CHARLES UNIVERSITY IN PRAGUE

FACULTY OF SOCIAL SCIENCES

Institute of Economic Studies

Jiří Jílek

European Real Estate Investment Trusts: Analyzing Correlation with a DCC-GARCH Model

Master thesis

Prague 2012

Author: **Bc. Jiří Jílek**

Supervisor: **Tomáš Jandík MA MSc MRICS**

Academic Year: **2012**

Bibliographic Record

JÍLEK, Jiří. *European Real Estate Investment Trusts: Analyzing Correlation with a DCC-GARCH Model*. Prague, 2012. 50 p. Master thesis (Mgr.) Charles University in Prague, Faculty of Social Sciences, Institute of Economic Studies. Supervisor: Tomáš Jandík MA MSc MRICS.

Abstract

The main goal of this thesis is to study the interdependencies between returns of European real estate investment trusts (REITs) and other investment asset classes such as European equities, government bonds and commodities. The thesis is divided into two parts: in the first part, we describe the necessary background that led to the emergence of first REIT structures and also provide an overview of the European REITs market. In the second part, we apply the Dynamic Conditional Correlation GARCH (DCC-GARCH) model to examine correlations between the above mentioned asset classes. The general understanding of real estate is that it provides diversification benefits to a diversified portfolio. However, our results suggest that returns of European REITs and stocks show a relatively high correlation and more importantly, the correlation increases in time. These findings have significant implications for investors and portfolio managers who seek protection for their portfolios in time of market downturns. Our results further indicate low and decreasing correlation for government bonds, while the correlation between returns of REITs and commodities is low and increasing in time. The added value of this thesis lies in the employment of the DCC-GARCH model on the European REIT data.

Keywords

Real estate investment trusts, European Union, diversification, correlation, DCC-GARCH model

Bibliografický záznam

JÍLEK, Jiří. *European Real Estate Investment Trusts: Analyzing Correlation with a DCC-GARCH Model.* Praha, 2012. 50 s. Diplomová práce (Mgr.) Univerzita Karlova, Fakulta sociálních věd, Institut ekonomických studií. Vedoucí diplomové práce: Tomáš Jandík MA MSc MRICS.

Abstrakt

Hlavním cílem této práce je korelační analýza výnosů mezi evropskými realitními investičními trusty (REITs) a dalšími investičními aktivy jakými jsou evropské akcie, státní dluhopisy a komodity. Tato práce je rozdělena na dvě části: v té první popisujeme kontext, v jakém byl umožněn vznik prvních trustů, a zároveň se věnujeme současné podobě těchto struktur v Evropě. Ve druhé části aplikujeme Dynamic Conditional Correlation GARCH (DCC-GARCH) model, který nám umožní zkoumat vývoj korelace v čase u výše uvedených aktiv. Obecně se má za to, že realitní aktiva vylepšují výkonost akciových portfolií díky svým diverzifikačním vlastnostem. Nicméně naše výsledky poukazují na to, že korelace mezi REITs a akciemi je relativně vysoká a navíc roste v čase. Tyto zjištění můžou mít poměrně zajímavé důsledky pro investory a portfolio manažery, kteří chtějí ochránit svá portfolia před značnými poklesy, zejména v období propadů na finančních trzích. Naše výsledky dále indikují relativně nízkou a v čase klesající korelaci mezí REITs a vládními dluhopisy, zatímco korelace mezi REITs a komoditami je nízká a rostoucí v čase. Přidaná hodnota této práce spočívá zejména v aplikaci modelu DCC-GARCH na data evropských realitních investičních trustů.

Klíčová slova

realitní investiční trusty, Evropská unie, diverzifikace, korelace, DCC-GARCH model

Declaration of Authorship

1. The author hereby declares that he compiled this thesis independently, using only the listed resources and literature.
2. The author also declares that this thesis has not been submitted for the award of any other academic degree or diploma.
3. The author grants to Charles University permission to reproduce and to distribute copies of this thesis document in whole or in part.

Prague, May 12, 2012 Jiří Jílek

Acknowledgements

I would like to express my gratitude to Tomáš Jandík MA MSc MRICS for supervising my work on this thesis, his encouragement and useful comments.

I would also like to thank Hana and my parents for their moral support.

Master Thesis Proposal

Institute of Economic Studies
Faculty of Social Sciences
Charles University in Prague

Author:	**Bc. Jiří Jílek**	Supervisor:	Tomáš Jandík MA MSc MRICS
E-mail:	jilek.jiri@gmail.com	E-mail:	tomas.jandik@cbre.com
Phone:	737 828 918	Phone:	776 279 964
Specialization:	FFTaB	Defense Planned:	June 2012

Proposed Topic:

European Real Estate Investment Trusts: Analyzing Correlation with a DCC-GARCH Model

Topic Characteristics:

In my thesis I will focus on European Real Estate Investment Trusts (REITs). These tax-advantaged real estate entities are sought for by investors because they provide opportunities to invest in real estate while maintaining high liquidity. From a portfolio manager's point of view, REITs are generally viewed as a defensive investment. This means that real estate stabilizes one's portfolio during a market downturn. However, some scholars argue that the correlation between REITs and equities significantly increased during the economic crisis that evolved after the fall of Lehman Brothers. This would indicate dampening of diversification benefits.

The objective of this thesis will be therefore twofold. For one, I would like to describe the current trends for REITs in the European Union. Second, and more importantly, I want to apply the DCC-GARCH model to analyze the correlation between European REITs and equities/fixed income assets. This method is relatively new and to my knowledge has not yet been applied to analyze the interdependencies between European REITs and non-REIT indices. Moreover, the period of market downturns that started in 2008 represents an ideal background for studying the behavior of REITs in respect to their defensive properties.

The REIT index used for the purpose of this analysis is Euronext IEIF REIT Europe (available at http://www.ieif.fr). The equity index is Dow Jones Euro Stoxx 50 (available at www.euronext.com). This index does not include any real estate stocks; therefore our results should not be biased.

Hypotheses:

1. The correlation between the European REIT index and the equity index evolves in time.
2. The global financial crisis of 2008/2009 increased correlations between the two asset classes.
3. The correlation between REITs and fixed income assets is negative and increases during a market downturn.
4. A diversified portfolio that includes REITs performs better than a diversified portfolio that does not.

Methodology:

To model correlations between European REITs and equity indexes I will use a Dynamic Conditional Correlation General Autoregressive Conditional Heteroscedasticity (DCC-GARCH) model. In the past, in order to simplify the estimation process, it was commonly assumed that the correlation was time-invariant. However, later on, it was shown that the correlation can vary, especially during economic downturns. To solve this issue, Engle (2002) introduced the DCC-GARCH model, which is able to capture the dynamic nature of correlations.

To estimate the conditional correlation, we need to use the following two-step approach. Firstly, we need to estimate the GARCH(1,1) variance represented by: $x_{i,t} = \mu + \varepsilon_{i,t}$, $\varepsilon_{i,t}$ as $N(0, h_{ii,t})$, $h_{ii,t} = \gamma_i + \alpha_i \varepsilon_{i,t}^2 + \beta_i h_{ii,t}$, $i = 1, ..., N$. Using the obtained standardized residuals, we then estimate a time-varying correlation matrix using the DCC(1,1).

Outline:

1. Introduction
2. The Evolution of Real Estate Investment Trusts in the European Union
    a. REITs in the U.S., Australia, Asia
    b. REITs in the EU
3. Theoretical background
    a. Correlation and various methods for its modeling
    b. DCC-GARCH modeling
4. Data
5. Empirical findings
    a. DCC-GARCH models
    b. Forecasting
    c. Portfolio Analysis
6. Conclusion and suggestions for further research

Core Bibliography:

1. **Bollerslev, T. (1990)**: "Modelling the Coherence in Short-Run Nominal Exchange Rates: A Multivariate Generalized ARCH Model." *The Review of Economics and Statistics*, 72(3), pp. 498-505.
2. **Bollerslev, T., Engle, R., Wooldridge, J.M., (1988)**: "A capital asset pricing model with time varying Covariances." *Journal of Political Economy*, 96, pp. 116-131.
3. **Bond, S. A., Glascock, J. L. (2006)**: "The Performance and Diversification Benefits of European Public Real Estate Securities." (March 2006). Available at SSRN: http://ssrn.com/abstract=896524
4. **Campbell R.D. and Sirmans C.F. (2002)**: "Policy implication of structural options in the development of real estate investment trusts in Europe: Lessons from the American experience." *Journal of Property Investment & Finance* V20, No 4: pp. 388-389
5. **Case, B., Yang Y., Yildrim Y. (2009)**: "Dynamic Correlations Among Asset Classes: REIT and Stock Returns." *The Journal of Real Estate Finance and Economic*. Available at SSRN: http://ssrn.com/abstract=1755592
6. **Chong, J., Miffre, J. and Stevenson, S (2009)**: "Conditional correlations and real estate investment trusts." *Journal of Real Estate Portfolio Management*, 15, 2, pp.173-184.
7. **Engle, R. (2002)**: "Dynamic Conditional Correlation: A Simple Class of Multivariate Generalized Autoregressive Conditional Heteroskedasticity Models." *Journal of Business & Economic Statistics,* 20(3), pp.339-350
8. **Engle, R.F. and Sheppard, K. (2001)**: "Theoretical and Empirical Properties of Dynamic Conditional Correlation Multivariate GARCH." *NBER Working Paper*, No. 8554.
9. **Fei, P., Ding, L. and Deng, Y. (2010)**: "Correlation and Volatility Dynamics in REIT Returns: Performance and Portfolio Considerations." Available at http://ssrn.com/abstract=1581243
10. **Liow, K.H. and Lee, Z. (2011)**: "Extreme Dependence between public real estate and stock markets." *IRES Working Paper Series*, IRES2011-014, June 2011.
11. **Niskanen, J. and Falkenbach, H. (2011)**: "REITs and Correlations with Other Asset Classes: A European Perspective." *Journal of Real Estate Portfolio Management,* Vol. 16, No. 3, Sep-Dec 2010, pp. 227-239.
12. **Trück, S. and Rong, N. (2010)**: "Modeling the dependence structure between Australian equity and real estate markets-a Copula approach." Available at http://ssrn.com/abstract=1663152

Author

Supervisor

Contents

List of Tables

List of Figures

1 Introduction

The main reason why real estate investment trusts were introduced in 1960's in the United States was to enable small investors to invest in real estate assets without the transaction costs burden associated with mortgages. Furthermore, if we look at real estate from an investor's point of view, this investment asset class is viewed as relatively safe, bearing diversification benefits. However, given the recent trends on the financial markets these properties should be scrutinized so that portfolio managers do not expose their portfolios to excessive risk.

The modern portfolio theory begins with the seminal paper of Markowitz (1952) in which he stresses the importance of correlations between different asset classes. An investor who would like to maintain a portfolio with stable returns does not have to rely only on less volatile/risky assets. Instead, an investor can include more risky assets with a low level of correlations. However, the question remains: how can we estimate correlation?

Originally, correlation was viewed as a constant variable. This was a simplifying restriction that enabled researchers to apply the basic multivariate GARCH models proposed by Bollerslev et al. (1988). As pointed out by Bollerslev (1990), thanks to this assumption the maximum likelihood estimate of the correlation matrix is identical with the sample correlation matrix. The latter matrix is positive definitive under any circumstances, which implies that the optimization of the log-likelihood function needs only the matrix of conditional variances to be positive definite. That way the problem of heteroskedasticity in disturbance terms can be solved. But as the situation in the past few years has shown, the reality is more complex. When markets go through a period of downturns, the rolling, constant, correlation has little to no explanatory power. Investors thus cannot determine the diversification benefits of particular assets. To overcome this drawback, Engle and Sheppard (2001) and Engle (2002) proposed a new version of multivariate GARCH models. The so-called Dynamic Conditional Correlation GARCH (DCC-GARCH) models take into account time-varying nature of correlations.

In the current research, scholars have been applying this method to study the interdependencies between REITs and other asset classes. Case et al. (2009) examine the dynamics in correlation of returns between publicly traded REITs and non-REIT stocks. Using the DCC-GARCH they

confirm the changing trends in correlation over the period under review. Moreover, they quantified the benefits of using DCC-GARCH over rolling correlation to roughly 20 basis points in a well-diversified portfolio return. This result is supported by the findings of Rong and Trück (2010) who conclude that a multivariate GARCH model significantly outperforms a static variance covariance approach. Fei et al. (2008) apply Asymmetric Dynamic Diagonal Conditional Correlation (AD-DCC) GARCH to explore asymmetries in dynamic correlation. They find that correlations can be explained by macroeconomic variables. Above that, they find that there is the following relationship: when the correlation between REITs and S&P are at the lowest levels, the future REIT returns are the highest. Chong et al. (2009) present results suggesting that the correlation between REITs returns and equity returns increased over the studied period (2/2/1990-31/12/2005), while for bond and commodities the results are reversed. The second result shows that the correlations with REITs increased during highly volatile periods. The DCC-GARCH method can be also applied to examine correlations between the REIT sub-sectors, which I mention in the introductory section to real estate investment trusts. Liow, K.H. and Lee, Z. (2011) provide evidence from Asia that under the current market conditions the level of correlations between REITs and stocks is very high. Chong et al. (2011) find that the U.S. REITs sub-sectors are increasingly homogenous as for their respective returns. Alternatively, Liow (2009) uses the DCC-GARCH model to examine interdependencies among the U.S., U.K., Japanese and Australian REITs markets. He finds that the correlations between the respective markets increase in time.

In comparison to the U.S or Asia, the research focused on the REITs in Europe is relatively limited. Bond and Glasckock (2006) study diversification benefits of European real estate. They find that real estate adds to a well-diversified portfolio; real estate performs well during a period of market change—real estate is a low beta investment; and third the European real estate performed well since the 2000 stock market decline. Niskanen and Falkenbach (2011) examine correlations between European REITs and European stocks, fixed income assets as well as commodities. Based on their results, they conclude that REITs and equities show positive correlation, while REITs and fixed income assets negative. As for commodities, their findings suggest that there is positive and increasing correlation. However, they do not draw any conclusion in relation to commodities as previous academic literature implied a decreasing trend

(see Chong et al. (2009) o Bond and Glasckock (2006)). Niskanen and Falkenbach (2011) did not employ the DCC-GARCH model, their methodology is based on rolling correlations.

