DIVERSIFICATION BENEFITS OF REAL ESTATE

ASSETS AND EQUITY ASSETS IN A

REGIONAL AND GLOBAL

PERSPECTIVE

by

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ABSTRACT

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The primary purpose of this dissertation is to utilize recently available and reliable high frequency transactions based data provided by FTSE EPRA/NAREIT and employ modern day time series techniques and recently developed diagnostic tests to evaluate the degree of long-run integration and short-run dynamics among major public property markets (in terms of market capitalization) over a period beginning January 2000 and ending March 2006 to evaluate diversification possibilities from the perspective of the US investor. Both Asia and Europe are investigated. A secondary objective is to examine the long-run and short-run interaction among the corresponding major

international equity markets to compare and contrast diversification benefits from exploitation of international property markets.

Overall, the study provides corroborative evidence that US investors can attain substantial diversification benefits from investing in many of the international property markets in the long-run as well as the short-run. Long-term benefits are available in both the Asian and the European property markets, while greater short-term opportunities are available in the Asia-Pacific markets in the more recent sub-period. The findings also suggest securitized property markets is some countries behave similarly to their corresponding stock markets while others behave in ways that set them apart from the wider equity market (Gordon and Canter, 1999; and Gordon et al. 2001).

As hypothesized a-priori, real estate markets show greater signs of (long-run) segmentation or weaker evidence of (long-run) integration (as evidenced by the strength of the relationships among the international property markets) implying that unlike equity markets, US investors can exploit greater opportunities from international portfolio diversification in several of the international property markets in the long-run.

Short-run results indicate relatively fewer lead-lag relationships between the US and the international property markets confirming earlier contentions, that due to the underdeveloped state of the securitized property sector (relative to equity markets) and due to the "real estate" nature of these markets, the securitized property sector is less impacted by the US property market in the short run than the corresponding equity markets.

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CHAPTER 1

INTRODUCTION

1.1 Background and Purpose of the Proposed Study

For several decades, real estate had been an integral component of institutional investors' portfolios primarily due to its steady and predictable appreciation over time (Hudson-Wilson et al. 2003, Hudson-Wilson and Harbaugh, 2006 and Chin et al. 2007), its low correlation with other asset classes and across national boundaries (Eichholtz 1996 and 1997; Bigman 2002; Kallberg and Liu 1996 and Hudson-Wilson et al. 2003), its strong risk adjusted performance in comparison to stocks and bonds (Eichholtz 1997; Liu and Mei 1998; Gordon, Canter and Webb 1998; Conover et al., 2002; and Hudson-Wilson et al. 2003) and its inflation hedging capabilities (Hoesli et al. 1999; Bond and Seiler, 1998, Hudson-Wilson et al. 2003 and Hudson-Wilson and Harbaugh, 2006). Traditionally, the only option available to investors' needing to gain exposure to domestic or international commercial real estate was via/through direct (physical) real estate investing that is by means of purchasing the actual physical property. The high cost of acquisition coupled with setting up a team to manage the property and illiquidity however, made it difficult if not impossible for smaller investors and pension funds to gain exposure to commercial real estate.

Since the advent of securitization in the early 1960s and especially more over the last decade, REITs (Real Estate Investment Trusts) and REOCs (Real Estate Operating Companies) have emerged as a viable alternative for domestic commercial real estate ownership, making real estate available, albeit indirectly, to a wide audience. REITs and REOCs are publicly traded entities that own and operate income producing real estate. REITs in most countries are exempt from corporate income tax but REOCs are simply listed property companies that may or may not enjoy tax-transparent status. These securities offer investment benefits similar to their directly held counterparts [see for example Feldman 2003; Pagliari et al. 2005 and Frost et al. 2005], but are more liquid, are traded on financial exchanges (and are thus priced and quoted on a real time basis), can be bought and sold at a relatively lower cost[1] and have a rigorous corporate governance structure that makes them inherently appealing to investors at large.

With institutional investors increased appetite for these securities, foreign countries have also started to introduce tax transparent REITs or REIT like structures throughout the world, thereby fostering the growth and (indirectly) promoting transparency of the global real estate securities market. This growth is evidenced by the fact that that market capitalization of publicly-traded property securities has grown from approximately $350 billion to $945 billion over the 7 year period beginning January 2000 and ending March 2006 a growth rate of 170% (Source: NAREIT 2007).

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[1] A recent research by Chin et al. 2007 of RREEF research group, presented at the American Real Estate Conference 2007, finds that in comparison to directly held real estate, transactions costs for real estate securities is 60 basis points or less in Asia-Pacific and in most parts of Europe and 25 basis points or less in North America.

With tremendous growth and strong risk-adjusted performance over time, the securitized property sector has gained widespread recognition as a distinct asset class that deserves permanent allocation in a real estate only or multi-class portfolio (Gerogiev et al. 2003; Dhar and Goetzmann, 2006; Idzorek et al. 2006). As a result, institutional investors and pension funds have become increasingly interested to increase the allocation of international real estate in their portfolios (Gerogiev et al. 2003; Dhar and Goetzmann, 2006; Idzorek et al. 2006). These investors are however in a dilemma especially because in comparison to the vast amount of literature that exists on world equity markets and bond markets that contends that these markets are becoming increasingly integrated over time (as a result of advancement in communications, liberalization and deregulations), thereby limiting opportunities available for international portfolio diversification, very little is known about the extent of interlinkages among international real estate markets.

Evidence suggest that since real estate markets are driven by the same macroeconomic fundamentals that affect other asset classes, it is reasonable to expect these markets to move together (Darrat and Glascock, 1993; McCue and Kling, 1994; Ling and Naranjo,1997 and Liow and Yang 2005). Hence earlier studies (Eichholtz 1996 and 1997, Liu and Mei 1998, Gordon, Canter and Webb 1998 and Conover, Friday and Sirmans, 2002) addressed the issue of integration between international real estate markets primarily by evaluating short-term correlation measures, contending (in the majority of cases) that the international real estate sector provides substantial diversification opportunities. To account for the nonstationarity property of the real

estate indices (Myer et al. 1997, 1999), and due to the fact that the correlation structure is susceptible to great instabilities over time (Tarbert, 1998), some of the studies have even gone a step further and examined long-run comovement of international real estate markets across entire regions or across a few developed markets (Myer et al. 1996, 1997, 1999; Wilson and Okunev 1998; Wilson and Zurbruegg 1998; Stevenson et al. 2000, Kleiman et al. 2002, Payne and Sahu 2004, Yang et al, 2004, Gerlach et al. 2006) but have reported conflicting results.

One problem has been the unavailibility of suitable and reliable benchmarks coupled with the lack of "long enough" historical data for the international public property markets limiting the quantity and quality of research that could be undertaken to model the long-run interaction among the major markets across the globe (Wilson and Okunev, 1996; Myer et al. 1996, 1999a, b; Tarbert, 1998; Kleiman, Pyne and Sahu 2002; Bond, Karolyi and Sanders. 2003).

Fairly recently, (since December 31st 1999) the European Public Real Estate Association (EPRA) in conjunction with the National Association of Real Estate Investment Trusts (NAREIT) has started to publish daily stock price data for several (major) individual public property markets throughout North America, Asia and Europe. The EPRA/NAREIT indices are well recognized and well accepted indices comprised of shares of property stocks and REIT stocks that are listed on organized exchanges all over the world and can thus be seen as a truly representative benchmark for the global real estate market (Bond, et al., 2003; Yang et al. 2005 and Bond et al. 2006). Moreover, these indices are used by investors world wide for investment

analysis, performance measurement, portfolio hedging and for creating index tracking funds (Liow, 2006).

This dissertation uses these recent data and fills the void in the international real estate literature by investigating the long-run interaction and short-run dynamics among the largest (in terms of market capitalization) individual listed property markets of Asia (Australia, Hong Kong, Japan and Singapore) and Europe (UK, France, the Netherlands and Spain) vis-à-vis the US market over a seven year period beginning January 2000 and ending March 2006 in order to critically evaluate which of the markets (if any) provide the greater diversification benefits to the US investor and should be included in a portfolio in the long-run.[2] The study also evaluates interrelationship among the equity markets of the aforementioned countries over the same period to compare the extent of linkages among the financial markets and the real estate markets. This is motivated by the fact that since real estate markets are not as mature or developed as other financial markets, they may be more segmented (across national boundaries) than equity markets and may thus provide greater diversification opportunities in the long-run. Modern day time series techniques as well as several relatively new diagnostic techniques, none of which have been employed in previous real estate market integration studies, are utilized throughout the analysis to robustly evaluate the dynamic interaction among the international property markets and the US market.

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[2] Data limitations restrict the study period to January 2000 through March 2006, only six and a half years of data making the measures more nearly intermediate length than long-term. The expression "long-run" or long-term" is used to differentiate the analysis from a short-term analysis where the period is typically one year or less.

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Since the indices used in this study are relatively new their suitability and desirability merit further elaboration: First, these indices have become so popular and acceptable that as of May 2007, there exist four ETFs created by ishares:

I. iShares FTSE EPRA/NAREIT Asia Property Yield Fund,

II. iShares FTSE EPRA/NAREIT Europe Property Yield Fund,

III. iShares FTSE EPRA/NAREIT US Property Yield Fund

IV. iShares FTSE EPRA/NAREIT UK Property Yield Fund and

V. iShares FTSE EPRA/NAREIT Global Property Yield Fund and

each of which is based on or developed with the goal of tracking the actual corresponding FTSE EPRA/NAREIT index. And second, in a recent report published by Barclays Global Investors (US) where various index providers are compared, the EPRA/NAREIT indices has scored the highest point[3] (totaling to 24) and is ranked among the best indices for global property shares in terms of coverage,[4] investability,[5] liquidity, float adjustment, published rules, accuracy and institutional investor acceptance, issues critical to real estate investment.

Although some argue that the direct property indices proxied by the NPI index in the US and IPD indices in Europe and Asia may be more suitable for evaluating long-run linkages among international property markets, much of the literature has shown that these indices suffer from "appraisal smoothing" which has some serious

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[3] The Dow Jones Real Estate indices also scores 24 points but is not considered in this study since the company does not provide data for most of the major international markets evaluated in this study.
[4] Marketed as representing 100% of the Global REITmarket.
[5] Methodology stipulates liquidity screens that remove extremely illiquid names.

consequences and limitations[6]: First, recent studies have shown that the individual property "smoothing" does affect the accuracy and reliability of the aggregate index (Edelstein and Quan, 2006) in contrast to older studies that concluded otherwise (Geltner, 1993). Second, since the appraisers (current) estimate is based on historical comparables, the indices will exhibit serial correlations (Geltner, 1989, 1991 and 1993; Fisher Geltner and Webb, 1994; Gilberto, 1993). And third, "smoothing" reduces the variability of the index which disguises the true nature of the underlying data generating process (by dampening the peaks and troughs that may arise at any point in time) and distorts the index's correlation with other asset classes (Geltner, 1989, 1991 and 1993; Fisher Geltner and Webb, 1994; Gilberto, 1993) leading to dangerous/harmful repercussions from a portfolio diversification/management perspective (Brown and Matysiak, 1998 and Geltner, 1997, 1998 and Edelstein and Quan, 2006).

The EPRA/NAREIT indices however are based on actual transactions and the components of the indices (REOCs and REITS) are valued daily. Thus the biases arising from the appraisal "smoothing" do not creep into these transactions based indices making them more appropriate and suitable from a portfolio diversification perspective and in the context of this study. Moreover, from a statistical point of view, evidence has suggested that the long-run performance of the REIT indices are indistinguishable from the "refined" direct property counterpart (Feldman 2003 and

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[6] "Appraisal smoothing" refers to the bias that is induced in the index primarily because the appraiser uses historical comps or comparables to appraise the "current" value of the property. The "smoothing bias" will be exacerbated if the market is changing quite rapidly and if the transaction levels (on comparables) are fairly low (Geltner, 1989, 1991; Fisher Geltner and Webb, 1994; Gilberto, 1993).

Pagliari et al. 2005) and thus several authors argue that REIT indices can be viewed as an appropriate proxy for direct real estate as well as indirect real estate (Frost et al. 2005) and advocate the use of these indices rather than their direct property counterparts (Hudson-Wilson et al., 2003 and Hudson-Wilson and Harbaugh, 2006).

Building on information gleaned from recent studies, and due to the unique availability of the international EPRA/NAREIT indices for several major public property markets over relatively long period of time, I use these indices throughout this dissertation as an appropriate benchmark for the commercial real estate sector in general.

<u>1.2 Importance and Implications of the Study</u>

A very recent survey conducted by Dhar and Goetzmann (2006) has found that liquidity risk, lack of reliable data and the risk of poor investment decisions were the top three perceived risk factors in real estate investing from the (top) institutional investors' perspective. However the dramatic growth and impressive performance of the global securitized property sector (that have increased transparency), the introduction of tax-transparent REITs or REIT like structures throughout the world (that have reduced the barriers to entry), and the creation of ETFs such as iShares (that provided investors with liquid exposure to real estate quickly and at a relatively low cost) many of the perceived risks of real estate investing have been reduced. Thus institutional investors have raised the allocation of international real estate in their portfolios (Hudson-Wilson et al. 2003, Dhar and Goetzmann, 2006).

In order to identify optimal diversification benefits over the long-run and or over the short-run, this thesis' primary objective is to model linkages among the major international property markets over the most recent period of time and over a relatively long period of time.[7] A secondary objective is to evaluate the long-run interaction among several major international equity markets. Since a growing number of studies suggest that equity markets have become increasingly integrated over recent times, this study will further attempt to answer whether greater diversification opportunities are available in the securitized property sector relative to the equity market sector and whether increasing allocation of real estate in a portfolio is justified/justifiable.

The analysis has important implications for both long-term and short-term diversification possibilities. If markets are found to be linked in the long-run (or cointegrated), it would imply that shocks to one market are propagated to the other markets fairly easily which limits long-run diversification opportunities. On the other hand, if international markets are found to be segmented, (that is not cointegrated) it would indicate they are not affected by the same economic stimuli and hence international portfolio diversification can be exploited. Finally, if markets interact in the short-run (in the causal sense), it would suggest that the performance of one market can be predicted using past (lagged) information of one or more markets in the short-run.

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[7] It is important to note that relatively new ETFs do not exist for several of the property markets used in this study and that some of the funds that have been created are available to UK investors. It is worth reiterating however that due to the popularity, acceptance and success of the existing funds, it is reasonable to expect that instruments such as ishares may create more new funds based on the EPRA/NAREIT indices in the near future and that these funds will be available to US investors.

Thus this thesis will be beneficial to portfolio managers, pension fund managers and other institutional investors in the US and abroad who are contemplating incorporating international real estate funds in their portfolios and are concerned about the about the dynamic interrelationships of these assets across different geographical markets.

<div align="center">1.3 Research Questions</div>

In summary, this paper seeks to answer the following research questions:

1. Are there important long-run linkages and causal relationships between the property markets of the Asia-Pacific region and the US and between the property markets of Europe and the US, and, if so, which of the countries provide the greater diversification benefits?

2. Are there important long-run linkages and causal relationships between the financial markets of the Asia-Pacific region and the US and between the financial markets of Europe and the US, and, if so, which of the countries provide the greater diversification benefits?

3. Due to the immature state of the property markets in certain parts of the world, is there less (long-term and short-term) interaction among these markets in comparison to the equity markets, thereby creating more room for diversification benefits?

<div align="center">1.4 Hypothesis Tests</div>

H1: The domestic property market is not integrated with the Asia-Pacific property markets in the long-run.

H2: The degree of integration between the domestic property market and the Asia-Pacific property markets has not been increasing over time.

H3: The domestic property market does not lead the Asia-Pacific property markets in the short-run.

H4: The domestic property market is not integrated with the European property markets in the long-run.

H5: The degree of integration between the domestic property market and the European property markets has not been increasing over time.

H6: The domestic property market does not lead the European property markets in the short-run.

H7: The international equity market diversification possibilities in the long-run and short-run exhibit a similar pattern of the property markets.

CHAPTER 2

LITERATURE REVIEW

2.1 Securitized Property Markets Integration and Diversification Benefits

Investing in internationally listed property stocks and REITs provides attractive opportunities for portfolio diversification. These shares avoid the potential problems that are frequently associated with directly held real estate such as low liquidity, high transactions and monitoring costs as well as high information asymmetry that arises due to lack of local market knowledge (Eichholtz 1996 and 1997). The following two sections thus review the literature on indirect or securitized property and summarizes the various studies that evaluate whether indirect property securities contribute to a real estate only and a mixed-asset portfolio.

2.1.1 Real Estate Portfolio and Mixed-Asset Portfolio

One of the first authors to investigate the issue of international real estate diversification in a real estate only context is Gilberto (1990) who examines the property stocks of 11 countries of Asia, Europe, Canada and the US over a period from 1985-1989 and finds in most cases low and in some cases even negative cross correlations between the property markets under consideration. He then creates efficient portfolios and concludes that for an American investor, adding European investments dominates the lower risk-return portfolios while adding Japanese investments dominates

the higher risk-return portfolios. Along the same lines, Eichholtz (1996) and Liu and Mei (1996), compare correlation structures between international stock returns, international bond returns and international real estate stock returns over a period from 1985-1994 and find that property stocks in general have relatively low cross correlations and that these markets have lower degrees of international correlation relative to or in comparison to stock and bond markets and concludes that international property investment is more effective in reducing overall portfolio risk than international investment in stocks and bonds. In a later study, Eichholtz, Koedijk and Schuin (1998) identify "continental factors" in Europe and North America and show that real estate investors find diversification benefits across continents and that European investors should diversify in Asia and North America, Asian investors should look at their prospects in North American markets, and North American investors should exploit their opportunities in Europe.

Similarly, Bigman (2002) also find relatively low correlations between the US property index and the indices of Asia and Europe. They both start by creating efficient portfolios comprised of US only real estate and conclude that adding international real estate contributes positively and enhances portfolio performance. More recently, Bond, Karolyi and Sanderson (2003) find significant diversification benefits for international real estate securities funds that have invested in several Asian real estate countries while Barry and Rodriguez (2004), evaluate diversification possibilities in 15 emerging and 21 developed countries, compare and analyze the correlation of returns and risk adjusted performance of each of the property indices and conclude that even though

substantial diversification opportunities are available to real estate investors in their own local markets, investors should allocate part of their portfolios outside their home country.

In a mixed-asset context, Asabere Kleiman and McGowan (1991) find that returns on international property stocks are negatively correlated with US T-bills and weakly correlated with the US securitized property market concluding that international real estate enhances portfolio efficiency for US investors. Similarly, Eichholtz (1997), Liu and Mei (1998), Gordon, Canter and Webb (1998) and Conover et al. (2002) find lower correlation between US stock market returns and international real estate returns than foreign stock market returns and conclude that foreign real estate stocks provide additional diversification benefits and should thus be incorporated to a mixed-asset portfolio. Gordon and Canter (1999), Stevenson (1999), Seiler, Webb and Myer (1999), Hoesli, McGregor, Adair and McGreal (2001) and Maurer and Reiner (2002) create efficient frontiers and analyze mixed asset portfolios including stocks, bonds, and real estate stocks of several countries. They show that for US investors, adding international real estate stocks enhances the performance of a portfolio comprised of US and international equities.

Due primarily to the unavailability of high frequency and high quality real estate stock price data for each individual country, not many papers have concentrated on regional diversification benefits (that is diversification benefits that can be attained across countries in a specific region) within a real estate only or mixed asset portfolio context; some recent papers, one by Newell (2003) and the other by Bond and Glascock

(2006), use a relatively new data-set provided by EPRA/NAREIT and conclude that significant diversification benefits (within Europe) can be achieved by incorporating listed securities in a mixed-asset or a real estate only- portfolio. Liow and Yang (2006) focusing on Asian property stocks conclude that even though these stocks do not contribute to the Asian mixed-asset portfolio, they do "add value" and have positive implications for US and UK investors.

2.1.1.1 Summary of Findings

The findings from the correlation studies can be summarized as follows: First, by focusing solely on the correlation of returns, most authors have found that public property stocks do offer significant diversification benefit to a real estate only portfolio as well as a mixed-asset portfolio. And second, many take the correlation studies a step further, formulate Markowitz's efficient portfolio and conclude that mixed-asset portfolios including real estate stocks outperform those that do not.

Most of the above mentioned studies, however, focus on the short-term correlation of returns which are susceptible to instabilities over time (Tarbert, 1998; Eichholtz, 1996). Even if the correlation structure is found to be stable over time, the benefits from international diversification indicated by low correlations may be overstated for investors with long-term investment horizons if markets trend together (Kasa, 1992).[8] Also several authors' (one of the first being Myer et al. 1996), have characterized real estate indices as non-stationary data generating processes contending

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[8]Investors in real estate are expected to be interested in the long-run diversification characteristics of their real estate portfolios which is an important reason why correlation coefficients may not be an appropriate measure for analyzing property indices.

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that the nonstationarity property of the indices makes the application of classical linear regression models invalid giving rise to what Granger and Newbold (1974) referred to as the "*spurious regression*" problem. Hence to address this issue, the second strand of literature employs multivariate cointegration techniques to assess whether international real estate markets comove with other capital market securities or whether they are integrated amongst themselves (i.e. across different geographical regions).

2.1.2. Real Estate Indices (Cointegration Studies)

As with correlation studies mentioned in the preceding section, international cointegration analysis between real estate and other capital markets or amongst real estate indices is somewhat limited primarily due to lack of reliable data.

Two cointegration studies focusing on the interrelationship between the domestic securitized market and the general stock market are conducted by Myer, Chaudhry and Webb (1999 a, b) who find that the two types of markets are linked to one another; Along the same lines, and Glascock, Lu and So (2000) investigate the integration of REITs, bond and stock returns and find that the three markets are interrelated concluding that benefits of real estate in a multiasset portfolio is decreasing over time. Using *appraisal-based* (direct) real estate wealth indices (proxied by the NACRIEF index) for the United States, Canada, and the United Kingdom and for several property types, Myer et al. (1997) find a cointegrating relationship among the real estate indices across the three countries and conclude that that there is a common factor that creates a link among the indices. Tarbert (1998), using publicly traded indices, also applies cointegration techniques to investigate diversification opportunities

available to UK investors and finds evidence of cointegration among sectors and across regions concluding that sectoral and geographical diversification benefits within property portfolios is more limited that previously believed. Wilson and Okunev (1996) test for cointegration among the property markets and equity markets of US, UK and Australia and find absence of cointegration among both real estate and equity markets and among the securitized property markets themselves thereby concluding that there are benefits that can be achieved through diversifying in real estate stocks in a real estate only as well as in a mixed asset portfolio. In a later study, Wilson and Zurbruegg (2001), test for cointegration among the markets of UK, USA, Australia and Japan and finds that after structural changes are taken into account, the real estate markets are interrelated contrary to the previous study. They therefore conclude that adding real estate stocks does not improve portfolio performance as previously thought. Similarly, Kleiman et al. (2002) use stock market indices of real estate share prices for three regions (Europe, Asia, and North America) to explore the random walk hypothesis. Their findings suggest cointegration among the three markets, implying diversification benefits can be achieved only in the short run. In contrast to Kleiman et al. (2002), Payne and Sahu (2004) test for random walk behavior for the US and world commercial real estate markets and find that the markets are not cointegrated. They therefore conclude that US investors can achieve diversification benefits both in the long-run and the short-run.

Due to the recent availability of high frequency and high quality property stock price data, many authors' have started testing for integration among individual countries

in a specific region. Relevant new studies on Asian property stocks include Garvey, Santry and Stevenson (2001), who use securitized property indices for the markets of Australia, Japan, Hong Kong and Singapore. They conduct bivariate cointegration analysis and conclude that with the exception of Australia, each of the other markets sees an improvement in performance from extending their real estate portfolios into the remaining Asian markets. Liow and Yang (2005) find evidence to support fractional cointegration between securitized real estate prices, stock market prices and key macroeconomic factors in the Asia-Pacific economies of Japan, Hong Kong, Singapore Malaysia and the US. Investigating crisis effects, Bond et al. (2006) examine how unanticipated shocks are propagated through real estate backed securities and equity markets of the major developed economies of the Asia Pacific region (Australia, Japan, Singapore and Hong Kong) over the late Asian crisis period and conclude that Australia and the US were receivers of contagion over this period although the magnitude of the shocks received by the US were small.

With respect to assessing the interdependence of European property stocks, Yang Kolari and Zhu, (2005) look at the impact of the EMU on long-run and short-term linkages among nine European public real estate markets and find that the larger EMU markets (Germany, France, Netherlands) have become more integrated (relationship has strengthened) after the establishment of the EMU. However, increased real estate integration is not found for some EMU markets (Italy, Belgium, and Spain) and for some non-EMU participants (United Kingdom, Switzerland, and Denmark). The

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authors' therefore conclude that EMU has been beneficial in increasing real estate market integration only among the larger EMU member countries.

2.1.2.1 Summary of Findings

The findings from the cointegration studies can be summarized as follows: First, since correlations of returns are unstable over time, developing portfolios based solely on the correlation of returns is fraught with problems and is not appropriate for investors in real estate who are typically more interested in the long-run diversification attributes of their portfolio. Second, even though some of the earlier research shows evidence of segmentation between the property markets and other capital markets, and among the property markets themselves, recent work shows increasing tendency of the markets to commove with each other. This implies that the potential benefits of adding real estate assets to a mixed-asset or real-estate only portfolio may be decreasing. However these results may have been influenced by the property index used, the time period studied and the frequency of data used (Mull and Sonen, 1997, Tarbert, 1998). And third, due to the recent availability of reliable high frequency data for several individual property markets throughout North America, Asia and Europe provided by EPRA/NAREIT academicians are able to investigate and evaluate the performance of their portfolios more accurately.

2.2. Equity Market Integration and Diversification Benefits

According to modern portfolio theory of Markowitz (1952), there are potential gains from international portfolio diversification if returns from investment in different national markets are not perfectly correlated and if the correlation structure is found to

be stable over time (Alexander, 2001). According to modern portfolio theory of Markowitz (1952), there are potential gains from international portfolio diversification if returns from investment in different national markets are not perfectly correlated. One of the first studies that applied Markowitz's and Tobin's (1958) analysis was conducted by Grubel (1968) who formulated a two country, two asset portfolio and demonstrated the advantages of international diversification between stocks markets if the correlation of returns is less than one. This stimulated similar studies such as Levy and Sarnat (1970), Lessard (1973), Solnik (1974), Elton and Gruber (1995), Farrell (1997) and Strong (2000) who also provide additional evidence of the advantages of international diversification. In recent years, however, following the seminal works of Engle and Granger (1987) and Johansen (1988, 1992), considerable focus has been on the interdependence among the major world equity markets. The following section summarizes some relatively new studies that investigate the long-run and short-run interlinkages among Asian equity markets and the US, among European equity markets and the US and among global equity markets.

