Largest-Economies&id=1484083 [Accessed 13 October 2008].

PHILIPPATOS, A., CHRISTOFI, A., and CHRISTOFI, P., 1983. The Inter-temporal Stability of International Stock Market Relationships: Another View. *Financial Management.* 12, 4: 63-69.

POLWITOON, S., and TAWATNUNTACHAI, O., 2006. Diversification Benefits and Persistence of US-Based Global Bond Funds. *Journal of Banking & Finance.* 30, 10: 2767-2786.

RANGVID, J., 2001. Increasing Convergence among European Stock Markets? A Recursive Common Stochastic Trends Analysis. *Economic Letters.* 71, 3: 383–389.

RAPACH, D.E., and WEBER, C.E., 2004. Are Real Interest Rates really Nonstationary? New Evidence from Tests with Good Size and Power. *Journal of Macroeconomics.* 26, 3: 409-430.

REGHUNATH, R., MURTHY, T.R.S., and RAGHAVAN, B.R., 2002. The Utility of Multivariate Statistical Techniques in Hydrogeochemical Studies: An Example from Karnataka, India. *Water Research.* 36, 10: 2437-2442.

RIPLEY, D.M., 1973. Systematic Elements in the Linkage of National Stock Market Indices. *The Review of Economics and Statistics.* 55, 3: 356-361.

ROBINSON, B., and WARBURTON, P., 1980. Managing Currency Holdings: Lessons from the Floating Rate Period. Economic Outlook. 4, 5: 18-27.

SANDER, H., and KLEIMEIER, S., 2006. Interest Rate Pass-Through in the Common Monetary Area of the SACU Countries. *South African Journal of Economics.* 74, 2: 215-229.

SIEGEL, J. J., 2002. *Stocks for the Long Run* (3e). New York: McGraw-Hill.

SILIVERSTOVS, B., L'HÉGARET, G., and NEUMANN, A., 2005. International Market Integration for Natural Gas? A Cointegration Analysis of Prices in Europe, North America and Japan. *Energy Economics.* 27, 4: 603-615.

SKINTZI, V., and REFENES, A.N., 2006. Volatility Spillovers and Dynamic Correlation in European Bond Markets. *Journal of International Financial markets, Institutions & Money.* 16, 1: 23-40.

SMITH, K.L., 2002. Government Bond Market Seasonality, Diversification, and Cointegration: International Evidence. *Journal of Financial Research*. 25, 2: 203-221.

SOLNIK, B., BOUCRELLE, C., and LE FUR, Y., 1996. International Market Correlation and Volatility. *Financial Analysts Journal*. 52, 5: 17-34.

SOUTH AFRICAN RESERVE BANK (SARB), 2006. *Monetary Policy and South African Bond Market Developments – Address by Mr. T.T. Mboweni, Governor of the South African Reserve Bank, at the South African Bond Market Conference organised by the Debt Issuers Association, 5 October 2006*. [Online]. Available: http://www.reservebank.co.za/internet/Publication.nsf/0/98DA11E9D2247992422571FD0057D205?opendocument [Accessed 22 October 2008].

SOUTH AFRICAN RESERVE BANK (SARB), 2008. *2008-10-09: Statement of the Monetary Policy Committee*. [Online]. Available http://www.reservebank.co.za/ [Accessed 20 October 2008].

SUTTON, G., 2000. Is there Excess Comovement of Bond Yields between Countries? *Journal of International Money and Finance*. 19, 3: 363-376.

SWART, J., 1999. Optimising Investment Performance through International Diversification. *ORION*, 15: 1-24.

TOBIN, J., 1958. Liquidity Preference as Behavior Towards Risk. *The Review of Economic Studies*. 25, 2: 65-86.

VAN DEN HONERT, R., and AFFLECK-GRAVES, J.F., 1985. International Diversification and the South African Investor. *South African Journal of Business Management*. 16, 2: 87-91.

VAN DER MERWE, E.J., 2004. *Inflation Targeting in South Africa*. Occasional Paper No. 19 July 2004.

VON FURSTENBERG, G.M., 1998. From Worldwide Capital Mobility to International Financial Integration: A Review Essay. *Open Economics Review*. 9, 1: 53-84.

WAGNER, W.H., and LAU, S.C., 1971. The Effect of Diversification of Risk. *Financial Analysts Journal*. 27, 6: 48-53.

WEBBSTOCK, M., WESSELS, A., FIRER, C., and DAVIDSON, S., 2005. Portfolio Size and Diversification on the JSE Securities Exchange and the Australian Stock Exchange. *Studies in Economics and Econometrics*. 29, 2: 50-60.

WEBSTER, A., 1987. Purchasing Power Parity as a Theory of International Arbitrage in Manufactured Foods: An Empirical view of UK/USA Prices in the 1970s. *Applied Economics*. 19, 11: 1433-1456.

YANG, J., 2005. International Bond Market Linkages: A Structural VAR Analysis. *Journal of International Financial Markets, Institutions, & Money*. 15, 1: 39-54.