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Long-term Benefits from Investing in International Real Estate

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Non-technical Summary

This paper analyses the short- and long-term linkages between 14 international real estate stock markets. While research in many previous studies mainly focused on the U.S. real estate market, this analysis is broadening the horizon to a more global perspective accounting for the growing attractiveness of real estate by investors. Using data from January 1990 to December 2008, the analysis incorporates the period of the financial market crisis starting in 2007 and does not only focus on a period of a fast growing and upward moving real estate (stock) market as many studies before.

The empirical results indicate several long-term relationships between the national real estate stock markets, between and within continents. The analysis of short-term dynamics shows that within each region, there are one or two key markets influencing neighbouring markets. These key markets are Australia in the Asia-Pacific region, the U.S. in the Anglo-Saxon area, and France and the Netherlands in the EMU. Thus, focusing on these central markets is sufficient from an investor's point of view and reduces investor's efforts in analysing the international real estate markets. The finding of stable long-term relationships across real estate markets challenges the implications given by low correlation among national securitized real estate stock markets. The weak long-term linkages between national real estate markets across continents suggest that long-term oriented investors benefit from broadening their investment horizon from domestic markets while long-term benefits from diversification across markets within a continent are limited. Furthermore, the results put further question on the validity of the efficient market hypothesis for securitized real estate markets.

Das Wichtigste in Kürze

Dieser Aufsatz analysiert die kurz- und langfristigen Abhängigkeiten zwischen 14 internationalen Immobilienaktienmärkten. Während sich zahlreiche, bisherige Untersuchungen hauptsächlich auf den US-amerikanischen Immobilienmarkt konzentriert haben, erweitert die vorliegende Analyse den Untersuchungsraum und trägt durch ihre globale Ausrichtung dem gestiegenen Interesse von Investoren an Immobilienanlagen Rechnung. Im Vergleich zu vielen bisherigen Analysen berücksichtigt die Untersuchung durch die Verwendung eines von Januar 1990 bis Dezember 2008 reichenden Datensatzes nicht nur einen Zeitraum, der von einem stark wachsenden und steigenden Immobilien(-aktien-) marktumfeld geprägt war, sondern auch die Auswirkungen in Folge der seit dem Jahr 2007 anhaltenden Finanzmarktkrise.

Die empirischen Ergebnisse zeigen, dass zwischen den nationalen Immobilienaktienmärkten zahlreiche langfristig stabile Abhängigkeiten bestehen, die nicht nur zwischen Märkten eines Kontinents, sondern auch interkontinental wirken. Die Analyse der kurzfristigen Beziehungen zwischen den Märkten zeigt, dass in jeder Region ein bis zwei zentrale Märkte existieren, die ihren Einfluss auf die Nachbarmärkte ausüben, wie Australien für die asiatisch-pazifische Region, der US-amerikanische Markt für den angelsächsisch geprägten Raum sowie Frankreich und die Niederlande für die Europäische Währungsunion. Die Konzentration auf diese Märkte erscheint somit für die Investoren als ausreichend. Des Weiteren stellen die Ergebnisse langfristig stabiler Abhängigkeiten die Implikationen geringer Korrelationen zwischen den nationalen Immobilienaktienmärkten in Frage.

Auf Grund der schwächeren langfristigen Beziehungen zwischen Märkten auf unterschiedlichen Kontinenten als auf Märkten des gleichen Kontinents ergeben sich für den langfristig orientierten Anleger bei einer Ausdehnung des Anlageraumes vom nationalen Markt auf eine globale Ebene größere Diversifikationseffekte als bei einer Ausdehnung auf lediglich benachbarte Märkte. Mit Bezug auf die Hypothese effizienter Märkte liefern die Resultate weitere Belege dafür, dass deren Gültigkeit für die Immobilienaktienmärkte nicht uneingeschränkt bestätigt werden kann.

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Abstract

This paper analyses long- and short-term co-movements between 14 international real estate stock markets based on bivariate testing for cointegration and correlation analysis. The results indicate that there exist strong long-term relationships within economic and geographical regions, but less long-run linkages between real estate markets in different continents. Thus, investors would benefit from broadening their investment horizon from their domestic continent to Australia, Europe, and Northern America. Furthermore, it is shown that within each region there are one or two key markets influencing neighbouring markets like Australia in the Asia-Pacific region, the U.S. in the Anglo-Saxon area, and France and the Netherlands in the EMU. Therefore it is implied, from an investor's point of view, that it should be sufficient to focus only on these central markets. With respect to the efficient market hypothesis, the findings by cointegration analysis put some further doubt on its validity for securitized real estate markets.

Keywords: Cointegration; Correlation Analysis; Diversification; Securitized Real Estate Markets

JEL-Classification: C22; G11; G14

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1 Introduction

Over the last two decades, real estate attracted more and more investors worldwide and became a fast growing asset class, securitized real estate in particular. This trend was accompanied by the introduction of REIT legislation in several countries worldwide like in Belgium (1995), France (2003), Germany (2007), Hong Kong (2003), Italy (2007), Japan (2000), Singapore (1999), and the U.K. (2007).[1] Other countries like the U.S. and Australia have had this type of legislation or an equivalent one for a long time and represent the leading securitized real estate markets according to their market capitalization related to their GDP.

While the stock and bond markets became more and more integrated in the last decades, benefits from diversification across international stock and bond markets decreased, both in the long- and in the short-term. These stronger linkages between international stock markets prompted investors to search for different opportunities to diversify their portfolio. Beside investments in raw materials like oil, precious and industrial metals, real estate investments show low correlation with stocks and bonds and therefore, have appropriate characteristics contributing to portfolio optimization. A summary of former research on the benefits from investing in real estate is presented by Sirmans and Worzala (2003) and Worzala and Sirmans (2003). Further analyses were conducted by Steinert and Crowe (2001), Conover et al. (2002), Bond et al. (2003), Brounen and Eichholtz (2003), Lee (2005), Lee and Stevenson (2005), Waggle and Agrrawal (2006), Cheng and Roulac (2007), Idzorek et al. (2007), Jin et al. (2007), Fugazza et al. (2008), Yat-Hung et al. (2008), and Sebastian and Sturm (2009). But the vast majority of research on mixed-asset-portfolio analysis is concentrated more on the characteristics of real estate as an asset class and less on the linkages between national real estate markets and the optimal composition of a real estate portfolio.

In the relevant literature, it is well documented that asset allocation is home biased by investors and therefore available diversification benefits are eliminated. This argument is even more relevant for real estate investments since property companies operate mainly in their domestic markets. Therefore, these companies are exposed to domestic economic and political shocks and thus, their business is more influenced by local shocks than the business of internationally operating companies in other sectors like e.g. automobile or pharmaceuticals. On the other hand, these considerations raise the question on how investors in domestic real estate can benefit from broadening their investment horizon to neighbouring markets and

[1] See EPRA (2008) and Ooi et al. (2006).

other continents. Second, international investors are interested in the opportunities offered by the long- and short-term co-movements between their domestic real estate markets and the foreign ones. These two major concerns present the main points of this study. In previous research, the main focus regarding benefits from diversification across real estate markets rested mainly on the U.S. market and was based on different types of real estate (e.g. office, residential, industrial, and retail) and geographical regions within the U.S. Even though European and Asia-Pacific real estate markets have experienced fast growth and the number of listed property companies increased rapidly in the last decade, there have been very few studies showing their contribution to diversification benefits. From the international investors' perspective, the investment opportunities in Europe and in the Asia-Pacific real estate markets in particular, increased dramatically. Furthermore, the institutional framework supports this tendency with fewer trade barriers, open markets, and by introducing the REIT legislation according to the U.S. REIT framework.