In our work, we attempt to find answers to the following research questions:

1. The relationship between the returns of European REITs and European stocks show positive correlation.
2. The correlation between the returns of European REITs and European stocks has an increasing trend. If the results of our analysis indicate that this statement is true, there would be important implications for investors and portfolio managers who seek protection for their diversified equity portfolios in times of market downturns.
3. We ask the above mentioned questions for other investment asset classes such as fixed income asset (in our analysis represented by Germany government bonds, which are considered a relatively safe asset) and commodities that will be in our analysis represented by a global commodity index.

We believe that answering these questions by employing the DCC-GARCH model will add significantly to the current research on European real estate investment trusts.

The thesis is structured as follows. After the introduction in Chapter 2, we continue with the description of the background to real estate investment trusts both in Europe and the United States where these structures were introduced. In Chapter 3, we describe the methodology and the model we employ. Chapter 4 characterizes the data and in Chapter 5 we give the empirical results obtained in our analysis. In Chapter 6 we summarize the key findings and suggest possible areas for further research.

2 The Evolution of REITs

Although REITs have a rich history on the U.S. financial markets (and to similar extent in Australia), in Europe, they might be considered a relatively recent phenomenon. Except for the Netherlands, most of the European countries introduced REITs into their legislation in 2000's.[1] But despite this long track of the U.S. REITs, Europe is catching up quickly and shows great potential. Currently, there are 14 countries in Europe that allow for creating a REIT structure. The four countries with the highest market capitalization of the REIT sector represent approximately 16.7% of the global REIT market. Moreover, there are more and more countries that either adopt REIT legislation or make such legislative changes that would enable to form REIT-like companies. Therefore the European REIT market is constantly expanding.

The aim purpose of this chapter is to explain the role that REITs play in the financial and real estate markets and describe the E.U. REIT evolution reflecting the U.S. experience. The main focus will be put on Germany, France, the United Kingdom, and the Netherlands due to its importance and the current REIT development.

2.1 REITs: the fundamentals

REITs represent an analogous concept to mutual funds: they enable investors (both retail and institutional) to buy shares of large corporations. In this case, however, the corporations, i.e. REITs, invest predominantly in real estate. The reasons that led the U.S. policy-makers in the early 1960's to incorporate the REIT Act into the legislation remain unchanged for other countries adopting REIT regimes: enable especially small investors to participate in efficient and liquid real estate investments. Investors find real estate attractive mainly due to its diversification benefits and its inflation-hedging properties. These characteristics are empirically documented.

[1] The Dutch form of REITs, Beleggingsinstelling (or in English: Fiscal Investment Institutions) was created as early as 1969.

Eichholtz (1996) as well as Brounen et al. (2007) confirms real estate investment benefits using long set of data from the Dutch real estate market.[2]

There are essentially two types of REITs both of which are publicly traded: mortgage and equity[3]. The mortgage REITs (MREITs) invest in mortgage loans and mortgage-backed securities (MBS). On the other hand, equity REITs buy, maintain, manage and sell real estate. The focus of this thesis lies primarily on equity REITs, albeit a short overview of MREITs is provided, as well.

In the case of equity REITs, investors can therefore participate in real-estate investments without bearing the burden of transaction costs associated with buying or selling properties directly. The possibility to carry out investments in real estate via REITs makes it more liquid and therefore the asset allocation becomes more flexible. More on REITs and liquidity in Cannon & Cole (2008), where the authors provide literature review and focus on the changes in REIT liquidity between 1988 and 2007.

What makes REITs appealing is the fact that they do not have to pay taxes on their net income provided that some conditions—stipulated in the legislation of individual countries—are fulfilled. The aim of this tax exemption is to prevent investor's cash flow from being taxed twice: first, on the corporate level and second, on the shareholder level. Therefore, under the REIT regime, the investor is in a similar situation as investors who invested directly in their own real estate properties—the income stemming from their investment is taxed only once.

Campbell & Sirmans (2002), pg. 389-390, describe the following three elements that are essential for the U.S. REIT structure and that have also been incorporated, in some form, into the structure of the European REITs[4]:

1. Their assets and revenues are closely restricted to real estate, plus a limited portfolio of securities.
2. Although they are usually public companies, they can avoid paying corporate taxes, so that their owners are not subject to the double taxation normally associated with public corporations.

[2] However, if we take into account shorter time spans the diversification benefits are not that clear.
[3] In this thesis, the abbreviation "REITs" is used for equity REITs. The mortgage REITs are denoted as MREITs.
[4] The REITs structure in European countries is described more deeply in its own section of this chapter.

3. They are required to distribute essentially all of their accounting earnings, so that they become taxable at the investor level.

REITs invest in real estate and are allowed to manage a portfolio of securities. However, there are limitations imposed on the income structure of REITs. The U.S. legislation request the following two: first, more than 75% of their gross income must stem from real estate; and second, more than 90% of their gross income must be derived from real estate and other financial instruments that they hold in their portfolios. Above that, other restrictions are imposed on the security portfolio itself: "the REIT may not hold more than 10 percent of the outstanding voting securities of any one issuer and no more than 5 percent of its total assets may consist of the securities of any one issuer, unless that issuer is another REIT" (Campbell & Sirmans (2002), pg. 390). There might be other limitations imposed on revenue such as the one in the U.S.: no more than 30% of REIT income can result from securities that would be in a securities portfolio of a REIT for a period shorter than 12 months. Furthermore, a new real estate property is not allowed to be held for a period shorter than four years. These rules are imposed on U.S. REITs so that they cannot take advantage of their benefits associated with the potential of a zero effective tax rate against mutual funds or developers[5].

REITs are corporations with a tax-advantaged regime; they have the possibility to claim an income tax deduction for the whole amount of dividends redistributed to shareholders. But if REITs do not pay corporate taxes, they have to distribute a substantial amount of their net earnings to shareholders. This will ensure that the taxes will be paid (on the investor's level). Ordinarily, REITs are required to redistribute at least 90% of their accounting earnings (in Belgium 80%, in Italy 85%, in the U.S., Germany and the UK 90%, and in the Netherlands 100%). Therefore, after the taxable income is computed in compliance with the general accounting principles of individual countries (or GAAP, IFRS), the dividends distributed to the shareholders are then deducted. This enables REITs to pay up to 0% corporate income tax. However, shareholders are not exempted from paying the taxes on their dividend income.

The regulatory framework in which REITs are set has an impact on the REITs corporate structure. Feng et al. (2007) explore the capital structure of REITs evolving in time and attempt

[5] We will discuss this further later on in this chapter when describing the country specific restrictions imposed on REITs.

to spot patterns in REITs financing decisions. According to the trade-off theory, the target debt ratio is a result of a trade-off between costs and benefits stemming from a debt. There are two main benefits associated with having a debt. First, there is the interest tax deductibility enabling a company to decrease its taxable income. And second, we have to take into account the fact that interest payments on debt incurred reduces free cash flow of a company. This in return alleviates the problem of agency costs between managers and company owners. Therefore, the trade-off theory suggests that companies with a relatively high income would have higher leverage, whereas a company with a relatively low income would have a lower leverage. However, according to the conclusions drawn by Feng et al. (2007), REITs with a high potential for future growth as well as substantial market capitalization favor debt issuance. The debt ratio for REITs in their sample is relatively high, amounting to 65% after ten years from the initial public offering. The authors attribute this finding to the special regulatory environment in which REITs operate. Ott et al. (2005) offer an argument that regular interest payments on debt serve as a monitoring mechanism of managers.

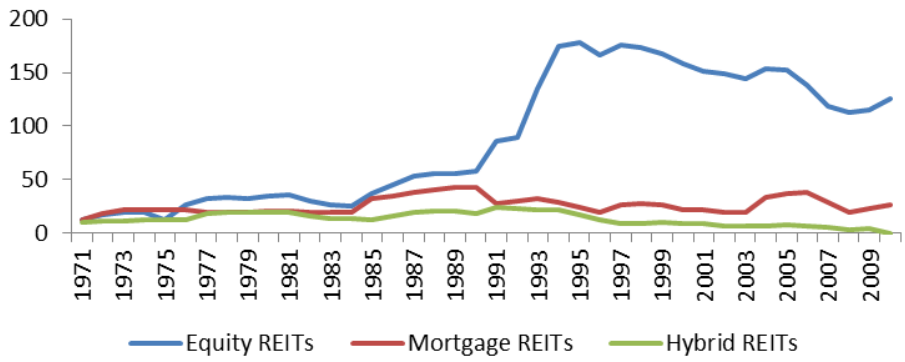
2.1.1 The global perspective: The U.S. REIT experience

The history of REITs dates back to September 14, 1960 when the U.S. president Dwight Eisenhower signed into law the REIT Act[6]. The essential reason for creating such tax-advantaged structures was to enable small investors to participate in investments in real estate while maintaining the liquidity that can be seen at stocks. During the period of 1960 to 1961 first REITs were created—some of them still exist: Winthrop Realty Trust (NYSE: FUR), Pennsylvania REIT (NYSE: PEI), and Washington REIT (NYSE: WRE). Today, there are 160 REITs in the U.S. The initial year were dominated by the mortgage REITs. Block (2002) describe the first REITs as small in size but still they managed to provide a total return of 11.5% as opposed to S&P 500's 6.7%. The 1970's are characterized by the 1973 oil crisis. The real estate market experienced severe contractions – between January 1973 and January 1975 the Share Price Index of the NAREIT was reduced by half (Park, 2009)[7]. Despite all the difficulties, in 1970's the U.S. REIT market attained compound annual return of 12.9% as opposed to 5.8% for S&P 500 (Block,

[6] The REIT Act was incorporated into the Cigar Excise Tax Extension of 1960.
[7] NAREIT stands for National Association of Real Estate Investment Trusts which is an association formed by individual REITs.

2002). During 1980's, the U.S. introduced the Tax Reform Act of 1986, which had very positive effects on the REIT performance. Firstly, the Act abolished tax benefits of Real Estate Limited Partnerships, which led to outflow of funds towards REITs. Secondly and more importantly, the Act abolished the requirement according to which REITs had to be managed externally and allowed REITs to own and manage real estate. This led to a boom in equity REITs during the following decade. The annual compound return in 1980's was above 15% (Park, 2009). The 1990's are characterized as a new REIT era. In 1993, the Omnibus Budget Reconciliation Act of 1993 was passed. In this Act the five-or-fewer rule was modified so that the U.S. pension funds had more possibilities to invest in REITs[8]. Second, under this Act the Umbrella Partnership REITs (UPREITs) were created. According to Park (2009), in an UPREIT framework, a REIT could hold a major stake in an operating partnership that owned the property. As a result, property owners could transfer their property into shares of a REIT to which they transferred the real estate. These two factors contributed to the REIT development in 1990's. By 1996, the number of REIT IPO came to 113 and the compound annual return was 12.4% (Park, 2009), see Figure 2.1.

Figure 2.1: Number of the U.S. REITs: 1972-2010



Source: data provided by www.reit.com

There is no surprise that such a successful development inspired countries around the world to form their own tax-advantaged regimes, which we discuss in the remaining parts of this chapter.

[8] According to the five-or-fewer rule no more than 50% of the shares can be held by 5 or fewer individuals in the course of the second half of each year.

2.2 REITs structure

2.2.1 Mortgage REITs

As we stated above, there are two types of REITs. The first one is represented by mortgage REITs (MREITs). In the early years, MREITs represented a majority on the market. In June, 1965, Continental Mortgage Investors became even the first MREIT to be listed on the New York Stock Exchange.[9] What differentiates mortgage and equity REITs is the subject of their investments. MREITs do not own, neither they operate properties; instead, they manage a portfolio of mortgage-backed securities (MBS). The investment process of MREITs can be divided into the following three steps:

a) The MREIT raises money through an initial public offering (IPO) and uses the means obtained to buy MBS.
b) The MBS are then used as collateral to borrow more money.
c) The preceding step is repeated until the desired leverage ratio is attained. At this point, the MREIT has sufficiently enough of leveraged assets for paying dividends to its investors.

The profit reflects the spread between the borrowing costs and the portfolio of MBS. So, if MREITs want to amplify their returns (and pay higher dividends), they proceed with the leveraging process. Let us consider the following example: an MREIT obtains a spread of two and the leverage ratio of seven. Then, thanks to the leverage, the portfolio generates a gross yield of 14. But this makes these entities very dependent on short-term financing provided by banks. If interest rates increase, the change is reflected in the book value of its portfolio and the share price.

As we mention above, the first REIT on the NYSE belonged to the group of MREITs. However, as we can see in the above mentioned Figure 2.1, the number of publicly traded equity REITs began increasing dramatically after 1990, leaving MREITs behind. There are two possible reasons for this development. First, as pointed out by Harding and Sirmans (1997), there was a rapid development of the market for commercial MBS, which enabled investors to buy MBS directly. Second, in 1986 the Tax Reform Act was enacted. This permitted REITs to both own

[9] "REIT Industry Timeline: Celebrating 50 years of REITs and NAREIT", http://www.reit.com/timeline/timeline.php

and manage their properties. Beforehand, the management and ownership of real estate were required to stay separate for REITs. This led to the explosion of REITs initial public offering in 1990's and MREITS started falling behind.[10] Moreover, there have been currently discussions whether MREITs should keep their REIT status; in fact they do not own, neither are they engaged in the management of properties.

2.2.2 Equity REITs

On the other hand, we have equity REITs. Most of what is described in the introducing sections to this chapter is directly related to this type of REITs. Since MREITs are de facto finance companies and do not own real estate properties, in this thesis the focus is put primarily on publicly traded equity REITs.