2.2.1. Asian, European and World Equity Markets

Numerous studies investigate the interdepedance between the United States and major world equity markets. The most often cited paper is one by Kasa (1992) who examines the potential interrelationships amongst several major world equity markets and finds a single common stochastic trend that is driving the stock prices of the countries under consideration, thereby concluding that diversification benefits within these markets are minimized since the markets are perfectly correlated in the long-run.

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Utilizing more robust cointegration techniques and diagnostic tests, Crowder and Wohar (1998) re-examine Kasa's data, utilize robust cointegration techniques and find only a single cointegrating vector or four common trends contrary to Kasa's results and contend that that there are potential diversification benefits in many of the countries.

More recently, however, Masih and Masih (2002), find five long-run relationships among six major stock markets and conclude that there is a single common stochastic trend that is binding all the markets together, findings similar to those found by Kasa (1992). The findings of various other studies concerning international stock price linkages are also decidedly mixed (e.g. Hamao et al., 1990; Jeon and Chiang, 1991; Chan et al., 1992; Lai et al., 1993; Lin et al., 1994; Arshanapalli et al., 1995; Chan et al., 1997; Cheung et al., 1997; Choudhry, 1997; Masih and Masih, 1997; Francis and Leachman, 1998; Chatterjee et al., 1998; Aggarwal et al., 1999; Ghosh et al., 1999; Ratanapakorn and Sharma, 2002; Swanson, 2003 and Bessler and Yang, 2003).

Focusing exclusively on the interdependence between the US and the European stock markets, Taylor and Tonks (1989) find no evidence of bivariate cointegration between the equity markets of UK and US. Similarly, Gilmore and McManus (2002) find no evidence of bivariate cointegration and conclude that there exists significant risk-reduction benefits from investing in each of the European markets under study. In contrast, Arshanapalli and Doukas (1993) and Byers and Peel (1993) however find evidence of cointegration between the US and a select group of European markets.

Recent studies implementing multivariate cointegration techniques also find diverging results: Laopodis (2004) finds that some of the Euroepan stock markets are integrated with the US while others are not; Syriopoulos (2004) and Voronkova (2004) also show that several European stock markets display stronger interlinkages with their more mature counterparts such as the US than amongst themselves. More recently, Fraser and Oyefeso (2005) investigate long-run convergence between US, UK and seven European stock markets and find that the stock prices share a single common stochastic trend driving the markets but that the US and UK markets are less influenced by, and contribute less to, innovations to this common trend than the other European markets.

With the emergence of Asian capital markets, several studies have also investigated the long-run interlinkages between Asian markets and the stock markets of developed countries. One of the first studies is conducted by Chan, Gup and Pan (1992) who perform bivariate cointegration tests and find no evidence of cointegration among the stock prices. They therefore conclude that the stock prices in major Asian markets and the United States are weak-form efficient individually and collectively in the long run and thus international diversification among the markets is effective. Similarly Ghosh, Saidi and Johnson (1999) evaluate the linkages among several Asian stock markets, Japan and the US and find that some of the Asian markets share a long-run equilibrium relationship with the US, others with Japan and still others with neither of the two dominant markets. Along the same lines, Siklos and Ng (2001) find that the US and the Asian markets share one common stochastic trend and that if integration exists

it is a fairly recent phenomenon. More recently, Baharumshah, Sarmidi and Tan (2003) find that the Asian markets are linked with each other and with the US, specially during the post-liberalization era and Wong, Penm, Terrel and Lim (2004), Dunnis and Shannon (2005) and Phylaktics and Ravazzolo (2005) also find that many (but not all) of the Asian markets commove with the developed US markets in the long run.

Studies have also been conducted to investigate the causal relationship between the United States and other equity markets. Results indicate that the United States is an important "*global factor*" that moves many of the major and emerging world markets. One of the first studies for example, Eun and Shim (1989), examine nine major stock markets and find evidence that the United States market is the global leader. Similarly, Arshanapalli and Doukas (1993), Mallaris and Urrutia (1992), Cheung and Mak (1992), Kwan, Sim and Cotsomitis (1995), Janakiramanan and Lamba, (1998) examine the causal relationship between several developed markets and emerging markets and find that the United States market is a *'global factor'* which leads but is not "lead" by most of the markets.

2.2.1.1. Summary of Findings

It is evident that the results from the above studies are mixed. The disparity in results may be attributed to the difference in the frequency of data used, (daily, weekly, monthly, quarterly) and methodologies employed, different time periods used and the quality of the different market indices that were used as a proxy for the markets. It is also apparent that even though earlier studies have found no evidence of cointegration implying that many of the markets provide attractive diversification opportunities for

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US investors, latter studies find a reduced number of common trends suggesting that world capital markets may have become increasingly integrated due to deregulations, trade liberalizations, lax capital controls, proliferation of new investment vehicles and enhancement in communications, thereby decreasing/reducing the opportunities for beneficial international portfolio diversification.

CHAPTER 3

DATA, THEORY AND METHDOLOGY

3.1. Description, Source and Frequency of the Data

3.1.1. Data for Property Markets

For the property market analysis, the data consists of publicly-traded real estate stock price indices (quoted on a daily basis) provided by the European Public Real Estate Association (EPRA) in conjunction with the National Association of Real Estate Investment Trusts (NAREIT) for the nine real estate markets under study: Australia, Hong Kong, Japan, Singapore, France, the Netherlands, Spain, UK and the US, over the period beginning January 2000 and ending March 2006.[9] The starting date is chosen as it coincides with the date from which the EPRA/NAREIT has started to publish daily stock price data for its Asian and North American series.[10]

The strengths of daily data are believed to outweigh the possible problems of daily data despite the relatively short time period which results from data limitations. As noted by Yang et al. (2005), these NAREIT data have inherent properties that make them very attractive for use in a real estate market integration study. A primary advantage is that each index is based on actual transactions and thus "provides a more

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[9] Companies must meet specific requirements in order to qualify for inclusion in the publicly traded property indices. Detailed description is freely available in the "Ground Rules for Management of the FTSE EPRA/NAREIT Global Real Estate Index" version 2005 pages 7-8.
[6] Each series has a base value of 1000 on the 31st of December 1999.

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up-to-date assessment of the market's valuation of the underlying real estate portfolio"
(Chandrashekaran, 1999, p 91). Another related benefit stems from the fact that real
estate stocks are valued daily which implies that the prices from these indices
incorporate information much more efficiently than private real estate market prices,
which are highly illiquid due to infrequent trading and private information (Yang et al.
2005). Further, the data will be more reflective of the "true" data generating process by
increasing the sample size and consequently the power of the tests (Zhou, 2003). As
noted by Fang, Lai and Lai (1991), higher frequency data is preferred to lower
frequency data in view of the speedy transmission of information between markets.

Each of the indices is calculated using to the following formula:

$$\text{Index value} = \sum_{i=1}^{n} \frac{P_i * w_i * F_i * Pe_i}{d},$$

where n is the number of securities in the index, P_i is the latest trade price of the ith
component security (or the price at close of the previous business day), w_i is the weight
for the ith component stock (equal to the number of ordinary shares issued by the
company), F_i is the free float weighting adjustment, Pe_i is the exchange rate of the ith
component security (where applicable), and d is the total issued equity value of the
index on the base date (Yang et al. 2005).

These indices are market-capitalization weighted on a free-float adjusted basis.
They are comprised of the largest and the most heavily traded real estate stocks for each
of the countries under consideration and therefore can be viewed as an objective and

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representative benchmark for the real estate market of a country (Bond et al. 2003 and Yang et al. 2005). [11]

Since the indices used in this study are relatively new their suitability and desirability merit reiteration: First, these indices have become so popular and acceptable that as of May 2007, there exist four ETFs created by ishares:

    I.   iShares FTSE EPRA/NAREIT Asia Property Yield Fund,

    II.   iShares FTSE EPRA/NAREIT Europe Property Yield Fund,

    III.   iShares FTSE EPRA/NAREIT US Property Yield Fund

    IV.   iShares FTSE EPRA/NAREIT UK Property Yield Fund and

    V.   iShares FTSE EPRA/NAREIT Global Property Yield Fund

each of which is based on or developed with the goal of tracking the actual corresponding FTSE EPRA/NAREIT index. And second, in a recent report published by Barclays Global Investors (US) where various index providers are compared, the EPRA/NAREIT indices has scored the highest point[12] (totaling to 24 points) and is ranked among the best indices for global property shares in terms of coverage, investability, float adjustment, published rules, accuracy and institutional investor acceptance.

Some may argue that the direct property indices proxied by the NPI index in the US and IPD indices in Europe and Asia may be more suitable for evaluating long-run

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[11] The REITs that are included in the NAREIT indices are those that are listed in organized stock exchanges better known as "listed REITs" in comparison to non-publicly traded unlisted REITs. For a detailed description of how these indices are constructed, see Yang el al. (2005).

[12] The Dow Jones Real Estate indices also scores 24 points but is not considered in this study since the company does not provide data for most of the major international markets evaluated in this study.

linkages among international property markets. However studies have shown that these appraisal based indices suffer from serious limitations such as serial correlation, appraisal smoothing and seasonality that tend to bias results and distort intra-asset correlations (Geltner, 1989, 1991; Fisher Geltner and Webb, 1994; Gilberto, 1993) which make them inappropriate for use in the context of this study.

Moreover, from a statistical point of view, the long-run performance of the REIT indices are indistinguishable from the "refined" direct property counterpart (Feldman, 2003 and Pagliari et al. 2005) and thus several authors' have argued REIT indices can be viewed as appropriate proxies for direct real estate as well as indirect real estate (Frost et al. 2005). In a very recent paper, Hudson-Wilson and Harbaugh (2006) compare and contrast the performance and characteristics of the public and private indices and advocates the use of public property indices; they question

> *"…why not use the better real estate equity quadrant [i.e. indirect property segment proxied by the REIT indices] to measure the performance of the less well-measured equity quadrant [i.e. the direct equity sector proxied by the NPY]?"*

Building on the evidence of recent studies and due to the availability of the international EPRA/NAREIT indices for several major public property markets over a relatively long period of time, I use these indices throughout this dissertation as an appropriate benchmark for the commercial real estate sector in general.

3.1.2. Data for Equity Markets

The data series used to analyze equity markets consists of financial only stock price indices (quoted and updated on a daily basis) provided by Financial Times Stock

Exchange (FTSE) over a period beginning January 2000 and ending March 2006 for each of the nine aforementioned markets under consideration.[13]

To consider equity markets relative to real estate only markets, a traditional equity index will have overlapping content. Thus an index such as the FTSE that separates out real estate is needed. Table A.1 shows the market capitalization (billions of dollars) of various equity market indices, followed by the number of REITs and or REOCs (Real Estate Operating Companies) in each of the indices, followed by the market capitalization (billions of dollars) of the real estate stocks in each of the indices and finally the proportion of REITs or REOCs in each of the indices. Thus the benefit of using a financial only stock index, "ex-REIT" or "ex-listed real estate" is beneficial and provides a suitable measure for (comparative) purposes of this study.

3.2 Theory and Methodology

This section is organized as follows: Section 3.2.1. provides the theoretical and economic justification for utilizing cointegration techniques; Section 3.2.2 describes the unit root tests employed; Section 3.2.3. discusses the Johansen's cointegration technique; Section 3.2.4. presents the diagnostic tests utilized while section 3.2.5. explains the causality tests used in each of essays.

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[13] Companies must meet stringent requirements in terms of market capitalization (at least 100 million US dollars) and liquidity among other requirements in order to qualify for inclusion in indices. Each of the constituent companies is evaluated on a quarterly basis and is removed from the index if their market capitalization falls below USD 75 million for two consecutive quarters.

3.2.1. Theoretical Justification

3.2.1.1. Problems with Correlation Analysis

Traditionally, academic researchers and professionals have used the correlation of returns measure to investigate the degree of integration (high correlation) or segmentation (low correlation) between real estate markets across national boundaries and across assets classes to evaluate the potential benefits from international portfolio diversification (Markowitz, 1952; Elton and Gruber, 1995; Eichholtz et al.1996 and 1997; Liu and Mei, 1998; Gordon, Canter and Webb, 1998; Conover, Friday and Sirmans, 2002 and Bigman 2002).

However, there are several reasons why correlation analysis may not be suitable for analyzing the long-term relationships. First, the correlation measure/statistic, is based on "returns" information. Where the $\mathrm{Re}\,turn$ of an asset i is calculated as

$$\mathrm{Re}\,turn_{it} = \log P_{it} - \log P_{it-1} = \Delta P_{it} \tag{1}$$

This implies that the modeler or the researcher (incorrectly) assumes a priori (that is at the beginning of the analysis) that there is no relevant information contained in the levels of the data generating process (the raw prices) that may be lost due to differencing (converting them into returns). This is a very serious issue/problem since differencing (or converting prices into returns at the initial stage of the analysis) can eliminate the common trends that will be contained in the levels data. Thus any decisions based on the differenced (returns) data will not be reliable especially in the long-run as it precludes the long-run information that is an inherent part of the (levels) raw price data.

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Second, correlation of returns are susceptible to great instabilities over time (Tarbert, 1998) and thus, the size and the sign of the correlation coefficients can differ and are dependant on the choice of markets, the sample period, or the frequency of observations (Crowder, 1998) which implies that hedging strategies based on the correlation measure will require frequent rebalancing (Syriopoulos, 2004). And third, most macroeconomic indices including real estate indices are nonstationary $I(1)$ data generating process (Myer et al. 1997 and 1999) which makes the application of classical linear regression model invalid and gives rise to what Yule (1926) and Granger and Newbold (1974) refer to as the "*Spurious Regression*" problem.

Due to the various problems associated correlation analysis including the inherent dangers of using this measure to analyze long-run trends in the data and because of the stochastic properties of the real estate indices, suggestions of convergence (section 3.2.1.3.) indicate that it is appropriate to apply cointegration techniques to investigate the interdependence among international real estate markets and among other asset classes over time.

3.2.1.2. Appeal of Cointegration

In their 1987 paper, Engle and Granger formally introduced the underlying concept behind cointegration: If two series x_t and $y_t \sim I(1)$ (i.e. the levels of the series are nonstationary and integrated of order one), but if a linear combination of the two series $z_t = m + ax_t + by_t \sim I(0)$ then x_t and y_t are said to be cointegrated (Engle and Granger, 1991, p.6).

Due to the inherent problems associated with the Engle-Granger methodology such as arbitrary normalization of variables and difficulty in estimating the number of cointegrating vectors when the number of variables is greater than two, Johansen's (1988) and Johasen and Juselius's (1990) MLE (Maximum Likelihood Estimation) VAR (Vector Auto Regressive) technique is more widely employed in recent empirical work. The beauty of the (any) cointegration procedure[14] is that the first/initial stage of the procedure is estimated using the levels data. In the second stage of the analysis, a Vector Error Correction model (VECM) is formulated with the variables in their first differences and with the inclusion of the Error Correction Term(s) if evidence of one or more cointegrating vectors is found.

Thus, cointegration addresses the many problems associated with correlation analysis: First it models the linkages among prices (in levels) in the initial stage of the analysis and then formulates an vector error correction model (VECM) to examine the short-run "causal" linkages or relationships among the returns (differences) in the next stage of the analysis; second, it takes into consideration and utilizes the nonstationarity property of the data and third, since it measures long-run co-movements in prices, portfolio management and hedging strategies based on cointegrated financial assets may be more effective in the long term (Alexander, 2001).

Due to the advantages and appeal of cointegration, it has emerged as a powerful and popular technique for investigating interlinkages among markets and provides a

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[14] Please refer to Cointegration an Introduction to the Literature by Perman (1991) for an overview of cointegration analysis.

sound methodology for modeling both long-run and short-run dynamics within a multivariate system (Hamilton, 1994, Enders, 1995).

3.2.1.3. Cointegration and market convergence

Since Engle and Granger (1987) formally introduced the underlying concept behind cointegration into the time series econometrics literature, the technique has been implemented in a variety of settings: it has been used to study stock market linkages, bond market linkages and commodity market linkages and to test for sport futures parity and other international parity conditions.[15] However, this technique is rarely utilized or implemented to study international property linkages. Further, with the recent availability of transactions based real estate stock price data, it is now possible to investigate more precisely the extent to which international real estate prices have converged across national boundaries and across asset classes.

Authors' such as Hall et al. (1997) and Bernard and Deluf (1995), among others, have argued that

"…cointegration of a set of series is a precondition for convergence".

As an illustration, let us suppose that we are considering 2 real estate stock prices. Let us denote the price of real estate market i as P_{it} and the price of real estate market j as P_{jt} respectively. Let us also assume the real estate stock prices only contain information about the past history of the individual market price or in other words they contains all the available/relevant information. This would imply that

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[15] There are numerous other settings where this technique is applied to but are not mentioned to maintain brevity.

$$P_{it} = E(P_{it} \mid INFO_{t-1}) + u_{it} \tag{2}$$

and

$$P_{jt} = E(P_{jt} \mid INFO_{t-1}) + u_{jt} \tag{3}$$

Where $\quad E(u_{it} \mid INFO_{t-1}) = 0 \tag{4}$

and where $\quad E(u_{jt} \mid INFO_{t-1}) = 0 \tag{5}$

where $INFO_{t-1}$ is the information set available as of time period $t-1$. Each of the sequences above follow a martingale process (that is a process in which all the information is contained in the current price, and the best forecast of tomorrow's price based on the current price should be the current price see for example Stengos and Panas, 1992) iff $\quad E(P_{it} \mid INFO_{t-1}) = P_{it-1} \tag{6}$

and $\quad E(P_{jt} \mid INFO_{t-1}) = P_{jt-1} \tag{7}$

After some (minor) algebraic manipulations we end up with the following:

$$P_{it} = P_{it-1} + u_{it} \tag{8}$$

and $\quad P_{jt} = P_{jt-1} + u_{jt} \tag{9}$

and the two processes are the familiar stochastic nonstationary processes or random walks (without any drift terms). Now the real estate stock prices in both countries would converge if the long-term forecasts of the prices of both the countries are equal at time period t. This definition attempts to answer whether forecast of the price differential tends to zero as the forecast horizon tends to infinity (Bernard and Deluf 1995):

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$$\lim_{n \to \infty} E(P_{it+n} - P_{jt+n} \mid INFO_t) = 0 \tag{10}$$

Thus, the prices would equalize only iff the price differential is exactly equal to zero. In a practical/more realistic world/setting, the price differences will not tend to zero

$$\lim_{n \to \infty} E(P_{it+n} - \beta P_{jt+n} \mid INFO_t) = 0 \tag{11}$$

where the β is some non-zero number that is $\neq 1$.

Thus, if two random walks or nonstationary DGPs are cointegrated, they will converge over time (see Hall et al. 1992 and Bernard and Durlauf 1995). Conversely, if they are not cointegrated, they cannot converge. The degree of convergence or equalization will then of course depend on the size of the β coefficient.

3.2.1.4. Economic Rationale for Utilizing Cointegration

Bachman et al. (1996) cites three reasons as to why stock prices are expected to converge over time: (1) liberalizations and opening of domestic capital markets to foreigners equate marginal products of capital across countries and given that the marginal products of capital are equal (across countries), international stock prices will converge (2) the marginal product of capital may converge over time if the stock markets are affected by common technological shocks as stated in Kasa (1992), and (3) stock prices are expected to converge if financial regulations that limit foreign ownership of domestic capital stocks are relaxed. That is to say if (due to restrictions), the prices of two markets vary, then after the restriction has been relaxed or removed, the forces of arbitrage should equate the international stock prices.

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Is there any economic rationale that should lead us to believe that international real estate prices should also be trending together in the long run? The answer is most certainly yes. In this section I will review pertinent research that examines the potential "drivers" of real estate returns.

Numerous studies have found property markets to be driven by the same macroeconomic fundamentals/indicators that drives stock and bond markets. Building on the seminal work of Chen, Roll and Ross (1986), Darrat and Glascock (1993) show that real estate markets are affected by the term structure of interest rates, industrial production and money base; McCue and Kling (1994) show that prices, nominal interest rates, inflation, output and investment all directly influence the real estate series. Similarly, Ling and Naranjo (1997) show that the growth rate in real per capita consumption, real T-bill rate, the term structure of interest rates and unexpected inflation are the permanent drivers that systematically affect real estate returns while Case, Goezmann and Rouwenhorst (2000) illustrate that that the cross-border correlations across international real estate markets are due in part to common exposure to fluctuations in the global economy, as measured by an equal weighted index of international GDP changes.

Recent studies have applied cintegration techniques to assess whether international property markets are cointegrated across national boundaries and whether these markets are driven by key macroecomic fundamentals. Myer, Chaudhry and Webb (1996) find the property markets of US, UK and Canada to be cointegrated and contend that the common linkage binding the three series maybe attributable to

inflationary expectations; Wilson and Zurbruegg (2001) find that US economic forces affect international real estate markets. They show that the US GDP as well as US term structure of interest rates and inflation have a flow-thorough effect on the property markets of Australia, Japan and the UK. More recently, Liow and Yang (2005) find overwhelming evidence to support fractional cointegration between securitized real estate prices, the stock market and several macroeconomic factors including GDP, inflation, short term rates, money supply in several economies in the Asia-Pacific region contending that public property markets and stock markets are exposed to the same economic conditions.

Overwhelming evidence indicate that linkages among real estate prices should arise due to common macroeconomic and since interest rates and inflation have been converging over time (Awad and Goodwin, 1998; Fase and Vlaar, 1998; Phylaktis, 1999; Wu and Fountas, 1999, 2000; Zhou, 2003; Buch, 2004; Obstfeld and Taylor 2004; Phylaktis 2004; Siklos and Ng, 2004; Siropolous 2004; Dunis and Shannon 2006), it is reasonable to expect that international property prices will also be trending together across national boundaries in the long-run (Myer et al. 1996, 1998, 1999a,b; Kleiman et al., 2002; Payne and Sahu, 2004; Wilson and Zurbruegg, 1999, 2001; Wilson and Okunev, 1996; Gerlach et al., 2006).

3.2.2. Unit Root Tests

A prerequisite for cointegration is that at least two of the variables must be integrated of order one or $I(1)$ (Juselius and Hansen, 2002). To test the statistical properties of each of the time series, the Augmented Dickey-Fuller (ADF) procedure (1979, 1981), and the Kwiatkowski et al. (KPSS) (1992) tests are performed on the levels and the differences of the price indices.

The ADF tests for nonstationarity of a time series Y_t and begins with an estimation of the following regression assuming that there is no trend in the data.

$$\Delta Y_t = \mu + \delta t + \gamma Y_{t-1} + \sum_{j=1}^{k} \beta_j \Delta Y_{t-j} + \varepsilon_t \tag{12}$$

Where Δ is the difference operator, Y_t is the price index in levels, μ and t are the constant and the time trends respectively while k is the minimum lag length that is sufficient to ensure that the residuals are free from serial correlation as measured by the Ljiung Box Q statistics at the 5% level of significance.

However it is well known that the ADF test has low power against local stationary alternatives [see for example Crowder (1996)] and hence the Kwiatkowski et al. (1992) (henceforth KPSS) test is used to complement the results of the ADF regressions.[16] Unlike most other unit root testing methodologies, the KPSS procedure tests the null hypothesis of stationarity against a nonstationary alternative. KPSS (1992)

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[16] The ADF and the KPSS procedures are well known and details are not included to conserve space. For the ADF regression, the Ljiung Box Q statistics are employed to find the optimum lag length, while for the KPSS test, the lag truncation parameter is set to 8 as it allows for an acceptable compromise between low power and size distortions [see for example Schlitzer (1995)]. Detailed results are available upon request.

developed a Lagrange Multiplier (LM) statistic and start their analysis by assuming that

a time series can be decomposed into three components; a deterministic trend, a random

walk process and a white noise error:

$$Y_t = \delta t + P_t + \varepsilon_t \tag{13}$$

Where δt is the deterministic time trend and P_t is a unit root process

$$P_t = P_{t-1} + e_t \tag{14}$$

where ε_t and e_t are stationary white noise processes (that is ε_t is an i.i.d. $[0, \sigma_\varepsilon^2]$ process

while e_t is an i.i.d. $[0, \sigma_e^2]$ process) that are uncorrelated with one another. The

stationary null hypothesis implies that the variance of the unit root process $\sigma_e^2 = 0$.

Under the null hypothesis of trend stationarity, $\sigma_e^2 = 0$ and $\delta \neq 0$ while under the null

hypothesis of "pure" stationarity, $\sigma_e^2 = 0$ and $\delta = 0$ respectively.

In general, a regression of Y_t over a constant or constant and time trend is

conducted and the residuals from the regression u_t is used to calculate the LM statistic:

$$LM = \sum_{t=1}^{T} \frac{S_t^2}{s_\varepsilon^2} \tag{15}$$

Where s_e^2 is the estimated variance of ε_t and $S_t = \sum_{i=1}^{t} u_i$

The distribution of the LM is non-standard; the limiting values of the test are

provided in KPSS. To allow for weaker assumptions about the properties of ε_t, one can

rely on the Newey and West (1987) estimate of the long-run variance of ε_t:

$$s^2(l) = T^{-1} \sum_{t=1}^{T} u_t^2 + 2T^{-1} \sum_{k=1}^{l} w(k,l) \sum_{t=k+1}^{T} u_t u_{t-k} \tag{16}$$

Where $w(k,l) = 1 - \left(\dfrac{k}{l+1}\right)$ and the test becomes:

$$v = T^{-2} \sum_{t=1}^{T} \frac{S_t^2}{s^2(l)} \tag{17}$$

The value of the KPSS test is dependant on the choice of the lag truncation parameter l. For the purpose of this study, the lag truncation parameter is set to 8 as suggested Schlitzer (1995), since it allows for an acceptable compromise between low power and size distortions.

Finally since several authors' have contended that the diversification benefits from investing in securitized real estate may be time-period specific (Mull and Soenen, 1997), the Zivot and Andrews (1992) procedure is applied to test for endogenous structural breaks in each of the univariate series. This avoids misleading cointegration results, since the existence of structural breaks can disguise the true nature of long run relationship(s) among the markets under consideration [Gerlach et al. 2006].