In the relevant literature, the main examinations of benefits from diversification and portfolio optimization are based on correlation analysis. However, this concept is associated with some crucial points resulting in strong limitations on its meaning. First, from a technical point of view, the returns have to be normally distributed when applying correlation analysis and portfolio optimization based on the mean-variance-approach by Markowitz (1952). But as shown by Brounen et al. (2008), Liow and Sim (2006), and Liow (2007), this assumption does not hold for real estate returns. Thus, the concept of portfolio optimization based on the first two moments of a return distribution is not sufficient and investors' preferences towards skewness and kurtosis have to be taken into consideration or a different concept must be applied. Second, correlation coefficients capture only the short-term dependence between asset returns, even though investors are usually interested in long-term interrelation and linkages between prices, where cointegration analysis focuses on. Third, correlation analysis is combined with a loss of valuable information contained in time series, since correlation coefficients have to be based on stationary variables and price indices are not stationary commonly. Hence, first differences or logarithmic returns respectively, have to be used together with information on the level of the price series as this is valuable information for the long-term oriented investors. Thus, it is more appropriate to investigate the cointegration of prices rather than the correlation of returns with regards to the long-term oriented investor.

Due to these shortcomings of correlation analysis, the paper concentrates on long-term benefits from diversification across international real estate markets by applying cointegration methodology as suggested by Engle and Granger (1987). The implications of cointegration analysis on portfolio diversification depend on the type of investor assumed. Long-run oriented investors with a passive investment strategy realize their highest utility by diversifying across non-cointegrated markets as these markets share no common price trend and do not have a significant linkage between each other. Contrary to this investor type, investors following an active investment approach focus on cointegrated markets and on the modelling of the short-term error correction model, to exploit these adjustment processes for additional return. Thus, the concept of cointegration possesses its relevance for different types of investors. When comparing correlation analysis and cointegration methodology, it is worth emphasizing that these two concepts are not redundant, but complementary and supportive of each other.

The remainder of the paper is laid out as follows. Section 2 briefly discusses the methodology of testing long- and short-term real estate market interdependence. After discussing the data, the empirical findings are presented in section 4, while section 5 summarizes the central results and draws some concluding remarks.

2 Econometric Methodology

The two-stage cointegration methodology presented by Engle and Granger (1987) is employed, instead of the multivariate cointegration test developed by Johansen (1988). The analysis of each individual long-term relationship between two markets enables us to draw some conclusions on building up real estate portfolios and keeps the analogy with the concept of bivariate correlation coefficients.

2.1 Augmented Dickey-Fuller Tests

In the first step, before applying cointegration analysis, the order of integration of each time series Y is tested or in other words, it is necessary to test whether each time series requires the same degree of differencing to achieve stationarity. In this paper the order of integration of a time series is determined by applying different approaches of the Augmented Dickey-Fuller t-tests (ADF).[2] The ADF-values are calculated by estimating regression equations for a random walk, a random walk with drift, and a random walk with drift and trend, respectively:

[2] See Dickey and Fuller (1981) and Said and Dickey (1984).

$$\Delta Y_t = \gamma Y_{t-1} + \sum_{i=1}^{p-1} \beta_i \Delta Y_{t-i} + \varepsilon_t , \tag{1}$$

$$\Delta Y_t = \mu + \gamma Y_{t-1} + \sum_{i=1}^{p-1} \beta_i \Delta Y_{t-i} + \varepsilon_t , \tag{2}$$

$$\Delta Y_t = \mu + \lambda t + \gamma Y_{t-1} + \sum_{i=1}^{p-1} \beta_i \Delta Y_{t-i} + \varepsilon_t , \tag{3}$$

where μ and λ are coefficients of the constant, and the time trend respectively, β_i are coefficients of the ith order lagged differenced series (ΔY_{t-i}) and the error term $\varepsilon_t \sim$ i.i.d. $(0,\sigma^2)$. If γ is equal to zero, the time series Y_t is said to have a unit root and to be nonstationary, whereas the time series of ΔY_t is stationary, I(1). The time series Y_t is stationary and integrated of order zero, I(0), if the null-hypothesis, that γ equals zero is rejected.

In contrast to the Dickey-Fuller test,[3] the ADF-test solves the problem of autocorrelation in the residuals by incorporating a sufficient number of lagged changes of the dependent variable in the regression equation.

2.2 Engle-Granger-Test for Cointegration

While the concept of correlation refers to the co-movement in asset returns, cointegration is related to asset prices and their linkages. Two time series are said to be cointegrated and are characterized by mean-reversion if they share a common stochastic trend. The procedure by Engle and Granger (1987) tests the null hypothesis of no cointegration against the alternative of cointegration and consists of two steps. First, the two nonstationary time series Y_{1t} and Y_{2t} are regressed on each other to obtain the residuals from ordinary least square regression:

$$Y_{2t} = \alpha + \beta Y_{1t} + \varepsilon_t \tag{4}$$

In the second step, these residuals ε_t are tested for unit root characteristics by employing the ADF-test again. Since the residuals are no observed values, but estimated from the OLS regression, the estimated critical values K for the test statistic according to MacKinnon (1991) are applied:

$$K = \beta_\infty + \beta_1 Z^{-1} + \beta_2 Z^{-2} \tag{5}$$

[3] See Dickey and Fuller (1979).

where Z denotes the sample size and the βs are the parameters to be estimated and tabulated in MacKinnon (1991), depending on the level of significance and the ADF-test specification. Technically, the two time series are said to be cointegrated, if they are integrated of the same order and the residuals from the OLS regression are stationary in levels and integrated of order zero respectively.

2.3 Error Correction Model

Furthermore, if two time series share a common stochastic trend and are said to be cointegrated, an error correction model (ECM) can be estimated (Granger representation theorem) and specified, delivering further insight into the linkage between the two time series and their co-movement over time. The estimation is based on stationary time series and thus, the logarithmic return series are used:

$$\Delta Y_{1t} = \gamma_1 + \lambda_1 \cdot \varepsilon_{t-1} + \sum_{i=1}^{m} \alpha_{11}(i) \cdot \Delta Y_{1t-i} + \sum_{j=1}^{n} \alpha_{12}(j) \cdot \Delta Y_{2t-j} + u_{1t}, \qquad (6)$$

$$\Delta Y_{2t} = \gamma_2 + \lambda_2 \cdot \varepsilon_{t-1} + \sum_{i=1}^{m} \alpha_{21}(i) \cdot \Delta Y_{1t-i} + \sum_{j=1}^{n} \alpha_{22}(j) \cdot \Delta Y_{2t-j} + u_{2t}, \qquad (7)$$

where γ_1 and γ_2 are coefficients of the constant, $\varepsilon_{t-1} = Y_{2t-1} - \alpha - \beta\, Y_{1t-1}$ from equation (4), and α_{11}, α_{12}, α_{21}, and α_{22} represent coefficients measuring the impact of the lagged returns on the current return of series Y_{1t} and Y_{2t} respectively. The coefficients λ_1 and λ_2 are mainly describing the error correction process.