In contrast to MREITs, these structures actually own and manage properties. Based on the sector in which they invest, we can further divide them into the following groups: Retail, Residential, Healthcare, and Office focused REITs. Dividing REITs into these groups is more specific for the U.S. This is mainly due to the unified REIT legislation in the U.S., which enables REITs to take advantage of the U.S. market size and focus on a specific sector.

Since we have already described the REITs structure and the overall REIT characteristics, we will now have a look at REITs from the financial side and try to describe what determines the REITs growth. The main metrics used by investors to assess the profitability of REITs is funds from operations (FFO). The general reason why FFO is preferred over net income (or let us say Earnings Before Interest and Taxes, EBIT for short) is that in case of real estate companies depreciation as an expense does not make much sense to be deducted from the gross income. The general idea behind this is as follows: properties maintain their values or even increase[11]. Therefore we use FFO, which in fact has a similar explanatory value as Earnings Before Interest Taxes Depreciation and Amortization (EBITDA for short) for non-real estate companies.

[10] Section "All about REITs", REIT.com
[11] For further details see Block (2006)

2.2.3 REITs: the experience with open-end structure

In this subchapter we discuss issues related to the structure of REITs, or real estate funds in general. We provide arguments based on the Dutch and Australian experience in favor of closed-end structure.

Let us begin with the specification of closed-end and open-end funds. The latter group is characterized by the fact that only a limited amount of shares is issued when the fund is launched and this amount cannot be changed. Moreover, existing shares are not redeemable until the fund liquidates. On the other hand, open-end fund can issue as well as redeem shares any time it needs to. What also ordinarily differentiates the closed-end and open-end funds is the fact that a shareholder can buy shares directly from the open-end funds, while in case of closed-end funds, an investor can buy shares only from other investors. Now, let us look closer at real estate companies. If the company were to be structured as open-ended, the price of its real estate portfolio would need to be determined on daily basis as well. And this is where the problem arises. As discussed in Eichholtz et al. (2007), the actual property value cannot be exactly determined on daily basis. Properties are purchased with insufficient frequency and the property price must be determined by external valuers. But again, these valuations cannot be carried out on daily basis mainly due to its complexity and use of old information. More on valuation of real estate properties and the use of past information can be found in Clayton et al. (2001).

What problems the above-mentioned caused to the real estate open-end structures of real estate funds can be illustrated on the example of two crises – in the Netherlands and in Australia. The Dutch case shows how an example of Rodamco, a big real estate company investing in Western Europe and the U.S., that suffered during a global real estate crisis in late 1980's. This company was structured as open-end fund and as such, its value was determined at the end of each fiscal year. As a result of this, an arbitrage opportunity arose—the crisis had an adverse impact on the value of the Rodamco properties but the Rodamco share price could not adjust until the end of fiscal year. Investors realized this and a substantial outflow of capital followed. Throughout the year 1990, Rodamco was forced to buy a significant amount of its share but when its cash reserves dried up, it had to leave the open-end structure. Similarly in Australia, the open-end structure of real estate funds was terminated after the real estate market crash in late 1980's. The difference from the Dutch example was that first after the market crash huge capital inflow

occurred (backed by the expansive monetary policy of the Australian central bank as well as soaring real estate prices). But after the central bank let the interest rate drop in order to tighten its monetary policy, real estate prices went down. Subsequently, investors started massively redeem their shares and in order to prevent the complete fall of Australian real estate funds, the government ultimately compelled all funds to be quoted on the stock exchange and thus terminate the open-end structure. Eichholtz et al. (2007) aptly sum up this problem: an illiquid asset, which real estate certainly is, is covered by equity callable on daily basis. This results in severe problems in case of market crashes.

With respect to open-end funds and their sustainability, we should mention one more country-Germany. German open-end funds have a long tradition and in the past they managed to go through global real estate downturns/liquidity crises without a significant harm. Eichholtz et al. (2007) consider one of the main reasons the high proportion of liquid assets (i.e. cash) in the portfolio of German open-end funds. This is, however, exchanged for the poor performance, see Figure 2.2. This graph compares the average year on year growth of German open-end funds (red line) with two other European property indices – GPR General Europe (the black line) and the GPR 250 Europe (the blue line).

Figure 2.2: Performance of German open-end funds

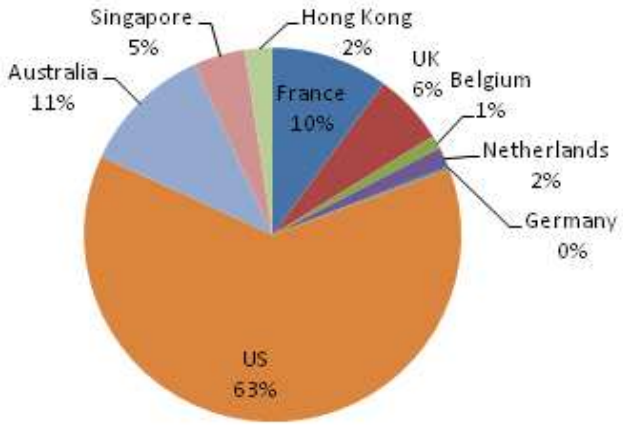
Source: Eichholtz et al. (2007), pg. 82

2.3 Focus on the EU REIT markets

Given the not so long history of modern REITs in the European Union, the development has been rapid in recent years. However, if we look at the EU REITs industry from the global perspective, we can still see some potential for future growth and development. In this subchapter, we describe the recent development in the EU REITs area. Above that, we attempt to identify the key drivers that played the major role during the recent years and discuss their sustainability in feeding the future growth of the EU REIT market. Further, we provide an overview of several national REITs markets, present the milestones in the history of the EU REITs and discuss current trends on the background of the U.S. REIT experience. Lastly, we also discuss issues on which the policy makers should focus in order to facilitate the operation of REITs in the European market. These areas are interlinked and include, inter alia, cross-border real estate investments, REIT taxation, and the lack of harmonization of the REIT legislation.

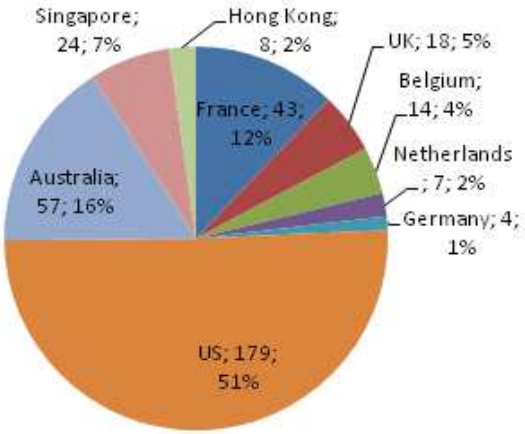
Currently, there are twelve countries in the EU that have adopted the REIT-like legislation so far. Out of these twelve, eight countries have REIT markets, which in total represent 17.1% of the global REIT market. In Figure 2.3 and Figure 2.4, we can see that the countries with the highest market capitalization in the EU are France (43 companies, 8.8% of the global market), the United Kingdom (18, 5.4%), the Netherlands (7, 1.5%), and Belgium (14, 1.0%).

Figure 2.3: % of the global market capitalization



Source: Global REIT Survey 2011, September (EPRA), author's calculations

Figure 2.4: Number of REITs (number; % of 354)



Source: Global REIT Survey 2011, September (EPRA), author's calculations

In the above-mentioned figures, we depicted countries that represent more than 1% of the global REIT market measured by the market capitalization. It is evident that Europe plays currently only a minor role in the listed REIT market. Several factors can be responsible for this. First, as we have already mentioned, REITs are relatively a new phenomenon in Europe and for some countries it can be a matter of several years before the REITs fully establish. On the other hand, if there are the right conditions, countries can easily catch up. This is the case of France (REITs possible since 2003) where the market capitalization represents 10% of the global market, almost as much as in Australia (REITs possible since 1985).

Interestingly, we can see that Germany is relatively underrepresented on the EU (as well as global) REIT market. Given the economic position of Germany, its relatively mature financial markets, one would expect much higher numbers in the REIT sector. Germany managed to implement the G-REIT into its legislation only in 2007. This was to be mainly a response to other REIT regimes successfully implemented into respective laws in the preceding years: France (2003), Belgium (1995), the Netherlands (1969). Long negotiations and intensive political discussions preceded the enacting of the German REIT legislation on May 28, 2007. The law came into force on June 1, 2007 having retroactive effect as of the beginning of the year.

The expectations were not modest: some of the conservative estimates about the G-REITs potential value were €30 billion and €70 billion[12]. And according to some other sources, the value could have been even higher: "within the next five to 10 years a market worth a staggering €140 billion could open up"[13]. The fact is that the current market capitalization of the G-REIT sector is "only" €1.3 billion. There might be several reasons why the G-REIT market has not fully developed yet. For one, the legislation came into effect right before the global financial crisis evolved. With stock markets tumbling down and a financial crisis that started with a real estate bubble, it was especially hard to attract investors' attention towards REITs. Second, in Germany there is a long tradition of open-ended real estate funds, which have been dominating the German market for 40 years. The total portfolio value of German open-ended fund (GEOF) can be as much as €70 billion. From an investor's point of view, GEOFs can be seen as less risky compared to REITs as they are not securities, therefore they should not be as volatile as REITs. Third, G-

[12] Economist (2006). "Blood, sweat and REITs (Property funds in Germany)". The Economist (2006, July 27), available at http://www.economist.com/node/7226093

[13] Corbett, Charlie (May 7, 2007). "All Eyes on German REITs". (2007, May 7). Investor Daily.

REITs are restricted from investing in residential properties built before January 1, 2007. In our opinion, this is one of the reasons why many of the German real estate funds do not convert into REITs. This argument goes hand in hand with the last fact: some of the real estate companies, such as for example Deutsche Wohnen, carry forward losses incurred during the acquisitions of residential properties, therefore its tax liability is significantly decreased and the motivation to change its structure to REIT diminishes[14].

2.3.1 Country overview – REITs regimes in the EU

Europe is a very diverse continent with countries that have their own history and specific legal systems. Since no pan-European REIT regime has been established yet, the REITs in individual countries are also specific. Out of the 13 countries currently having some form of REITs, we selected four, which we describe more in detail. France, the United Kingdom and the Netherlands are countries with the most developed REIT markets in Europe (and are also countries with the highest market capitalization in Europe). In Germany, on the other hand, the REIT market represents relatively small fraction of the global market. This is against expectations that were presented before the German REITs were introduced in 2007. Therefore, we decided to provide a description of G-REITs and suggest reasons why the REIT market has not fully developed so far.

GERMANY

There are currently four REITs listed in Germany (see Table 2.1). Prime Office AG, the second largest according to the market capitalization, is the most recent issuer of its stocks in an IPO. In July 1, 2011, it became a listed company with a pre-REIT status. Except for Prime Office AG, all the G-REITs were transformed from listed real estate companies. They also diversify their investments into various sectors—mostly office, residential and retail[15].

[14] Boston, William (October 14, 2009). "REITs Gear Up in Germany". The Wall Street Journal.
[15] After Prime Office AG became the fully-fledged G-REIT it changed its name to Prime Office REIT-AG in order to be in compliance with the German REIT law.

Table 2.1: German REITs (data as of July, 2011)

Company Name	Market cap (€m)	Sector type
Alstria Office REIT-AG	726	Office, Others, Residential, Retail
Prime Office AG	310	Office
Hamborner REIT AG	239	Office, Residential, Retail
Fair Value REIT-AG	43	Logistic, Office, Others, Retail

Source: EPRA (2011)

In order a company to qualify for a fully-fledged G-REIT, it needs to fulfill certain requirements. Following EPRA (2011), pg. 3, the registration of a G-REIT is conditioned upon the following:

- joint stock company with minimum share capital of EUR 15 million;
- corporate seat and place of management in Germany;
- by-laws must provide for certain provisions (e.g. purpose of the company, compensation of shareholders with a shareholding of less than 3% in case
- of termination of the tax-exempt G-REIT status, etc.);
- listing at stock exchange;
- at least 25% widely held shares at IPO (after listing reduced to 15%);
- direct shareholding of a shareholder must be less than 10%.

Upon the successful completion of these requirements, the company can be registered with the Commercial Register and the G-REIT can operate. However, in some cases, the company first opts for a pre-REIT status as it was the case of Prime Office AG. As a pre-REIT, the company can take advantage of the tax benefits most typical for G-REITs (a tax exemption of capital gains). If a joint-stock company with a registered seat in Germany is registered with the Federal Central Tax Office as a pre-REIT, it needs to fulfill several conditions at the end of each business year (EPRA, 2011, pg. 3):

- objectives of the pre-REIT must be limited to the objectives of a G-REIT;
- 75% of its total assets must consist of immovable property;
- 75% of its gross earnings must be derived from renting, leasing, letting and disposal of real estate;
- a pre-REIT service company's assets may not exceed 20% of the pre-REIT's total assets;

- a pre-REIT service company's gross earnings may not exceed 20% of the pre-REIT's gross earnings.

G-REITs are joint stock companies (in German: *Aktiengesellschaft – AG*) with a minimum share capital of €15 million (in the U.S. there is no condition set for the minimum share of a REIT). Furthermore, the companies registered as REITs must include the REIT reference (in any form) in the company's name. At first sight, including the word "trust" (or any reference to it) in a name of a German company can be seen as vague. This is due to the fact that the German legal system has its roots in Roman law, which does not know the term "trust". But since REITs were first introduced in the U.S. (Anglo-Saxon legal system), the term became generally accepted all over the world. Unlike in the U.S. where private REITs are possible, in Germany all REITs must to be listed.