3.2.3. Cointegration Tests

Results of the unit root tests provide the needed information for determination of the indices to be included in the cointegration tests which are conducted using the maximum likelihood procedure developed by Johansen (1988) and Johansen and Juselius (1990). It is a reliable procedure to test for cointegration and avoids the potential pitfalls that are frequently associated with the Engle and Granger (1987) methodology such as the arbitrary normalization of the variables and the difficulty in

estimating the appropriate number of cointegrating vectors within a system. A brief description of the methodology ensues:

Johansen's (1988) and Johansen and Juselius's (1990) analysis starts by considering an n variable VAR given by

$$x_t = A_1 x_{t-1} + ... + A_k x_{t-k} + \mu + \varepsilon_t \qquad (18)$$

Where x_t is an n dimensional vector of real estate stock price indices, A_i are $(n \times n)$ coefficient matrices, μ is the matrix composed of all the deterministic components of the vector process x_t, ε_t are white noise error terms and k is the lag length of the VAR system. It is well known in the cointegration literature that the Johansen tests are very sensitive to the choice of lag length k. Although there are several procedures that can be used to compute k, the optimum lag length for the VAR system is selected by implementing the Likelihood Ratio test[17] (henceforth LR) and then checking the residuals in each equation to ensure that they are free from serial correlation as measured by the Ljiung-box Q statistic at the 5% significance level (Crowder and Wohar, 1998).

Subtracting x_{t-1} from both sides of equation (18), the VAR above can be transformed into an error correction model:

$$\Delta x_t = \Gamma_1 \Delta x_{t-1} + ... \Gamma_{k-1} \Delta x_{t-k+1} + \Pi x_{t-1} + \mu + \varepsilon_t \qquad (19)$$

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[17] Let T = the number of usable observations, c = number of parameters estimated in each equation of the unrestricted system and let $\sum u$ and $\sum r$ be the variance/covariance matrices of the unrestricted

where, Γ_i is an $(n \times n)$ coefficient matrix equal to :

$-(I - A_1 - ... - A_i), (i = 1, ...k - 1)$ representing short-run dynamics while Π is an $(n \times n)$ matrix equal to $-(I - A_1 - ... - A_k)$, whose rank determines the number of distinct cointegrating vectors that exist among the variables in x_t. The most important component of the above equation (2) is the rank of the long-run impact matrix Π which determines the number of cointegrating vectors (henceforth, CIVs).

Letting r denote the rank of the Π matrix, there are three distinct possibilities: 1. Π has a full rank $(r = n, \text{ or } n - r = 0)$ which implies that all the variables in x_t are stationary to begin with, $x_t \sim I(0)$ and hence cointegration is not defined. The VAR can then be estimated in levels (since there is no problem of spurious regression) and standard inferences (based on F - statistics, t-statistics and χ^2) apply. 2. Π is a null matrix $(r = 0, \text{ or } n - r = n)$ in which case, even though the components of x_t are $I(1)$, no linear combination(s) of the variables in x_t are stationary. Hence standard inferences still apply but the appropriate modeling strategy is to estimate the VAR in first differences. 3. Finally Π can be of reduced rank $(n - r > 1 \text{ or } r < n)$, implying that there are r linear combinations of x_t that are stationary or cointegrated and thus $\beta' x_t \sim I(0)$.

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and the restricted model respectively. Then the test statistic: $(T - c)(\log | \sum r | - \log | \sum u |)$ can be compared to a χ^2 distribution with degrees of freedom equal to the number of restrictions in a system.

In general, if one or more CIVs are found, the Π matrix can be decomposed into two $n \times r$ matrices such that $\Pi = \alpha\beta'$ where β is the matrix of r CIVs which implies $n - r$ common (stochastic) trends (see for instance Kasa 1992 and Gonzalo and Granger 1995), while α is the matrix comprised of the error correction coefficients which measure the deviations from the long run long-run equilibrium relationship. The significance of the β and α coefficients will further indicate which of the variables participate in the cointegrating space and which of the variables are weakly exogenous, respectively. In essence if there are r CIVs, exclusion tests can be conducted by restricting the corresponding row in the β matrix to zero while tests of weak exogeneity can be conducted by setting the relevant row of the α matrix to zero. Both the tests are χ^2 distributed with r degrees of freedom.

The two test statistics for the existence of cointegrating vectors are the λ_{trace} and the $\lambda_{\max}$. Under the λ_{trace} statistic, the null hypothesis is that the number of CIVs is $\leq r$ against a general alternative; while under the $\lambda_{\max}$ statistic, the null hypothesis is that the number of CIVs $= r$ against the alternative $r+1$ CIV.

$$\lambda_{trace(r)} = -T \sum_{i=r+1}^{n} \ln(1 - \lambda_i) \qquad (20)$$

$$\lambda_{\max(r,r+1)} = -T \ln(1 - \lambda_{r+1}) \qquad (21)$$

In the above equations, λ_i represents the eigenvalues that have been obtained from the Π matrix and the significance of the λ_i s will determine the appropriate rank of the

matrix. The critical values for both the tests are provided by Osterwald-Lenum (1992) (for at most 11 variables).

It is important to note that the asymptotic distribution of the λ_{trace} and the λ_{max} statistic is heavily dependant upon the specification of the deterministic component of the VAR. If the deterministic components are not properly specified, the inference regarding the number of CIVs and subsequent hypothesis testing may be misleading [see for instance Crowder, (1996)]. In this study the appropriate deterministic component(s) in the VAR system is specified by using the $G(r)$ statistic as advocated by Johansen (1994).

Johansen (1994) proposes five models: $H0(r), H0*(r), H1(r), H1*(r)$ and $H2(r)$[18]. Model 1: $H0(r)$, allows for quadratic trends in the levels of the data that is eliminated by the cointegrating relationships and linear trends in the differenced data. Model 2: $H0*(r)$, does not allow for quadratic trends in the levels, but do contain linear trends that are not eliminated by the cointegrating relationships. Model 3: $H1(r)$, allows for linear trends in the levels of data but the trends cancel out in the cointegrating relationships. Model 4: $H1*(r)$, only allows for an intercept or constant in the cointegrating relationship and finally Model 5: $H2(r)$ contains no deterministic components.

The test for $Hi*(r)$ versus $Hi(r)$ is asymptotically distributed $\chi^2(p-r)$ and can be achieved by using the following $G(r)$ statistic:

$$G(r) = -T \sum_{i=r+1}^{p} \ln[(1 - \hat{\lambda}_i^*)/(1 - \lambda_i)] \sim \chi^2(p - r) \tag{22}$$

On the other hand the test for $Hj(r)$ versus $Hi^*(r)$, $j = i + 1$ is asymptotically distributed $\chi^2(r)$ and can be attained by using the following $G(r)$ statistic:

$$G(r) = -T \sum_{i=1}^{r} \ln[(1 - \hat{\lambda}_i)/(1 - \lambda_i^*)] \sim \chi^2(r) \tag{23}$$

In both the equations (5) and (6), the λ^*s are the eigenvalues from the restricted model while the λs represent the eigenvalues from the unrestricted model.

Apart from estimating the number of cointegrating vectors that is shared among the variables in the system, the Johansen's technique also makes it possible to estimate the number of common stochastic trends (CTs from now onwards) that drives each of the markets. These are essentially the markets that do not respond to the deviations from the long-run equilibrium relationships and are thus weakly exogenous. By Gonzalo and Granger's (1995) definition, if there are r CIVs there must be $n - r$ common trends or unit roots that drive the system in the long run:

$$X_t = \sum Transitory \ component + \sum Unitroot \ or \ Permanent \ component$$

$$X_t = \alpha(\beta'\alpha)^{-1}\beta'X_t + \beta_\perp(\alpha_\perp'\beta_\perp)^{-1}\alpha_\perp'X_t \tag{24}$$

Where $\alpha_\perp$ and $\beta_\perp$ are $p \times (p - r)$ matrices and the orthogonal complements of α and β respectively such that $\alpha'\alpha_\perp = 0$ and $\beta'\beta_\perp = 0$. Thus the $\beta'X_t$ represents the stationary component while the $\alpha_\perp'X_t$ component reflects the permanent or nonstationary (non

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[18] For a detailed description of each of the models, the reader is referred to Johansen (1994).

mean reverting component). The estimates of the common trend(s) can be evaluated by examining the permanent component portion of the above equation.

3.2.4. Diagnostic Tests

Gregory (1994) and Richards (1996), among others, have contended that the Johansen VAR Maximum Likelihood estimation procedure may lead to misleading conclusions regarding the number of CIVs while other authors such as Sephton and Larsen (1991) argue that the procedure may be characterized by sample dependency. Still others claim that the Johansen procedure may cause the researcher to incorrectly reject the null of no cointegration in the presence of fractionally integrated series (Gonzalo and Lee, 2000). Thus, this study incorporates two relatively new diagnostic techniques to augment the results from the standard Johansen tests.[19]

First, the stationarity of the CIV(s) and CT(s) is verified by performing ADF[20] unit root tests on the corresponding CIV(s) and CT(s). Essentially, since the CIV(s) represent stationary linear combinations among nonstationary variables, it is important to confirm that the cointegrating vector(s) found from the Johansen procedure are indeed stationary and do not show any evidence of a unit root or nonstationarity. Similarly, since CT(s) represent the common trends that drive the variables in the system, it is important to ensure that they are statistically nonstationary.

Second, a recursive cointegration analysis (Hansen and Johansen 1999) is employed in order to test for the constancy of the cointegration rank and to visually

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[19] The diagnostic techniques implemented are discussed in more detail in Crowder and Wohar (1998) and Phengpis and Apilado (2004).

determine the time path of the linkages over time. The recursive analysis can be conducted under the "Z-representation" and the "R representation": Under the "Z-representation", all the parameters of the VECM in equation (2) are re-estimated during the recursions while under the "R-representations", the short run parameters Γ_i in equation (2) are kept fixed to their full sample values and only the long-run parameters are re-estimated.[21] Finally, a recursive likelihood ratio test verifies the constancy of the cointegration space, motivated by the fact that the models used will be inadequate if the parameters are not stable over time.

3.2.5. Causality Tests

After examining whether or not there exist long-run relationships among the property markets, short term linkages are investigated with causality tests. The Granger (1969) method determines whether or not the explanation of a variable Y can be improved by lagged values of another variable X. If two variables are found to be stationary but not cointegrated, the Granger causality relationship can be formulated as follows:

$$\Delta Y_t = \delta_0 + \sum_{i=1}^{m} \alpha_i \Delta X_{t-i} + \sum_{j=1}^{m} \beta_i \Delta Y_{t-j} + \mu_t \tag{25}$$

On the other hand, if two nonstationary variables are cointegrated, then the VAR in first differences is misspecified (Engle and Granger, 1987) and an error correction term $\lambda \hat{\varepsilon}_{t-1}$ must be added:

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[20] KPSS (1992) only supply the critical values for evaluating the time series properties of univariate series which may not be suitable for examining the statistical characteristics of cointegrating vectors. Thus, the KPSS procedure is not conducted to test for unit roots in the CIV or CT.

[21] Hansen and Johansen (1999) however contend that the results from the "R-representations" are more appropriate in the recursive estimation analysis and hence only the results from the "R-representation" are reported. The results from the "Z representation" are very similar and are available upon request.

$$\Delta Y_t = \delta_0 + \sum_{i=1}^{m} \alpha_i \Delta X_{t-i} + \sum_{j=1}^{m} \beta_i \Delta Y_{t-j} + \lambda \hat{\varepsilon}_{t-1} + \mu_t \qquad (26)$$

However, bi-variate causality tests do not take into consideration interactions among the variables in the system, and a multivariate VAR causality test (Granger, 1988) is needed to rectify this shortcoming. For instance if the variables are not found to be cointegrated, tests for causality are implemented using the following VAR:

$$y_t = \mu + \Gamma_1 y_{t-1} + ... + \Gamma_p y_{t-p} + \varepsilon_t \qquad (27)$$

Where y_t is a $(n \times 1)$ matrix of endogenous variables, that is the natural logarithms of first differences of the property indices of each of the respective countries in the system, μ is a (5×1) vector of constants, Γ_i, $i = 1, 2, ... p$, (where p is the number of lags) is a (5×5) matrix consisting of beta coefficients, y_{t-i} is a (5×1) matrix of the lagged endogenous variables and ε_t is a (5×1) matrix of white noise error terms. The lag length p is chosen using the LR tests discussed above.

Because the property markets of the different regions operate in different time zones, i.e. markets in Asia-Pacific and European countries close before those in the US open, adjustments must be made for geographical timing differences. For instance, if some major event takes place in the Asian or the European region real estate market in time period t, this will affect the returns in the US market also in time period t.[22]

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[22] The issue of timing difference has been explained in more detailed in Mallaris and Urrutia (1992)

Under such circumstances the Granger causality equation does not need to be adjusted (without cointegration):

$$y_t^{US} = C_o + \sum_{i=1}^{p} \alpha_i y_{t-i}^{Foreign} + \sum_{j=1}^{P} b_j y_{t-j}^{US} + \varepsilon_t \tag{28}$$

On the other hand, if an event occurs in the US market at time period t then the foreign markets cannot be affected until time period, $t+1$ (without cointegration):

$$y_{t+1}^{Foreign} = C_o + \sum_{i=1}^{p} \alpha_i y_t^{Foreign} + \sum_{i=1}^{P} b_i y_t^{US} + \varepsilon_t \tag{29}$$

If the variables are found to be cointegrated, then an error correction term is added:

$$y_t = \mu + \Gamma_1 y_{t-1} + ... + \Gamma_p y_{t-p} + \lambda \hat{e}_{t-1} + \varepsilon_t \tag{30}$$

Where $\hat{e}_{t-1}$ represents the error correction term which measures the adjustment to deviations from long-run equilibrium.

CHAPTER 4

EMPIRICAL RESULTS

The following section is structured in the following manner; section 4.1 details the results of the Asian real estate analysis; section 4.2 reports the findings of the European property section; and finally section 4.3 discusses the results of the equity markets analysis. Each section closes with concluding remarks.

4.1 Empirical Results for Asian-Pacific Property Markets

It is often argued that the world equity markets are becoming increasingly integrated as a result of deregulation and financial market liberalization, thereby decreasing opportunities available for international portfolio diversification. Early studies investigated the dynamic interaction among the stock markets of developed nations. However with the emergence of Asian capital markets, studies have begun to include them as well [Siklos and Ng (2001), Baharumshah et al. (2003), Wong et al. (2004), Dunis and Shannon (2005) and Phylaktis and Ravazzolo (2005)]. In addition, the focus of past work has been almost exclusively on equity markets with little attention given to real estate markets. Specifically, consideration of the degree of integration among international real estate markets, especially the public property markets of the Asia-Pacific region[23], has been minimal. This is despite increased

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[23] In the context of this paper, the terms "Asian markets" and "Asia-Pacific markets" are used interchangeably and refer to the property markets of Australia, Hong Kong, Japan and Singapore.

recognition that shares of publicly-traded real estate companies in the region may provide significant diversification opportunities.

The emergence of new investment vehicles such as Real Estate Investment Trusts (REITs), greater accessibility of foreign investors to these markets, and increased interest among institutional investors has increased the interest of US investors, portfolio managers and regulators in the dynamic linkages among these public property markets of the Asia-Pacific region and the US. This interest is evidenced by the fact that market capitalization of publicly-traded property securities in the Asia-Pacific region has grown at a rapid rate over the last few years, e.g. over a two year period from January 2004 through December 2005, it grew from approximately $104.039 billion to $198.352 billion, a growth rate of more than 90% over two years. (source: FTSE EPRA/NAREIT).

Thus, the primary objective of this study is to investigate the longer-term relationships and short-run linkages among the major and largest (in terms of market capitalization) public property markets[24] of the Asia-Pacific region and the US to evaluate diversification possibilities from the perspective of the US investor.

Essentially, the following questions will be addressed:

1. Are there long run relationships among the Asian property indices and the US index?

2. If cointegration exists, which of the markets are excludable and which of these contribute to the common stochastic trends?

3. Are there short term causal linkages between the individual property markets and the US?

In essence this section will update the property market literature by utilizing several modern diagnostic techniques to evaluate the number of cointegrating vectors shared among the markets of Asia and the US and the number of common stochastic trends that drive these markets in the long-run.

4.1.1. Univariate Analysis

Table A.2 provides basic characteristics of the indices. As expected in 2006, the US dominates the Asia-Pacific markets both in terms of number of companies included in the index and capitalization. The daily returns are between .000006% (Singapore) to 0.000564% (Japan) with standard deviations between 0.0088% (US) and 0.0199% (Japan). The negative values for skewness apparent in some of the real estate markets imply that the distribution of the series has a long left tail, while the Jarque-Bera test statistics indicate rejection of the normality hypothesis.

Unit root tests presented in Table A.3 reveal that when the series are in levels, the null hypothesis of a unit root cannot be rejected irrespective of the choice of model used in the ADF or KPSS tests. The results are consistent and for the entire period (January 2000 to March 2006) and each sub-period (January 2000 to December 2002 and January 2003 to March 2006) and are similar to those of several authors' such as Kleiman et al. (2002), Payne and Sahu (2004) and Yang et al. (2005), who find international real estate stock price indices to be nonstationary data generating

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[24] Unless otherwise stated, the terms "real estate markets", "public property markets" and "listed property

processes and Garvey et al. (2001) who finds unit roots in the securitized property indices of Australia, Hong Kong, Singapore and Japan.

Finally, because diversification benefits from investing in securitized real estate may be time-period specific (Mull and Soenen, 1997) the Zivot and Andrews (1992) procedure is applied to test for endogenous structural breaks in each of the univariate series. This avoids misleading cointegration results, since the existence of structural breaks can disguise the true nature of long run relationship(s) among the markets under consideration [Gerlach et al. 2006].

The results presented in Table A.4 indicate the presence of a structural break approximately around the end of 2002-beginning 2003 for most of the time series involved. One would strongly suspect that the structural break in 2002-2003 is a global phenomenon and is caused by the boom in the commercial real estate markets in the Asia-Pacific region. As a result, the data-set is divided into two sub-periods to examine the degree of interdependence among the markets and the US over time. The two sub-periods are January 2000 – December 2002 and January 2003 – March 2006.

4.1.2. Multivariate Long-run Analysis, US and Asia

The Johansen (1988, 1990) cointegration procedure requires the selection of the appropriate deterministic component for the VAR system which is calculated using $G(r)$ statistics. The results indicate that most suitable deterministic component for the

markets" are used interchangeably.

entire period and for both the subperiods is the model that contains only an intercept in the cointegrating relationship. [25]

The results of cointegration tests are shown in Table A.5. For the entire period (Panel A), the null hypothesis of no cointegration cannot be rejected using either the λ_{trace} and λ_{max} statistic.[26] Similarly, there is no evidence of cointegration among the markets in the first sub-period (Panel B), but both the λ_{trace} and λ_{max} statistics indicate the presence of 1 CIV in the second sub-period (Panel C).

As pointed out by Masih and Masih (1997, 1999), to the extent that markets are cointegrated, the potential for long-term benefits that can be attained through international diversification is lessened relative to non-cointegrated markets. Thus, the results above suggest that since the property markets have started trending together in the more recent sub-period, the potential for long-run diversification from investing in the Asia-Pacific property stocks may be decreasing for US investors.

4.1.3. Hypothesis Tests

While the finding of a cointegrating vector suggests reduced potential diversification gains, some of the included countries may not participate in the cointegration space and contribute to the cointegrating relationship. As pointed out by Allen and McDonald (1995), the finding that one CIV exists in a system of variables does not require that a subset of the variables will be cointegrated. In other words, one

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[25] The results are omitted to conserve space. Details are available upon request.
[26] Even though some author's have pointed out that the power of the Trace test is lower in comparison to the Max tests (Johansen and Juselius, 1990), both the test statistics are used since it has been found recently that neither test dominates the other one uniformly over a local alternative (Paruolo, 2001).

CIV among a set of five variables does not imply that diversification gains are limited within all the markets. Instead it is possible that some of the markets do not share in the cointegrating relationship and thus the potential for diversification benefits may not be reduced for these markets.[27] Exclusion tests for the second sub-period allow us to identify the independent markets where diversification gains are greatest.

Table A.6. repeats the Johansen λ_{trace} and λ_{max} statistics (Panels A and B respectively) followed by the exclusion test results (Panel C). Panels A and B, indicate the existence of one CIV when all the property markets are incorporated in the system.[28] The exclusion tests (Panel C row one), however, suggest that Hong Kong and Japan do not participate in the cointegrating space and are not required for the CIV. As a result, a smaller set of variables including only the non-excludable markets (US, Australia and Singapore) is tested for cointegration for verification purposes. Panel C, row 2 confirms Panels A and B, and the three markets are indeed interlinked by a single cointegrating vector. Finally a "joint exclusion" test of the null hypothesis that $\beta JP = \beta HK = 0$ (Panel D) finds that the two property indices can be excluded further confirming the exclusion tests. Finally Panel E and F shows that the markets of US and Australia are weakly exogenous and are the sources of the common stochastic trends that link the markets of the three non-excludable markets in the long-run.

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[27] It should be noted that in previous real estate market integration studies (Myer et al. 1996 and Kleiman et al. 2002), authors have not conducted exclusion tests on the coefficient of the cointegrating vectors and hence it cannot be established whether all the markets participated in the cointegration space.
[28] Again the appropriate deterministic component in the VAR equations is specified by utilizing the $G(r)$ statistics.

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Overall the results show that the public property markets of the US, Australia and Singapore are linked and that their joint diversification benefits are reduced. Greater benefits are possible for Japan and Hong Kong because these markets are not trending long-term with the other markets. Australia and the US have the oldest and the most developed/established public property markets and thus it is quite reasonable to expect that the two markets will comove with one another. In May 1999, the Monetary Authority of Singapore (MAS) released guidelines to facilitate the setting up of property trusts and funds. These guidelines were drawn broadly based on practices in the Australian Listed Property Trust (LPT) market. Thus the two real estate investment trust (REIT) markets not only share a similar institutional structure, they are also likely to be closely driven by common economic factors (Ling and Sing, 2003).

The possible exclusion of Hong Kong and Japan may be related to macroeconomic factors.[29] In contrast to the other three countries, GDP for both Hong Kong and Japan suffered a major drop in mid-2002 and was extremely variable over the entire period. Inflation in the two countries followed a similar path while increasing for the remaining three countries. These generally divergent economic situations help explain why Hong Kong and Japan are not a part of the longer-term trending behavior of public property markets for this time period.

Finally, the results of the weak exogeneity test reveals that the markets of Australia and the US are the sources of the trends since they do not respond to the deviations from the long-run equilibrium relationships. Since these are two huge

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markets in comparison to the smaller slice (Singapore) it is quite reasonable to expect that these two markets will lead the three markets in the system.

The use of exclusion tests and weak exogeneity tests extend previously published real estate market integration studies by explicitly determining which of the markets are not contributing to the long-run equilibrium relationship thereby providing the greater diversification benefits and which markets lead the other markets in the system respectively.[30]

4.1.4. Diagnostic Tests

Diagnostic tests are conducted to evaluate the robustness of Johansen's cointegration results to verify whether the markets indeed have become cointegrated in the more recent sub-period.

To corroborate that both Japan and Hong Kong property markets can be excluded and that the markets of the US and Australia are weakly exogenous, the ADF unit root[31] test is performed on the single cointegrating vector found in the preceding section. [32] Essentially, if the property markets of either or both of these two countries are not necessary for the long-run equilibrium relationship, excluding either or both of them should not affect the stationarity property of the CIV. In other words, if the CIV

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[29] Liow and Yang (2005) also found macroeconomic factors to be important in their cointegration results of Asia-Pacific countries.

[30] Transactions costs will reduce diversification gains. However, since indexes are being used and portfolios are not created to determine portfolio returns, a valid estimate for transactions costs is complicated by comparisons of long-term and short-term diversification gains because varying holding period assumptions would be required. Portfolio analysis is left for a later study.

[31] KPSS (1992) only supply the critical values for evaluating the time series properties of univariate series which may not be suitable for examining the statistical characteristics of cointegrating vectors. Thus, the KPSS procedure is not conducted to test for unit roots in the CIV or CT.

estimate shows evidence of a unit root when Japan or Hong Kong or both are excluded, one or both of the variables are required to achieve the stationary long-run relationship (as implied by cointegration) among the property markets under consideration. On the other hand, common trends are nonstationary by definition and should show no statistical evidence of unit root. If they do show signs of stationarity, the model needs to be rechecked.

For ease of interpretation, the restricted CIV estimate has been normalized with respect to the US and takes the following form[33]:

$$LUS_t = 0.411LAU_t + 0.387LSPORE_t \tag{31}$$

The above equation can be read as a regression equation bearing in mind that the relationship among the variables is long-run. This means that in the long-run, a unit change in the value of the log of the Australian property index (keeping the other variables in the equation constant) would increase the value of the log of the US index by 0.411. It is also apparent from the equation the strength of the relationship between the Australian and the Singapore index is extremely high (almost 1 for 1) implying that for investors in these two markets diversification opportunities within these markets is fairly limited. The extent of relationship between the US and the other markets however

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[32] Stationarity checks of CIV(s) in different contexts have been performed in Crowder and Wohar (1998) and Phengpis and Apilado (2004).

[33] The cointegrating vector in the equation above is simply the linear combination of the cointegrated variables in the system of equations. It is calculated by multiplying the transposed β matrix (from the $\Pi = \alpha\beta'$) with each of the x_t s.

is moderately high indicating that for the investor diversification benefits within these markets is minimal

The results from the unit root tests on the CIV estimate are presented in Table A.7. It is evident that CIVs show no evidence of a unit root while the CTs are statistically stationary processes irrespective of the number of lags used in the ADF regressions further supporting earlier findings.

Next, recursive cointegration analysis (Hansen and Johansen, 1999) for the constancy of the cointegration rank aids in determining when the public property markets of US, Australia and Singapore began to share their long-run equilibrium relationship. The recursive trace statistic is normalized by the 10% critical value [34] such that the number of trace statistics great than 1.0 indicates the number of CIVs shared by the variables in the system.

Figures A.1 and A.2 depict the trace statistics for the first and second sub-periods, respectively. For the first sub-period (2000-2002), it is evident that the null hypothesis of no cointegration cannot be rejected because no trace statistic is above the critical value of 1.0 (Figure A.1),. However, in the second sub-period (Figure A.2), the cointegrating vector becomes statistically significant in early 2004 (only one trace statistic shows a prominent upward tendency and crosses the critical value of 1.0).

Lastly, recursive likelihood ratio test (Hansen and Johansen, 1999) results in figure A.3 for the stability of the CIVs also indicate that only 1 CIV (or $r = 1$) is

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[34] Hansen and Johansen (1999) remark that the results from the "R-representations" are more appropriate/relevant in the recursive estimation analysis and hence only the results from the "R-

appropriate for the markets of US, Singapore and Australia, (Figure 1.c).[35] The null hypothesis that a single CIV is stable over the sample cannot be rejected as shown by the test statistic not crossing the normalized critical value of 1.0 indicating that the models under consideration are adequate and support the findings from Johansen's cointegration tests.