By implementing lagged returns in the ECM, which is also estimated by using OLS regression, the short-term relationship and linkages between time series are detected (e.g. analyzing whether the lagged returns from series Y_{1t} influence the returns of series Y_{2t} and/or vice versa). Additionally, by adding the stationary residuals from the cointegration equation, the adjustment process to the common stochastic trend is analysed. While ε_{t-1} indicates how far the system drifted apart from the common long-term path of equilibrium, the sign and the magnitude of the coefficients λ_1 and λ_2 from the regression indicate which time series adjusts to the common trend and how fast the adjustment process takes place. If $\lambda_1 > 0$ ($\lambda_2 < 0$) and is significant, then a deviation from the common stochastic trend is at least partially corrected by the series Y_{1t} (Y_{2t}). The higher the absolute value of the coefficients is, the faster the adjustment process takes place.

3 Data and Descriptive Statistics

The empirical analysis in this paper is based on the monthly indices from the European Public Real Estate Association (EPRA) and the National Association of Real Estate Investment Trusts (NAREIT) between January 1990 and December 2008. The study covers the following 14 national real estate stock markets: Australia (AU), Belgium (BE), Canada (CA), France (FR), Germany (DE), Great Britain (GB), Hong Kong (HK), Italy (IT), Japan (JP), the Netherlands (NL), Singapore (SG), Sweden (SE), Switzerland (CH), and the United States (US). The time series contains 228 monthly data for each market. Due to the lack of data, the analysis of the Canadian market is based on 144 monthly returns between 1997 and 2008 only. To our knowledge, it is the most comprehensive analysis of international cointegration in securitized real estate markets. Sample statistics are calculated in market values based on local currency to focus on real estate factors and to avoid distortions caused by changes in exchange rates. The real estate indices are calculated in natural logarithms, whereas the monthly rates of return are calculated on the first differences of the logarithmic monthly index levels. The national real estate indices are delivered by the same index provider (EPRA/NAREIT) with respect to potential differences between index construction and index criteria, when using different index providers. The time span from 1990 to 2008 is given by the availability of data.

Figure 1 and Figure 2 present the logarithms of the level of the indices. Depicted in Figure 1, the Anglo-Saxon real estate markets (Australia, Canada, the U.K., and the U.S.) show a continuous upward trend from the beginning of the 1990s until mid of 2007. In contrast, the Asian markets are characterized by a much more volatile performance but they seem to have a common trend and move together which is in support of applying cointegration analysis. The performance of the Continental European real estate markets is mixed as well. While the markets moved within a range in the 1990s with the exception of the small Swedish market, this pattern changed in the second half of the period investigated. From a graphical point of view, the markets can be divided into two groups with one outlier (Germany). First, the Belgian and Swiss market move close in line with each other, whereas the economic motivation is not obvious. The second group consists of the securitized real estate markets in France, Italy, the Netherlands, and Sweden. These markets show a strong common upward trend until the first half of 2007 followed by a downward movement in the second half of 2007 and 2008. These markets are members of the European Union and are subject to the monetary policy of the European Central Bank with the exception of Sweden. Related to the performance of the real estate markets, a different story applies to the German market, which is characterized by high volatility and poor performance. From all the European markets, the German market suffered the most from the burst of the high-tech-bubble at the beginning of the 21st century. Afterwards, it was accompanied by a huge upward movement until January 2007, while the period after has been dominated by a downward movement, which suggested a close link to the common stock markets. The reasons are manifold. First, the German securitized real estate stock market is small compared to the Dutch and French ones and thus, it might be more closely related to influences from the common stock market. Second, only few listed property companies are dominating the market. Therefore, company specific events have greater consequences to index changes and trends. And third, the German direct (residential) real estate market did not take part in the tremendous international growth and appreciation from the last decade like e.g. the markets in Ireland, Spain, the U.K., and the U.S. This last point is relevant, as real estate companies invest mainly in their domestic market and less in foreign markets. Thus, their performance is highly related to the performance of the national real estate market in the long-run.[4]

From Figure 1 and Figure 2 it is also evident, that the Asian markets followed a common downward trend in the aftermath of the Asian and Russian crisis in 1997 and 1998, which was more extended than the one for the non-Asian markets. A more common development on the international real estate stock markets is shown in the aftermath of the turmoils at the international financial markets starting in June 2007, when Bear Stearns announced serious problems regarding their hedge funds. 13 out of the 14 securitized real estate markets have had their highest index level between December 2006 and June 2007, while the markets in the U.K. and the U.S. first reached their turning point prior to other markets. This finding is a first indication of a potential leading function of these two markets, with the U.S. market in particular. The exception from this trend is the market in Hong Kong, which did not reach its highest index level until November 2007. This special performance might be related to changes in the tax legislation and trading opportunities in Chinese stocks for foreign investors, impacting this way the whole stock market in Hong Kong. Thus, this unique behaviour of the market in Hong Kong it is not driven by factors and events in the direct or indirect real estate market of Hong Kong.

[4] See Fuess et al. (2008).