As for the regulatory requirements imposed on the G-REITs to compensate for the tax benefits, they do not significantly differ from the U.S. REIT model presented in the earlier sections of this chapter (2.1 REITs: the fundamentals). In order to fulfill the REIT criteria, the company has to have at least 75% of its assets in the form of real estate. Secondly, also at least 75% of its gross income must be derived from the real estate activities, i.e. rent, leasing, and sale of real estate. In order not to compete with development firms, trading activities for G-REITs are forbidden. As such trading activities is considered a disposal of real estate before five years of its acquisition/development if the revenues stemming from the disposal exceed 50% of the total real estate portfolio. We mentioned that the REIT law had been a subject of heated political discussions in Germany. This was mainly due to the requirement according to which the investment in residential property should be forbidden. In the end, the rules became not so strict and G-REITs are prohibited from owning only residential property located in Germany and built before January 1, 2007. This condition was incorporated into the REIT law because German policy-makers were afraid that G-REITs would increase rents had they owned residential property. Next important requirement is the leverage ratio, which cannot exceed 66.25%. This number results from the fact that the REIT law stipulates that the equity at the end of each fiscal year must be at least 45% and given that G-REITs are required to hold at least 75% of their assets in real estate, we get the above-mentioned leverage ratio. In accordance with the U.S. REIT model, G-REITs must redistribute at least 90% of its net income. If German REITs stick to these

rules, they can take advantage of the tax benefits. First, the income of a G-REIT is not subject to corporate taxes, i.e. tax exemption on the corporate level and this hold for capital gains as well. Above the income taxes, there are real estate transfer taxes, which are applied and G-REITs do not have any exception in this area, and withholding taxes levied on dividend distributions to G-REITs subsidiaries (in December, 2011, the rate is 25%). However, in this case, two fifths can be returned from the financial authorities.

FRANCE

In the European REIT context, France can be considered a successful story. Currently, there are 43 REITs representing approximately 10% of the global REIT market. These results are in Europe by far the most noteworthy. Moreover, one of the French REITs, Unibail-Rodamco is one of the forty constituents of the French stock market index CAC 40. The investment portfolio of the top 5 SIICs (ranked by market capitalization) covers a wide range of sectors: office, retail, healthcare, and logistic). For the full overview of Top 5 French REITs, see Table 2.2. Similarly to G-REITs, SIICs do not focus only on one or two sectors as it is the case in the U.S. As we describe below, the French REIT regulations are relatively liberal, especially in comparison to G-REITs.

Table 2.2: Top 5 French REITs (data as at July, 2011)

Company Name	Mkt. Cap. Mon end (€M)	Sector type
Unibail-Rodamco SE	14285	Office, Retail
Gecina SA	6064	Healthcare, Hotel, Logistic, Office, Residential
Klepierre	4950	Office, Retail
ICADE	4172	Healthcare, Industrial, Office, Residential, Retail
Fonciere Des Regions	3736	Healthcare, Hotel, Leisure, Logistic, Office, Others, Parking

Source: EPRA (2011)

In January 1, 2003, France enabled the creation of tax-advantaged corporations, in French called SIICs (Sociétés d'Investissements Immobiliers Cotées), by enacting the Article 11 of the Finance Act for 2003. The legislative framework has been amended several times (see EPRA, 2011): the

Amended Finance Act for 2004, the Finance Act for 2005, the Amended Finance Act for 2006, the Amended Finance Act for 2007, the Finance Act for 2008, the Finance Act for 2009 and the Amendatory Finance Act for 2009. The last amendments are of great importance for SIICs as well as other European REITs. Before January 1, 2010, every real estate company wishing to become a SIIC was obliged to be listed on the French stock exchange. But since that date, every real estate company (REIT) listed on a stock exchange in one of the EU countries can apply to become a SIIC. This is, however, upon the condition that all other legislative requirements stipulated in the French legislation are met. Further on, the 2009 and 2010 amendments enabled to form joint ventures between SIICs and SPPICAVs (société d'investissement à capital variable), which are structures analogues to the German open-ended funds investing in real estate. The popularity of SPPICAVs in France, as well as their tax benefits, led the French policy-makers to enable subsidiaries owned mutually by SIICs and SPPICAVs to apply for SIIC regime, provided that certain conditions are met (see EPRA, 2011). Another feature that helped to set the French REIT market in motion was a tax-advantaged treatment (i.e. reduced tax rate) related to sale of commercial property to SIICs. This step was beneficial for companies, which managed to gain cash and invest it in a more effective way, while small private investors can participate in real estate investments through the publicly owned SIICs that bought the commercial estate.

There are several way how to become a SIICs. First, the parent company (listed real estate company) can fulfill its obligations and apply itself during the first quarter of the financial year. Second, a subsidiary performing such activities according to which it would qualify for a SIIC can apply for a SIIC regime if it is owned either by a SIIC parent company or by a SIIC company (or several of them) and one or more SPPICAV companies, provided that these listed companies own at least 95% of the subsidiary. The company applying for the SIIC regime must be a corporation (Société Anonyme), as it is the case of Gecina SA (the second largest SIIC), or any other form that enables public listing of its shares (e.g. Societas Europaea, as it is the case of the largest SIIC Unibail-Rodamco SE). As opposed to the practice in Germany, French REITs are not obliged to have their registered seat in France. This provision enables real estate companies listed in any EU country to apply for a SIIC regime. However, the French conditions have to be fulfilled. The minimum share capital is set to €15 million, which is the same as in Germany.

French SIICs are not exempt from certain regulation imposed on their activities. However, as we have pointed out in the introduction to this chapter, individual countries have the right to formulate their own restriction, which can be different from the U.S. REITs or even from the EU counterparts. According to Ashurts (2008), the main activity of a SIIC must be construction and acquisition of real estate with the goal to rent it out. Above that, SIICs can pursue direct or indirect (through partnerships) portfolio investments. In contrast to G-REITs, SIICs do not have any obligation to have real estate assets above a certain level. However, similarly to Germany, SIICs are exposed to limitations related to the activities such as real estate development and brokerage. There is a test according to which the gross asset value of real estate related to these two (secondary) activities must not exceed 20% of the total gross asset value. Similarly to the U.S. REIT model, the French SIICs do not have any required leverage ratio.

All around the world, REITs are required to redistribute a substantial part of their profit to its shareholders. In France, the profit redistribution rule is that at least 85% of the tax-exempt rental income must be redistributed to its shareholders in the form of dividends. Second, at least 50% of the capital gains stemming from the disposal of properties (owned directly or through partnerships) is redistributed. And finally, the whole amount of dividends received from its subsidiaries that applied for the SIIC regime must be redistributed as well.

THE UNITED KINGDOM

With London being one of the financial centers and such rich history of real estate in the United Kingdom, it is surprising that the REIT regime was introduced only in 2006, taking effect from January 1, 2007.

Table 2.3: Top 5 UK REITs (data as at July, 2011)

Company Name	Market cap (€m)	Sector type
Land Securities Group PLC	7550	Office, Others, Retail
British Land Co PLC	5931	Industrial, Leisure, Office, Retail
Hammerson Plc	3791	Office, Retail
Capital Shopping Centres Group	3666	Retail
Segro	2559	Industrial, Logistic, Office

Source: EPRA (2011)

Initially, there were nine companies that applied for the REIT regime. However, over the years the total number of the U.K. REITs grew (through the conversion of listed real estate companies as well as start-up REITs) and now there are 24 REITs (as at December 1, 2011), see Table 2.3.

The original REIT legislation, the Finance Act 2006, is no exception and was amended as it was the case in France and Germany. In addition to the above-mentioned Act, the operation of REITs is subject to the guidelines. There are further changes that will influence the UK REIT regime—they will probably take effect in July, 2012. These new rules will especially influence the following three groups (for more details see Deloitte, 2011):

- REITs – the current 2% entry charge will be abolished, which will decrease the costs associated to the creation of a REIT;
- Institutional investors – diversely-owned institutions will be able to form REITs, which is not possible now;
- Start-up and family owned real estate companies – there will be a three-year period, which will help the new companies entering the REIT market to overcome the non-close-company requirement and thus build some renomé on the market[16].

The above-mentioned entry charge corresponds to 2% of the gross market value of real estate associated to the tax-advantaged business at the time of the conversion. This purpose of this charge is to erase any capital gain the company attained before it had converted to a REIT.

In order to qualify for the UK REIT, a company has to fulfill the following criteria (EPRA, 2011):

- is UK resident and not resident elsewhere;
- has shares listed on a recognized stock exchange;
- is not an open-ended investment company;
- is not a close company;
- has only one class of ordinary shares (i.e., non-voting fixed rate preference shares which may be convertible are permitted);
- has no performance-related loans; and
- that the parent company will produce financial statements.

[16] A close company means that the company is controlled by no more than five shareholders

We can see that the rule concerning the UK tax residency is analogous to the rule in Germany (in France there is no such restriction). The parent company must be closed-ended and its shares must be publicly traded on a stock exchange fully recognized by the UK financial authorities. If a REIT is listed on the UK stock exchange, then there is a minimum share capital restriction, which is the same for all UK companies listed on the UK stock exchange and amounts to GBP 50,000. After the above-discussed amendment is effective, not only stock exchange, but also the UK Alternative Investment Market will be considered by the UK authorities as appropriate to receive a REIT status[17].

Following the common practice, UK REITs must follow several requirements. There is a 75/75 rule. This means that first, 75% of REIT's net profit must stem from real estate and second, 75% of a UK REIT's total assets must be related to real estate. Furthermore, a UK REIT is obliged to hold at least three separate assets—both commercial and residential—which can be located in the UK as well as in other parts of the world. As for the real estate development, UK REITs are allowed to engage in such activities, provided that the property is not sold within the first three years. Otherwise, this activity would be considered property trading and income resulting from such activities would be taxable. In line with German REITs requirements, UK REITs are required to maintain certain level of leverage. There is a criterion called Financial Cost ratio, which is defined as follows (EPRA, 2011, pg. 5):

Financial cost ratio = **property profits** / **property financing costs**, where

property profits - *profits of the property rental business before a deduction for interest, losses from a previous accounting period and tax depreciation (capital allowances)*, and

property financing costs – *that is finance related to the property rental business which is broadly defined and includes, for example, costs incurred on breaking debt*.

If the financial cost ratio gets below 1.25 (i.e. property financing cost are too high), then the UK financial authorities can apply tax charges which would lead to an increase in the financial cost ratio above 1.25.

[17] The Alternative Investment Market (AIM) belongs under the LSE and allows especially smaller companies to list their shares. Regulatory requirements are more relaxed as opposed to the LSE.

As for the property income distributions (operative income and capital gains), there is an obligation to distribute 90% of tax-exempt profits, income from the property rental business). Proceeds from capital gains of disposed real estate are not to be distributed.

THE NETHERLANDS

The Dutch REIT market can be regarded as an exception in the European context. Real estate companies that would take advantage of tax benefits were first introduced in 1969. In that year, the Fiscal Investment Institution regime (in Dutch fiscale beleggingsinstelling or for short "FBI") was incorporated in the Dutch Corporate Income Tax Act and became the first REIT-like regime on the European continent. Over the year, FBIs underwent legislative changes out of which the most important one was that since 2007 foreign investors can apply for the Dutch REIT regime. Interestingly, there are both private and publicly traded REITs in the Netherlands, albeit with different regulatory restrictions.

As at the end of July, there are 7 FBIs with a total market capitalization of €8.4 million. This represents 1.5% of the global REIT market. As for the investment distribution according to sectors, the FBIs go hand in hand with other European REITs and diversify their investment across all sectors (see Table 2.4).

Table 2.4: Top 5 FBIs (data as at July, 2011)

Company Name	Market cap (€m)	Sector type
Corio NV	3,929	Industrial, Office, Retail
Wereldhave NV	1,401	Industrial, Leisure, Office, Residential, Retail
Eurocommercial Properties NV	1,359	Retail
Vastned Retail NV	885	Retail
Nieuwe Steen Investments Funds NV	562	Industrial, Office, Residential, Retail

Source: EPRA (2011)

The Dutch REITs are also specific by its admission requirements—it is sufficient to apply only in the corporate tax return provided that the investment company is eligible. For the REIT status, four different types of companies can apply, see Table 2.5.

Table 2.5: Legal form and minimum share capital of FBIs

Legal form	Minimum share capital
Dutch private limited liability company (BV).	EUR 18,000
Dutch public limited liability company (NV).	EUR 45,000
Open-ended mutual investment fund (FGR).	None
Comparable foreign legal entity.	

Source: EPRA (2011)

We can see that the spectrum of companies that can become FBIs is relatively broad. Foreign legal entities (comparable to the Dutch eligible entities) do not have to be tax residents in the Netherlands; however, they naturally need to be liable with the local corporate income tax. As for the activities that the Dutch REIT is allowed to be engaged in, this is only passive investments in real estate (both locally and globally). Developing activities are allowed only through a subsidiary that is no engaged in any other activity than development. However, this subsidiary will be taxed on a corporate level (currently, the corporate tax rate is 25%). Two restrictions are imposed on the leverage: first, the total amount borrowed must not exceed 60% of the total real assets owned by a REIT and second, the borrowings must not exceed 20% of all other investments (except for real estate). In order an FBI to be eligible for a special tax treatment, it needs to redistribute the whole amount of its taxable profits. Capital gains can be used as reinvestment reserves. If such use of capital gains is selected, it is excluded from the taxable income.

2.3.2 Pan-European REITs

Even though the European Union represents one of the largest economic powers in the world, its role in the global REIT market is underrepresented as shown in the Figure 2.3 and Figure 2.4. There are several reason why this is so. The major EU economies adopted the REIT regimes only

a few years ago: France (2003), the UK (2007), and Germany (2007). Second, the fact that global markets went through a serious crisis did not help either. Nevertheless, the potential for future growth is apparent; countries that have not adopted the REIT structure yet put their respective real estate sectors at a disadvantage because they will not be as competitive as companies with a more beneficial tax treatment. Therefore, we can expect that there will be pressures on law makers to pass the corresponding legislation.

3 Theoretical Background

This chapter provides an essential introduction to GARCH modeling. We present individuals GARCH models: univariate and multivariate GARCH models. The main focus is placed at the DCC-GARCH models that belong to multivariate GARCH models and that became a very popular method for estimating correlations between financial time series. In the introductory chapter, we provide the main reasons why there is such an interest to correctly estimate correlations. In this chapter we aim to present the method that is used in our analysis: a DCC-GARCH model.