4.1.5. Multivariate Short-run Analysis, US and Asia

The previous cointegration tests indicate that there is no consistent evidence of a long-run relationship between the public property markets of Asia and the US during the entire period and during the first sub-period. However, it is still possible that short-run relationships exist. For these two periods, the general form of the multivariate causality equation (7) (simply the VAR in first differences) is appropriate while for the second sub-period, the error correction model is required [36]:

Because the property markets of the different regions operate in different time zones, i.e. markets in Asia-Pacific countries close before those in the US open, adjustments must be made for geographical timing differences. For instance, if some major event takes place in the Asian region real estate market in time period t, this will affect the returns in the US market also in time period t.[37] Under such circumstances the Granger causality equation does not need to be time adjusted (without cointegration). However, if an event occurs in the US market at time period t then the

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representation" are reported. The results from the "Z representation" are very similar and are available upon request.
[35] The calculated test statistics are divided by the appropriate 5% critical value such that values below 1.0 indicate non-rejection of the null hypothesis that the cointegration space is stable or constant over time.

Asia-Pacific markets cannot be affected until time period, $t+1$ (without cointegration).

These adjustments are made for all causality tests. When cointegration exists, the error

correction model provides two possible sources of causation to the dependant variable

by the independent variables: (1) through the lagged values of the independent variables

(short-term effects) and (2) through the error correction term (long-term effects).

The Granger causality test results are presented in table A.8**.** Panels A and B

reflect short-term relationships only while Panel C includes long-term relationships (via

the error correction term). For the entire period and the first sub-period (Panels A and

B), the results are somewhat unexpected in that there is virtually no short run causality

between the US and the Asia-Pacific markets and among the Asia-Pacific markets. For

the entire period, Hong Kong and Singapore are most impacted by short-term

movements with both being affected by Australia, Hong Kong also being affected by

Japan, and Singapore also being affected by Hong Kong. The only bi-directional

causality is between Australia and Hong Kong. Neither US nor Singapore has any short-

term effect on any market. For the first sub-period (early in the study), the US affects

Singapore and is affected by Australia, Japan and Singapore. The only remaining

identifiable relationship is the effect of Hong Kong on Singapore.

The lack of short-term lead lag relationships indicates that basically the markets

are short-term independent, despite long-term relationships in the recent sub-period. A

possible explanation is that real estate is typically considered a long-term investment

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[36] In all cases, lag lengths chosen are computed using the Likelihood Ratio procedure and checking the
residuals from each equation to ensure that they are stationary white noise processes.
[37] The issue of timing difference has been explained in more detailed in Malliaris and Urrutia (1992)

such that daily data may not reflect significant relationships. These results are very similar to those of Garvey et al. (2001) who also find very little causality among the markets in the Asia-Pacific region (in a bi-lateral Granger causality framework), over a period beginning 1975 and ending 2001 and for several shorter sub-periods.

In the latter sub-period where long-term effects are included, there is no significant lead lag relationship between the markets although each of the Asian markets adjusts to deviations from the long-run equilibrium relationship. The US market bears none of the long-term adjustment process. With regard to short-term linkages among the Asia-Pacific markets, Australia is affected by each of the remaining markets, Singapore is affected by both Hong Kong and Japan, and finally Japan is affected by Hong Kong. Hence, similar to the findings of the earlier sub-period, Hong Kong dominates in terms of short-run impacts followed by Japan and Singapore.

4.1.6. Section Conclusions

This section investigates the long-run relationships and short-run linkages among a group of Asia-Pacific public property markets (Australia, Hong Kong, Japan and Singapore) and the US. Based on daily real estate stock price data provided by EPRA/NAREIT, the property markets are studied over a period beginning January 2000 and ending March 2006 and over two sub-periods of January 2000-December 2002 and January 2003-March 2006. Its contributions include (a) consideration of primarily emerging economies' real estate markets, specifically the markets in the Asia-Pacific region, (b) representation based on more timely and representative data than has been

available previously and (c) improved methodologies for analyzing public property markets. The primary findings are as follows.

No long term relationship between the Asia-Pacific and US property market is found for the entire study period or for the early sub-period. However evidence of cointegration in the second sub-period suggests that the markets are beginning to trend together. Further analysis, however, reveals that only the property markets of US, Australia and Singapore are contributing to the cointegrating relationship implying that there still exists important potential long-run diversification opportunities in the property markets of Japan and Hong Kong. These findings extend previously published real estate integration studies such as Myer et al. (1997, 1999), Garvey et al. (2001) and Keliman et al. (2002), that conclude reduced diversification opportunities occur due to the presence of one or more cointegrating vectors and provides additional insights by determining which of the markets actually account for the long run relationship in order to evaluate possible diversification gains among the countries.

Little evidence is found of short-term relationships during the entire period or the first sub-period, and Hong Kong dominates short-run effects for all three periods. Also, in the latter sub-period when the error correction term is included, all the Asia-Pacific markets adjust to long-term disequilibrium except the US indicating that the Asian markets bear the brunt of long-term adjustments. These results suggest that the US property market is essentially independent of these markets, a finding consistent with many stock market integration studies where the US stock market is found to be the "*global factor*" (Cheung and Mak, 1992; Kwan et al. 1995; Cha and Cheung; 1998).

The results of this study suggest that investors in international real estate can derive benefits from diversification in some of the public property markets of the Asia-Pacific region both in the long-run and in the short-run. These findings enrich the thin body of literature on the Asia-Pacific public property markets and aid institutional investors and portfolio managers interested in the Asian securitized property sector in making more informed investment decisions. The use of more reliable data provides further insights for both investors and policymakers. For short-term investors, diversification gains are available from all the Asia-Pacific markets. For long-horizon US investors, greater diversification gains occur from Hong Kong and Japan because Australia and Singapore will be trending together making only one of them an essential part of the portfolio. Policymakers can thus better track influences on domestic markets for making better directed decisions.

4.2 Empirical Results European Property Markets

The rapid pace of globalization has reached most aspects of financial markets over the past few years. However, one of the slowest to become internationally integrated has been the real estate markets. Their unique characteristics such as being real property, obvious lack of liquidity, and political risk to direct investors slowed their entry into the portfolios of global investors. In recent decades, securitization has provided a great boon to the integration of these markets and their diversification gain potential has begun to be investigated.[38] Previous work has been hampered by

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[38] Eichholtz (1996, 1997), Gordon and Canter (1999), Conover, et al. (2002) and Kleiman, et al. (2002) find relatively low correlations of returns between several international public property markets and

inadequate data and limited methodological approaches. This paper addresses these issues by taking advantage of the newly available EPRA/NAREIT indexes and by applying cointegration and causality techniques to analyze existing relationships.

Specifically, the primary objective is to investigate the long-term relationships and short-run linkages among the public property markets of Europe and the US in order to evaluate real estate diversification possibilities.[39] Based on market capitalization of public property markets, the four largest property markets in Europe are selected for the study: France, Netherlands, Spain and UK.

Essentially, the following questions will be addressed:

1. Are there long run relationships among the public property markets of Europe and the US property index?

2. If cointegration exists, which of the markets are excludable and which of them are the sources of the common stochastic trends?

3. Are there short term causal linkages between the individual European property markets and the US?

4.2.1. Univariate Analysis

Table A.9 provides basic characteristics of the indices. The daily returns vary from 0.000459%   (the Netherlands) to 0.001063% (Spain) with standard deviations

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between international real estate and other asset classes, contending that significant diversification benefits can be achieved by adding securitized property stocks to portfolios. Focusing on Europe, Newell and Webb (2003) and Bond and Glascock (2006) show that European property shares enhance the risk-adjusted performance of European and US mixed-asset and real estate only portfolios.

[39] Because data limitations restrict the study period to January 2000 through March 2006 only slightly more than six years) the long-term measures are more nearly intermediate length than long-term. The expression "long-run" or "long-term" is used to differentiate the analysis from a short-term analysis where the period is typically one year or less.

between 0.008% (US) and 0.0328% (Spain). The negative values for skewness apparent in some of the real estate markets imply that the distribution of the series has a long left tail, while the Jarque-Bera test statistics indicate rejection of the normality hypothesis.

Table A.10 summarizes the results for the ADF regressions under the null hypothesis of a unit root with a constant and with a constant and trend in the regression, respectively. Also reported are results of the KPSS procedure under the null hypotheses of level stationarity and trend stationarity, respectively. Both the ADF and the KPSS tests indicate that each of the indices is nonstationary in levels and that each of the series is integrated of order one or $I(1)$. Finally, the Zivot and Andrews (1992) procedure is applied to test for endogenous structural breaks in each of the univariate series. The results presented in Table A.11 indicate no evidence of a structural break for any of the series under consideration and hence all subsequent analysis is conducted over the entire sample period.

4.2.2. Multivariate Long-run Analysis, US and Europe

The appropriate lag length chosen is the minimum to eliminate serial correlation in the residuals as measured by the L-B-Q statistics (at the 5% level of significance). Next, the appropriate deterministic component for the VAR, based on the $G(r)$ statistics (Johansen, 1994), indicate that the most suitable deterministic component is the model that contains trends in levels that are eliminated by the cointegrating relations.[40] Next, the markets are tested for cointegration. The results presented in Table A.12. support a single cointegrating vector (1 CIV) among the European markets and the US. Both the

λ_{trace} and $\lambda_{\max}$ test statistics are compared to their corresponding critical values as tabulated in Osterwald-Lenum (1992).

4.2.3. Hypothesis Tests

In a system comprising of n variables, there can be at most $n-1$ CIVs which would suggest a single common trend (see for example Kasa 1992 and Gonzalo and Granger 1995). In other words $n-r=1$ would indicate that each of the markets is driven by a single common stochastic trend implying that diversification benefits from investing within these markets is substantially reduced. More than one common stochastic trend, however, signifies that there are certain variables in the system that operate independently of the others in the long-run and hence diversification benefits are still attainable within those markets. Results from exclusion tests identify the excludable markets.

Table A.13. repeats the Johansen λ_{trace} and $\lambda_{\max}$ statistics which are followed by the exclusion test results in Panel C. In Panels A and B, row one indicate the existence of one CIV when all the property markets are incorporated in the system. However, the exclusion tests results in Panel C indicate that the property markets of Netherlands, France and Spain can be excluded from the cointegration space. In addition, the joint exclusion test in Panel D suggests that the null hypothesis $\beta_{France} = \beta_{Netherlands} = \beta_{Spain} = 0$ cannot be rejected, providing additional evidence that the markets of France, the Netherlands and Spain are not part of the single cointegrating

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[40] The calculations are available upon request but are not reported for brevity.

vector and implying that only the US and the UK property markets are part of the long run cointegrating relationship.

Finally, tests of weak exogeneity examine which of the markets do not respond to the deviations from the long-run equilibrium relationship. Results are shown in Panel E. The null hypothesis that the property indices of US ($\alpha_{US} = 0$) is weakly exogenous cannot be rejected at the conventional level of significance. This implies that the US property market does not respond to the deviations in the long run equilibrium relationship and can thus be seen as the source of the common stochastic trend.

Overall the results show that the US public property market shares a long-run linkage only with the property market of the UK. Hence greater diversification benefits should be possible for the US investor in the markets of France, the Netherlands and Spain. The fact that the US and UK markets are trending together is not surprising. They are large and more mature with greater liquidity relative to the excludable markets of France, Spain and the Netherlands. These findings are consistent with a recent study by Michayluk et al. (2006) who analyze the returns behavior, asymmetric volatility spillover effects and correlation structure between the securitized property markets of the US and UK and find that the two markets experience significant interaction on a daily basis.

The exclusion of the Netherlands, France and Spain from the cointegration space may be attributed partially to the fact that since each of these markets is part of the Euro block, they may be converging with the other member property markets (Yang et al. 2005) but behaving independently of the US and the UK over the long-run. Finally, the

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finding that the US property market is weakly exogenous and the more influential market that is the driving force behind the trend that exists between the US and the UK, is also logical, due to the pre-eminent position of the US as an economy and with its large share in the listed property sector in relation to the UK.

4.2.4. Diagnostic Tests

In order to corroborate the findings that the restrictions imposed in the previous section are valid and appropriate, the ADF and KPSS tests are performed on each of the restricted cointegrating vectors and the common trends found in the preceding section. Essentially since CIV(s) represent stationary long-run relationship(s) among nonstationary variables, the *restricted* CIV estimates should show no statistical signs of a unit root. Likewise, since the CT(s) represent the permanent components that drive the cointegrated markets they should not be stationary by definition. For ease of interpretation, the restricted CIV estimate has been normalized with respect to the US and takes the following form:

$$LUS_t = 0.65LUK_t \tag{31}$$

The above equation can be read as a regression equation bearing in mind that the relationship among the variables is over the long-run. This means that in the long-run, a unit change in the value of the log of the UK property index would increase the value of the log of the US index by 0.65 indicating that the strength of the relationship between

the two property markets is moderately high indicating that for US investors diversification benefits in the property market are limited. [41]

The results of the tests are presented in Table A.14. Contingent on the following restrictions, $\beta_{NL} = \beta_{FR} = \beta_{SP} = 0$ and $\alpha_{US} = 0$, the single cointegrating vector shared by the US and the UK shows no sign of nonstationarity while the common trend shows no evidence of stationarity irrespective of the lag length used. These results verify the statistical properties of the CIV and CT corroborating the findings of the preceding section.

Next, recursive procedures are performed under the "R-representation", where the short run parameters are kept fixed and equal to the full sample values, over the entire sample, and only the long-run parameters are allowed to vary over time.[42] The recursive trace statistic is normalized by the 10% critical value such that the number of trace statistics great than 1.0 indicates the number of CIVs shared by the variables in the system while the recursive likelihood ratio tests are normalized by the appropriate 5% critical value such that values below 1.0 indicate non-rejection of the null hypothesis that the cointegration space is stable or constant over time.

From Figure A.4 it is apparent that only a single cointegrating vector is shared between the US and the UK (only a single cointegrating vector becomes statistically significant from 2003) and that 1 CIV specification (or $r = 1$) is appropriate for the

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[41] It is important to note that if a set of variables is found to be cointegrated, it does not necessarily imply that diversification benefits will be zero unless of course the relationship among the variables is 1 for 1, that is, the beta transposed matrix take the form [1 -1]. If the beta transposed matrix takes any other form, diversification opportunities will be minimal and the extent of the benefit will be determined by the size and the sign of the beta coefficient.

system (the null hypothesis that a single CIV is stable over the sample cannot be rejected) as shown in Figure A.5. In summary, results of recursive trace test analysis graphically depict the progression of the long-term relationship between the property markets of the US and the UK while the results of the recursive likelihood ratio test indicate stability of the cointegration space indicating that the model under consideration is adequate, supplementing the findings from the standard Johansen cointegration test.

4.2.5. Multivariate Short-run Analysis, US and Europe

Cointegration implies causality in at least one direction (Granger 1969, 1988) and since definitive long-run relationships among markets have been found, an examination of the short-run dynamics among the property markets merits attention. As mentioned earlier, because the property markets of the different regions operate in different time zones, i.e. markets in the European countries close before those in the US open, etc., adjustments must be made for geographical timing differences. For instance, if some major event takes place in the European region real estate market in time period t, this will affect the returns in the US market also in time period t.[43] Under such circumstances the Granger causality equation does not need to be time adjusted (without cointegration). However, if an event occurs in the US market at time period t then the European markets cannot be affected until time period, $t+1$ (without cointegration). These adjustments are made for all causality tests.

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[42] See for example Crowder and Wohar (1998), Phengpis and Apilado (2004).
[43] The issue of timing difference has been explained in more detailed in Malliaris and Urrutia (1992)

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The Granger causality results presented in Table A.15. show unilateral causality running from the US to each of the European markets (with the exception of Spain) but no feedback from any of the markets to the US. The UK also causes each of the European markets (except for Spain) in the short-run with no feedback from the other markets. There is however little evidence of bilateral short-run causality among/across the other (the Netherlands, France and Spain) European markets.

4.2.6. Section Conclusions

This section provides new insights into the measurement of possible diversification gains resulting from real estate investments. It utilizes EPRA/NAREIT data to examine the dynamic linkages among the four largest European listed property markets (France, Netherlands, Spain, and UK) and the US property index to evaluate whether diversification possibilities can be exploited from incorporating European property funds in a US real estate only portfolio. Its contributions include (a) explicit consideration of European economies' real estate markets (b) representation based on more timely and representative data than has been available previously and (c) improved methodologies for analyzing public property markets. The primary findings are as follows.

Over a period beginning January 2000 and ending March, 2006 the US property index trends with the property markets of the UK but not with the remaining European countries. The fact that the US and UK markets are trending together is not surprising. They are large, more mature with greater liquidity and exhibit similar financial market structure relative to the excludable markets of France, Spain and the Netherlands. The

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absence of linkages between the US and the other European property markets may be attributed in part to the fact that since each of these (excludable) countries are part of the Euro-zone, they may be converging with other member country property markets (Yang et al. 2005) but behaving independently of the US and the UK over the long-run.

From a portfolio diversification perspective, the results imply that there exists significant potential long run benefits in risk reduction from diversifying into the listed property markets of Netherlands, France and Spain. These conclusions are based not only on simple cointegration results but also on exclusions tests and exogeneity tests. Further, the US is found to be weakly exogenous and the source of the common stochastic trend that links the market of the US and UK, suggesting that the US is "driving" or "leading" the property market of the UK toward the long-run equilibrium relationship.

Short-run causality results indicate uni-directional causality running from the US to each of the markets (with the exception of Spain) but no feedback from any of the European markets to the US. These findings are analogous to many equity market integration findings where the US stock market is found to be the "*global factor*" in that it leads (but is not lead by) most of the European markets (Cheung and Mak, 1992; Kwan et al. 1995; Cha and Cheung; 1998).

Overall the results suggest that in contrast to the studies that show the European equity markets to have become increasingly integrated with each other and the US over time (See for example Taylor and Tonks, 1989; Kasa, 1992; Serletis and King, 1997; Kanas, 1998; Syriopolous, 1997, 1998 and 2004; Yang et al. 2003; Gilmore and

MacManus, 2002; Fraser and Oyefso, 2004; and Lapodis, 2004), US investors can exploit profitable opportunities from international portfolio diversification in several of the European property markets both in the long-run and in the short-run. These conclusions enrich the thin body of literature on European public property markets and benefit portfolio managers, pension fund managers and other institutional investors in the US and abroad who are contemplating incorporating European real estate funds in their portfolios and are concerned about the dynamic interrelationships of these assets vis-à-vis the US.

4.3 Empirical Results for Equity Markets

As noted earlier, numerous studies have suggested that international financial markets have become increasingly integrated because of capital market liberalization, deregulations, improvements in communications and technology and the development of new and innovative financial products, all of which have contributed to increased capital flows across countries leading to the globalization of financial capital markets (Kasa, 1992; Choudhry, 1994,1996; Ghosh, Saidi and Johnson; 1999; Siklos and Ng, 2001; Laopodis, 2004; Dunis and Shannon 2005; Phylaktis and Ravazzolo, 2005). An important implication of international capital market integration is that stock prices of different economies may be responding to the same economic stimuli, that is, there may be some underlying (economic) factors that affect all markets (due to contagion and/or spillovers) thereby limiting the scope of independent monetary policies across nations (Heimonen, 2002).

Integration of global stock markets also has important portfolio diversification implications: for instance, if stock markets are cointegrated, it would imply that the gains from international portfolio diversification may be limited while if capital markets are segmented, profitable opportunities from international portfolio diversification can be exploited (Syriopoulos, 2004).

The purpose of this section is to investigate/examine the long-run relationships and short run causal interlinkages among the equity market of the US and a select group of Asian and European markets to evaluate diversification possibilities from the perspective of the US investor. To retain consistency and for comparative purposes, the same group of countries that have been analyzed in the property markets sections, that is the markets of Australia, Hong Kong, Japan and Singapore for the Asian group and the markets of UK, France, the Netherlands and Spain for the European group are analyzed (separately). This enriches and extends previous work by evaluating the linkages among several developed markets of Asia and Europe vis-à-vis the US over the most recent period of time.

Essentially, (similar to the sections pertaining to the property markets), the following questions will be addressed:

4. Are there long run relationships among the Asian and European stock price indices and the US stock price index?

5. If cointegration exists, which of the markets are excludable and which of them are the sources of the common stochastic trends?

6. Are there short term causal linkages between the individual equity markets and the US?

4.3.1. Asia-Pacific Equity Markets

4.3.1.1. Univariate Analysis

Table A.16 provides basic characteristics of the indices. The daily returns are between 0.000009% (Singapore) and 0.000426% (Australia) with standard deviations between .0105899% (Australia) and .0144161 (Singapore). The negative values for skewness apparent in some of the equity markets imply that the distribution of the series has a long left tail, while the Jarque-Bera test statistics indicate rejection of the normality hypothesis.

Table A.17 reports the results for the ADF regressions under the null hypothesis of a unit root with a constant and with a constant and trend in the regression, respectively, as well as the KPSS procedure under the null hypotheses of level stationarity and trend stationarity, respectively. Both the tests consistently indicate that each of the indices is nonstationary in levels.[44] Finally, the Zivot and Andrews (1992) procedure is applied to test for endogenous structural breaks in each of the univariate series. The results presented in Table A.18 indicate no evidence of a structural break for any of the series under consideration and hence all subsequent analysis is conducted over the entire period of time.

4.3.1.2. Multivariate Long-run Analysis

Since each of the indices has been found to be nonstationary in levels, it is possible that one or more linear combination(s) of the markets may be stationary and cointegrated. Consistent with the prior analysis, the Johansen's cointegration test is employed. Again, the VAR is fit with the suitable deterministic component by calculating the $G(r)$ statistic while the lag length of the system has been appropriately chosen by ensuring that the residuals are free from serial correlation as measured by the Ljiung-box Q statistic at the 5% significance level (Crowder and Wohar, 1998). The Johansen's cointegration results are reported in Table A.19. The findings indicate the presence of only a single cointegrating vector among the markets of Australia, Hong Kong, Japan, Singapore and the US as evidenced by both the λ_{trace} and λ_{max} statistics at conventional levels of significance.

4.3.1.3. Hypothesis Tests

Table A.20, Panels A and B repeat the Johansen's cointegration results while the exclusion test results in Panel C (row one) indicate that the markets of Australia and Japan do not enter into the cointegration space and can thus be excluded. As a result, a smaller set of variables including only the non-excludable markets (US, Hong Kong and Singapore) is tested for cointegration for verification purposes. Panel C, (row two) confirms Panels A and B in that the three markets are indeed interlinked by a single cointegrating vector. Next, "joint exclusion" test shown in Panel D also finds that the

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[44] Since it is reasonable to expect that each of the stock prices will be *I(1)* DGPs (Nelson and Plosser, 1982), unit root tests of the first differences of the series have not been included for brevity.

two property indices of Australia and Japan can be excluded "jointly" from the cointegrating vector further supporting the results of the individual exclusion tests. Finally, tests of weak exogeneity are conducted on the non-excludable markets to evaluate the two sources of common stochastic trends. The results in Panels E and F signify that the markets of US and Singapore are weakly exogenous (jointly or otherwise) and contribute to the common stochastic trends.

Overall the results show that the markets of the US, Hong Kong and Singapore are linked together and that their joint diversification benefits are reduced. During this period of time, greater benefits are possible from the markets of Australia and Japan because these markets are not trending long-term with the other markets. The results also suggest that the markets of US and Singapore are two sources of common stochastic trends driving the three variables in the system.

4.3.1.4. Diagnostic Tests

Because the sole use of the Johansen's cointegration tests often can lead to conflicting and misleading results, the ADF unit root test is performed on the restricted estimates of the single cointegrating vector and the common trends found in the preceding section.[45] The cointegrating vector should be stationary while the common trend should be nonstationary as per definition.

For ease of interpretation, the restricted CIV estimate has been normalized with respect to the US and takes the following form:

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[45] KPSS (1992) only supply the critical values for evaluating the time series properties of univariate series which may not be suitable for examining the statistical characteristics of cointegrating vectors. Thus, the KPSS procedure is not conducted to test for unit roots in the CIV or CT.

$$LUS_t = 1.014LHK_t + 0.582SPORE_t \qquad\qquad (32)$$

The above equation can be read as a regression equation bearing in mind that the relationship among the variables is over the long-run. This means that in the long-run, a unit change in the value of the log of the Hong Kong property index would increase the value of the log of the US index by 1.014 indicating that the strength of the relationship between the two property markets is very high implying that for US investors diversification benefits in the property market are limited. On the other hand, a unit change in the value of the Singapore property index would increase the value of the log of the US index by 0.582 indicating that the strength of the relationship between the two property markets is moderately high.[46]

The CIV-CT unit root test results tabulated in table A.21 provide overwhelming evidence to support that the CIV and the corresponding CTs do conform to their theoretical properties in that the null hypothesis of a unit root can be rejected for the single CIV but not the two CTs at conventional levels of significance regardless of the number of lags used.

Next, recursive analysis is conducted to visually examine the evolution of linkages among the three cointegrated markets of the US, Hong Kong and Singapore. The recursive trace statistic is normalized by the 10% critical value such that the number of trace statistics great than 1.0 indicates the number of CIVs shared by the

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[46] It is important to note that if a set of variables **is** found to be cointegrated, it does not necessarily imply that diversification benefits will be zero unless of course the relationship among the variables is 1 for 1 that is the beta transposed matrix take the form [1 -1]. If the beta transposed matrix takes any other form, diversification opportunities will be minimal and the extent of the benefit will be determined by the size and the sign of the beta coefficient.

variables in the system.[47] Figure A.6 depicts the trace statistics for the entire period of study. It is apparent that a single cointegrating vector becomes statistically significant in early 2004 (only one trace statistic shows a prominent upward tendency and crosses the critical value of 1.0). This suggests that if cointegration exists, it is a fairly recent phenomenon, a finding that supports a study by Phengpis and Apilado (2004) who find no evidence of cointegration among any of the markets of Australia, Hong Kong, Japan, Singapore and the US over a period beginning January 1979 and ending June 2002.

Finally, the recursive likelihood ratio test is conducted to evaluate whether the cointegrating relationship is stable over the time period under study. For ease of interpretation, the calculated test statistics are divided by the appropriate 5% critical value such that values below 1.0 indicate non-rejection of the null hypothesis that the cointegration space is stable or constant over time. The results depicted in Figure A.7 indicate that the model is indeed adequate providing further support to the earlier findings.