Figure 1: Price Series of the Non-Continental European Country Indices

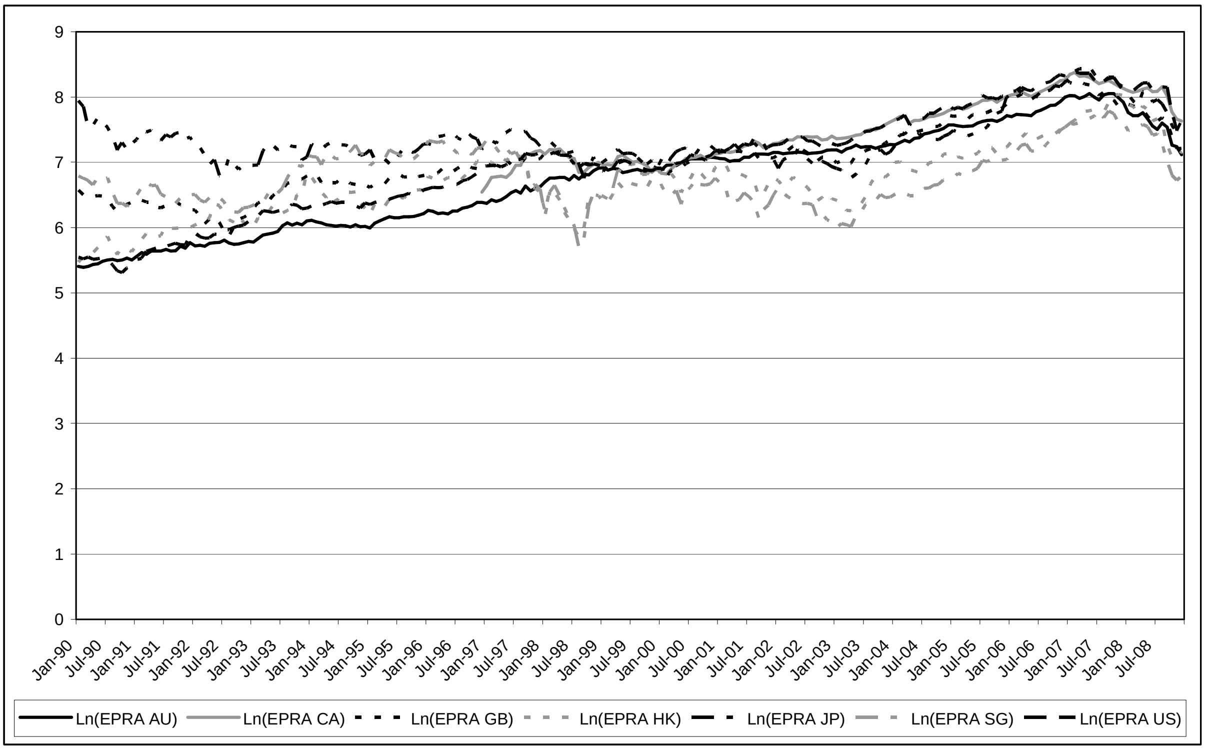

Figure 2: Price Series of the Continental European Country Indices

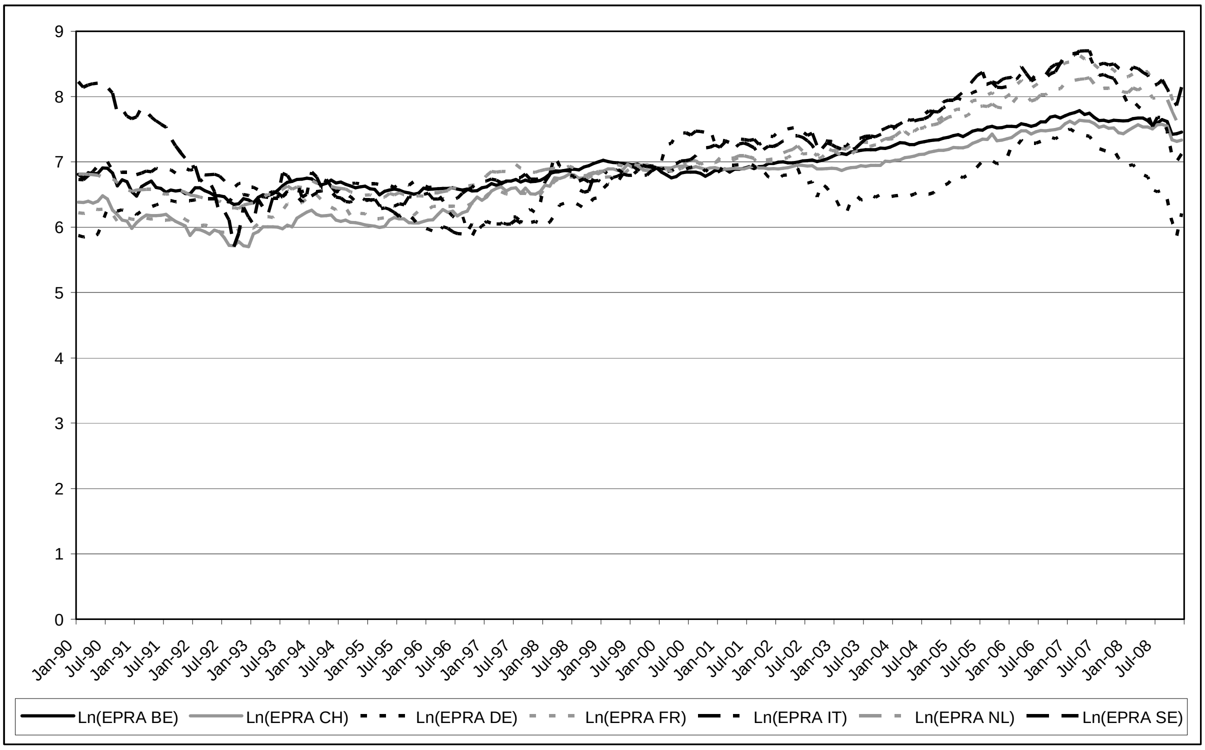

Table 1: Descriptive Statistics of the EPRA Country Indices

Index	Mean	Min.	Max.	S.D.	Skewness (z-stat.)	Kurtosis (z-stat.)	J.-B.
AU	0.0076	-0.2751	0.1060	0.0414	-1.8048 (11.2724)	12.7786 (31.2278)	1,032.1810***
BE	0.0026	-0.1985	0.1464	0.0408	-1.0535 (6.5799)	8.0235 (16.0829)	281.9085***
CA	0.0076	-0.2525	0.1685	0.0543	-1.1289 (5.6463)	7.5947 (11.9599)	157.2501***
CH	0.0040	-0.2112	0.1951	0.0482	-0.3264 (2.0387)	6.1851 (10.2278)	100.4243***
DE	0.0013	-0.3451	0.3452	0.0751	-0.2665 (1.6647)	7.7571 (15.2345)	217.6834***
FR	0.0074	-0.2308	0.1298	0.0468	-0.8630 (5.3900)	5.7446 (8.8247)	99.8594***
GB	0.0025	-0.2517	0.1498	0.0565	-0.6440 (4.0222)	4.3218 (4.2933)	32.3567***
HK	0.0073	-0.4406	0.4498	0.1023	-0.0439 (0.2745)	6.0533 (9.8082)	88.6413***
IT	0.0018	-0.3712	0.3420	0.0807	-0.0287 (0.1793)	6.7254 (11.9487)	131.8795***
JP	-0.0024	-0.3174	0.2299	0.0891	-0.1737 (1.0849)	3.3727 (1.2706)	2.4664
NL	0.0036	-0.1808	0.0967	0.0405	-0.7516 (4.6941)	5.3142 (7.4542)	72.3430***
SE	-0.0005	-0.4064	0.3978	0.0964	0.2732 (1.7062)	7.9066 (15.7105)	231.5416***
SG	0.0007	-0.3899	0.4844	0.1090	-0.2339 (1.4611)	5.8490 (9.1572)	79.1868***
US	0.0090	-0.3886	0.1581	0.0548	-2.3493 (14.6732)	17.1341 (45.0995)	2,107.5510***

Notes:

Min. and Max. are the minimum and maximum monthly return, whereas S.D. is the standard deviation of the return distribution of the national real estate stock indices. ***, ** and * indicate the rejection of the null hypothesis of the Jarque-Bera test statistic (J.-B.) for normality at the 1 %-, 5 %- and 10 %-level of significance. The test results of statistical significance from zero, for skewness coefficients, and from three, for the kurtosis coefficients, are reported in parentheses. The critical values for the coefficient test at 1 %-, 5 %-, and 10 %-level of significance are 2.58, 1.96, and 1.65.