3.1 GARCH modeling

A detailed overview of GARCH modeling has been provided for instance by Bauwens et al. (2006) or Orskaug (2009). In this subchapter, we aim to outline the past developments based on the work of the above-mentioned authors. This overview is necessary to understand the rationale behind the DCC-GARCH models. We start with an overview of simple univariate GARCH models (definition, use, drawbacks). Then, we mention multivariate GARCH models, make a division into three subgroups of multivariate GARCH models. One of these groups, models of conditional variances and conditional correlations, is more deeply described. This is due to the fact that DCC-GARCH models—the analytical tool used in this thesis—belongs to this group of multivariate GARCH models.

3.1.1 Univariate GARCH models

Robert F. Engle (together with Clive W. J. Granger) won the Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel in 2003 for the development of the ARCH model and time-series analysis using this model. ARCH models became a commonly used means for analyzing the volatility of time series given the time-varying nature of volatility.

A generalized autoregressive conditional heteroskedasticity (GARCH) model was introduced by Bollerslev (1990) as an extension of an autoregressive conditional heteroskedasticity (ARCH) model developed by Engle (1982). The main purpose of this model is to predict future volatilities.

GARCH models

Following Orskaug (2009), we start with a GARCH models that is defined as follows:

$$r_t = \mu_t + a_t,$$

$$a_t = h_t^{1/2} z_t,$$

$$h_t = \omega + \alpha_1 a_{t-1}^2 + ... + \alpha_q a_{t-q}^2 + \beta_1 h_{t-1} + ... + \beta_p h_{t-p},$$

where:

r_t - log return of an asset class at time *t*,

a_t - mean-corrected return of an asset at time *t*; it is serially uncorrelated

μ_t - the expected value of the conditional r_t,

h_t - the square of the volatility, i.e. the conditional variance at time t, conditioned on the history,

$\{z_t\}$ - sequence of independent and identically distributed (iid) standardized, random variables, i.e.

$E[z_t] = 0$ and $Var[z_t] = 1$,

$\omega, \alpha_1, ..., \alpha_q, \beta_1, ..., \beta_p$ - parameters of the model,

p, q - order of the GARCH model.

We can rewrite the volatility as follows:

$$h_t = \omega + \sum_{i=1}^{q} \alpha_i a_{t-i}^2 + \sum_{j=1}^{p} \beta_j \alpha_{t-j}.$$

Apparently, the conditional variance is dependent on a_{t-i}^2. This implies volatility clustering. When a significant movement in return occurs, the volatility increases and becomes serially dependent. This means that a period of relatively high volatility tends to be replaced by a period of low volatility (given a new shock did not occur).

For the purposes of this thesis, we do not consider deriving the unconditional mean, variance or autovariance of the asset return important. Likewise, we do not proceed with the theoretical estimation of the GARCH model since the main focus of this thesis is the DCC-GARCH model.

What is viewed as a weakness of GARCH models is the fact that it does not differentiate between positive and negative shocks[18]; this is due to the fact that the return in the model is squared (see the volatility equation).

3.1.2 Multivariate GARCH models

In this section we provide a theoretical backgroung for multivariate GARCH models, while the specifics of DCC-GARCH modeling are covered more in detail in the section 3.3 DCC-GARCH modeling.

The multivariate GARCH models can be specified as follows:

$$r_t = \mu_t + a_t,$$

$$a_t = H_t^{1/2} z_t,$$

where:

r_t - $n \times 1$ vector of log returns of n assets at time t,

a_t - $n \times 1$ vector of mean-corrected returns of n assets at time t, i.e. $E[a_t] = 0$. Also

$Cov[a_t] = H_t$,

μ_t - $n \times 1$ vector of the expected value of the conditional r_t,

[18] See Orskaug (2009), page 10

H_t - $n \times n$ matrix of conditional variances of a_t at time *t*,

$H_t^{1/2}$ - Any $n \times n$ matrix at time *t* such that H_t is the conditional variance matrix of a_t.

$H_t^{1/2}$ is a positive definite matrix,[19]

z_t - $n \times 1$ vector of iid errors such that and $E[z_t] = 0$ and $E\left[z_t z_t^T\right] = I$, where I is the identity matrix of order N.

What becomes important here is the specification of the matrix H_t. If H_t is large, we can get into difficulties with our computations.

Following Silvennoinen and Teräsvirta (2007), let us have a look at different specifications of conditional matrices, which will results in different categories of multivariate GARCH models:

I. Direct modeling of H_t. VEC and BEKK models belong to this category.

II. Factor models.

III. Conditional variances and correlations. We model conditional variances and conditional correlations instead of modeling a conditional correlation matrix. This is also a group of models we will cover mode in detail as it constitute the primary tool for analyzing times series in this thesis.

IV. Nonparametric and semiparametric approaches, these models benefits from the flexibility they add to the estimation process.

3.2 DCC-GARCH model

The Dynamic Conditional Correlation GARCH (DCC-GARCH) model was formulated by Engle and Shepard (2001). This model belongs to the multivariate class of GARCH models and became a very popular method for estimating correlations between returns various asset classes. Even though GARCH models were relatively successful and broadly used for empirical research,

[19] $H_t^{1/2}$ may be obtained by a Cholesky factorization of H_t, which is a factorization of positive-definitive matrix (let us denote it ***H***) into the product of a lower triangular matrix (***A***) and its conjugate transpose ($\boldsymbol{A^T}$), i.e. $\boldsymbol{H=AA^T}$.

scientists were limited due to the time-varying nature of correlation as it had to be viewed as stable in time.

Engle and Shepard (2001) provide an overview of estimating correlation using GARCH models. Originally, the univariate GARCH models were used. When applying the univariate GARCH model to estimate correlation, the GARCH models needed to be estimated for each asset class separately to obtain standardized residuals. Then, using these standardized residuals, a time-varying correlation matrix could be estimated. Later on, it was Bollerslev (1990) who came up with the bivariate form – constant conditional correlation GARCH (CCC-GARCH) model. This model (as well as the DCC-GARCH model) belongs to the group of Conditional variances and covariances described in the preceding section. In the case of CCC-GARCH, the conditional correlation matrix is held constant $R_t = R$, therefore we get

$$H_t = D_t R D_t .$$

GARCH models are also estimated for each asset class, but the correlation matrix is then estimated using the Maximum Likelihood Estimator (MLE). In order the estimation of the model to be plausible, the model is based on the assumption that the conditional correlation is held constant (the estimator matrix must be positive definite, for more details see below) and therefore the estimation is relatively simple. However, this simplification was later found as too restrictive. Originally, Bollerslev (1990) relied upon this condition. However, later work of Tsui and Yu (1999) put the validity of this assumption into question and on the data used in their paper (stock indices) they did not find any evidence supporting the conditional correlation being constant. Subsequently, tests for the constancy of correlation were developed; see Tse (2000) who introduced a multivariate LM test. Further, Tse and Tsui (1998) introduced a dynamic correlation multivariate (MV-) GARCH model. But still, their model suffered from drawback that did not enable to use the full potential of estimating time-varying correlation. Finally, Engle (2001) proposed a model based on the foundations laid down by Bollerselev and formulated dynamic conditional correlation (DCC) MV-GARCH model. This model is further scrutinized, both from the theoretical and practical sides, in Engle and Shepard (2001).

Following Orskaug (2009), pg. 23, the DCC-GARCH model can be defined as follows:

$$r_t = \mu_t + a_t,$$

$$a_t = H_t^{1/2} z_t,$$

$$H_t = D_t R_t D_t.$$

We accept the following notation:

r_t - n × 1 vector of log daily returns of *n* assets at time *t*, where $t = 1,...,T$

a_t - n × 1 vector of mean-corrected returns of *n* assets at time *t*, i.e. $E[a_t] = 0.$

$Cov[a_t] = H_t,$

μ_t - n × 1 vector of the expected value of the conditional r_t

H_t - n × n matrix of conditional variances of a_t at time *t*

$H_t^{1/2}$ - Any n × n matrix at time *t* such that H_t is the conditional variance matrix of a_t.

$H_t^{1/2}$ is a positive definite matrix.[20]

D_t - n × n, diagonal matrix of conditional standard deviations of a_t at time *t*. The D_t matrix can have the following form:

$$D_t = \begin{bmatrix} \sqrt{h_{1t}} & 0 & \dots & 0 \\ 0 & \sqrt{h_{2t}} & \dots & \vdots \\ \vdots & \vdots\ddots & \vdots\ddots & 0 \\ 0 & \vdots\ddots & 0 & \sqrt{h_{nt}} \end{bmatrix}, \text{ where } h_{it} = \omega_i + \sum_{q=1}^{Q_i} \alpha_{iq} \alpha_{i,t-q}^2 + \sum_{p=1}^{P_i} \beta_{ip} h_{i,t-q}.$$

The conditional variances from GARC(1,1) model are:

[20] $H_t^{\frac{1}{2}}$ may be obtained by a Cholesky factorization of H_t, which is a factorization of positive-definitive matrix (let us denote it ***H***) into the product of a lower triangular matrix (***A***) and its conjugate transpose ($\boldsymbol{A^T}$), i.e. $\boldsymbol{H=AA^T}$.

$$h_{it} = \omega_i + \sum_{q=1}^{Q_i} \alpha_{iq} \alpha_{i,t-q}^2 + \sum_{p=1}^{P_i} \beta_{ip} h_{i,t-q} \qquad (1)$$

z_t - $n \times 1$ vector of iid errors such that and $E[z_t] = 0$ and $E[z_t z_t^T] = I$, where I is the identity matrix of order N

R_t - $n \times n$ conditional correlation matrix of a_t at time t and can have the following form:

$$R_t = \begin{bmatrix} 1 & \rho_{12,t} & \rho_{13,t} & \cdots & \rho_{1n,t} \\ \rho_{12,t} & 1 & \rho_{23,t} & \cdots & \rho_{1n,t} \\ \rho_{13,t} & \rho_{23,t} & 1 & : & : \\ : & : & : & : & \rho_{n-1,n,t} \\ \rho_{1n,t} & \rho_{2n,t} & \cdots & \rho_{n-1,n,t} & 1 \end{bmatrix}$$

As we have already mentioned above, the estimator matrix, in our case H_t, must be positive definite. To satisfy this condition, the conditional correlation matrix R_t must be positive definite, too.[21] Orskaug (2009), pg. 25, decomposes R_t in the following manner:

$$\begin{aligned} R_t &= Q_t^{*-1} Q_t Q_t^{*-1}, \\ Q_t &= (1-a-b)\overline{Q} + a\varepsilon_{t-1}\varepsilon_{t-1}^T + bQ_{t-1}, \end{aligned} \qquad (2)$$

where $\overline{Q} = Cov[\varepsilon_t \varepsilon_t^T]$ is the unconditional covariance matrix of the standardized errors ε_t. Furthermore, Q_t^* is a diagonal matrix that has on its diagonal squared elements of the matrix Q_t. The matrix Q_t^* has the following form:

[21] Matrix of conditional standard deviations D_t is positive definite because all of its diagonal elements are equal to one, i.e. they are positive.

$$Q_t^* = \begin{bmatrix} \sqrt{q_{11t}} & 0 & \dots & 0 \\ 0 & \sqrt{q_{11t}} & \ddots & \vdots \\ \vdots & \vdots & \ddots & 0 \\ 0 & 0 & & \sqrt{q_{nnt}} \end{bmatrix}.$$

For R_t to be positive definite, Q_t has to be positive definite as well. Next, we need to impose certain conditions on the scalars *a* and *b* so that the matrix H_t is positive definite. The following must hold:

$$a \geq 0,\ b \geq 0 \text{ and } a + b \prec 1.$$

Engle and Shepard (2001) describe the estimation of the DCC-GARCH model as a two-step process. In the first step, we estimate univariate GARCH models for every particular series. Then, in the second stage, we use the residuals from the first step, transform them by using the estimated standard deviations, and estimate the dynamic correlation.

Following Orskaug (2009), let us have multivariate Gaussian distributed errors $z_1, ..., z_T$ described by the following joint distribution function:

$$f(z_t) = \prod_{t=1}^{T} \frac{1}{(2\pi)^{\frac{n}{2}}} \exp\left(-\frac{1}{2} z_t^T z_t\right).$$

Upon the linear transformation, we could derive the likelihood function as:

$$L(\theta) = \prod_{t=1}^{T} \frac{1}{(2\pi)^{\frac{1}{2}} |H_t|^{\frac{1}{2}}} \exp\left(-\frac{1}{2} a_t^T H_t^{-1} a_t\right).$$

Here, we have a likelihood function of the parameter θ. The parameter θ includes the following two subgroups:

a) $\phi = (\phi_1, ..., \phi_n)$, where $\phi_i = (\omega_i, \alpha_{1i}, ..., \alpha_{qi}, \beta_{1i}, ..., \beta_{pi})$ are the parameters of the GARCH model for individual time series (asset class $i, ..., n$),

b) $\varphi = (a, b)$, which are the correlation parameters.

Now, we need to take the logarithm of the likelihood function from the previous step and to substitute $H_t = D_t R_t D_t$:

$$\ln\left(L(\theta)\right) = -\frac{1}{2}\sum_{t=1}^{T}\left(n\ln(2\pi) + \ln\left(|H_t|\right) + a_t^T H_t^{-1} a_t\right)$$

$$= -\frac{1}{2}\sum_{t=1}^{T}\left(n\ln(2\pi) + \ln\left(|D_t R_t D_t|\right) + a_t^T D_t^{-1}{}_t R_t^{-1} D_t^{-1} a_t\right)$$

$$= -\frac{1}{2}\sum_{t=1}^{T}\left(n\ln(2\pi) + 2\ln\left(|D_t|\right) + \ln\left(|R_t|\right) + a_t^T D_t^{-1}{}_t R_t^{-1} D_t^{-1} a_t\right).$$

This log-likelihood function is to be estimated in two steps. First, the parameter ϕ of the GARCH models for respective time series is estimated. Second, the parameter φ is estimated given the ϕ. Based on Orskaug (2009), we show the estimation procedure of the correctly specified log-likelihod function.