4.3.1.5. Multivariate Short-run Analysis

The Granger causality results presented in Table A.22 show unilateral causality running from the US to each of the Asian markets but no feedback from any of the markets to the US. There is also little evidence of bilateral short-run causality within the Asian markets. The error correction coefficients for the US and Singapore are insignificant confirming earlier findings these two markets do not respond to the

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[47] Hansen and Johansen (1999) remark that the results from the "R-representations" are more appropriate/relevant in the recursive estimation analysis and hence only the results from the "R-

deviations from the long-run equilibrium relationship and are therefore the sources of the common stochastic trends. These results are similar to those of Eun and Shim (1989), Cheung and Mak (1992), Kwan et al. (1995) and Janakiramanan and Lamba (1998) among others, who find that the US is a global factor that dominates and influences international equity markets but is not affected by them.

4.3.1.6. Section Conclusions

This section investigates the long-run relationships and short-run linkages among a group of Asia-Pacific equity markets (Australia, Hong Kong, Japan and Singapore) and the US. Based on daily data the markets are studied over a period beginning January 2000 and ending March 2006. The primary findings are as follows:

Over the study period, the US market trends with the markets of the Hong Kong and Singapore but not with the markets of Australia and Japan implying that for the US investor, greater diversification benefits can be exploited from the markets of Australia and Hong Kong. The finding of cointegration only among the markets of US, Hong Kong and Singapore but the exclusion of Japan and Australia are very similar to the findings of Bessler and Yang (2003) who also find these countries do not form part of the cointegrating vector that binds the US with several other Asian and European markets. Traditionally, Australia's largest trading partners have been the UK and the US. However over the last decade and a half its trade has shifted primarily to Japan (Source: Australia Government website, 2006). So, even though the US and UK are still Australia's major partners, Japan accounts for the largest share of Australia's trade.

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representation" are reported. The results from the "Z representation" are very similar and are available

Thus it may be reasonable to expect that Australia as well as its biggest trading partner, does not move with the other markets under consideration, consistent with the findings of Roca (2001) who finds no evidence of cointegration between Australia, Hong Kong, Singapore and Taiwan and Roca (2005) who uses a robust methodology and shows that the market of Australia does not lie in the cointegration space that is spanned by the US and the UK.

The finding that Japan is not part of the cointegrating vector is also somewhat surprising and may be attributed to the fact that Japan has become more economically integrated with China over the last few years making China its biggest trading partner (excluding Hong Kong) by the year 2006.[48] Even though historically the US has been Japan's major trading partner, attractive opportunities in China in terms of geographic proximity, cheap labor and vast market potential, Japan's trade has been shifting primarily to China over the last decade or so. In the words of Senshu University economics professor Hideo Ohashi.

> *"The two economies [of China and Japan] have strong links through direct investment while the flow of goods has increased sharply, ensuring that trade relations between the two Asian giants are likely to remain strong."*

The finding that Japan can be excluded from the cointegrating relationship is similar to the findings by Heimonen (2002) who contends that the results may be due to the fact that that the markets of the US and Japan has diverged significantly after the October 1987 stock market crash as suggested in Arshanapalli and Doukas (1993)

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upon request.
[48] China including Hong Kong had been Japan's largest trading partner since 2004.

Finally, the result that Hong Kong and Singapore share the cointegration space with the US may be due to the fact that US is the second largest trading partner for both the economies while Singapore and Hong Kong are the third largest trading partners of each other. Furthermore, the Hong Kong dollar has been pegged to the US dollar since 1983 and thus Hong Kong would be expected to share linkages with the US in the long-run. Moreover, recent studies (Cheung and Yuen, 2002) have shown that the inflation rates of Singapore, Hong Kong and the US are tied together in the long-run which may be another (indirect) reason why these three stock markets are trending together over time.

Granger causality results suggest that the US leads each of the markets but is itself not led by any of the Asia-Pacific markets in the short-run, implying that the US property market is essentially independent of these markets, a finding consistent with many stock market integration studies where the US stock market is found to be the "*global factor*" (Eun and Shim, 1989; Cheung and Mak, 1992; Kwan et al. 1995; Cha and Cheung, 1998; Knif and Pynnonen, 1999) where the US stock market is the most influential stock market which influences stock markets throughout Asia and Europe.

Overall the results suggest that in the long-run, the diversification benefits from investing in the equity markets may be much less than what previous studies have suggested. These findings extend the literature on Asian equity markets by focusing on the most recent period of time and by utilizing robust methodologies to determine the extent of linkages over time.

4.3.2. European Equity Markets

4.3.2.1. Univariate Analysis

Table A.23 provides basic characteristics of the European indices. The daily returns are between -0.000106% (Netherlands) to 0.000329% (France) with standard deviations between 0.0136526% (US) and 0.0211409% (Netherlands). The negative values for skewness apparent in some of the equity markets imply that the distribution of the series has a long left tail, while the Jarque-Bera test statistics indicate rejection of the normality hypothesis.

Similar to the earlier essays, two unit root tests namely the ADF and the KPSS tests are employed in order to evaluate the presence of stochastic nonstationarity in each of the indices involved. As shown in table A.24, irrespective of the choice of the deterministic component(s), both the tests unanimously suggest that each of the DGPs is nonstationary in levels. Next, the Zivot and Andrews (1992) procedure is applied to test for endogenous structural breaks in each of the univariate series. The results presented in Table A.25 indicate no evidence of a structural break. Thus the all subsequent analysis is conducted using the entire data set.

4.3.2.2. Multivariate Long-run Analysis

After confirming the presence of stochastic nonstationarity in each of the markets, the Johansen's cointegration technique is employed to test for long-run linkages among the European markets and the US. The results presented in Table A.26 point to the existence of a single cointegrating vector (1 CIV).

4.3.2.3. Hypothesis Tests

Table A.27, Panels A and B, repeat the cointegration results, while exclusion test results (Panel C), reveal that none of the markets can be excluded. Finally, tests of weak exogeneity reported in Panels D and E show that the markets of the US, UK, France and the Netherlands are weakly exogenous jointly or otherwise and are thus the sources of the four common stochastic trends driving each of the markets.

Overall the findings suggest that the four property markets of US, UK, France, the Netherlands and Spain are tied together in the long-run by a single cointegrating vector and are driven by four common stochastic trends implying that diversification benefits within these markets may be fairly limited.

4.3.2.4. Diagnostic Tests

The statistical properties of the cointegrating vector and common trends are analyzed by performing unit root test on the resultant CIV and the three CT estimates found in the previous section.

For ease of interpretation, the restricted CIV estimate has been normalized with respect to the US and takes the following form:

$$LUS_t = 0.854LUK_t + 1.316LFR_t + 0.497SP_t + 0.272NL_t \tag{33}$$

The above equation can be read as a regression equation bearing in mind that the relationship among the variables is long-run. This means that in the long-run, a unit change in the value of the log of the UK index (keeping all the other variables in the equation constant), would increase the log of the US index by 0.854; a unit change in

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the value of the log of the French index (keeping all the other variables in the equation constant), would increase the log of the US index by 1.316 indicating that markets of the US, UK and France move in tandem. The strength of the US and the Spanish and the Netherlands index is positive but quite low. The results of the CIV-CT unit root tests are presented in Table A.28 and suggest that the estimates comply with their theoretical properties at the conventional level of significance irrespective of the lag length used.

Next, Figure A.8 depicts the recursive trace statistic and it is apparent that a single cointegrating vector becomes statistically significant in early 2003 (only one trace statistic shows a prominent upward tendency and crosses the critical value of 1.0). Finally, recursive likelihood results depicted in Figure A.9 indicate that the model is adequate thus providing further support to the previous results.

4.3.2.5. Multivariate Short-run Analysis

The Granger causality test results are presented in table A.29 and indicate that the US causes each of the European markets and the coefficients are highly significant at the 1% level of significance. The European markets, however, also lead the US markets (except for Spain), results similar to those by Laopodis (2004) who evaluates the short-run linkages among several European markets vis-à-vis the US over a longer period of time. Furthermore, the results also reveal substantional lead-lag relationships among the European markets: the UK leads each of the other property markets but is itself caused only by the French property index; the Spanish index leads the property indices of the Netherlands and France but is itself led only by the property index of the Netherlands. The error correction coefficients are insignificant for all but Spain

confirming earlier findings that Spain is the only variable that responds to the deviations from the cointegrating relationship while the US, UK, France the Netherlands are the four sources of common stochastic trends within the system.

Overall, contrary to the results of the Asian equity section, the findings suggest that there is bi-directional causality between the markets of Europe and the US suggesting that even though the US leads each of the European markets it is also led by them (the only exception being Spain) findings implying that the US may be playing a less important role over the short-run than found in earlier studies of equity market integration between the US and developed European markets (Eun and Shim, 1989; Cheung and Mak, 1992; Kwan et al. 1995; Cha and Cheung, 1998; Knif and Pynnonen, 1999).

4.3.2.6. Section Conclusions

This section investigates the long-run relationships and short-run linkages among a group of European equity markets (UK, France, the Netherlands and Spain) and the US. Based on daily data the markets are studied over a period beginning January 2000 and ending March 2006. The primary findings are as follows:

The markets of the US, UK, France, the Netherlands and Spain are bound by a single cointegrating vector. The finding of cointegration among US and the more developed Euro-zone markets can be backed/supported by Ehrmann and Fratzscher (2005) who show that the linkages of money markets between the US and the Euro area have strongly increased especially after the establishment of the EMU. They contend the cause is increased "real" integration among these developed economies over recent

times. US macroeconomic news affects the Euro-zone money markets and has become a leading indicator for the Euro area.

Recent studies such as Hardouvelis et al. (2006) have found that after the establishment of the EMU, the Euro-zone stock markets have fully converged. However the country that never adopted the single currency – the UK - showed no signs of increased integration with the rest of the European markets. These findings are similar to Yang, et al. (2003) who find that the UK stock market has become less integrated with member countries especially after the establishment of the EMU. These authors' argue that since the UK did not adopt the single currency "Euro", it is considerably "different" from the Euro-zone member economies.

The results of my analysis reveal that the markets of the US, UK, France, the Netherlands and Spain are bound by a single cointegrating vector. These results are not inconsistent with the aforementioned studies but simply imply that in a multivariate context, the UK must be cointegrated with the Eurozone member countries (indirectly) that is through its strong relationship with the US (Janakiramanan and Lamba, 1998).

Granger causality results suggest bi-directional causality between the markets of Europe and the US suggesting that even though the US leads each of the European markets, it is also led by them, findings in contrast to the Asian equity results and implying that the US may be playing a less important role over the short-run than found in earlier studies examining equity market integration between the US and developed European markets (Eun and Shim, 1989; Cheung and Mak, 1992; Kwan et al. 1995; Cha and Cheung, 1998; Knif and Pynnonen, 1999).

Overall the results suggest that in the long-run, the diversification benefits from investing in each of the European equity markets are fairly limited. These findings extend the literature on European equity markets by focusing on the most recent period of time and by utilizing robust methodologies to determine the extent of linkages over time.

<p style="text-align: center;">4.4 Property Markets and Equity Markets: Comparative Analysis</p>

As mentioned previously, the Johansen's (1988) and Johansen and Juselius's (1990) cointegration techniques and several diagnostic tests were utilized to appropriately and accurately model long-run linkages, while Granger's (1988) VAR causality test was employed to evaluate the short-run dynamics among the property markets of Asia (Australia, Japan, Hong-Kong and Singapore) and Europe (UK, France, the Netherlands and Spain) vis-à-vis the US property index.

4.4.1. Asian Real Estate versus European Real Estate

Over the period of study, the growth rates of the overall Asia-Pacific securitized property sector and the US securitized property sector were impressive and spectacular. The market capitalization of the Asia-Pacific securitized sector grew from approximately $98 billion dollars in December 1999 to $270 billion dollars by March 2006 a growth rate of 176%; the market capitalization of the US securitized property sector grew from $115 billion in December 1999 to $360 billion as of March 2006 a growth rate of 213%. However, the European property sector experienced only a modest growth rate over the period with market capitalization increasing from

approximately $200 billion in December 1999 to 290 billion by March 2006 a growth rate of 45% over the six year period (Source: FTSE EPRA/NAREIT 2006).

The rapid growth rate in Asia was fueled by the proliferation of REITs and REIT like securities in Japan, Singapore and Hong Kong during the latter part of 2002 and beginning of 2003. The US real estate market also experienced a similar real estate boom during that time. Due to this extraordinary growth rate, structural breaks for the US and each of the Asian markets (except for Australia) were observed towards the end of 2002 or beginning of 2003. The Asian real estate analysis is thereby conducted over two sub-periods in order to take account for the structural break in the data.

In a comparison of long-run and short-run results, evidence of cointegration is found among the markets of US and the Asia-Pacific markets as well as the US and the European markets. Further analysis however reveals that within the Asia-Pacific region, only the markets of Australia and Singapore are trending with the US (only in the most recent sub-period, but not over the entire period or the earlier sub-period), while within the European region, only the property market of the UK is commoving with the US (over the entire period of time). This implies that from the perspective of the US investor, the property markets of Japan and Hong Kong from the Asia-Pacific region, and the property markets of France, the Netherlands and Spain from the European region provide the greater diversification benefits and merit inclusion in a US real estate only portfolio.

Overall, the long-run findings suggest that for the US investor, diversification opportunities are available in the listed property markets of both Europe and Asia,

findings consistent with a very recent study by Ibboston (2006) who finds low correlation between the US property market and the markets of the Asian and European region, but does not identify the individual markets that provide the greater opportunities over longer periods of time. The findings also extend previously published real estate integration studies such as Myer et al. (1997, 1999), Garvey et al. (2001) and Keliman et al. (2002), Wilson and Okunev (1997), Wilson and Zurbruegg (2001) that conclude reduced diversification opportunities occur due to the presence of one or more cointegrating vectors and provides additional insights by determining which of the markets actually account for the long run relationship in order to evaluate possible diversification gains among the countries.

Very few lead lag relationships are evident between the Asia-Pacific and US markets. This suggests that the property markets of Asia are not affected by the US in the short-run. The US however leads each of the European property markets in the short-run (with the exception of Spain) indicating that the US exerts a considerable influence towards the European markets. Overall, the results of the short-run analysis suggest greater short-run opportunities in the Asia-Pacific markets that behave independently of the US over shorter periods of time.

4.4.2. Asian Equity versus European Equity

In comparing long-run and short-run results, evidence of comovement is found among the markets of US and the Asia-Pacific markets as well as the US and the European markets. Further analysis however reveal that within the Asia-Pacific region, only the markets of Hong-Kong and Singapore are trending with the US, while within

the European region, each of the European markets is comoving with the US. This implies that from the perspective of the US investor, the property markets of only Australia and Japan provide the greater diversification benefits and merit inclusion in a US equity portfolio since all of the European markets are trending together with the US.

The finding that Japan can be excluded from the cointegration space that is spanned by the US, Singapore and Hong Kong, is similar to the findings of Malliaris and Urrutia (1992), who find that the Japanese market plays a passive role in transmitting information to other stock markets; Francis and Leachman (1998) who show that Japanese stock market is the least open or responsive to the other major stock markets and are consistent with Bessler and Yang (2003) who find that the Japanese market is relatively isolated from other markets and suggest that Japan is an appropriate candidate for the purpose of international diversification. The finding that Australia can be excluded is consistent with the findings of Roca (2001, 2005) who contends that since over the last decade and a half Australia's trade has shifted primarily to Japan it may be reasonable to expect that Australia as well as its biggest trading partner (Japan), move with each other but not with other major world markets. The finding that US is integrated with each of the European markets is consistent with a study Fraser and Oyefeso (2005) who show that the long-run and short-run linkages between US and the major developed markets have significantly increased over time.

Granger causality results suggest bi-directional causality between the markets of Europe and the US but uni-directional causality running from the US to each of the Asian markets, implying that from the perspective of the US investor, minimal

diversification benefits are attainable in the markets of Europe in the short-run but investors can use US market changes to predict Asian market changes, indicating short-run diversification opportunities in the Asian region.

4.4.3. Asian Real Estate versus Asian Equity

As stated earlier for the Asian property sector, long-run property results indicate greater opportunities in the markets of Japan and Hong Kong while for the Asian equity sector greater opportunities are available in the markets of Japan and Australia. Thus if US investors wish to invest in real estate, they should invest in the property markets of Hong Kong and Japan, while if they wish to invest in equity markets they should invest in Japan and Australia. In both cases (equity or real estate) greater long-run opportunities are available in Japan.

Finally short-run results indicate few little lead-lag relationships between the property markets of the Asia-Pacific region but unidirectional causality between the US equity market and the markets in the Asian region suggesting that the US investors can attain substantial diversification benefits both in the property markets of the Asia-Pacific region because of the markets' independence and in the equity markets of the region since each of the individual markets are led by the US.

4.4.4. European Real Estate versus European Equity

From above, for the European property sector, long-run results indicate greater opportunities in the markets of the Netherlands, France and Spain while the European equity sector provides minimal diversification opportunities for the US investor. The strength of the relationship between the US and the UK equity markets is very high

implying that diversification benefits cannot be attained in the market of UK (since these two markets are almost perfectly correlated). The equity markets of Spain or the Netherlands (but not both) can be incorporated in a US portfolio since they are strongly related with one another, but not with the US equity market. In general, the strength of the relationship between the US equity market and the equity markets of UK is stronger than that of the US property markets and UK property markets.

Short run relationships suggest unidirectional causality between the US and the European property markets but bi-directional causality between the equity markets of the US and Europe indicating minimal diversification benefits in the European equity markets in the short-run.

4.4.5. Overall Conclusions

Overall, the study provides corroborative evidence that US investors can attain substantial diversification benefits from investing in many of the international property markets in the long-run as well as the short-run. Long-term benefits are available in both the Asian and the European property markets, while greater short-term opportunities are available in the Asia-Pacific markets in the more recent sub-period. The findings also suggest securitized property markets is some countries behave similarly to their corresponding stock markets while others behave in ways that set them apart from the wider equity market (Gordon and Canter, 1999; and Gordon et al. 2001).

As hypothesized a-priori, real estate markets show greater signs of (long-run) segmentation or weaker evidence of (long-run) integration (as evidenced by the strength of the relationships among the international property markets) implying that unlike

equity markets, US investors can exploit greater opportunities from international portfolio diversification in several of the international property markets in the long-run.

Short-run results indicate relatively fewer lead-lag relationships between the US and the international property markets confirming earlier contentions, that due to the underdeveloped state of the securitized property sector (relative to equity markets) and due to the "real estate" nature of these markets, the securitized property sector is less impacted by the US property market in the short run than the corresponding equity markets.

CHAPTER 5

CONCLUSIONS AND IMPLICATIONS

Understanding the behavior of international securitized property markets has been a source of interest for academics and practitioners alike (Eichholtz et al. 1994, 1996b, 1997; Pizerak, 2001; Bigman 2002 and Hudson-Wilson et al. 2003). Knowledge of behavior of this asset class has become extremely important especially over the recent decade. The spectacular growth and performance of the global securitized property market has enhanced the transparency of the sector and contributed to the creation of an increasing number of ETFs on REITs and REOCs, all of which have enticed institutional investors and pension fund managers to increase portfolio allocation to the more liquid form of real estate investment (Gerogiev et al. 2003; Dhar and Goetzmann, 2006; Idzorek et al. 2006).

The primary purpose of this dissertation is to utilize recently available and reliable high frequency transactions based data provided by FTSE EPRA/NAREIT and employ modern day time series techniques and recently developed diagnostic tests to evaluate the degree of long-run integration and short-run dynamics among major public property markets (in terms of market capitalization) over a period beginning January 2000 and ending March 2006. Both Asia and Europe are investigated. A secondary objective is to examine the long-run and short-run interaction among the corresponding major

international equity markets to compare and contrast diversification benefits from exploitation of international property markets.

The several testable hypotheses and the rationale for each can be summarized as follows:

1. Is the domestic (US) listed property market integrated with the major listed property markets of Asia and of Europe in the long-run and the short-run? If evidence of (long-run) integration is found, exclusions tests are conducted to determine which of the markets (if any) provide greater diversification benefits in the long-run. As mentioned earlier, due to the growth, performance, popularity and widespread acceptance/recognition of commercial real estate as a distinct asset class, institutional investors and pension fund managers have become increasingly interested in increasing the allocation of real estate in their portfolios. Since real estate investors typically hold their investments over long periods of time (Tarbert, 1998; Wilson and Okunev, 1998; Gerlach et al. 2006, Kleiman et al. 2002) and because it has become fairly easy to gain access to commercial real estate through the newly created ETFs, investors will be extremely keen/eager to understand the dynamic interaction of real estate markets across national boundaries and identify which of the market(s) provide greater benefits over the long-run as well as the short-run.

2. Do the largest listed property markets behave like or follow the pattern of their corresponding stock markets in the long-run and in the short-run? Using conventional correlation analysis, numerous studies have documented that over the last decade or so, listed property markets have been acting more like the underlying direct counterparts

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and less like stock markets or bond markets, contending that due to the increased sophistication, maturity and transparency of the securitized property sector, real estate markets may be driven by factors that are different than those that influence/govern stocks, bonds, and other asset classes (Khoo, et al. 1993; Ghosh et al. 1996; Ziering et al; 1997,1999 and Clayton and McKinnon, 2000, 2001).

3. Are the indirect property markets more segmented than their corresponding equity markets? Since the securitized property sector is relatively new and not as mature as the general stock market and since a growing number of studies have suggested that equity markets have become increasingly integrated over recent times (Kasa, 1992; Choudhry, 1994,1996; Ghosh, Saidi and Johnson; 1999; Siklos and Ng, 2001; Lapodis, 2004; Dunis and Shannon 2005; Phylaktis and Ravazzolo, 2005), this dissertation will further attempt to answer whether international property markets show weaker evidence of integration relative to the wider equity markets and whether increasing allocation of real estate in a portfolio is justified/justifiable.

These hypotheses were addressed in three essays: The first essay analyzed the interrelationship among the US property market and the major Asia-Pacific property markets of Australia, Japan, Hong-Kong and Singapore. Long-term results indicated that the property markets of the US, Australia and Singapore are trending together implying that the markets of Japan and Hong Kong provide the greater diversification benefit. The normalized cointegrating vector showed a very strong relationship between the Australia and Singapore markets but not the US market. The markets of the US and Australia are found to be the sources of the common stochastic trends that pull the three

cointegrated markets towards the long-run equilibrium relationship. Short-run findings show very minimal lead lag relationships between the US and the Asia-Pacific markets, suggesting that the property markets are short-term independent of the larger US as well as the neighboring markets.

The second essay evaluated the interdependence among the domestic property market and the major European property markets of UK, the Netherlands, France and Spain. Evidence of cointegration is found only between the two largest markets of the US and the UK indicating that the smaller property markets of the Netherlands, France and Spain provide the greater diversification benefits. The normalized cointegrating vector showed a moderately strong relationship between the property markets of the US and the UK and the US is found to be the source of the common trend that drives the property market of the US and the UK toward the long-run equilibrium relationship. Short-run causality results indicate uni-directional causality running from the US to each of the markets (with the exception of Spain) but no evidence of causality running from any of the European markets to the US, suggesting that the US plays a more dominant role and leads most of the European property markets in the short-run.

The third and the final essay examines the interlinkages among the domestic equity market and the corresponding Asian and European equity markets. The findings of the Asian equity section suggest that the markets of the US, Hong-Kong and Singapore are tied together in the long-run and that diversification benefits can be exploited only in the markets of Australia and Japan. The normalized cointegrating vector shows a stronger relationship (almost one to one) between the markets of the US

and Hong Kong than between the markets of the US and Singapore. The US and Hong-Kong are found to be the sources of the common stochastic trends that drive the three markets to the long-term relationship. Short-run findings indicate that the US leads each of the Asian markets but is not led by any of the markets findings suggestive of the dominant role of the US vis-à-vis the Asia-Pacific markets.

Finally, the results of the European equity section reveal that the US market is bound by a single cointegrating vector with each of the European markets in the long-run suggesting that diversification opportunities in each of these European markets is fairly limited. The normalized cointegrating vector shows a strong relationship between the markets of the US and each of the European markets. Each of the markets with the exception of Spain is found to be the sources of the common stochastic trends implying that Spain is the only market that is responding to the deviations from the long-run equilibrium relationships. Short-term results indicate bi-directional causality between most of the European markets and the US implying that the US may be playing a less dominant role towards the European markets in the short-run relative to the Asian equity markets.

The implications of the findings are varied. The first essay analyzes the interaction between the US and major Asia-Pacific securitized property markets and suggests that greater diversification benefits can be exploited in the markets of Hong-Kong and Japan since they do not trend with the other markets. This implies that these are the markets that merit inclusion in a US real estate only portfolio. The fact that the property markets of Australia and Singapore are strongly related to one another but not

with the US indicates that any one but not both of the markets can be included in the portfolio. Short run results indicate few lead-lag relationships between the US and each of the Asia-Pacific markets implying that these Asia-Pacific markets are short-term independent of the US market indicating that US investors can exploit short-run diversification opportunities in these markets.

The second essay evaluated the linkages between the property markets of the US and major European property markets and finds only the UK to be cointegrated with the US over the long-run suggesting that the property markets of the Netherlands, France and Spain provide the greater diversification benefits and should be included for portfolio considerations. Short-run results reveal uni-directional causality running from the US to each of the European property markets (with the exception of Spain) implying minimal short-run opportunities in these markets from the perspective of the US investor.

Finally, the results of the equity section suggest that the US is trending with each of the European markets and that only the Asian markets of Australia and Japan provide the greater diversification benefits. Causality results reveal significant bidirectional interaction between the European markets and the US but uni-directional causality runs from the US to the Asian markets indicating that the US plays a more dominant role toward the Asia-Pacific markets relative to the European markets in the short-run.

Overall, the study provides corroborative evidence that US investors can attain substantial diversification benefits from investing in many of the international property

markets in the long-run as well as the short-run. Long-term benefits are available in both the Asian and the European property markets, while greater short-term opportunities are available in the Asia-Pacific markets in the more recent sub-period. The findings also suggest securitized property markets is some countries behave similarly to their corresponding stock markets while others behave in ways that set them apart from the wider equity market (Gordon and Canter, 1999; and Gordon et al. 2001).

As hypothesized a-priori, real estate markets show greater signs of (long-run) segmentation or weaker evidence of (long-run) integration (as evidenced by the strength of the relationships among the international property markets) implying that unlike equity markets, US investors can exploit greater opportunities from international portfolio diversification in several of the international property markets in the long-run.

Short-run results indicate relatively fewer lead-lag relationships between the US and the international property markets confirming earlier contentions, that due to the underdeveloped state of the securitized property sector (relative to equity markets) and due to the "real estate" nature of these markets, the securitized property sector is less impacted by the US property market in the short run than the corresponding equity markets.