For the period under consideration, Table 1 gives an overview of the return and risk characteristics of the 14 national real estate stock indices. As it can be seen, the performance of the countries' securitized real estate markets is very heterogeneous and differs substantially between national markets. While the U.S. have an average monthly return of 0.90 % and Australia, Canada, France, and Hong Kong of around 0.75 % respectively, the Japanese and the Swedish market have a slightly negative monthly average return of around -0.24 % and -0.05 % only. The three countries with the highest average returns (Australia, Canada, and the

U.S.) are the countries with the longest history in REIT legislation. Furthermore, with the exception of Hong Kong, the well-performing countries are characterized by relatively low standard deviations resulting in the highest Sharpe-ratios for the real estate markets in Australia, Canada, France, and the U.S. But there has to be made one point in defence of the high volatility in the Asian markets. The Asian securitized real estate markets are dominated by property developers and construction activities. Therefore, the cash flows of their business and consequently the equity returns are more volatile in contrast to REITs and other property companies, where rental investments dominate.[5]

However, it is reasonable to evaluate the attractiveness of the markets by their Sharpe-ratios solely based on the first and second moment of the return distribution only, when the observed returns are normally distributed or investors' utility functions are quadratic. However, according to the test statistics of the Jarque-Bera normality test, the null hypothesis of normally distributed returns is rejected for 13 out of 14 national indices at the 1 %-level of significance.[6] Only the Japanese real estate market has normally distributed returns. The third and fourth moment emphasize these findings. With the exception of the Japanese market, the return distributions are leptokurtic and negative skewness dominates. Due to the results above, the use of standard deviation as a measure of risk may result in distortions of the true performance. The z-values, in parentheses in Table 1, specify whether the deviation from normality is attributed to the third and/or the fourth moment of the return distribution. Using the testing method suggested by Urzúa (1996), the findings indicate that for Australia, Belgium, Canada, France, Great Britain, the Netherlands, and the U.S. both higher moments are responsible for the significant non-normality. For all other non-normally distributed indices, kurtosis alone determines the rejection of normality. Thus, low correlation coefficients can be in support of pervasive diversification benefits, but portfolio optimization and investment decisions based on them are of restricted relevance. Furthermore, the findings show that the characteristic of non-normally distributed returns is not only typical for low-capitalized and developing securitized real estate markets like the Belgian, German or Italian market, but also for the high-capitalized markets with a long history like the Anglo-Saxon markets, where the Australian and US-market show extremely high negative skewness and leptokurtosis.

[5] See Newell and Chau (1996), Liow (1997), and Hoesli and Serrano (2008) as well.
[6] See Brounen et al. (2008), Liow (2007), and Liow and Sim (2006) as well.

4 Empirical Results

The presentation of the empirical findings is divided into two parts. First, the correlation structure is considered despite its mentioned limitations. In the second part, the examination focuses on the long-term relationships between the real estate markets and their implications for diversification and investors' investment opportunities.

4.1 Correlation Analysis

The return correlation coefficients between the 14 real estate market indices are displayed in Table 2. All correlation coefficients are positive and in a range between 0.16 (Hong Kong/Italy) and 0.55 (Australia/Canada) with four exceptions. Thus, they are very low compared to correlations between common stock markets and indicate pervasive benefits from diversification across national borders and continents, even if the correlation coefficients increased in the last two years in consequence of the international financial crisis. The relatively low correlation between real estate markets could be due to the national orientation of the vast majority of publicly listed property companies. Thus, this sector is not submitted to global events and shocks as much as banking companies or mainly exporting firms are. From an investors' perspective, the focus on international diversification is even more important when investing in real estate stocks than in broad stock markets.

The highest dependencies exist between markets strongly connected both geographically and economically. In the Asia-Pacific region, these are the real estate markets in Hong Kong and Singapore with the highest pairwise correlation coefficient of 0.73. The two well-integrated markets in Northern America show the second highest correlation of 0.69, whereas the largest securitized real estate markets in Europe show relatively high correlation with 0.66, between the two continental European markets of France and the Netherlands and with 0.58, between France and the U.K. respectively. The lowest correlation can be found when considering the relationship of real estate markets located in different continents. Therefore, the findings suggest that real estate investors gain more benefits from diversification when diversifying across continents than across markets within one continent.

But there are some limitations in the validity of the suggested results. Since correlation analysis is only valid for stationary variables, the prices have to be de-trended by calculating first differences. However, this procedure vanishes valuable information regarding the detection of common trends in prices. While correlation is an appropriate and highly used measure of short-term co-movements, it is not assured by low correlation coefficients that there are low long-term co-movements as well and vice versa. Thus, the further examinations of this paper focus on long-term linkages between the price series of the 14 real estate indices and the dynamic interactions between these markets.

Table 2: Return Correlation Coefficients between the EPRA Country Indices

	AU	BE	CA	CH	DE	FR	GB	HK	IT	JP	NL	SE	SG	US
AU	1.0000													
BE	0.3722	1.0000												
CA	0.5548	0.4684	1.0000											
CH	0.2661	0.4057	0.4029	1.0000										
DE	0.2206	0.2730	0.3176	0.2453	1.0000									
FR	0.4264	0.4997	0.5027	0.4655	0.4218	1.0000								
GB	0.3465	0.4106	0.4888	0.4053	0.3853	0.5821	1.0000							
HK	0.2881	0.2080	0.3477	0.2524	0.2058	0.2527	0.2814	1.0000						
IT	0.3950	0.3204	0.4326	0.4180	0.4556	0.4639	0.3867	0.1567	1.0000					
JP	0.2363	0.1640	0.4134	0.1771	0.1447	0.3512	0.2385	0.1658	0.2188	1.0000				
NL	0.4406	0.4432	0.5002	0.4609	0.4283	0.6579	0.5021	0.2862	0.4487	0.3153	1.0000			
SE	0.2604	0.4305	0.3979	0.2387	0.2190	0.4857	0.3688	0.2078	0.3028	0.2566	0.3983	1.0000		
SG	0.2939	0.2697	0.4387	0.2410	0.2612	0.3113	0.3193	0.7287	0.2654	0.2330	0.3658	0.2623	1.0000	
US	0.4315	0.3302	0.6860	0.3147	0.3684	0.4580	0.5024	0.2777	0.3728	0.2880	0.4775	0.2754	0.3320	1.0000

4.2 Unit Root Test of Prices and Returns

As described above, stationarity tests are conducted by applying the Augmented Dickey-Fuller (ADF) unit root test to levels and first differences. ADF-values are calculated by estimating regression equations of three types of specification: a random walk (ADF), a random walk with drift (ADF_C), and a random walk with drift and trend (ADF_T), respectively. The relevant literature suggests different procedures to determine the lag length and the ADF-test.