In the first step of the DCC-GARCH model estimation, we need to replace R_t with an identity matrix I_n, which helps us obtain a quasi-log-likelihood function:

$$\ln\left(L_1(\phi)\right) = -\frac{1}{2}\sum_{t=1}^{T}\left(n\ln(2\pi) + 2\ln\left(|D_t|\right) + \ln\left(|I_n|\right) + a_t^T D_t^{-1} I_n D_t^{-1} a_t\right)$$

$$= -\frac{1}{2}\sum_{t=1}^{T}\left(n\ln(2\pi) + 2\ln\left(|D_t|\right) + \ln\left(|I_n|\right) + a_t^T D_t^{-1} I_n D_t^{-1} a_t\right)$$

$$= -\frac{1}{2}\sum_{t=1}^{T}\left(n\ln(2\pi) + \sum_{i=1}^{n}\left[\ln\left(h_{it}\right) + \frac{a_{it}^2}{h_{it}}\right]\right)$$

$$= \sum_{i=1}^{T}\left(-\frac{1}{2}\sum_{t=1}^{T}\left[\ln\left(h_{it}\right) + \frac{a_{it}^2}{h_{it}}\right] + \text{constant}\right).$$

Using this kind of equation, we can estimate the individual parameters $\phi_1,...,\phi_n$. Upon the successful estimation of $\phi_1,...,\phi_n$, we can estimate conditional variance for every single time series.

The first step is proceeded in order to estimate the unknown parameters *a* and *b*. We use the estimated parameters $\phi_1,...,\phi_n$ from the preceding step and the following quasi-log-likelihood function:

$$\ln\left(L_2(\varphi)\right) = -\frac{1}{2}\sum_{t=1}^{T}\left(n\ln(2\pi) + 2\ln\left(|D_t|\right) + \ln\left(|R_t|\right) + a_t^T D_t^{-1} I_n D_t^{-1} a_t\right)$$

$$= -\frac{1}{2}\sum_{t=1}^{T}\left(n\ln(2\pi) + 2\ln\left(|D_t|\right) + \ln\left(|R_t|\right) + \varepsilon_t^T R_t^{-1}\varepsilon_t\right).$$

When D_t depends on the parameters estimated in the preceding step, it is constant and therefore we can leave it out, which gives us the following quasi-log-likelihood function that will be maximized:

$$\ln\left(L_2^*(\varphi)\right) = -\frac{1}{2}\sum_{t=1}^{T}\left(\ln\left(|R_t|\right) + \varepsilon_t^T R_t^{-1}\varepsilon_t\right).$$

In our analysis, to model correlation between REITs and other time series (stocks, bonds, and commodities) we use the bivariate form of the DCC-GARCH model.

4 Data

This chapter provides the principal information related to the data used in our analysis. Here, we discuss the data origin, provide the rationale for the selection of particular time series, and finally explain the steps necessary to obtain the final version of time series suitable for the DCC-GARCH model. All of the data sets were adjusted for missing days, i.e. each of the data sets includes exactly the same number of values[22].

Four different time series will be used in our analysis. We will use stock, real estate, fixed income and commodity indices to find out how interdependent they are and how the correlations among them evolve over time. Before we delve into details, let us have a look at summary statistics if particular indices' returns. The returns are calculated as differences of logarithmic daily returns of individual indices. We provide a summary in Table 4.1. To illustrate the performance of individual indices, see Figure 4.1.

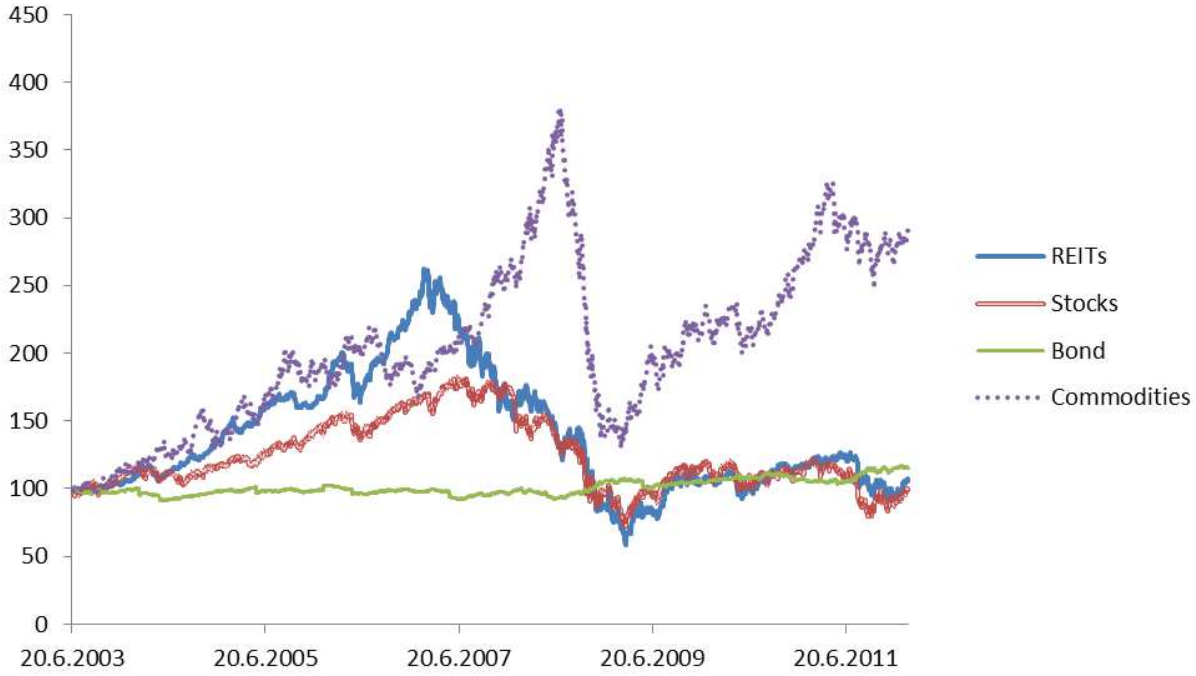
Table 4.1: Summary descriptive statistics of indices returns

	Min	Max	Mean	Std. deviation	Skewness	Kurtosis	Jarque Bera Test (p value <)
Real estate							
Euronext IEIF REIT Europe	-0,07735	0,07938	0,00014	0,01536	-0,18674	4,26273	1624.566 (2.2e-16)
Equities							
Dow Jones Euro Stoxx 50	-0,07880	0,12877	0,00011	0,01504	0,39132	8,15210	5954.059 (2.2e-16)
Fixed income							
Government Germany 5.5-10.5	-0,05031	0,04015	0,00008	0,00396	-2,94447	39,08032	138750.7 (2.2e-16)
Commodities							
S&P GSCI	-0,08099	0,10519	0,00064	0,01685	-0,03634	2,51745	562.2478 (2.2e-16)

Source: Own calculations

[22] The discepancies arise due to bank holidays in respective countries – indices are not associated only with one stock Exchange.

Figure 4.1: Graph of the daily cumulative return of our four time series



Source: Own calculations

The objective of this thesis is to analyze European REITs sector. For this purpose we have decided to use the Euronext IEIF REIT Europe index. This index is calculated jointly by Euronext and Institut de l'Epargne Immobilière et Foncière (IEIF), a French institution focused on the real estate listed companies and REITs. The components of this index are represented by REITs headquartered and active in the European Union that are selected on the basis of their actual market capitalization and liquidity. The index used in this thesis comprises 30 companies (the list of these REITs is included in the Appendix). The index is calculated every 15 seconds, however for our purposes, we used daily closing prices over the period 20 July 2003 to 10 February 2012, which means 2143 daily observations[23].

In order to compare real estate investment trusts (represented by the IEIF REIT Europe index) with other asset classes, we need to identify the most relevant equity, government bond, and

[23] This number is the original number of observations less the number of observations for which other indices values were not available.

commodity indices. For equities the decision was straightforward – Dow Jones Euro Stoxx 50 is a blue chip index covering 12 European countries[24] and compiled by Euronext—this provides a high degree of harmonization in respect to the Euronext IEIF REIT Europe index . The index is provided by Euronext. This equity index does not include any company that is a REIT or a publicly listed real estate company. We used daily closing prices over the period 20 July 2003 to 10 February 2012.

Next, we decided to include a fixed income index represented by government bonds. As it is rather difficult to find such a pan-european index for the selected period, we chose a German government bond index. We understand that this index does not fully reflect the economic situation in the whole European Union, moreover Germany can be considered a kind of safe harbor in Europe but still, we want to provide results concerning the comparison between REITs and a relatively low-risk asset class. We believe that German bonds represent such a low-risk asset. We decided to use iShares eb.rexx® Government Germany 5.5-10.5[25]. Through this index one can get the exposure to Euro denominated German government bonds with a time to maturity between 5.5 and 10.5 years. We used daily closing prices for the period between 20 July 2003 and 10 February 2012.

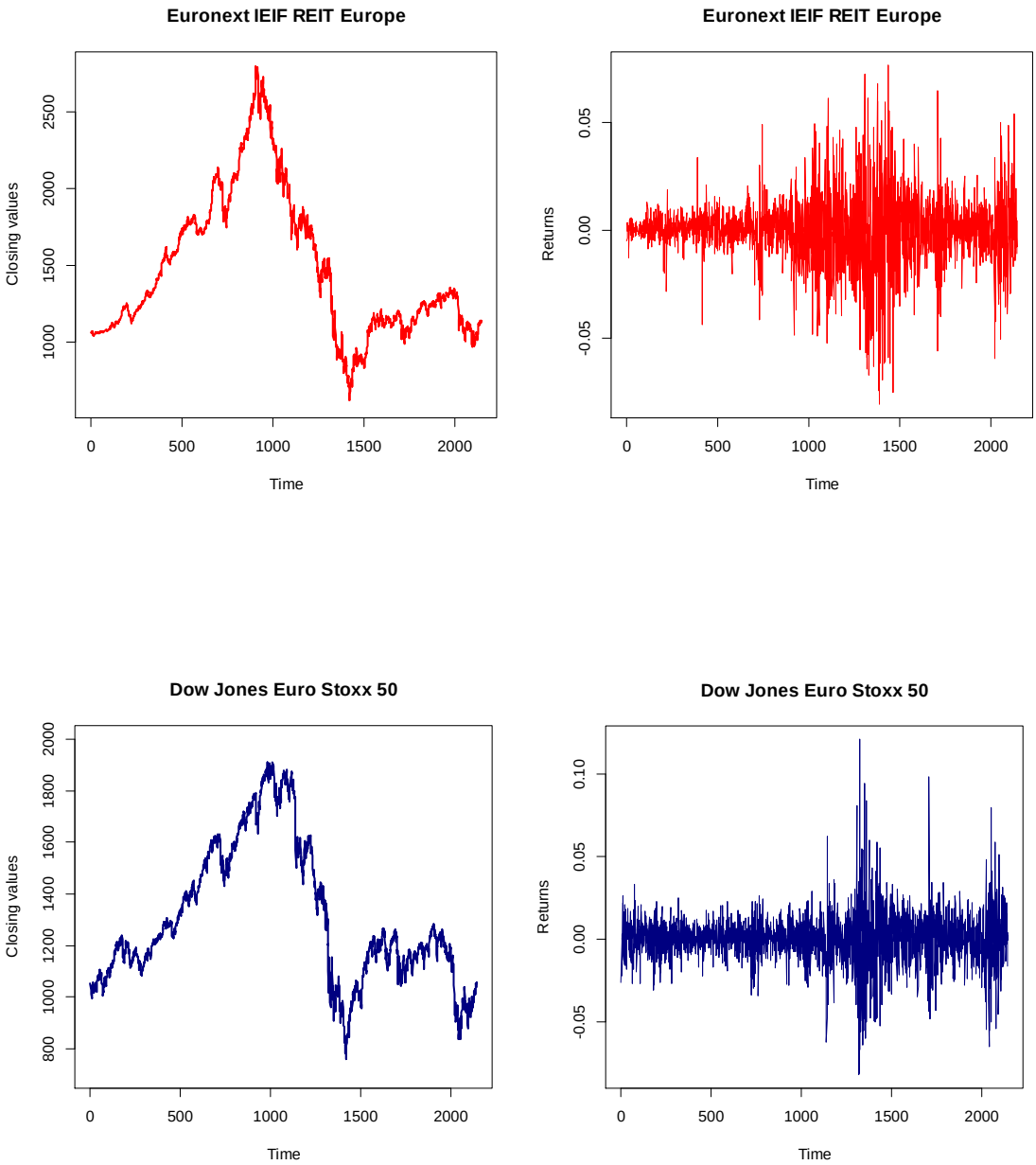
With the last index, we aimed to cover commodities. This is an asset class that can allow us to further examine the diversification properties of REITs. Since there is no European commodity index, and it would not make any sense to construct such index given the global nature of commodity trading, we selected the S&P GSCI (formerly known as S&P Goldman Sachs Commodity index). As in the previous cases, we used daily closing prices and the period was narrowed down to a period from 20 July 2003 to 10 February 2012.