Thus the findings of this analysis have implications for portfolio diversification. When formulating portfolios, and especially when contemplating incorporating newly created funds that track the FTSE EPRA/NAREIT indices, investors need to know which of the property markets do not trend with the US property market and provide greater diversification opportunities.

Also, different US trending behavior with the property markets and the equity markets implies that the factors affecting property markets differ from those affecting equity markets and is important information for portfolio managers, pension funds and other institutional investors.

Future Research Agenda

Two creative research ideas have emerged while undertaking this dissertation:

1. As mentioned earlier, one of the reasons why real estate markets are behaving differently from the corresponding stock markets may be because they are affected by different (macro-economic) factors. It would be very interesting to evaluate whether the economic forces that affect other financial markets also affect public property markets. Even though several papers have investigated this issue, the analysis has not been conducted in an international context and within a cointegration framework. With the availability of high frequency, transactions based data this research would be timely, feasible and very useful to economists, policymakers and investors at large.

2. Another interesting and compelling research would be to test whether the domestic and international public property markets are integrated with their private property counterparts (NCREIF in the US and the IPD indices in Asia and Europe) in the long-run and the short-run. Numerous papers have analyzed this issue over relatively short periods of time and have found conflicting evidence. The major problem in these studies is the use of appraisal based indices (as a proxy for the private property sector) which are prone to "smoothing" biases and leads to a misleading conclusions

regarding the true nature of the underlying relationships that exist between the unecuritized and the securitized sectors.

APPENDIX A

TABLES AND FIGURES

Table A.1: REITs and REOCs included in Major Equity Indices in the US as of 2006

Proxy	Market Cap of the total index	Number of REITs and REOCs in the index	Market Cap of REITs & REOCs in the index	% of REITs & REOCs in the index
S&P 500	$11,529	11	$98	0.85%
Russell 1000 Value	$6,470	42	$185	2.86%
Russell 1000 Growth	$6,264	12	$32	0.51%
Russell 2000 Value	$639	67	$52	8.08%
Russell 2000 Growth	$642	28	$11	1.79%
MSCI EAFE	$11,167	64	$242	2.16%

Source: NAREIT and Mornigstar, Inc.

Table A.2: Descriptive Statistics based on daily data

Market	No. of Companies[a]	Market Cap (Mil $)[a]	Obs	Mean	Std Dev.	Min	Max	Skewness	Kurtosis	J-B
AU	22	$64,163.1	1568	0.000343	0.009	-0.04	0.04	-0.27	1.17	110.65
HK	13	$42,746.6	1568	0.000109	0.016	-0.09	0.07	0.01	2.78	505.75
JP	20	$44,009.8	1568	0.000564	0.019	-0.06	0.09	0.28	3.32	743.77
SP	8	$7,122.6	1568	6E-06	0.017	-0.09	0.10	0.28	3.32	743.77
US	197	$300,000	1568	0.000498	0.008	-0.05	0.04	-0.58	3.76	1014.08

Source: FTSE EPRA/NAREIT (2005)

Abbreviated real estate stock price indices for included countries:

AU	Australia
HK	Hong Kong
JP	Japan
SP	Singapore
US	United States

[a]As of December 2005

Table A.3: Unit root tests

Country	ADF_C^a	ADF_{CT}^b	$KPSS_\mu^c$	$KPSS_\tau^d$
Entire period		*Jan 2000 –March 2006*		
LAU	-0.14708	-2.62059	8.35315	1.22825
LHK	-1.33554	-1.67004	1.83731	1.64090
LJP	-0.64307	-1.46499	4.20247	1.22685
LSP	-0.90885	-1.42868	1.81561	1.44588
LUS	-0.16895	-1.94609	7.51242	1.14910
Sub-period		*Jan 2000 – Dec 2002*		
LAU	-1.71595	-2.51837	2.33407	0.83654
LHK	-1.27645	-2.07427	1.03284	0.55514
LJP	-1.73034	-1.98049	1.17306	0.36943
LSP	-1.24903	-2.31393	1.93816	0.41116
LUS	-2.36133	-2.09270	2.16546	0.65299
Sub-period		*Jan 2003 – March 2006*		
LAU	-1.34761	-2.40334	5.71809	0.32051
LHK	-1.04087	-2.40253	4.99191	0.45079
LJP	-0.61890	-2.65004	5.60205	0.33372
LSP	-0.70574	-0.75548	5.5211	0.92771
LUS	-0.77375	-2.59143	5.99943	0.27913

Abbreviated real estate stock price indices and the corresponding countries:

AU	Australia
HK	Hong Kong
JP	Japan
SP	Singapore
US	United States

** and * Denotes statistical significance at the 1% and 5% level respectively.

[a] The ADF$_c$ regressions include only a constant. Critical values for the ADF$_c$ have been adopted from MacKinnon (1991) are -3.437 and – 2.864 at the 1% and 5% level of significance respectively.

[b] The ADF$_{ct}$ regressions include both a constant and a time trend. Critical values for the ADF$_{ct}$ have been adopted from MacKinnon (1991) are -3.969 and -3.415 at the 1% and 5% level of significance respectively. The lag length of the ADF regressions are sufficient to ensure that the residuals from each of the equation are free from serial correlation as measured by the LBQ statistics at the 5% level of significance.

[c]Under the null hypothesis of stationarity. The critical values are obtained from Kwiatkowski et al. (1992) are 0.739 and 0.463 at the 1% and 5% level of significance respectively.

[d]Under the null hypothesis of trend stationarity. The critical values are obtained from Kwiatkowski et al. (1992) are 0.216 and 0.146 at the 1% and 5% level of significance respectively. For the KPSS test, the lag truncation parameter is set to 8 (Schlitzer, 1995).

Table A.4: Zivot-Andrews Test for Structural Break

Country	Break Date	Test Statistic
	Daily Data	
AU	2001:01:04	-4.43385
HK	2003:04:05	-4.8868*
JP	2003:08:07	-4.93322*
SP	2002:08:29	-4.82643*
US	2002:06:27	-5.42089**

Abbreviated real estate stock price indices for included countries:

AU	Australia
HK	Hong Kong
JP	Japan
SP	Singapore
US	United States

*and ** denotes significance at the 5% and 1% level respectively. Critical Values have been adopted from Zivot and Andrews (1992). For infinite sample, -4.82 and -5.08 are the 5% and 1% critical values respectively.

Table A.5: Johansen's λ_{trace} and λ_{max} summary table

Panel A	*JAN00-MARCH06*		
H_0	$\lambda_{max} tests$	H_0	$\lambda_{trace} tests$
$r = 0$	22.12	$r = 0$	68.4
$r = 1$	19.1	$r \leq 1$	46.29
$r = 2$	13.19	$r \leq 2$	27.19
$r = 3$	9.2	$r \leq 3$	13.99
$r = 4$	4.79	$r \leq 4$	4.79
Panel B	*JAN00-DEC02*		
H_0	$\lambda_{max} tests$	H_0	$\lambda_{trace} tests$
$r = 0$	21.55	$r = 0$	54.36
$r = 1$	17.03	$r \leq 1$	32.81
$r = 2$	8.52	$r \leq 2$	15.79
$r = 3$	3.76	$r \leq 3$	7.27
$r = 4$	3.51	$r \leq 4$	3.51
Panel C	*JAN03-March06*		
H_0	$\lambda_{max} tests$	H_0	$\lambda_{trace} tests$
$r = 0$	**36.27****	$r = 0$	**74.43***
$r = 1$	17.19	$r \leq 1$	38.17
$r = 2$	9.8	$r \leq 2$	20.98
$r = 3$	6.57	$r \leq 3$	11.18
$r = 4$	4.61	$r \leq 4$	4.61

Abbreviated real estate stock price indices for included countries:

AU	Australia
HK	Hong Kong
JP	Japan
SP	Singapore
US	United States

The null hypothesis is $H0$ which tests for the number of cointegrating vectors (designated by r) is given by both the λ_{trace} and λ_{max} test statistics.

Critical values have been obtained from Osterwald-Lenum (1992) table 1*.

For each period the lag length used in the VAR is chosen to eliminate serial correlation in the residuals at the 5% significance level.

* and ** denotes significance at the 5% and 10% level respectively.

Table A.6: Exclusion Tests (January 2003 – March 2006)

Panel A		$\lambda_{trace}test$			
Countries	$H0:r=0$	$H1:r\leq 1$	$H2:r\leq 2$	$H3:r\leq 3$	$H4:r\leq 4$
US,AU,JP,HK,SP	74.43*	38.17	20.98	11.18	4.61
US,AU,SP	53.13**	18.09	5.44	-	-
Panel B		$\lambda_{max}tests$			
Countries	$H0:r=0$	$H1:r=1$	$H2:r=2$	$H3:r=3$	$H4:r=4$
US,AU,JP,HK,SP	36.27**	17.19	9.80	6.57	4.61
US,AU,SP	35.04**	12.64	5.44	-	-
Panel C					
$\beta_{i=}0^a$	**US**	**AU**	**HK**	**JP**	**SP**
US,AU,JP,HK,SP	15.92**	5.57**	0.50	0.10	13.64**
US,AU,SP	21.70**	5.45**	-	-	12.10**
Panel D	Test statistic				
$\beta JP = \beta HK = 0^b$	0.68				
Panel E					
$\alpha_{i=}0^c$	US	AU	HK	JP	SP
US,AU,SP	0.00	2.65	-	-	12.10**
Panel F	Test statistic				
$\alpha US = \alpha AU = 0^d$	0.12				

Abbreviated real estate stock price indices for included countries:

AU	Australia
HK	Hong Kong
JP	Japan
SP	Singapore
US	United States

The null hypothesis H_0, which tests for the number of cointegrating vectors (denoted by r) is given for both the Johansen's trace and the max tests.

[a] The exclusion statistic tests the null hypothesis that the coefficients of the cointegrating vectors relating to each market are zero. The test statistic is χ^2 distributed with r degrees of freedom.

[b] Asymptotically distributed $\chi^2(2)$

* and ** denotes significance at the 5% and 10% level respectively.

Table A.7:CIV Stationarity Tests

Lags	CIV1	CT1	CT2
1	-4.45257**	-0.93844	-2.01036
4	-4.53258**	-0.91883	-2.68244
8	-4.25976**	-1.04107	-2.54117
12	-4.38548**	-1.21844	-2.24852

$$LUS_t = 0.411LAU_t + 0.387LSPORE_t$$

Abbreviated real estate stock price indices for included countries:

AU	Australia
HK	Hong Kong
JP	Japan
SP	Singapore
US	United States

[a] Under the null hypothesis of a unit root. The critical values are obtained from Mackinnon (1996) are -4.71 and -4.43 at the 5% and 10% level respectively.

[b] Under the null hypothesis of stationarity. Critical values obtained from Kwiatkowski et al. (1992) are .739 and .46 and at the 1% and 5% level respectively.

* and ** denotes significance at the 5% and 10% level respectively.
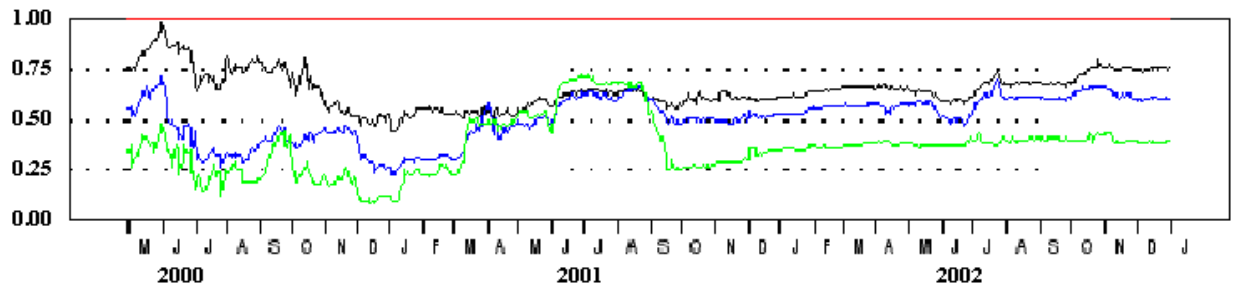
Figure A.1 Recursive trace tests (2000 - 2003)

Note: For ease of interpretation, the test statistics in Figures A.1 has been scaled by their critical values such that the number of line(s) above 1.0 indicate the number of cointegrating relationship(s) at the 10% level of significance. Thus, the first (upper most) line of the graph depicts the time path of the tests for $H\ (r=0\,|\,r=3)$, the second line shows the path of the tests for $H\ (r\leq1\,|\,r=3)$ and finally the third (last) line shows the path of the tests for $H\ (r\leq2\,|\,r=3)$.

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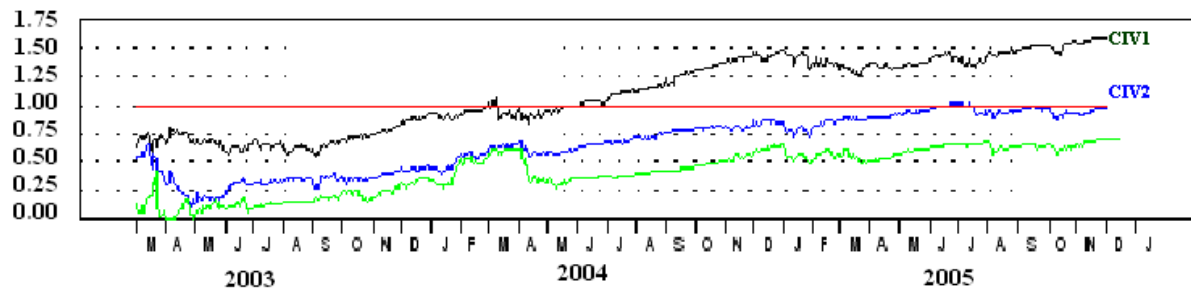
Figure A.2 Recursive trace tests (2003 – 2006)

Note: For ease of interpretation, the test statistics in Figure A.2 has been scaled by their critical values such that the number of line(s) above 1.0 indicate the number of cointegrating relationship(s) at the 10% level of significance. Thus, the first (upper most) line of the graph depicts the time path of the tests for $H\ (r=0\,|\,r=3)$, the second line shows the path of the tests for $H\ (r\leq 1\,|\,r=3)$ and finally the third (last) line shows the path of the tests for $H\ (r\leq 2\,|\,r=3)$.

Test of known beta eq. to beta(t)
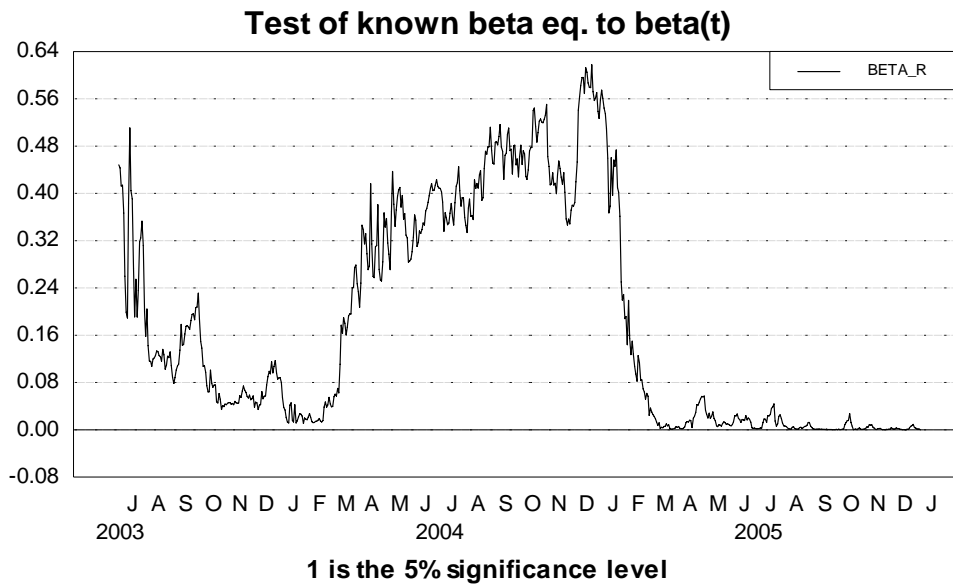
Figure A.3 Recursive likelihood ratio test of the constancy of Cointegrating vectors (2003-2006).

Note: For ease of interpretation**,** the test statistic in Figure A.3 is scaled by the 5% critical value such that a value greater than unity indicates the rejection of the null hypothesis that the parameters are constant over the period under consideration.

Table A.8: Multivariate causality tests

Panel A		2000 - 2006				
	Ind. Var					**ECT**
Dep. Var	ΔUS	ΔAU	ΔHK	ΔJP	ΔSP	
ΔUS	-	0.269	0.720	0.366	0.457	**-**
ΔAU	0.199	-	0.003*	0.613	0.760	**-**
ΔHK	0.422	0.056*	-	0.037*	0.153	**-**
ΔJP	0.419	0.229	0.176	-	0.131	**-**
ΔSP	0.209	0.015*	0.000*	0.120	-	**-**

Panel B		2000 - 2003				
	Ind. Var					**ECT**
Dep. Var	ΔUS	ΔAU	ΔHK	ΔJP	ΔSP	
ΔUS	-	0.099*	0.953	0.022*	0.058*	**-**
ΔAU	0.451	-	0.002*	0.466	0.453	**-**
ΔHK	0.447	0.681	-	0.537	0.285	**-**
ΔJP	0.296	0.516	0.477	-	0.794	**-**
ΔSP	0.087*	0.756	0.026*	0.347	-	**-**

Panel C		2003 - 2006				
	Ind. Var					**ECT**
Dep. Var	ΔUS	ΔAU	ΔHK	ΔJP	ΔSP	
ΔUS	-	0.621	0.729	0.133	0.220	0.656
ΔAU	0.095*	-	0.001*	0.061*	0.039*	0.120
ΔHK	0.562	0.454	-	0.807	0.118	-
ΔJP	0.149	0.654	0.000*	-	0.129	-
ΔSP	0.898	0.715	0.003*	0.003*	-	0.000*

Abbreviated real estate stock price indices for included countries:

AU	Australia
HK	Hong Kong
JP	Japan
SP	Singapore
US	United States

** and * Denotes statistical significance at the 5% and 10% level respectively.

Table A.9: Descriptive Statistics based on daily data (2000-2006)

Market	No. of Companies[a]	Market Cap (Bil $)[a]	Obs	← Mean	Std Dev.	Min	Max	Skewness	Kurtosis	J-B →
							Daily	**Returns**		
FR	6	$12.2	1568	0.000684	0.023	-0.081	0.100	0.11165	3.436	774.954
NL	8	$16.5	1568	0.000459	0.0219	-0.083	0.059	-0.1644	1.411	137.193
SP	2	$8.2	1568	0.001063	0.0328	-0.123	0.117	0.30326	7.440	3640.661
UK	37	$53.9	1568	0.000572	0.024	-0.117	0.083	-0.16965	2.663	471.124
US	197	$300	1568	0.000498	0.008	-0.05	0.04	-0.58	3.76	1014.08

Source: EPRA/NAREIT (2005)

[a]As of December 2005

Abbreviated real estate stock price indices for included countries:

LFR	France
LNL	Netherlands
LSP	Spain
LUK	United Kingdom
LUS	United States

Table A.10: Unit root tests of public property indices

Country	ADF_C^a	ADF_{CT}^b	$KPSS_\mu^c$	$KPSS_\tau^d$
LFR	1.65761	-2.303	5.07236**	2.152**
LNL	0.78217	-1.539	3.76063**	1.601**
LSP	1.77893	-1.603	5.37853**	1.568**
LUK	0.81468	-1.531	4.91787**	2.559*
LUS	0.16895	-2.005	10.04185**	1.203*

Abbreviated real estate stock price indices for included countries:

LFR	France
LNL	Netherlands
LSP	Spain
LUK	United Kingdom
LUS	United States

[a] Under the null hypothesis of a unit root. For each of the indices, the lag length of the ADF regressions are sufficient to ensure that the residuals from each of the equation are free from serial correlation as measured by the LBQ statistics at the 5% level of significance. The ADF$_c$ regressions include only a constant. Critical values for the ADF$_c$ have been adopted from MacKinnon (1991) is – 2.864 at the 5% level of significance.

[b] Under the null hypothesis of a unit root. For each of the indices, the lag length of the ADF regressions are sufficient to ensure that the residuals from each of the equation are free from serial correlation as measured by the LBQ statistics at the 5% level of significance. The ADF$_{ct}$ regressions include both a constant and a time trend. Critical value for the ADF$_{ct}$ have been adopted from MacKinnon (1996) is -3.41 at the 5% level of significance.

[c] Under the null hypothesis of stationarity. For the KPSS test, the lag truncation parameter is set to 8 (Schlitzer, 1995). The critical value is obtained from Kwiatkowski et al. (1992) is 0.146 at the 5% level.

[d] Under the null hypothesis of trend stationarity. For the KPSS test, the lag truncation parameter is set to 8 (Schlitzer, 1995). The critical value is obtained from Kwiatkowski et al. (1992) is 0.463 at the 5% level.

* denotes statistical significance at the 5% level.

Table A.11: Zivot-Andrews Test for Structural Break

Country	Break Date	Test Statistic
	Daily Data	
LFR	2001:01:04	-4.02189
LNL	2003:04:05	-3.88084
LSP	2003:08:07	-1.89058
LUK	2002:08:29	-2.83254
LUS	2002:06:27	-5.42089**

Abbreviated real estate stock price indices for included countries:

LFR	France
LNL	Netherlands
LSP	Spain
LUK	United Kingdom
LUS	United States

*and ** denotes significance at the 5% and 1% level respectively. Critical Values have been adopted from Zivot and Andrews (1992). For infinite sample, -4.82 and -5.08 are the 5% and 1% critical values respectively.

Table A.12: Johansen's λ_{trace} and λ_{max} summary table

H_0	$\lambda_{max} tests$	H_0	$\lambda_{trace} tests$
$r = 0$	42.20*	$r = 0$	104.44 *
$r = 1$	20.12	$r \leq 1$	62.24
$r = 2$	17.24	$r \leq 2$	42.12
$r = 3$	14.50	$r \leq 3$	24.88
$r = 4$	7.46	$r \leq 4$	10.37

Abbreviated real estate stock price indices for included countries:

LFR	France
LNL	Netherlands
LSP	Spain
LUK	United Kingdom
LUS	United States

The null hypothesis is H_0 which tests for the number of cointegrating vectors (designated by r) is given

by both the the λ_{trace} and λ_{max} test statistics.

Critical values have been obtained from Osterwald-Lenum (1992) table 1*.

For each period the lag length used in the VAR is sufficient to eliminate serial correlation in the residuals at the 5% significance level.

* and ** denotes significance at the 5% and 10% level respectively.

Table A.13: Exclusion Tests and Weak Exogeneity Tests

Panel A		$\lambda_{trace}test$				
Countries	$H_0:r=0$	$H_1:r\leq 1$	$H_2:r\leq 2$	$H_3:r\leq 3$	$H_4:r\leq 4$
US, UK, NL, FR, SP,	104.44 *	62.24	42.12	24.88	10.37
US, UK	20.86*	0.14			
Panel B		$\lambda_{max}tests$			
Countries	$H_0:r=0$	$H_1:r=1$	$H_2:r=2$	$H_3:r=3$	$H_4:r=4$
US, UK, NL, FR, SP,	42.20*	20.12	17.24	14.50	7.46
US, UK	20.72*	0.14			
Panel C					
$\beta_{i=}0^a$	**US**	**UK**	**NL**	**FR**	**SP**
US, UK, NL, FR, SP,	8.95*	11.86*	1.85	0.98	1.03
US, UK	20.21*	17.43*	-	-	-
Panel D					
$\beta_{FR}=\beta_{NL}=\beta_{SP}=0^d$					
Test Statistic[e]	**5.18**				
Panel E					
$\alpha_{i=}0^b$	US	UK	NL	FR	SP
Test statistic[c]	0.00	12.87*	-	-	-

Abbreviated real estate stock price indices for included countries:

LFR	France
LNL	Netherlands
LSP	Spain
LUK	United Kingdom
LUS	United States

[a] Property index i can be excluded from the cointegration space. The test statistic is χ^2 distributed $r*[n-(n-m)]$ degrees of freedom; where n is the number of variables in the VAR and m is the number of restrictions

[b] NL, FR and SP are jointly excludable.

[c] The test statistic is χ^2 distributed with $r*[n-(n-m)]$ degrees of freedom; where n is the number of variables in the VAR and m is the number of restrictions.

[d] Property index i is weakly exogenous.

[e] The test statistic is χ^2 distributed with $r*[n-(n-m)]$ degrees of freedom; where n is the number of variables in the VAR and m is the number of restrictions

* denotes significance at the 5% level.

Table A.14: Unit Root Test of the Resultant CIV and CT estimates

Lags	CIV1	CT1
1	-7.7618**	-1.32773
4	-5.62176 **	-1.18970
8	-5.78190**	-1.28928
12	-4.74250**	-1.08676

$$LUS_t = 0.65LUK_t$$

Abbreviated real estate stock price indices for included countries:

LFR	France
LNL	Netherlands
LSP	Spain
LUK	United Kingdom
LUS	United States

**Denotes statistical significance at the 1% level.
* Denotes statistical significance at the 5% level
Under the null hypothesis of a unit root. The critical values are obtained from Mackinnon (1991) are
-4.30696 and -3.74826 at the 1% and 5% level respectively.

R(t)

1 is the 10% significance level
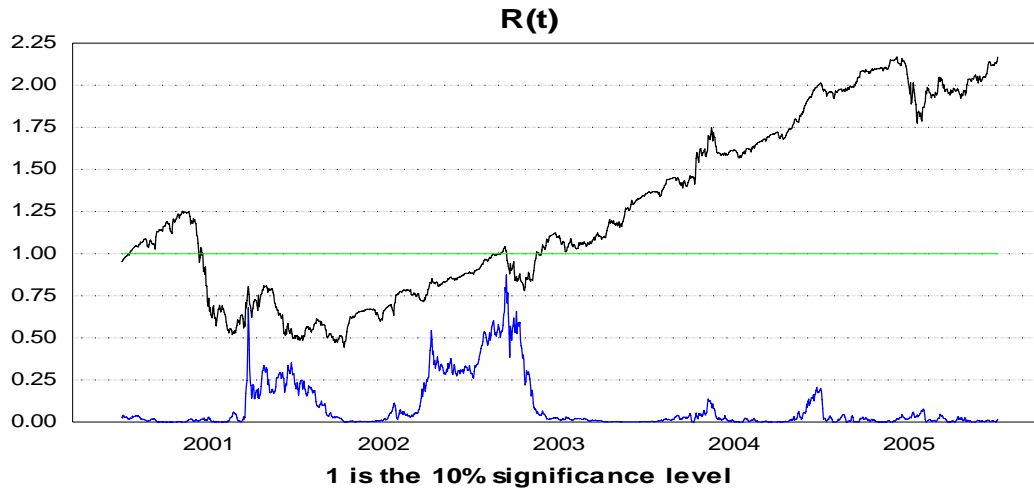
Figure A.4: Recursive trace tests

Note: For ease of interpretation**,** the test statistics in Figure A.4 has been scaled by their critical values such that the number of line(s) above 1.0 indicate the number of cointegrating relationship(s) at the 10% level of significance. Thus, the first (upper most) line of the graph depicts the time path of the tests for H $(r=0\,|\,r=2)$ and the second line shows the path of the tests for H $(r\leq 1\,|\,r=2)$.