In principle, there exist two ways on how to determine the adequate lag length. In one procedure, the optimal lag length is found by successively adding one additional lag until a significant lag is found. It is shown by Monte Carlo studies that this procedure is biased in its specification selection. Alternatively, the determination process can be started with a relatively long lag length and the model is pared down until a significant lag is identified as proposed by Ng and Perron (1995) and Enders (2004). In this study, the latter approach is used by starting with a lag length of 10 as the initial value. If the t-statistics are insignificant for all lags at the 10 per cent level of significance, the equations are re-estimated and the results are tested on 20 per cent level. The right ADF-test is chosen by minimizing Akaike information criterion or the Schwarz criterion. Additionally, the testing procedure by Phillips and Perron (1988) is conducted, confirming the stationarity of the first differences of logarithmic prices in 13 out of 14 indices.

As displayed in Table 3, the findings of the unit root tests are consistent for all 14 real estate indices with the exception of the Swedish real estate stock market. The null hypothesis of a unit root can not be rejected for the logarithmic prices. Thus, the indices are not I (0) at the 5 per cent significance level at least and not stationary in levels respectively. However, the first differences do not exhibit a unit root at the 5 per cent level and are stationary. The preferred specification of the ADF-test is the model without a constant and a trend. A different picture results for the Swedish securitized real estate market index. The ADF-test in logarithmic prices rejects the null hypothesis of a unit root at the 5 per cent level of significance and thus, states stationarity in levels and not in first differences. Hence, due to the different degree of integration compared to the indices of the other national real estate indices, the Swedish market is excluded from further examinations and the cointegration analysis.

Table 3: Unit Root Test of Prices and Returns

Indices	**Unit Root Test in ln (prices)**			**Unit Root Test in Δ ln (prices)**			**Integration Level**
	ADF_T	ADF_C	ADF	ADF_T	ADF_C	ADF	
AU		-1.7704 (10)				-2.7579*** (4)	I (1)
BE	-2.7454 (10)					-3.4940*** (9)	I (1)
CA			0.3144 (7)			-3.1270*** (6)	I (1)
CH			1.3795 (10)			-3.9615*** (9)	I (1)
DE		-2.5159 (6)				-12.7766*** (0)	I (1)
FR	-2.7378 (6)					-2,8584*** (10)	I (1)
GB		-1.6022 (5)				-4.2536*** (4)	I (1)
HK	-3.0220 (7)					-4.0434*** (10)	I (1)
IT			-0.0967 (9)			-3.5122*** (8)	I (1)
JP	-2.9232 (0)					-14.3145*** (0)	I (1)
NL	-2.6736 (5)					-4.6103*** (4)	I (1)
SE	-3.5185** (3)			-7.2598*** (2)			I (0)
SG		-2.7960* (8)				-4.5023*** (10)	I (1)
US		-1.7722 (2)				-2.2300** (10)	I (1)

Notes:

***, ** and * indicate the rejection of the null hypothesis of a unit root at the 1 %-, 5 %- and 10 %-level of significance. The lag lengths for unit root tests of prices and returns are given in parentheses.

4.3 Unit Root Test for Cointegration Residuals

Following the results of the unit root tests, all real estate markets – with the exception of the Swedish one – are integrated of the same order being essential for estimating the cointegration vectors. As described above, the first step of the pairwise cointegration test proposed by Engle and Granger (1987) implies the estimation of the ordinary least square (OLS) regression of logarithmic real estate market indices. In the second step of the two-stage procedure, the residuals from the OLS regression are subjected to the unit root test. From a theoretical point of view, there should not be any difference in the testimony on cointegration when Y_{2t} is regressed on Y_{1t} instead of the regression of Y_{1t} on Y_{2t}. However, it is documented in the relevant literature that differences emerge when using empirical data. Therefore, 156 regressions are estimated instead of 78 ones.

The methodology chosen for the unit root test of the residuals from the OLS regression is equivalent to the one described above with one exception. Instead of using the critical values of MacKinnon (1996), the critical values of MacKinnon (1991) are applied. The rejection of the null hypothesis of a unit root of the residuals indicates that the two time series are cointegrated.

For 30 out of 156 residual series, the null hypothesis of a unit root is rejected by the ADF-test at least at the 10 per cent level of significance and thus, these real estate markets share a common stochastic trend and are said to be cointegrated. While for nine relationships this result is independent of the endogenous and exogenous variable, the modelling matters for twelve pairs of real estate markets. Table 4 is summarizing the unit root tests for the cointegrated real estate market indices.

Table 4: Results for Bivariate Cointegration between Real Estate Markets

Indices		**Unit root tests in regression residuals**	
Endogenous variable	Exogenous variable	ADF_T	ADF_C
CH	AU	-4.0540** (6)	
AU	CH	-3.7619* (6)	
FR	BE		-3.7980** (10)
BE	FR		-3.7160** (10)
HK	BE		-3.9727*** (10)
BE	HK	-3.8274** (10)	
NL	BE		-4.0560*** (10)
BE	NL		-4.0231*** (10)
NL	CA	-4.2359** (7)	
CA	NL		-4.2126*** (7)
US	CA		-4.7553*** (5)
CA	US	-5.1299*** (5)	
US	CH	-3.6360* (6)	
CH	US	-3.8746** (6)	
HK	GB		-3.7181** (8)
GB	HK	-3.5773* (8)	
US	GB		-4.0159*** (9)
GB	US		-3.9220** (9)
HK	AU		-3.1274* (8)
CA	BE		-3.1620* (3)
HK	CA		-3.2648* (6)
HK	CH		-3.1457* (7)
HK	FR		-3.2724* (7)
JP	FR		-3.2991* (0)
AU	JP		-3.1354* (0)
HK	JP		-3.3769** (5)
HK	NL		-3.3658** (7)
JP	NL		-3.2596* (0)
JP	SG	-3.9869** (0)	
HK	US		-3.4560** (8)

Notes:

Approximate critical values for ADF-tests are based on MacKinnon (1991). ***, ** and * indicate the rejection of the null hypothesis of a unit root at the 1 %-, 5 %- and 10 %-level of significance. The lag lengths for unit root test of the regression residuals are given in parentheses.

While correlation analysis indicates pervasive benefits from diversification across securitized national real estate markets, the conclusions from cointegration analysis are different. During the period investigated, there are long-term interdependences between eleven national real estate markets, narrowing the benefits from international diversification. The German and Italian real estate stock markets are the unique ones, sharing no common stochastic trend with any other market and therefore investors from these markets can gain substantial benefits from broadening their investment horizon to other markets, both intra- and intercontinental.

On the other hand, international investors looking for long-run diversification opportunities might be attracted by these markets. But there is one substantial shortcoming of these two markets. Both of them are low capitalized and dominated by a few listed property companies limiting the attractiveness and investability extensively. With respect to the eleven remaining securitized real estate markets, the Swiss and Belgian market are very small, low capitalized, dominated by a small number of listed property companies, and characterized by a thin trading volume. Thus, both markets are afflicted by the same limitations as the German and Italian one. But as shown below, neither the Belgian nor the Swiss market play a key role or have any market influencing position. Rather they mainly adjust to the changes and trends of large and well-functioning markets like the Dutch, French, and the U.S. market.