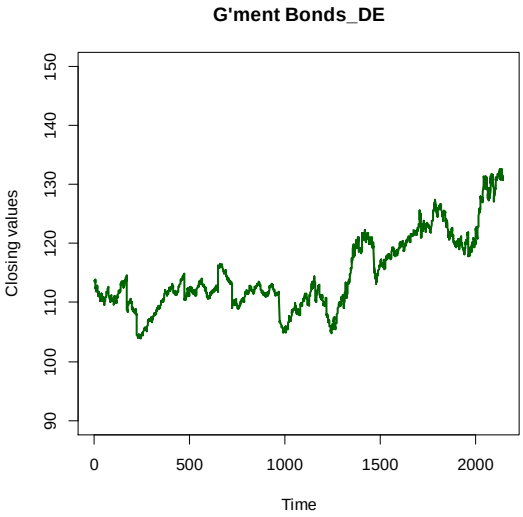
In Figure 4.2, we plotted daily returns of particular time series: European REITs, Dow Jones Euro Stoxx 50, index of German government bonds, and lastly the commodity index provided by Goldman Sachs. It is evident that REITs, stocks and commodity indices started falling steadily and the slump was further exacerbated by the panic that rocked financial markets in the subsequent months. Obviously, investors were in search for more safe assets, which is in our case

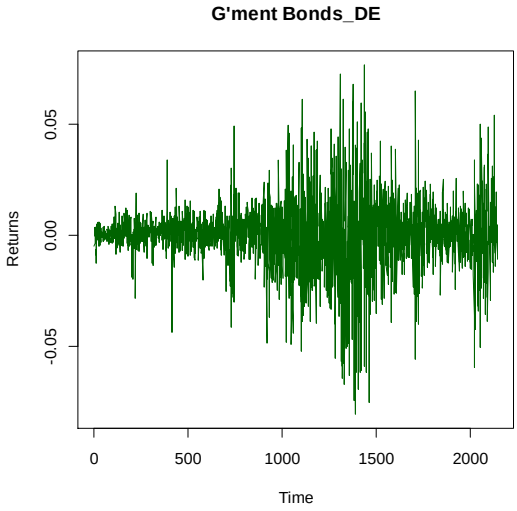
[24] There is a slight difference between Dow Jones Eurostoxx 50 and EURO STOXX 50 indices. The latter includes only companies based in Eurozone.
[25] For more details, see http://de.ishares.com/en/rc/products/EXHD.

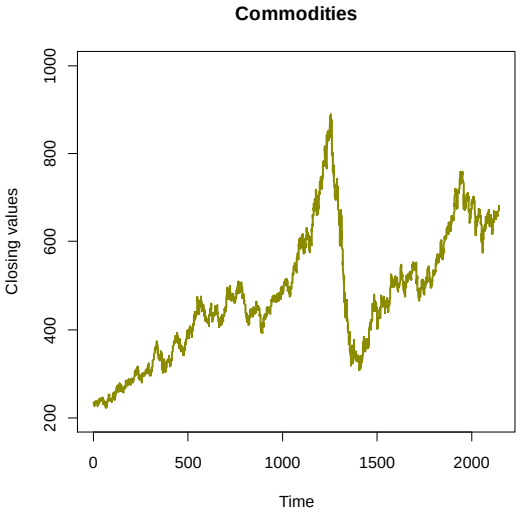
demonstrated by a gradual increase in German government bond's returns. Lastly, commodities, another asset class that is usually represented in a well-diversified portfolio, experienced a significant fall during 2007.

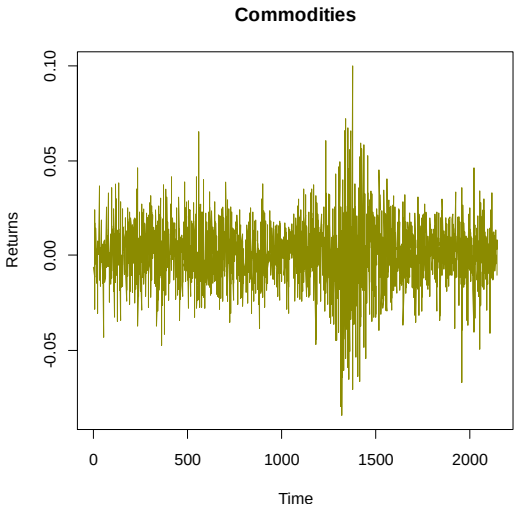
Figure 4.2: Daily index values of respective asset classes and their logarithmic returns











In order to assure that the selected method is appropriate, we carried out some basic analysis of log returns of particular time series and their residuals. Based on the plot of these time series returns in Figure 4.2 we can draw the main conclusion. Since all of the time series have periods of low volatility and high volatility, so called volatility clustering, we can say that GARCH model would be an appropriate method. We also evaluated the autocorrelation function and partial autocorrelation function of individual time series.

Lastly, as normality of returns is one of the conditions for a DCC-GARCH model, we needed to adjust our data. In the statistical software that we used, we normalized our data to ensure that this condition is satisfied.

5 Empirical Findings

The aim of this thesis is to analyze the interdependencies between returns of real estate investment trusts and three other investment asset classes (equities, fixed income, and commodities). In Chapter 4, we describe four indices upon which we base our analysis. The theoretical foundations of this analysis, the Dynamic conditional correlation GARCH model, are presented in the Chapter 3.

5.1 DCC-GARCH estimation

In this chapter, we present the results attained during the two step DCC-GARCH model estimation. We estimated the DCC-GARCH model described in Chapter 3, mainly equations (1) and (2). In Table 5.1, we summarize the results we received during the maximization of the log-likelihood function we described in the section *3.2.1 DCC-GARCH model*. The first panel contains estimates for the individual time series GARCH(1,1) model parameters and the second panel includes DCC(1,1) model parameters **a** and **b**.

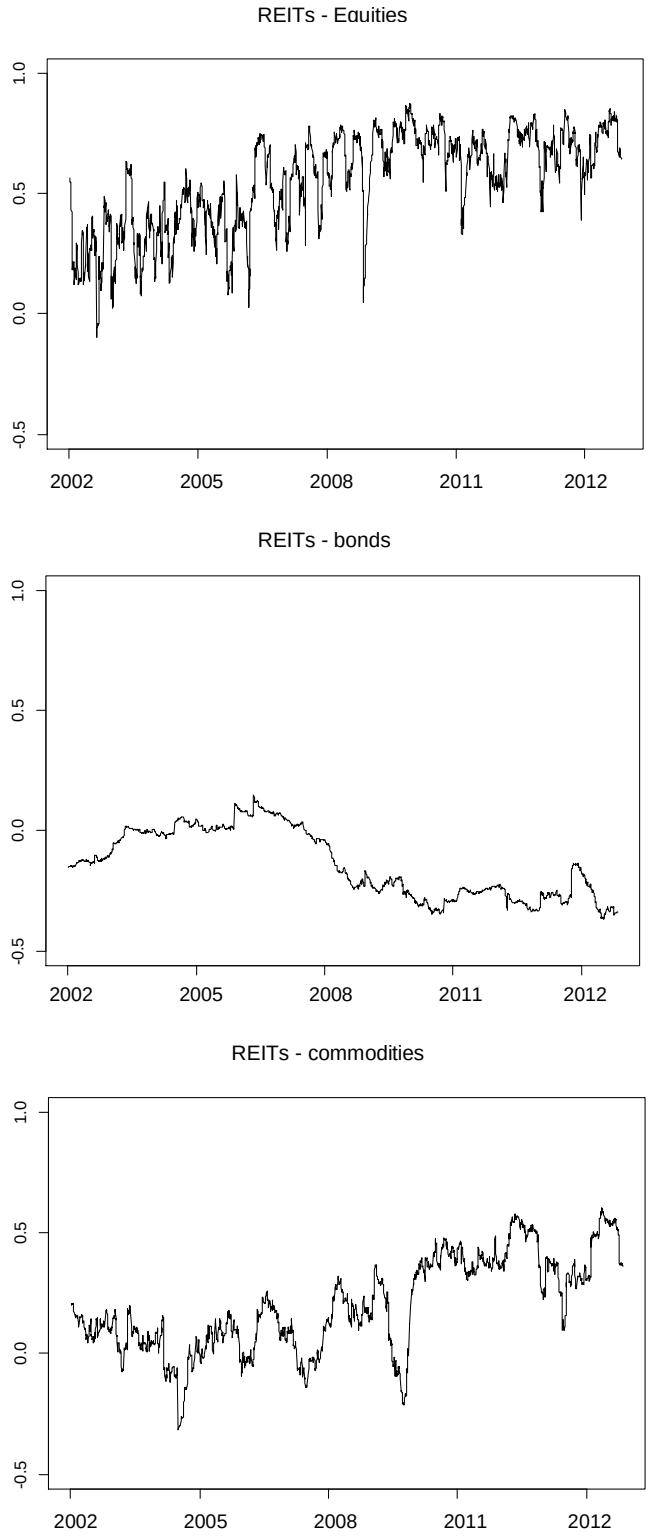
Table 5.1 Results of the DCC-GARCH model estimation for indices in pair with REITs

	REITs	Equities	Bonds	Commodities
ω	0.0004710306 (0.001913602)	0.0002051840 (0.01888574)	0.0004479078 (0.01888574)	0.0002794602 (0.01888574)
α	0.124277010 (0.01524739)	0.09285289 (0.007523476)	9.999943e-09 (5.533806e+02)	0.03816432 (0.01404656)
β	0.875518357 (0.02004517)	0.89811973 (0.01860358)	0.71819373 (3481.5859733)	0.95087111 (0.01187567)

	REITs-equities	**REITs-bonds**	**REITs-commodities**
a	0.05813302 (0.00849076)	0.006263140 (0.003238577)	0.019447410 (0.004225807)
b	0.92685049 (0.01356183)	0.992414808 (0.003844427)	0.976612864 (0.006376842)

Source: Own calculations
Note: The numbers mentioned in parentheses are standard deviations of respective parameters estimates.

Figure 5.1 Plot of time-varying correlations received from the DCC-GARCH model



The GARCH model is based on three parameters: ω, α, and β. ω is a long-term variance, α is this period actual variance, provides new information that is not captured anywhere else, and third β is this period predicted variance. While α and β need to be larger than zero in order to satisfy the condition imposed on GARCH models, the sum of α and β must be below one. Both of these conditions are satisfied in the case of our GARCH models for particular time series.

The focus of our analysis lies on the second panel where the DCC parameters are reported. We can see that in all of the cases the ***a*** parameters are of lower values relatively to α parameters. In the case of ***b*** parameters, all of them are higher than β parameters. This should indicate relatively high persistence in correlations between REITs and the three time series.

In Figure 5.1, we can see the development of individual conditional correlations in time. The first graph depicts the conditional correlation between European REITs and Dow Jones EuroStoxx 50. We can see that the correlation increases in time. This confirms our initial hypothesis that the correlation between REITs and stock indices have increased during the past years. We formulated the hypothesis based on the conclusions of research published on the topic: this trend is supported for instance by Chong et al. (2009), Case et al. (2009) or relatively new paper by Niskanen and Falkenbach (2011) who studied U.S. REITs[26].

In the second graph, we illustrate decreasing correlation between European REITs and fixed income assets, in our example represented by German government bonds with maturities from 5.5 to 10.5 years. This result also confirms our initial hypothesis that in recent years the correlation between European REITs and fixed income assets has been declining. This is also consistent with the above-mentioned research.

Third, we provide our results on the correlation between European REITs and a commodity index (S&P GSCI, formerly known as Goldman Sachs Commodity index). From the graph, there is evident an increasing trend in correlation. When making our initial hypotheses about the individual correlations we assumed that the correlation between European REITs and a commodity index would show a decreasing trend. Chong et al. (2009) came to a result that the

[26] Niskanen and Falkenbach (2011) studied the correlation between European REITs, however, instead of using the the DCC-GARCH model, they used rolling correlation.

U.S. REITs and S&P GSCI have a negative correlation, while Niskanen and Falkenbach (2011) found that an average correlation between European REITs and S&P GSCI is 0.26[27]. The latter is similar to our findings: the average dynamic conditional correlation is 0.199. For the values of average correlations resulting from our DCC-GARCH modeling, see Table 5.2. The obtained values are consistent with the results of Niskanen and Falkenbach (2011) which is to our knowledge the only research published on the study of European REITs correlations.

We also regressed the dynamic conditional correlations obtained in our analysis on a time trend and received the results reported in Table 5.2.

Table 5.2 Conditional correlations regressed on time

	Average DCC	Standard Deviation	ß (*1000)	t-ratio	Adj. R^2
Equities					
Dow Jones Euro Stoxx 50	0.553	0.200	0.240	51.003	54.86%
Fixed income					
Government Germany 5.5-10.5	-0.137	0.141	-0.172	-53.390	57.10%
Commodities					
S&P GSCI	0.199	0.195	0.234	50.850	54.70%

Source: Own calculations
Note: The ß is the slope coefficient in a simple regression on a time trend. It is multiplied by 1000 just for our convenience.

We see that the slope coefficient has positive values for the stock index. The results from this regression imply an increasing trend for the correlation between equities and REITs. In case of fixed income assets, we come to the conclusion that the trend is decreasing in time. Lastly, the relationship between the returns of REITs and commodities is increasing. The results obtained from the regression are consistent with the trends we can observe in Figure 5.1.

[27] Niskanen and Falkenbach (2011) used FTSE EPRA/NAREIT Developed Europe REITs Index.

5.2 Portfolio analysis

In this section, we construct hypothetical portfolios based on the correlation results obtained during the DCC-GARCH modeling. We attribute different weights to individual asset classes in our portfolio to find out which portfolio will have the highest Sharpe ratio, i.e. return on risk-adjusted basis[28].

Before we present the results, we provide a very brief introduction into the Sharpe ratio calculation. We calculate this ratio according to the following formula:

$$S = \frac{E\left[R_i - R_f \right]}{\sigma_i}, \text{ where}$$

R_i is the return of a portfolio *i*,

R_f is the return on a risk-free asset, which is in our case average return on German government bond over the studied period, and lastly

σ_i is the standard deviation of a portfolio.

The σ_i is calculated a square root of the portfolio variance σ_i^2. The variance was obtained using the following formula:

$$\sigma_i^2 = w_1^2\sigma_1^2 + w_2^2\sigma_2^2 + w_3^2\sigma_3^2 + w_4^2\sigma_4^2 + 2w_1w_2\,\mathrm{cov}(R_1,R_2) + 2w_1w_3\,\mathrm{cov}(R_1,R_3) + 2w_1w_4\,\mathrm{cov}(R_1,R_4) +$$

$$+2w_2w_3\,\mathrm{cov}(R_2,R_3) + 2w_2w_4\,\mathrm{cov}(R_2,R_4) + 2w_3w_4\,\mathrm{cov}(R_3,R_4), \text{ where}$$

$w_1,...w_4$ are weights associated to individual assets,

$\mathrm{cov}(R_i,R_j)$ are covariances between the returns of individual assets.