Test of known beta eq. to beta(t)

1 is the 5% significance level
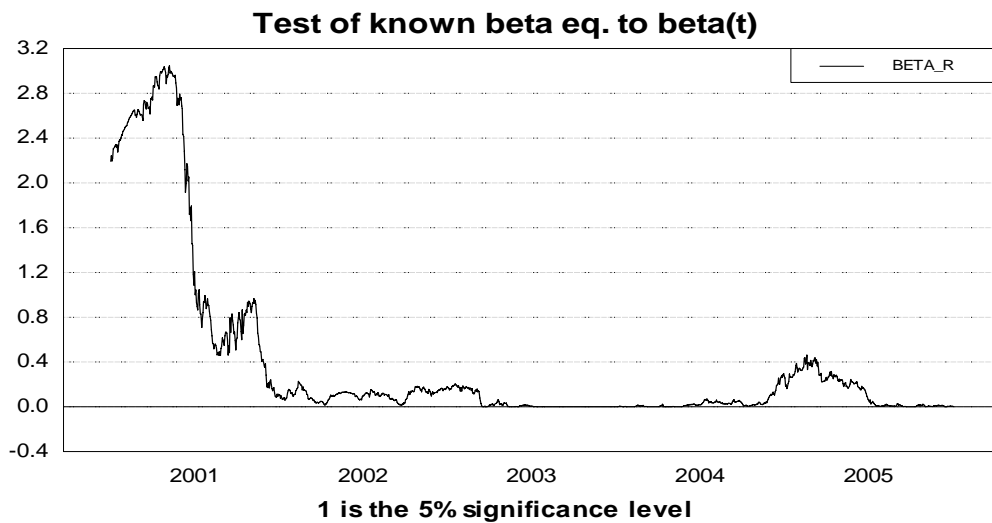
Figure A.5: Recursive likelihood ratio test of the constancy of Cointegrating vectors .

Note: For ease of interpretation**,** The test statistics in Figure A.5 is scaled by the 5% critical value such that a value greater than unity indicates the rejection of the null hypothesis that the parameters are constant over the period under consideration.

Table A.15: Multivariate causality tests

	Independent Variables					ECT1
Dependant Variables	ΔLUS	ΔLUK	ΔLNL	ΔLFR	ΔLSP	$p - value$
ΔLUS	-	0.6212242	0.3989447	0.2908278	0.1435030	0.68013144
ΔLUK	**0.0000144***	-	0.8073550	0.2652117	0.4670848	**0.00007848****
ΔLNL	**0.0701797***	0.0411235**	-	0.3508248	0.3379963	**-**
ΔLFR	**0.0901667***	0.0000283**	0.2136863	-	0.1780004	**-**
ΔLSP	**0.4688454**	0.2865402	0.2117864	0.1318020	-	**-**

Abbreviated real estate stock price indices for included countries:

LFR	France
LNL	Netherlands
LSP	Spain
LUK	United Kingdom
LUS	United States

** and * Denotes statistical significance at the 5% and 10% level respectively $X \Rightarrow Y$ indicates unilateral causality running from X to Y and $X \Leftrightarrow Y$ indicates bi-directional causality that is a feedback relationship.

Table A.16: Descriptive Statistics based on daily data (2000-2006)

Market	Obs	Mean	Std Dev.	Min	Max	Skewness	Kurtosis	J-B
AU	1568	0.000426	.0105899	-0.077975	0.039940	-0.391387	2.583969	476.255852
HK	1568	0.000084	.0135911	-0.082531	0.062496	-0.137874	2.867272	542.089282
JP	1568	0.000036	.018555	-0.098138	0.074675	-0.020156	1.764728	203.571408
SP	1568	9.00e-06	.0144161	-0.084405	0.067944	-0.097837	3.125031	640.534872
US	1568	0.000234	.0136526	-0.076808	0.081389	0.235185	3.526906	827.140591

Abbreviated real estate stock price indices for included countries:

AU	Australia
HK	Hong Kong
JP	Japan
SP	Singapore
US	United States

Table A.17: Unit root tests

Country	ADF_C^a	ADF_{CT}^b	$KPSS_\mu^c$	$KPSS_\tau^d$
LAU	-0.06986	-2.92800	4.32018**	0.90585**
LHK	-1.39219	-2.01315	1.54641**	0.79016**
LJP	-1.14996	-1.20635	2.06952**	1.18950**
LSP	-1.75600	-2.53965	1.62938**	1.18451**
LUS	-1.72066	-2.35995	2.43904**	0.56703**

Abbreviated real estate stock price indices and the corresponding countries:

AU	Australia
HK	Hong Kong
JP	Japan
SP	Singapore
US	United States

** and * Denotes statistical significance at the 1% and 5% level respectively.

[a] Under the null hypothesis if a unit root. The ADF$_c$ regressions include only a constant. Critical values for the ADF$_c$ have been adopted from MacKinnon (1991) are -3.437 and – 2.864 at the 1% and 5% level of significance respectively.

[b] Under the null hypothesis if a unit root. The ADF$_{ct}$ regressions include both a constant and a time trend. Critical values for the ADF$_{ct}$ have been adopted from MacKinnon (1991) are -3.969 and -3.415 at the 1% and 5% level of significance respectively. The lag length of the ADF regressions are sufficient to ensure that the residuals from each of the equation are free from serial correlation as measured by the LBQ statistics at the 5% level of significance.

[c] Under the null hypothesis of stationarity. The critical values are obtained from Kwiatkowski et al. (1992) are 0.739 and 0.463 at the 1% and 5% level of significance respectively.

[d] Under the null hypothesis of trend stationarity. The critical values are obtained from Kwiatkowski et al. (1992) are 0.216 and 0.146 at the 1% and 5% level of significance respectively. For the KPSS test, the lag truncation parameter is set to 8 (Schlitzer, 1995).

Table A.18: Zivot-Andrews Test for Structural Break

Country	Break Date	Test Statistic
	Daily Data	
AU	2001:01:04	-1.28885
HK	2003:04:05	-2.78562
JP	2003:08:07	-1.89229
SP	2002:08:29	-3.69084
US	2002:06:27	-2.98705

Abbreviated real estate stock price indices for included countries:

AU	Australia
HK	Hong Kong
JP	Japan
SP	Singapore
US	United States

*and ** denotes significance at the 5% and 1% level respectively. Critical Values have been adopted from Zivot and Andrews (1992). For infinite sample, -4.82 and -5.08 are the 5% and 1% critical values respectively.

Table A.19: Johansen's λ_{trace} and λ_{max} summary table

H_0	$\lambda_{max} tests$	H_0	$\lambda_{trace} tests$
$r = 0$	33.11*	$r = 0$	72.19*
$r = 1$	19.09	$r \leq 1$	39.08
$r = 2$	13.74	$r \leq 2$	19.99
$r = 3$	5.93	$r \leq 3$	6.25
$r = 4$	0.32	$r \leq 4$	0.32

Abbreviated real estate stock price indices and the corresponding countries:

AU	Australia
HK	Hong Kong
JP	Japan
SP	Singapore
US	United States

The null hypothesis is H_0 which tests for the number of cointegrating vectors (designated by r) is given by both the λ_{trace} and λ_{max} test statistics.

Critical values have been obtained from Osterwald-Lenum (1992) table 1*.

For each period the lag length used in the VAR is chosen to eliminate serial correlation in the residuals at the 5% significance level.

* and ** denotes significance at the 5% and 10% level respectively.

TableA.20:Exclusion Tests and Tests of Weak Exogeneity

Panel A		$\lambda_{trace} test$			
Countries	$H_0 : r = 0$	$H_1 : r \le 1$	$H_2 : r \le 2$	$H_3 : r \le 3$	$H_4 : r \le 4$
US,AU,JP,HK,SP	72.19*	39.08	19.99	6.25	0.32
US,HK,SP	33.60*	7.81	0.59	-	-
Panel B		$\lambda_{max} tests$			
Countries	$H_0 : r = 0$	$H_1 : r = 1$	$H_2 : r = 2$	$H_3 : r = 3$	$H_4 : r = 4$
US,AU,JP,HK,SP	33.11**	19.09	13.74	5.93	0.32
US,HK,SP	25.79*	7.21	0.59	-	-
Panel C					
$\beta_{i=} 0^a$	**US**	**AU**	**HK**	**JP**	**SP**
US,AU,JP,HK,SP	10.42 *	0.58	6.97*	2.60	5.87*
US,HK,SP	17.97*	-	15.81*	-	5.71*
Panel D	Test statistic				
$\beta AU = \beta JP = 0^b$	0.20				
Panel E					
$\alpha_{i=} 0^c$	**US**	**AU**	**HK**	**JP**	**SP**
Test statistic	2.37	-	7.57*	-	1.81
Panel F	Test statistic				
$\alpha US = \alpha SPORE = 0^d$	0.13				

Abbreviated real estate stock price indices and the corresponding countries:

AU	Australia
HK	Hong Kong
JP	Japan
SP	Singapore
US	United States

[a] Index i can be excluded from the cointegration space. The test statistic is χ^2 distributed $r*[n-(n-m)]$ degrees of freedom; where n is the number of variables in the VAR and m is the number of restrictions.

[b]The test statistic is χ^2 distributed with $r*[n-(n-m)]$ degrees of freedom; where n is the number of variables in the VAR and m is the number of restrictions

[c]Index i is weakly exogenous.

[d]The test statistic is χ^2 distributed with $r*[n-(n-m)]$ degrees of freedom; where n is the number of variables in the VAR and m is the number of restrictions.

*denotes significance at the 5% level.

Table A.21: ADF tests on the restricted CIV and CT

Lags	CIV1	CT1	CT2
1	-4.68002**	-2.45896	-2.01655
4	-4.29389**	-2.16091	-1.96795
8	-3.85036 *	-1.88451	-1.93145
12	-3.78447 *	-1.87605	-1.58702

$$LUS_t = 1.014 LHK_t + 0.582 SPORE_t$$

Abbreviated real estate stock price indices and the corresponding countries:

AU	Australia
HK	Hong Kong
JP	Japan
SP	Singapore
US	United States

**Denotes statistical significance at the 1% level.

* Denotes statistical significance at the 5% level

Under the null hypothesis of a unit root. The critical values are obtained from Mackinnon (1991) are
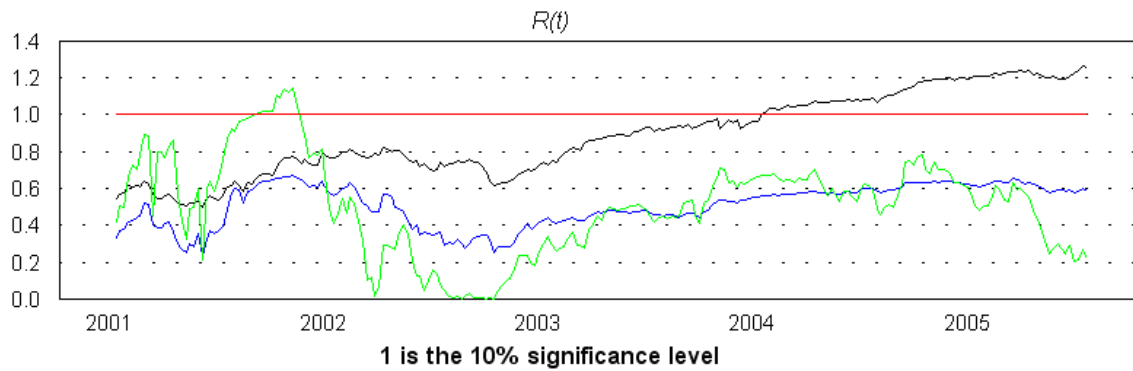-4.30696 and -3.74826 at the 1% and 5% level respectively.

Figure A.6 Recursive trace tests for the markets of US, Hong Kong and Singapore

Note: For ease of interpretation**,** the test statistics in Figure A.6 has been scaled by their critical values such that the number of line(s) above 1.0 indicate the number of cointegrating relationship(s) at the 10% level of significance. Thus, the first (upper most) line of the graph depicts the time path of the tests for $H\ (r=0\,|\,r=3)$, the second line shows the path of the tests for $H\ (r\le 1\,|\,r=3)$ and finally the third (last) line shows the path of the tests for $H\ (r\le 2\,|\,r=3)$.
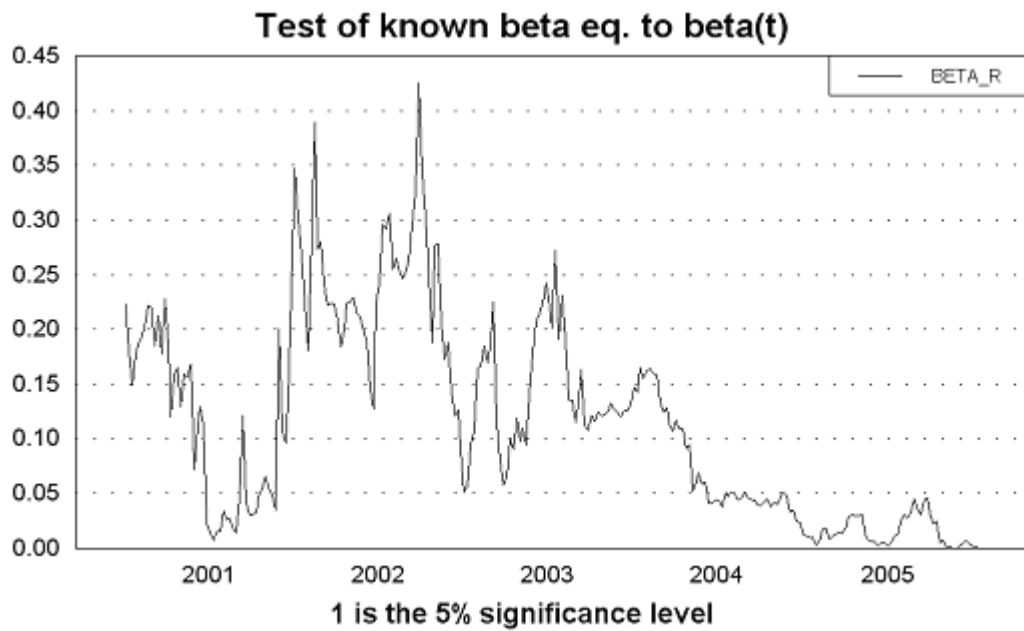
Figure A.7 Recursive likelihood ratio tests

Note: For ease of interpretation, the test statistics in Figure A.7 is scaled by the 5% critical value such that a value greater than unity indicates the rejection of the null hypothesis that the parameters are constant over the period under consideration.

Table A.22: Multivariate causality tests

Panel A	2000 - 2006					
	Independent Variables					**ECT**
Dependant Variables	ΔLUS	ΔLAU	ΔLHK	ΔLJP	ΔLSP	$p-value$
ΔLUS	-	0.2190797	0.6832531	0.7519044	0.2222785	0.38335041
ΔLAU	0.0963482*	-	0.2964000	0.2258535	0.8962875	-
ΔLHK	0.0865593*	0.1985670	-	0.8058730	0.0044296*	0.00000439**
ΔLJP	0.0426687**	0.0983873*	0.0000788**	-	0.0983661*	-
ΔLSP	0.0004391**	0.0915194*	0.0470347*	0.0842994*	-	0.91307339

Abbreviated real estate stock price indices and the corresponding countries:

AU	Australia
HK	Hong Kong
JP	Japan
SP	Singapore
US	United States

** and * Denotes statistical significance at the 1% and 5% level respectively.

Table A.23: Descriptive statistics based on daily data

Market	Obs	Mean	Std Dev.	Min	Max	Skewness	Kurtosis	J-B
FR	1568	0.000329	.0174676	-0.099918	0.111310	-0.075893	5.439592	1934.664020
NL	1568	-0.000106	.0211409	-0.119628	0.127584	0.029845	6.384010	2662.931241
SP	1568	0.000156	.0172576	-0.078901	0.094668	0.142595	2.367781	371.597833
UK	1568	0.000099	.0142129	-0.092062	0.067787	-0.082994	3.572568	835.665378
US	1568	0.000234	.0136526	-0.076808	0.081389	0.235185	3.526906	827.140591

Abbreviated real estate stock price indices for included countries:

LFR	France
LNL	Netherlands
LSP	Spain
LUK	United Kingdom
LUS	United States

Table A.24: Unit root tests

Country	ADF_C^a	ADF_{CT}^b	$KPSS_\mu^c$	$KPSS_\tau^d$
LFR	-0.13092	-1.31819	2.76050**	1.12030**
LNL	-1.63303	-1.34993	1.68122**	0.98953**
LSP	-0.75263	-1.48137	1.99415**	1.49154**
LUK	-1.44724	-2.13887	2.09126**	0.84887**
LUS	-1.72066	-2.35995	2.43904**	0.56703**

Abbreviated real estate stock price indices for included countries:

LFR	France
LNL	Netherlands
LSP	Spain
LUK	United Kingdom
LUS	United States

** and * Denotes statistical significance at the 1% and 5% level respectively.

[a] The ADF$_c$ regressions include only a constant. Critical values for the ADF$_c$ have been adopted from MacKinnon (1991) are -3.437 and – 2.864 at the 1% and 5% level of significance respectively.

[b] The ADF$_{ct}$ regressions include both a constant and a time trend. Critical values for the ADF$_{ct}$ have been adopted from MacKinnon (1991) are -3.969 and -3.415 at the 1% and 5% level of significance respectively. The lag length of the ADF regressions are sufficient to ensure that the residuals from each of the equation are free from serial correlation as measured by the LBQ statistics at the 5% level of significance.

[c] Under the null hypothesis of stationarity. The critical values are obtained from Kwiatkowski et al. (1992) are 0.739 and 0.463 at the 1% and 5% level of significance respectively.

[d] Under the null hypothesis of trend stationarity. The critical values are obtained from Kwiatkowski et al. (1992) are 0.216 and 0.146 at the 1% and 5% level of significance respectively. For the KPSS test, the lag truncation parameter is set to 8 (Schlitzer, 1995).

Table A.25: Zivot-Andrews Test for Structural Break

Country	Break Date	Test Statistic
	Daily Data	
LFR	2001:01:04	-4.02189
LNL	2003:04:05	-3.88084
LSP	2003:08:07	-1.89058
LUK	2002:08:29	-2.83254
LUS	2002:06:27	-2.42089

Abbreviated real estate stock price indices for included countries:

LFR	France
LNL	Netherlands
LSP	Spain
LUK	United Kingdom
LUS	United States

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Table A.26: Johansen's λ_{trace} and λ_{max} summary table

H_0	λ_{max} tests	H_0	λ_{trace} tests
$r = 0$	37.29*	$r = 0$	79.49*
$r = 1$	21.76	$r \leq 1$	42.20
$r = 2$	10.89	$r \leq 2$	20.44
$r = 3$	5.87	$r \leq 3$	9.55
$r = 4$	3.68	$r \leq 4$	3.68

Abbreviated real estate stock price indices for included countries:

LFR	France
LNL	Netherlands
LSP	Spain
LUK	United Kingdom
LUS	United States

The null hypothesis is $H0$ which tests for the number of cointegrating vectors (designated by r) is given by both the λ_{trace} and λ_{max} test statistics.

Critical values have been obtained from Osterwald-Lenum (1992) table 1*.

For each period the lag length used in the VAR is chosen to eliminate serial correlation in the residuals at the 5% significance level.

* and ** denotes significance at the 5% and 10% level respectively.

Table A.27:Exclusion Tests and Weak Exogeneity Tests

Panel A		$\lambda_{trace}test$			
Countries	$H0:r=0$	$H1:r\leq1$	$H2:r\leq2$	$H3:r\leq3$	$H4:r\leq4$
US, UK, NL, FR, SP	79.49*	42.20	20.44	9.55	3.68
Panel B		$\lambda_{\max}tests$			
Countries	$H0:r=0$	$H1:r=1$	$H2:r=2$	$H3:r=3$	$H4:r=4$
US, UK, NL, FR, SP	37.29*	21.76	10.89	5.87	3.68
Panel C					
$\beta_{i=}0^{a}$	**US**	**UK**	**NL**	**FR**	**SP**
US, UK, NL, FR, SP	13.88*	12.40*	3.89*	4.36*	6.04*
Panel D					
$\alpha_{i=}0^{b}$	US	UK	NL	FR	SP
US, UK,FR, SP	0.64	0.29	2.58	2.69	5.38**
Panel E	Test statistic				
$\alpha US=\alpha UK=\alpha FR=\alpha NL=0^{c}$	0.36				

Abbreviated real estate stock price indices for included countries:

LFR	France
LNL	Netherlands
LSP	Spain
LUK	United Kingdom
LUS	United States

[a] Index i can be excluded from the cointegration space. The test statistic is χ^2 distributed $r*[n-(n-m)]$ degrees of freedom; where n is the number of variables in the VAR and m is the number of restrictions.

[b] Index i is weakly exogenous.

[c] The test statistic is χ^2 distributed with $r*[n-(n-m)]$ degrees of freedom; where n is the number of variables in the VAR and m is the number of restrictions.

* denotes significance at the 5% level.

Table A.28: ADF tests on the restricted CIV and CT

Lags	CIV1	CT1	CT2	CT3	CT4
1	-6.33407	-1.17532	-2.41697	-0.86418	-1.88844
4	-5.01112	-0.99232	-2.22453	1.70444	-1.79269
8	-5.33446	-1.16118	-1.95902	-0.52029	-1.69529
12	-5.05817	-0.93493	-2.02163	-0.39061	-1.72820

$$LUS_t = 0.854LUK_t + 1.316LFR_t - 1.797SP_t + 0.272NL_t$$

**Denotes statistical significance at the 1% level.
* Denotes statistical significance at the 5% level
Under the null hypothesis of a unit root. The critical values are obtained from Mackinnon (1991) are
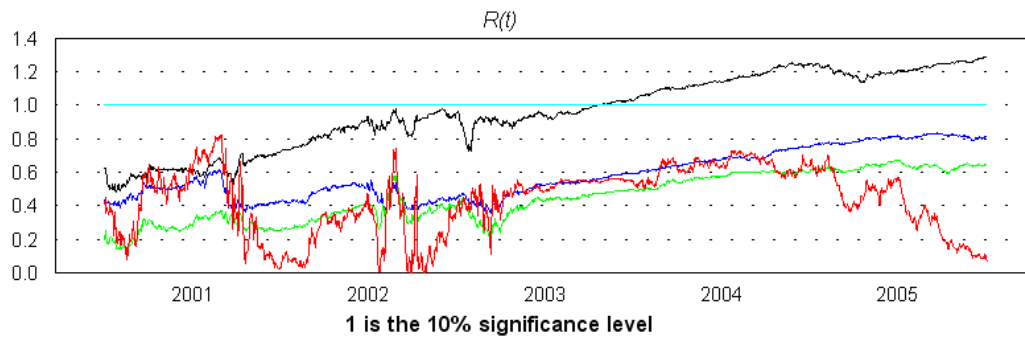 -4.97291 and -4.42725 at the 1% and 5% level respectively.

Figure A.8 Recursive trace tests on all markets

Note: For ease of interpretation, the test statistics in Figure A.2 has been scaled by their critical values such that the number of line(s) above 1.0 indicate the number of cointegrating relationship(s) at the 10% level of significance. Thus, the first (upper most) line of the graph depicts the time path of the tests for $H\ (r=0\,|\,r=3)$, the second line shows the path of the tests for $H\ (r\leq1\,|\,r=3)$ and finally the third (last) line shows the path of the tests for $H\ (r\leq2\,|\,r=3)$.
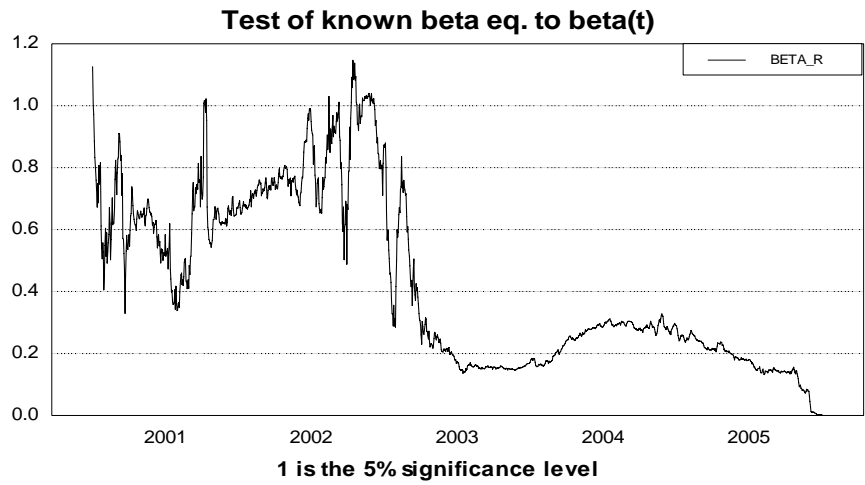
Figure A.9 Recursive likelihood ratio test of the constancy of Cointegrating vectors

Note: For ease of interpretation, the test statistics in Figure b is scaled by the 5% critical value such that a value greater than unity indicates the rejection of the null hypothesis that the parameters are constant over the period under consideration.

Table A.29:Multivariate causality tests

	Independent Variables					ECT1
Dependant Variables	ΔLUS	ΔLUK	ΔLNL	ΔLFR	ΔLSP	$p-value$
ΔLUS	-	0.0273688**	0.0029753**	0.0670874*	0.1353585	0.39688517
ΔLUK	**0.0000000*****	-	0.1507707	0.0003483**	0.1167346	0.4558245730
ΔLNL	**0.0000000*****	0.0044238**	-	0.1165489	0.0755758*	0.46492620
ΔLFR	**0.0000000*****	0.0023781**	0.1592927	-	0.0244265*	0.35287081
ΔLSP	**0.0000000*****	0.0457655**	0.0151635**	0.1394200	-	**0.00039682****

Abbreviated real estate stock price indices for included countries:

LFR	France
LNL	Netherlands
LSP	Spain
LUK	United Kingdom
LUS	United States

***, ** and * Denotes statistical significance at the 1%, 5% and 10% level respectively.

$X \Rightarrow Y$ indicates unilateral causality running from X to Y and $X \Leftrightarrow Y$ indicates bi-directional causality that is a feedback relationship.