Considering the Asia-Pacific markets, the Japanese market shows cointegration relationships with all three markets within this region, namely Australia, Hong Kong, and Singapore. However there is only one further long-run relationship between the Australian market and the one in Hong Kong. From Table 4 it is also apparent, that the cointegration relationship between Australia and the Asian markets is weaker than between the Asian markets. This result from the ADF-test is in line with the economic motivation that the Australian economy in total and the securitized real estate market in particular are more developed, were not so much affected by the Asian and Russian crisis in the late 1990s like Hong Kong and Singapore, and show a more stable performance in the last 20 years. Considering the Japanese market, it has to be remembered that the Japanese economy and its stock market suffered from deflation, decreasing house and stock prices and slow economic growth. These factors resulted in a huge budget deficit and an unstable banking system with highly indebted banking and insurance companies during the last 20 years. Hence, the Japanese market cannot be compared to the Australian situation in the last 20 years. In spite of these facts, the long-term benefits from diversification across Asian real estate markets are limited for the long-term oriented investors with passive investment strategies. These results of strong long-run equilibrium relationships among the Asian real estate markets are in contrast with the findings by Liow et al. (2005), stating no cointegrating relationships among the four Asian property stock indices of Hong Kong, Japan, Malaysia, and Singapore. Using Engle-Granger-test for cointegration, Garvey et al. (2001) identify only one long-term relationship between the real estate markets of Australia and Singapore during the period from 1993 to 2001, but no further cointegrating relationship between Australia, Hong Kong, Japan, and Singapore.

Focusing on intercontinental linkages between Asia-Pacific and European or Northern American real estate markets, there exist only three weak long-term relationships with the exception of the real estate market in Hong Kong. The Japanese market is cointegrated with the two largest real estate markets in continental Europe, France and the Netherlands. For Australia's real estate market, a cointegration relationship with the Swiss market is identified, whereas the linkage to the Swiss market is almost negligible for investors due to the reasons mentioned above. Only the market in Hong Kong is characterized by several long-term relationships to both the European and Northern American real estate markets. However, as it will be discussed later on, the relationship is mainly not dominated by Hong Kong.

Summarizing, in line with the findings of correlation analysis and with some limitations regarding Hong Kong, investors located in Asia can benefit from broadening their investment horizon to Australia, Europe, and Northern America. For international investors, considering real estate investments in the Asia-Pacific region, the Australian market is probably the most attractive one due to its low risk, low correlation and no strong long-term relationships with the international markets. Through Hong Kong's close link to the Chinese market, investors could benefit from China's fast growing economy connected with a booming construction sector and large infrastructure projects as well as through investments in Hong Kong's real estate stock market.

In contrast to the findings in the Asia-Pacific area, much stronger long-term relationships are identified among the Anglo-Saxon markets, namely Canada, the U.K., and the U.S. The latter one is cointegrated with both of the other markets. Additionally, the U.S. market shows a cointegration relationship with the Swiss real estate market giving an interesting feature to the Swiss market. While there is no cointegration with any other market in Europe, the Swiss real estate market is linked with the market in Australia, Hong Kong, and the U.S. reflecting the distance to the European Monetary Union (EMU). The U.K. real estate market shows a similar picture. In contrast, Canada is more closely connected to the EMU via sharing long-term linkages to the Dutch and Belgian real estate markets, additionally supported by correlation coefficient of around 0.50 between the Canadian market and the markets in Belgium, France, and the Netherlands.

The Dutch market could be counted to the Anglo-Saxon oriented markets as well, even if the categorization is not that obvious. On one hand, the Netherlands are a member of the European Monetary Union, being historically and geographically linked to Continental Europe. But on the other hand, the Dutch financial market is affected by the Anglo-Saxon system, to which it is also quite similar, being based more on financial markets, the so called market-oriented system. Related to its economic size, the Dutch stock market is highly capitalized and securitized real estate markets have a longer history than in Germany or France, whose financial system is built on a bank-oriented system. Therefore, the Netherlands are somewhere between the typical Anglo-Saxon and continental Europe markets, which is also apparent when considering correlation coefficients and the findings of cointegration analysis. With the exception of the three Asian and the Swedish real estate market, correlation coefficients for the Dutch market are higher than 0.40. Considering the results from cointegration analysis, long-term relationships with Canada and to the neighbouring market in Belgium are found, as mentioned above. The results for the French market show the same tendency. Pairwise correlations are higher than 0.40 with the exception of the Asian markets again, and cointegration with the Belgian market is found as well. On the other hand, no such linkage is found to the Anglo-Saxon market, which does not come as a surprise when considering the historical background of the financial system in France.

In summary, the compatibility of the results on correlation and cointegration analysis is mixed and to some extent supportive of each other even when it is worth emphasizing that both analyses are not redundant, they focus on different time horizons, and are based on different assumptions. The results suggest that intracontinental diversification is less beneficial for investors than intercontinental diversification. But the previous examinations are afflicted with a lack of regarding causality between the national real estate markets.

4.4 Short-term Relationship According to the Error Correction Model

While cointegration methodology presents a concept of modelling long-term relationships, nothing has been said about the short-term behaviour of cointegrated markets until this point. In general, cointegrated markets share a common stochastic trend, but both markets fluctuate around this common trend and are not exactly on their long-term path at each point in time. From an investors' perspective, it is of interest how and by which market the adjustment takes place, when one or both markets moved away from the long-term path of equilibrium. This procedure is often modelled by an error correction model (ECM) indicating the direction and rate of adjustment. In this paper, the analysis is conducted by the ECM-framework presented above. The ECM is estimated by OLS regression with stationary variables including an intercept term, the lagged residuals from the cointegration equation and the lagged returns of both cointegrated markets up to six month as exogenous variables and the actual return as endogenous variable. The model is re-specified until significant coefficients for the lagged returns are left only.

The magnitude and the sign of the regression coefficient of the residuals from cointegration equation are of special interest and indicate the rate and direction of adjustment as presented in Table 5.[7] The results are not uniform, but mixed. For one-side cointegration relationships (between Canada and the Netherlands), the deviation from the common long-term stochastic trend is revised through the impact of both markets. The coefficients have the "right" sign and they are significant. It is also shown, that the magnitude of the coefficients is almost identical, independent on how the regression is run. Furthermore, the adjustment process takes place very fast compared to the other adjustment processes specified. Additionally, there are five further stable long-term relationships, where the estimation of the error correction model results in two significant adjustment coefficients. While the sign of the coefficient is "right" in the sense that both market contribute to stabilize the process between Hong Kong and Switzerland and Hong Kong and Japan respectively, the other three error correction models (Australia/Hong Kong, France/Japan, and Switzerland/U.S.) do not indicate stabilizing processes. Whereas it has to be mentioned, that the coefficients responsible for destabilizing are not highly significant and the value of the coefficients is small in magnitude, compared to the adjustment coefficient of the other market. For all the other cointegrated securitized real estate markets, the adjustment process is driven by one market only, but the rate of adjustment varies tremendously between the individual pairwise error correction models. While the adjustment coefficient is estimated with 0.23 for the ECM between Canada and the U.S., this coefficient is only one tenth between Australia and Japan. The relative high value of 0.23 means that almost one fourth of the deviation from the long-term common stochastic trend is adjusted within one period. An effect of similar magnitude is observed for the relationship between the Canadian and Dutch real estate markets, by adding up the absolute values of the two coefficients (0.1214 and 0.1039). For all the other linkages, the adjustment process works much slower. Referring to Table 5, the average adjustment process takes place faster for these cointegration relationships, where the cointegration residuals are stationary independent of the regression specification. This finding qualifies the empirical evidence mentioned above regarding the properties of stationarity of the cointegration residuals.