REFERENCES

Aggarwal, R., Inclan, C. and Leal, R. (1999) Volatility in emerging stock markets, *Journal of Financial and Quantitative Analysis*, 34(1), 33–55.

Alexander, C. (2001) Market models: A guide to financial data analysis, *J. Wiley and Sons*, New York.

Allen, D. and Macdonald, G. (1995) The long-run gains from international equity diversification: Australian evidence from cointegration tests, *Applied Financial Economics,* 5(1), 33-42.

Arshanapalli, B. and Doukas, J. (1993) International stock market linkages: Evidence from the pre and post-October 1987 Period, *Journal of Banking and Finance*, 17, 193-208.

Arshanapalli, B., Doukas, J. and Lang, L. H. P. (1995) Pre and post-October 1987 stock market linkages between US and Asian markets, *Pacific-Basin Finance Journal*, 3, 57–73.

Asabere, P., Kleiman, R. and McGowan, C. (1991) The risk-return attributes of international real estate equities, *Journal of Real Estate Research,* 6(2), 143-152.

Awad, M.A. and Goodwin, BK. (1998) Dynamic linkages among real interest rates in international capital markets, *Journal of International Money and* Finance, 17, 881-907.

Baharumshah, A.Z., Sarmidi, T. and Tan, H.B. (2003) Dynamic linkages of Asian stock markets, An analysis of pre-liberalization and post-liberalization eras, 8(2), 180-209.

Barry, C. and Rodriguez, M. (2004) Risk and return characteristics of property indices in emerging markets *Emerging Markets review,* 5(2), 131-159.

Bernard, A. B. and Durlauf, S. N. (1995) Convergence of international output, *Journal of Applied Econometrics*, 10, 97-108.

Bessler, D. A. and Yang, J. (2003) The structure of interdependence in international stock markets, *Journal of International Money and Finance*, 22, 261–87.

Bigman, T. (2002) Investing in international listed property companies, *PREA Quarterly*, 53–61.

Bond, M. and Seiler, M. (1998) Real estate returns and inflation: an added variables approach, *Journal of Real Estate Research*, 15(3), 327-339.

Bond, S., Dungey, M. and Fry, R. (2006) A web of shocks: crisis across Asia-Pacific region real estate markets, *The Journal of Real Estate Finance and Economics,* 32(3), 253-274.

Bond, S.A., Karolyi, G.A. and Sanders, A.B.(2003) International real estate returns: A multifactor, multicountry approach, *Real Estate Economics,* 31(3), 481-500.

Brown, G.R. and Matysiak, G.A. (1998) Valuation smoothing without temporal aggregation, *Journal of Property Research,* 15(2), 89-103.

Buch, M.C. (2004) Globalization of financial markets: Causes of incomplete integration

and consequences for economic policy, *Springer*.

Byers, J. and Peel, D. (1993) Some evidence of interdependence of national stock markets and the gains from international portfolio diversification, *Applied Financial Economics*, 2, 239-243.

Case, B., Goetzmann, W., Rouwenhorst, K.G., 2000. Global real estate markets e cycles and fundamentals. *NBER Working Paper Series*, Paper No. 7566.

Cha, B., and Cheung, Y. (1998) The Impact of the U.S. and the Japanese equity markets on the emerging the Asia-Pacific region-pacific equity markets, *Asia-PacificFinancial Markets,* 5(3), 191-209.

Chan, K. C., Gup, B. E. and Pan, M. S. (1992) An empirical analysis of stock prices in major Asian markets and the United States, *The Financial Review*, 27, 89–107.

Chan, K. C., Gup, B. E. and Pan, M. S. (1997) International stock market efficiency and integration: a study of eighteen nations, *Journal of Business Finance and Accounting*, 22–38.

Chandrashekaran, V. (1999) Time-series properties and diversification benefits of REIT returns, *The Journal of Real Estate Research,* 17(1/2), 91-112.

Chatterjee, A., Ayadi, F. O. and Dufrene, U. B. (1998) International portfolio diversification in the African emerging equity markets: a cointegration analysis, *Journal of Emerging Markets*, 3(2), 49–60.

Chaudhry, M. K., Christie-David, R.A. and Sackley W.H. (1999) Long-term structural price relationships in real estate markets, *Journal of Real Estate Research*, 18(2-3), 335-354.

Chen, N-F, Roll, R. and Ross, S.A. (1986) Economic Forces and the Stock Market, *The Journal of Business*, Vol. 59(3), 383-403.

Cheung, Y.L. and Mak, S.C. (1992) The international transmission of stock market fluctuation between the developed markets and the Asia-Pacific markets, *Applied Financial Economics*, 2(1), 43-47.

Cheung, Y. W., He, J. and Ng, L. K. (1997) Common predictable components in regional stock markets, *Journal of Business and Economic Statistics*, 15(1), 35–42.

Chin, H., Keng, T.Y, Topintzi, E., Hobbs, P. and Mansour, W. (2007) Global real estate securities: an increasingly attractive sector for investors, *American Real Estate Society Conference.*

Choudhry, T. (1997) Stochastic trends in stock prices: evidence from Latin American markets, *Journal of Macroeconomics*, 19, 285–304.

Clayton, J. and MacKinnon, G. (2000) REIT market maturation and pricing dynamics, *Real Estate Finance,* 17(1), 52-64.

Clayton, J. and MacKinnon, G. (2001) The time-varying nature of the link between REIT, real estate and financial asset returns, *Journal of Real Estate Portfolio Management*, 7(1), 43-55.

Conover, M., Friday, H. and Howton, S. (1998) The relationship between size and return for foreign real estate investments, *Journal of Real Estate Portfolio Management*, 4(2), 107–112.

Conover, C., Friday, H. and Sirmans, G. (2002) Diversification benefits from foreign

real estate investments, *The Journal of Real Estate Portfolio Management*, 8(1), 17–25.

Crowder, W.J. (1996) A Reexamination of Long-Run PPP. The Case of Canada, the UK and the US, *Review of International Economics,* 4(1), 64-78.

Crowder, W. J., and Wohar, M. E. (1998) Cointegration, forecasting and international stock prices, *Global Finance Journal*, 9(2), 181-204.

Darrat, A.F. and Glascock, J.L. (1993) On the real estate market efficiency, *The Journal of Real Estate Finance and Economics,* 7(1), 55-72.

Dhar, R. and William N.G. (2006) Institutional perspectives on real estate inveting, *Journal of Portfolio Management*, 32(4), 106-116.

Dickey, D., and Fuller, W.A. (1979) Distribution of the estimate for autoregressive time series with a unit root, *Journal of the American Statistical Association,* 74(366), 427- 431.

Dickey, D. A., and Fuller, W. A. (1981) likelihood ratio statistics for autoregressive time series with a unit root, *Econometrica,* 49(4), 1057-1072.

Dunis, C. and Shannon, G. (2005) Emerging markets of south-east and central Asia: Do they still offer a diversification benefit?, *Journal of Asset Management,* 6(3), 168-190.

Eichholtz, P.M.A. (1996) Does International diversification work better for real estate than for stocks and bonds?, *Financial Analyst Journal*, 52(1), 56- 62.

Eichholtz, P.M.A. (1997) Real estate securities and common stocks: A first international

   look, *Real Estate Finance*, 14(1), 70-74.

Eichholtz, P.M.A., Huisman, R. Koedijk, K. and Schuin, L. (1998) Continental factors in international real estate returns*, Real Estate Economics,* 26(3), 493-509.

Edelstein, R. H. and Quan, D.C. (2006) How does appraisal smoothing bias real estate returns measurement? *The Journal of Real Estate Finance and Economics*, 32(1), 41-60.

Ehrmann, M. and Fratzscher, M. (2005) Equal Size, Equal Role? Interest Rate Interdependence Between the Euro Area and the United States, *The Economic Journal* 115 (506), 928-948.

Elton, E. J. and Gruber, M. J. (1995) Modern Portfolio Theory and Investment Analysis, *J. Wiley and Sons*, New York.

Enders, W. (1995) Applied Econometric Time Series, *J. Wiley and Sons*, New York.

Engle, R. F. and Granger, C.W.J. (1987) Co-Integration and Error Correction: representation, estimation and testing, *Econometrica*, 55(2), 351-276.

Eun, S. C. and Shim, S. (1989) International transmission of stock market movements, *The Journal of Financial and Quantitative Analysis*, 24(2), 241-256.

Fang, H., Lai, M. and Lai K. (1993) Dynamic linkages between the New York and Tokyo stock markets: a vector error correction analysis, *Journal of International Financial Markets, Institutions and Money*, 3(3), 73-96.

Farrell, J. L. (1997) Portfolio Management: Theory and Application, *McGraw-Hill*, New York.

Fase, M.M.G. and P.J.G. Vlaar, P.J.G. (1998) International convergence of capital

market interest rates, *De Economist*, 146(2), 257-269.

Feldman, B.E. (2003) Investment policy for securitized and direct real estate, *Journal of Portfolio Management*, Special Issue, 112-121.

Fisher, J., Geltner, D., and R. Webb, (1994). "Value indices of commercial real estate: A comparison of index construction methods, *Journal of Real Estate Finance and Economics*, vol. 9,137-164.

Fisher, J., Geltner,D. and Pollakowski., H. (2005) A quarterly transactions-based index of institutional real estate investment performance and movements in supply and demand, *MIT Center for Real Estate*.

Fountas S. and Jyh-lin Wu, J.L. (1999) Testing for real interest rate convergence in European countries, *Scottish Journal of Political Economy*, 46 (2), 158-174.

Francis, B. and Leachman, L. (1998) Superexogeneity and the dynamic linkages among international equity markets, *Journal of International Money and Finance*, 17, 475–92.

Fraser, P. and Oyefso, O. (2005) US, UK and European Stock Market Integration, *Journal of Business Finance & Accounting*, 32(1), 161-181.

Frost, C., Schioldager, A. and Hammond, S. (2005) Real estate investing the REIT way: a guide to REIT benchmarks and investing, *Investment Insights, Barclays Global Investors*.

Garvey, R., Santry, G. and Stevenson, S. (2001) The Linkages between real estate securities in the Asia-Pacific region, *Pacific Research Property Research Journal,* 7(4), 240-258.

Geltner, D., (1989). Bias in Appraisal-Based Returns, *American Real Estate and Urban Economics Association Journal*, 17(3), 338-52.

Geltner, D., (1991) Smoothing in Appraisal-Based Returns *Journal of Real Estate Finance and Economics*, 4(3), 327-45.

Geltner, D. (1997) The use of appraisals in portfolio valuation and index construction, *Journal of Property Valuation and Investment*, 15(5), 423-447.

Geltner, D. (1998) How accurate is the NCREIF index as a benchmark, and who cares?, *Real Estate Finance*, 14(4), 1-14.

Geltner, D., and W. Goetzmann, (2000) Two decades of commercial property returns: A repeated-measure regression-based version of the NCREIF index, *Journal of Real Estate Finance and Economics*, 21, 5-21.

Georgiev, G., Gupta, B. and Kunkel, T. (2003) Benefits of real estate investment, *The Journal of Portfolio Management*, Special Issue, 28-32.

Gerlach, R., Wilson, P. and Zurbruegg, R. (2006) Structural breaks and diversification: The impact of the 1997 Asian financial crisis on the integration of Asia-Pacific real estate markets, *Journal of International Money and Finance*, 25(6), 974-991.

Ghosh, A., Saidi, R. and Johnson, K. H. (1999) Who moves the Asia-Pacific stock markets - US or Japan? Empirical evidence based on the theory of cointegration, *The Financial Review*, 34, 159–70.

Giliberto, S. (1988) A note on the use of appraisal data in indexes of performance measurement, *AREUEA*, 16(1), 77-83.

Gilmore, C. G. and McManus, G. M. (2002) International portfolio diversification: US

and Central European equity markets, *Emerging Markets Review*, 3, 69–83.

Glascock, J. L., Lu, C. and So, R. W. (2000) Further evidence on the integration of REIT, bond, and stock returns, *The Journal of Real Estate Finance and Economics*, 20(2), 177-194.

Gonzalo, J. and Granger, C. W. J. (1995) Estimation of common long-memory components in cointegrated System, *Journal of Business and Economic Statistics*, 13(1), 27– 35.

Gonzalo, J. and Lee, T. (2000) On the robustness of cointegration tests when series are fractionally integrated, *Journal of Applied Statistics*, 27(7), 821– 827.

Gordon, J. and Canter, T. (1999) International real estate securities: A test of capital markets integration, *Journal of Real Estate Portfolio Management*, 5(2), 161-170.

Gordon, J., Canter, T. and Webb, J. (1998) The effects of international real estate securities on portfolio diversification, *Journal of Real Estate Portfolio Management*, 4(2), 83–92.

Granger, C.W.J. (1969) Investigating causal relations by econometric models and cross-spectral methods, *Econometrica*, 37(3), 424-438.

Granger, C.W.J. (1988) Some Recent developments in the concept of causality, *Journal of Econometrics,* 39, 199-211.

Granger C.W.J. and Newbold, P. (1974). Spurious regressions in economics, *Journal of Econometrics* 2, 111-20.

Gregory, A. W. (1994) Testing for cointegration in linear quadratic models. *Journal of Business and Economic Statistics*, 12(3), 347– 360.

Grubel, H. (1968) Internationally diversified portfolio: welfare gains and capital flows, *American Economic Review,* 58, 1299-1314.

Hall, S. G., Robertson, D. and Wickens, M. R. (1997) Measuring economic convergence, *International Journal of Financial Economics*, 2, 131-143.

Hamao, Y., Masulis, R. W. and Ng, V. (1990) Correlations in price changes and volatility across international stock markets, *Review of Financial Studies*, 3(2), 281–307.

Hamilton, J. D. (1994) Time Series Analysis, *Princeton University Press*, Princeton, NJ.

Hansen, H. and Johansen S. (1999) Some tests for parameter constancy in cointegrated VAR models, *Econometrics Journal,* 2(2), 306-333.

Hardouvelis, G. A., Malliaropulos, D. and Priestley, R. (2006) EMU and European Stock Market Integration, *The Journal of Business*, 79, 365–392.

Hoesli, M.B., MacGregor, G. and Nanthakumaran, N. (1997) The short-term inflation hedging characteristics of UK real estate, *Journal of Real Estate Finance and Economics*, 15(1), 27-57.

Hudson-Wilson, S., Fabozzi, F.J. and Gordon, J.N. (2003) Why real estate? *The Journal of Portfolio Management*, Special Issue, 12-25.

Hudson-Wilson, S., Fabozzi, F.J., Gordon, J.N., Anson, M.J.P and Gilberto, S.M. (2005) Why real estate? *The Journal of Portfolio Management*, Special Issue, 12-22.

Hudson-Wilson, S., and Harbaugh, M. (2006). Implementing a real estate allocation, *The Handbook of Inflation Hedging Investments*. New York: McGraw-Hill.

Idzorek,T., Barad, M. and Meier, S. (2006) Commercial real estate: The role of global

listed real estate equities in a strategic asset allocation, *American Real Estate Society*.

Janakiramanan, S. and Lamba, A. S. (1998) An empirical examination of linkages between Pacific-Basin stock markets, *Journal of International Financial Markets, Institutions and Money*, 8, 155–73.

Jeon, B. N. and Chiang, T. C. (1991) A system of stock prices in world stock exchanges: common stochastic trends for 1975–1990?, *Journal of Economics and Business*, 43, 329–38.

Johansen, S. (1988) Statistical analysis of cointegration vectors, *Journal of Economic Dynamics and Control,* 12(2-3), 231-254.

Johansen, S. and Juselius K. (1990) Maximum likelihood estimation and inference on cointegration with applications to the demand for money, *Oxford Bulletin of Economics and Statistics*, 52(2), 169-210.

Johansen, S. (1994) The role of constant and linear terms in cointegration analysis of nonstationary variables, *Econometric Reviews*, 13(2), 205–229.

Kasa, K. (1992) Common stochastic trends in international stock markets, *Journal of Monetary Economics,* 29(1), 95-124.

Kallberg, J. and Liu C. (1996) The role of real estate in the portfolio allocation process, *Real Estate Economics*, 24(3), 359-377.

Khoo, T., Hartzell, D. and Hoesli, N. (1993) An investigation of the change in real estate investment trust betas, *Real Estate Economics*, 21, 107-30.

Knif, J. and Pynnonen, S. (1999) Local and global price memory of international stock markets, *Journal of International Financial Markets,Institutions and Money*, 9, 129–47.

Kleiman, R.T., Payne, J.E. and Sahu. A.P. (2002) Random walks and market efficiency: evidence from international real estate markets, *Journal of Real Estate Research,* 24(3), 279-298.

Kramer, J.J.M., Ericsson, N.R. and Dolado, J. (1992) The Power of Cointegration Tests, *Oxford Bulletin of Economics and Statistics* 54(3), 325-348.

Kwan, A.C.C., Sim, A.B. and Cotsomitis, J.A. (1995) The causal relationship between equity indices on world exchanges, *Applied Economics*, 27(1), 33-37.

Kwiatkowski, D., Phillips, P.C.B., Schmidt, P. and Shin, Y. (1992) Testing the null hypothesis of stationary against the alternative of a unit root: How sure are we that economic time series have a unit root? *Journal of Econometrics,* 54, 159-178.

Lai, M., Lai, K. S. and Fang, H. (1993) Dynamic linkages between the New York and Tokyo stock markets: a vector error correction analysis, *Journal of International Financial Markets, Institutions and Money*, 3(2), 73–96.

Laopodis, N.T. (2004) Portfolio diversification benefits within Europe: Implications for a US investor, *International Review of Financial Analysis*, 14, 455–476

Lessard, D. (1973) International portfolio diversification: a multivariate analysis for a group of Latin American countries, *Journal of Finance,* 28, 619-33.

Levy, H. and Sarnat, M. (1970) International diversification of investment portfolios, *American Economic Review,* 60, 668-75.

Ling, D.C and Naranjo, A. (1997) The integration of commercial real estate

markets and stock markets, *Real Estate Economics*, 27 (3), 483-515.

Ling, S.C. and Sing, T. (2003) Role of Singapore REITs in a downside risk asset allocation framework, *The Journal of Real Estate Portfolio Management*, 9(3), 219-235.

Liow K. H. and Yang H. (2005) Long term co-memories and short-run adjustment: Securitized real estate and stock, *Journal of Real Estate Finance and Economics,* 31(3), 283-300.

Liow, K. (2006) Common factors in international securitized property markets, *American Real Estate Society.*

Liu, C.H. and Mei, J. (1998) The predictability of international real estate markets, exchange rate risks and diversification consequences, *Real Estate Economics,* 26(1), 3-39.

MacKinnon, J.G. (1996) Numerical distribution functions for unit root and cointegration tests, *Journal of Applied Econometrics*, 11(6), 601-618.

Malliaris, A.G. and Urrutia, J.L. (1992) The international crash of October 1987: Causality tests, *Journal of Financial and Quantitative Analysis,* 27(3), 353-364.

Markowitz, H. M. (1952) Portfolio selection, *Journal of Finance* 7(1), 77-91.

Masih, A. M. M. and Masih, R. (1997) Dynamic linkages and the propagation mechanism driving major international stock markets: An analysis of the pre-and-post-crash eras, *The Quarterly Review of Economics and Finance*, 37(4), 859-888.

Masih, A. M. M. and Masih, R. (1999) Are Asian stock market fluctuations due mainly to intra-regional contagion effects? Evidence based on Asian emerging stock markets, *Pacific Basin Finance Journal,* 7(3-4), 251-282.

Maurer, R. and Reiner, F. (2002) International asset allocation with real estate securities in a shortfall risk framework: the view point of German and US investors, *The Journal of Real Estate Portfolio Management*, 8(1), 27–43.

McCue, T.E. and Kling, J.L. (1994) Real estate returns and the macro economy: Some empirical evidence from real estate investment trust, *Journal of Real Estate Research*, 9(3), 277-288.

Michayluk, D., Wilson, P. J. and Zurbruegg, R. (2006) Asymmetric volatility, correlation and returns dynamics between the US and US securitized real estate markets, *Real Estate Economics*, 34(1), 109-131.

Mull, S. and Soenen, L. (1997) U.S. REITs as an asset class in international investment portfolios, *Financial Analysts Journal*, 53(2), pp. 55–61.

Myer, F.C.N., Chaudhry, M.K. and Webb. J.R. (1997) Stationarity and co-integration in systems with three national real estate indices, *Journal of Real Estate Research,* 13(3), 369- 381.

Myer, F.C.N., Chaudhry, M.K. and Webb. J.R. (1999) Stationarity and cointegration in systems with real estate and financial assets, *Journal of Real Estate Finance and Economics*, 18, 339-349.

Newey, W. K. and West, K. D. (1987) A simple positive definite, heteroskedasticity and autocorrelation consistent covariance matrix, *Econometrica*, 55, 703–8.

Obstefeld M. and Taylor, A.M. (2004) Global capital markets: Integration, crisis, and growth, *Cambridge University Press*, London.

Osterwald-Lenum, M. (1992) A note with quartiles as the asymptotic distribution of the maximum likelihood cointegration rank test statistics, *Oxford Bulletin of Economics and Statistics*, 54(3), 461–72.

Pagliari, J., Scherer, K. and Monopoli, R. (2005) Public versus private real estate equities: a more refined long-term comparison, *Real Estate Economics*, 147-187.

Paruolo, P. (2001) The power of Lambda Max, *Oxford Bulletin of Economics and Statistics,* 63(3), 395-403.

Pascual, A.G. (2003) Assessing European stock markets (co)integration, *Economics Letters* 78(2), 197-203.

Payne, J.E. and Sahu, A.P. (2004) Random walks, cointegration, and the transmission of shocks across global real estate and equity markets, *Journal of Economics and Finance,* 28(2), 198-210.

Phengpis, C. and Apilado, V.P. (2004) Economic interdependence and common stochastic trends: A comparative analysis between EMU and non-EMU stock markets, *International Review of Financial Analysis,* 13(3), 245-263.

Phylaktis, K. (1999), Capital Market Integration in the Pacific Basin Region: An Impulse Response Analysis, *Journal of International Money and Finance,* 18, 267–87.

Phylaktis, K. and Ravazzolo, F. (2005) Stock market linkages in emerging markets: implications for international portfolio diversification, *Journal of International Financial Markets, Institutions and Money,* 15(2), 91-106.

Rangvid, J. (2001) Increasing convergence among European stock markets? A recursive common stochastic trends analysis, *Economics Letters*, 71(3), 383– 389.

Ratanapakorn, O. and Sharma, S.C. (2002) Interrelationships among regional stock indices, *Review of Financial Economics*, 11, 91–108.

Richards, A. J. (1996) Comovements in national stock market returns: Evidence of predictability, but not cointegration, *Journal of Monetary Economics*, 36(3), 631–654.

Roca, E.D. (2001) Australia and the three little dragons: are their equity markets interdependent? *Applied Economics Letters*, 8, 203-207

Roca, E.D. (2005) The extent and stability of long-run relationship between stock prices: evidence from the U.S., the U.K. and Australia, *Investment Management and Financial Innovations*, 4, 80-94.

Schlitzer, G. (1995) Testing stationarity of economic time series: Further Monte Carlo evidence, *Ricerche Economiche*, 2, 125- 144.

Sephton, P.S. and Larsen, K.S. (1991), Tests of exchange market efficiency: Fragile evidence from cointegration tests, *Journal of International Money and Finance* 10(4), 561-570.

Serletis, A. and King, M. (1997) Common stochastic trends and convergence of European Union stock markets, *The Manchester School*, 65(1), 44–57.

Siklos, L. and NG, P. (2001) Integration among Asia-Pacific and international stock markets: common stochastic trend and regime shift, *Pacific Economic Review,* 6(1), 89-110.

Solnik, B. H. (1974) Why not diversify internationally rather than domestically?

Financial Analyst Journal, 30, 48-54.

Strong, R. A. (2000) Portfolio Construction, Management and Protection, *Southwestern College Publishing*, OH.

Swanson, P. E. (2003) The interrelatedness of global equity markets, money markets, and foreign exchange markets, *International Review of Financial Analysis*, 12, 135–55.

Tarbert, H. (1998) The long-run diversification benefits available from investing across geographical regions and property type: Evidence from cointegration tests, *Economic Modelling,* 15(1), 49-65.

Taylor, M. P. and Tonks, I. (1989) The internationalization of stock markets and the abolition of UK exchange control, *Review of Economics and Statistics*, 71, 332–6.

Voronkova, S. (2004) Equity market integration in Central European emerging markets: A cointegration analysis with shifting regimes, *International Review of Financial Analysis,* 13(5), 633-647.

Wilson, P. and Okunev, J. (1996) Evidence of segmentation in domestic and International, property markets, *Journal of Property Finance,* 7(4), 78-97.

Wilson, P. and Zurbruegg, R. (2001) Structural breaks, diversification and international real estate markets – Some new evidence, *Briefings in Real Estate Finance,* 1(4), 348-366.

Wilson, P. and Zurbruegg, R. (2003) International diversification of real estate assets – Is it worth it? Evidence from the literature, *Journal of Real Estate Literature*, 11(3), 259-278.

Wong, W.K., Penm, J., Terrell, R. D. and Lim, K.Y.C. (2004) The relationship between Stock markets of developed countries and Asian emerging markets, *Journal of Applied Mathematics And Decision Sciences*, 8(4), 201–218.

Yang, J., Kolari, W. and Zhu, G. (2005) European public real estate market integration, *Applied Financial Economics*, 15, 895-905.

Yule, G. U. (1926). Why do we sometimes get nonsense-correlations between time-series? A study in sampling and the nature of time series (with discussion), *Journal of the Royal Statistical Society*, 89, 164-181.

Ziering, B., Youguo L. and Willard, M. (1999) REIT correlations with capital market indexes: separating signal from noise, *Real Estate Finance*, 15(4) 61-68.

Ziering, B., Youguo L. and Winograd, B. (1997) The evolution of public and private market investing in the new real estate capital markets, *Real Estate Finance,* 14(2), 21-29.

Zivot, E. and Andrews, D. W, K. (1992) Further Evidence on the great crash, the oil-price shock and the unit-root hypothesis, Journal *of Business & Economic Statistics*, 10(3), 251-270.

Zhou, S. (2003) Interest rate linkages within the European Monetary system: new evidence incorporating long-run trends, *Journal of International Money and Finance*, 22, 571-590.

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