From an economic point of view, the findings when applying cointegration analysis and ECM(s) are in line with the assumption and the empirical evidence for common stock markets, according to which transmission and causality move from the most developed and high capitalized markets to the smaller ones. This issue is well shown for the relationship

[7] With respect to a clear layout the adjustment coefficient is presented only. The model specification is available from the author upon request.

between the two neighbouring markets of France and Belgium and Canada and the U.S. respectively, but also for the majority of the other relationships e.g. like Australia and Switzerland or the U.K. and the U.S. To give further evidence on the direction of causation, Ganger causality tests are conducted. The findings support the results from cointegration analysis and error correction modelling from above.

Table 5: Direction and Rate of Short-Term Adjustments between Cointegrated Markets

Indices		**Adjustment coefficient of the ECM for**	
Endogenous variable	Exogenous variable	Endogenous variable	Exogenous variable
CH	AU	-0.1020***	-0.0177
AU	CH	0.0035	0.0819***
FR	BE	-0.0020	0.0741***
BE	FR	-0.1490***	-0.0016
HK	BE	-0.0596***	0.0057
BE	HK	-0.0101	0.0578**
NL	BE	-0.0136	0.0890***
BE	NL	-0.1362***	0.0051
NL	CA	-0.1035**	0.1054**
CA	NL	-0.1214**	0.1039**
US	CA	-0.1180	0.2061***
CA	US	-0.2265***	0.1106
US	CH	0.0116	0.0531***
CH	US	-0.0672***	-0.0304*
HK	GB	-0.0961***	-0.0006
GB	HK	-0.0098	0.0778***
US	GB	-0.0082	0.0309*
GB	US	-0.0513**	-0.0006
HK	AU	-0.0715***	-0.0157*
CA	BE	-0.0402	0.0493**
HK	CA	-0.0721**	0.0184
HK	CH	-0.0548***	0.0204*
HK	FR	-0.0800***	-0.0015
JP	FR	-0.0557***	-0.0247**
AU	JP	-0.0047	0.0230***
HK	JP	-0.0419***	0.0418***
HK	NL	-0.0661***	0.0103
JP	NL	-0.0748***	-0.0170
JP	SG	-0.0554**	0.0247
HK	US	-0.0874***	0.0000

Notes:

***, ** and * indicate for significance of the coefficient from OLS regression at the 99 %-, 95 %- and 90 %-confidence level.

The estimation results from the error correction model bear implications for the hypothesis of market efficiency and feasible trading strategies. With respect to the definition of the weak form of market efficiency by Fama (1970 and 1991), the existence of cointegration relationships and Granger causality rejects the hypothesis of market efficiency, because there are lagged linkages between markets. Simultaneously, the findings raise the question if and how investor's can benefit from this type of inefficiency. For the investors' type using active trading strategies, the deviations from the stable common long-term trend can be exploited in two ways depending on the market situation. First, when the responding market is above its correct level according to the cointegration relationship, it is attractive to sell this market. On the other hand, when the responding market is below its theoretically expected level, this market should be bought. The analogous thoughts apply when both markets are responding. Then, one market should be bought and the other one should be sold to exploit the deviations from the common equilibrium. Subject to the estimated adjustment coefficients, these effects are highly pronounced for the cointegration relationships and the corresponding ECMs between the real estate markets in Canada and the U.S. and the markets in Belgium and France respectively. With respect to the extension of the adjustment process, similar effects are exploitable based on the markets of Canada and the Netherlands, where the sum of the two significant coefficients in absolute terms (0.1214 and 0.1039 respectively) adds up to 0.2253 and thus, the effect is equivalent to the one between Canada and the U.S. The arising question, whether these effects are exploitable regarding trading strategies and after trading cost, is not the focus of this paper and therefore will be left for further research.

5 Conclusion

In the relevant literature, authors often argue that diversification benefits are driven by country factors, broadening therefore the investment horizon from a domestic to a more global perspective. This improves the mean-variance-characteristics of a portfolio by an upward shift of the efficient frontier. The achievement of these beneficial return-risk-characteristics is often based on a concept through which, risk reduction is measured by correlation and covariance structures between the returns of different assets or markets. However, correlation analysis is accompanied by some essential limitations, which were discussed above in more detail. First, from a technical point of view, the returns have to be normally distributed when applying portfolio optimization based on correlation analysis. But as also shown above, this assumption does not hold for real estate returns at least. Second, correlation coefficients capture only the short-term dependence between these assets and investors, which are usually interested in long-term interrelation between prices, where cointegration analysis focuses on. Third, correlation analysis is combined with a loss of valuable information contained in the time series, since correlation coefficients have to be based on stationary variables and price indices are not stationary commonly. So, first differences or logarithmic returns respectively, have to be used combined with information on the level of the price series, which is important information for long-run oriented investors. Thus, the investigation of the cointegration of prices rather than the correlation of returns is a more appropriate approach with regards to a long-run oriented investor type.

By using 14 securitized real estate markets in total – four from the Asia-Pacific region, eight from Europe, and two from Northern America –, the findings, based on the approach suggested by Engle and Granger (1987), indicate the following main conclusions:

First, there exist several cointegration relationships between national real estate markets, between and within continents. Second, it is shown that within each region, there are one or two key markets influencing neighbouring markets like Australia in the Asia-Pacific region, the U.S. in the Anglo-Saxon area, and France and the Netherlands in the EMU, implying that focusing on these central markets is sufficient from an investor's point of view and reducing investor's efforts in analysing the international real estate markets. Third, the finding of stable long-term relationships across real estate markets challenges the implications given by low correlation among national securitized real estate markets. The weaker long-term linkages between national real estate markets across continents suggest that long-term oriented investors benefit from broadening their investment horizon from domestic markets while long-term benefits from diversification across markets within a continent are limited. Fourth, the findings from cointegration analysis, from the modelling of ECMs and from the Granger causality tests put further question on the validity of the efficient market hypothesis for securitized real estate markets. The arising question, from the investors' perspective that uses active trading strategies, is whether these effects are exploitable by means of trading strategies and after trading cost. This question however is not the focus of the present paper and will be left for further research.

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