[28] For more details on Sharpe ratio, see Sharpe (1966).

Table 5.3 Sharpe ratios of hypothetical portfolios

Portfolio	Weights	Volatility	Average return	Sharpe ratio
Full stocks	0% REITs 100% stocks 0% bonds 0% commodities	25.56%	24.15%	0.91
REITs & stocks	50% REITs 50% stocks 0% bonds 0% commodities	30.88%	31.38%	0.98
Conservative	10% REITs 50% stocks 30% bonds 10% commodities	14.94%	26.69%	1.72
Diversified	20% REITs 50% stocks 10% bonds 20% commodities	19.80%	40.83%	2.01

Source: Own calculations

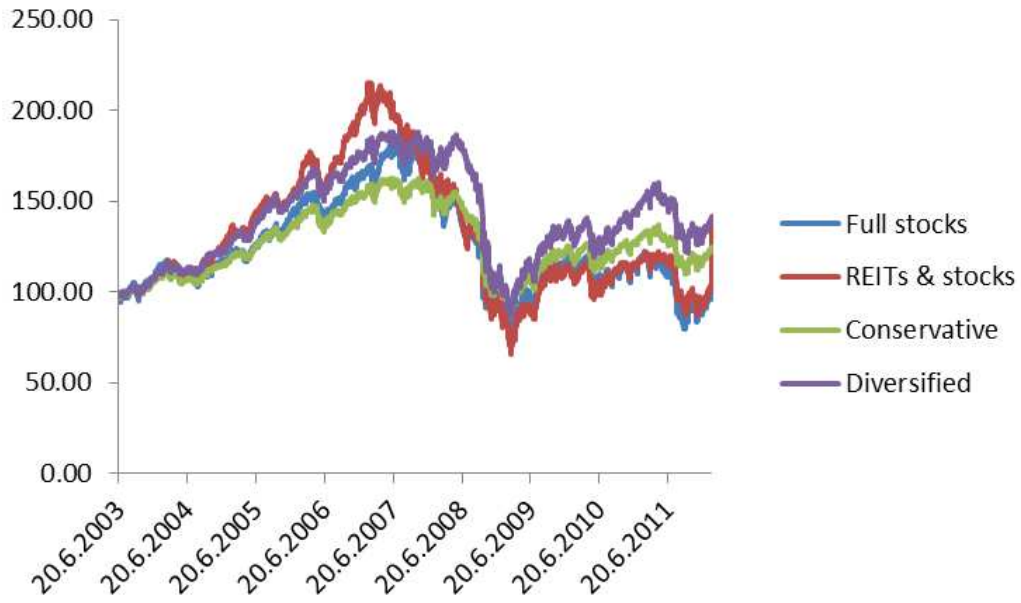
In Table 5.3 we report the characteristics of individual hypothetical portfolios. Each portfolio is created by attributing specific weights to European REITs index, German government bonds and commodities. First, we constructed a portfolio that is composed solely from the European equities (the portfolio is labeled as Full stocks). This portfolio has an average return over the studied period of 25.15% and volatility of 25.56%. Sharpe ratio for this portfolio then attains the value of 0.91, the lowest of the four. If we create a portfolio such as REITs & stocks where 50% is attributed to REITs and 50% to stocks we get a portfolio with an average return of 31.38% and volatility of 30.88%. This portfolio implies a Sharpe ratio of 0.98, only a relatively small increase in comparison to the preceding portfolio. The conservative portfolio was created by attributing 50% to stocks, 10% to REITs, 30% to government bonds and 10% to commodities. We can see that there is a significant decrease in the portfolio's volatility, which is due to the diversification over the individual assets. Sharpe ratio for this conservative portfolio attains the value of 1.72, which can be considered as a relatively high value, therefore providing an interesting return while

keeping the portfolio risk relatively low. The last portfolio we constructed is a Diversified portfolio where we attributed 50% to stocks, 20% to REITs, 10% to bonds, and 20% to commodities. This portfolio shows a very high average return of 40.83%.

This analysis serves as an addendum to our previous research. We show that a portfolio that is diversified through other investment asset classes such as government bonds and commodities can attain better values of Sharpe ratio that a portfolio constructed solely of REITs and stocks. This analysis provides a rather illustrative argument for diversification over various investment asset classes, not just real estate.

In the last Figure 5.2, we provide a plot of returns of individual portfolios.

Figure 5.2 Performance of hypothetical portfolios



6 Conclusion

In this thesis, we examine correlations between the returns of European REITs and other investment asset classes such as European equities, government bonds, and commodities. First, we describe the background that led to the emergence of first REIT structures in the United States. Further, we provide a thorough description of European real estate investment trust markets and discuss the possible trends.

In order to properly describe the correlation trends, we carefully selected the data that we were to use in our analysis. For European REITs, we used the Euronext IEIF REIT Europe index, the only publicly available REIT index covering Europe. In respect to stocks we used Dow Jones Euro Stoxx 50, another index provided by Euronext. To cover fixed income asset, we decided to choose exchange traded funds focused on German government bonds with a maturity between 5.5 and 10.5 years. By selecting this time series we were able to use a relatively low risk asset and circumvent the lack of publicly available data related to government bonds. Lastly, as a commodity index we used S&P GSCI, a broad commodity index. Our data series covered the period between 20 July 2003 and 10 February 2012.

There are several ways how to address such a complex issue that modeling of correlation between financial time series certainly represent. From a relatively basic methods based on calculation of rolling correlation, over GARCH models based on constant correlation, to dynamic conditional correlation GARCH models that we use in this work. By the substantial amount of literature that contains the DCC-GARCH model, we demonstrated the popularity of this model in assessing correlation. The cornerstone of its success lies in incorporating time varying nature of correlation, i.e. the model is based on the dynamic approach to modeling correlation.

This thesis is based on the application of a bivariate form of the DCC-GARCH model. We studied the correlation development in time and came to the conclusion that correlation between the returns of European REITs and European stock index is relatively high and increases in time. These findings were illustrated both graphically (we plotted the daily values of dynamic conditional correlations over the studied time period) and empirically. The latter means that we regressed the daily values of dynamic conditional correlation on a time trend and confirmed that

correlation increase in time. The results therefore imply that the diversification benefits of real estate, in our case represented by the European REITs, are fading away. This is even more compelling considering the recent development on the financial markets when portfolio managers would seek safe assets in order to protect their portfolios. As for other investment asset classes such as fixed income assets and commodities, there we can observe also certain dynamics. The correlation between European REITs and government bonds is relatively low but decreases in time. This is, in our view, not surprising as we assume that investors have been looking for the safest assets that German government bonds certainly are. In case of commodities, the correlation is relatively low and increasing in time. This conclusion differs from the previous academic results obtained from the U.S. REIT data where the correlation was decreasing. However, our results are backed by certain studies that were also focused on the European REIT data.

Our thesis offers interesting results that will add to the existing literature focused on real estate investment trusts and their correlation with other investment asset classes. Moreover, the thesis enriches a rather limited research on European REIT structures and therefore contributes to the ongoing debates on the future developments of real estate investment trust in the European Union.

References

Bauwens, L., Laurent, S. and Rombouts, J. V. K. (2006): Multivariate GARCH Models: A Survey. *Journal of Applied Econometrics,* 21(1), pp. 79-109.

Block, R. (2002). Investing in REITs. Bloomberg Press, Princeton, NJ, USA.

Bollerslev, T. (1990): "Modelling the Coherence in Short-Run Nominal Exchange Rates: A Multivariate Generalized ARCH Model." *The Review of Economics and Statistics,* 72(3), pp. 498-505.

Bollerslev, T., Engle, R., Wooldridge, J.M., (1988): "A capital asset pricing model with time varying Covariances." *Journal of Political Economy*, 96, pp. 116-131.

Bond, S. A., Glascock, J. L. (2006): "The Performance and Diversification Benefits of European Public Real Estate Securities." (March 2006). Available at SSRN: http://ssrn.com/abstract=896524

Brounen, Dirk, Eichholtz, Piet M. A. and Theebe, Marcel A.J., Inflation Protection from Homeownership: Long-Run Evidence: 1814-2004 (May 2007). Available at SSRN: http://ssrn.com/abstract=984454

Campbell R.D. and Sirmans C.F. (2002): "Policy implication of structural options in the development of real estate investment trusts in Europe: Lessons from the American experience." *Journal of Property Investment & Finance* V20, No 4: pp. 388-389

Cannon, Susanne E. & Cole, Rebel A., 2008. "Changes in REIT liquidity 1988 - 2007: Evidence from daily data," MPRA Paper 24694, University Library of Munich, Germany, revised 20 Aug 2010

Case, B., Yang Y., Yildrim Y. (2009): "Dynamic Correlations Among Asset Classes: REIT and Stock Returns." *The Journal of Real Estate Finance and Economic*. Available at SSRN: http://ssrn.com/abstract=1755592

Chong, J., Miffre, J. and Stevenson, S (2009): "Conditional correlations and real estate investment trusts." *Journal of Real Estate Portfolio Management*, 15, 2, pp.173-184

Chong, J., Krystalogianni, A., and Stevenson, S. (2011): "Dynamic Correlations across REIT Sub-Sectors." *Real Estate & Planning Working Papers*, 2011-07, Henley Business School, Reading University

Clayton, J., D.M. Geltner, and S.W. Hamilton, 2001, Smoothing in Commercial Property Valuations: Evidence from Individual Appraisals, *Real Estate Economics* 29, 337-360.

Eichholtz, Piet M. A., A Long Run House Price Index: The Herengracht Index, 1628-1973. Available at SSRN: http://ssrn.com/abstract=598 or doi:10.2139/ssrn.598

Eichholtz,Piet M.A. and Kok, Nils, The EU REIT and the Internal Market for Real Estate (November 2007). Available at SSRN: http://ssrn.com/abstract=1081198

ENGLE, R. F. (1982): "Autoregressive Conditional Heteroscedasticity with Estimates of the Variance of United Kingdom Inflation". *Econometrica*, 50(4), pp. 987-1007.

Engle, R.F. and Sheppard, K. (2001): "Theoretical and Empirical Properties of Dynamic Conditional Correlation Multivariate GARCH." *NBER Working Paper*, No. 8554.

Engle, R. (2002): "Dynamic Conditional Correlation: A Simple Class of Multivariate Generalized Autoregressive Conditional Heteroskedasticity Models." *Journal of Business & Economic Statistics*, 20(3), pp.339-350

Fei, P., Ding, L. and Deng, Y. (2010): "Correlation and Volatility Dynamics in REIT Returns: Performance and Portfolio Considerations." Available at http://ssrn.com/abstract=1581243

Harding, J.P. and Sirmans, C.F. (1997), "Commercial mortgage-backed securities: an ntroduction for professional investors", *Real Estate Finance*, Vol. 14 No. 1, pp. 43-51.

Liow, K. H. (2010): "Integration among USA, UK, Japanese and Australian securitised real estate markets: an empirical exploration." *Journal of Property Research*, Vol. 27, No. 4, December 2010, pp. 289–308.

Liow, K.H. and Lee, Z. (2011): "Extreme Dependence between public real estate and stock markets." *IRES Working Paper Series*, IRES2011-014, June 2011.

Markowitz, H. (1952): "Portfolio Selection." *Journal of Finance* 7(1):77-91.

Niskanen, J. and Falkenbach, H. (2011): "REITs and Correlations with Other Asset Classes: A European Perspective." *Journal of Real Estate Portfolio Management*, Vol. 16, No. 3, Sep-Dec 2010, pp. 227-239.

Orskaug, E. (2009): "Multivariate DCC-GARCH Model -With Various Error Distributions", SAMBA 19/09, Norwegian Computing Center, June 2009.

Ott, S. H., Riddiough, T. J., & Yi, H.-C. (2005). Finance, investment and investment performance:Evidence from the REIT sector. *Real Estate Economics*, 33(1), 203–235.

Park, A. U. (2009): "The REIT Niche and the UK REIT Market." *Journal of Global Business Management*, Vol. 5 No. 1, April 2009.

Silvennoinen, A. and Terasvirta (2007), T.: "Multivariate garch models".*Working Paper Series in Economics and Finance, No. 669*.

Sharpe, W. F. (1966). "Mutual Fund Performance". *Journal of Business* 39 (S1): 119–138.

Trück, S. and Rong, N. (2010): "Modeling the dependence structure between Australian equity and real estate markets-a Copula approach." Available at http://ssrn.com/abstract=1663152

Tse, Y. K.(2000): "A test for constant correlations in a multivariate GARCH model," *Journal of Econometrics*, Elsevier, vol. 98(1), pages 107-127, September, 2000.

Tse, Y. K. and Tsui, A. K. C. (2002): A Multivariate Generalized Autoregressive Conditional Heteroscedasticity Model with Time-Varying Correlations. *Journal of Business & Economic Statistics*, 20(3), pp. 351-362.

Zhilan Feng, Chinmoy Ghosh and C. Sirmans, (2007): "On the Capital Structure of Real Estate Investment Trusts (REITs)." *The Journal of Real Estate Finance and Economics*, Springer, vol. 34(1), pages 81-105, January.

Appendix

The composition of the Euronext IEIF REIT Europe index as at February 10, 2012:

NOMENCLATURE DE L'INDICE EURONEXT IEIF REIT EUROPE

AU 10.02.12

	Capitalisation en M€	Flottant	Capitalisation flottante capée en M€	Poids	Code ISIN	Cours en €	Nombre de titres
ALSTRIA OFFICE REIT	643	80%	514	1.0%	DE000A0LD2U1	8.95	71 763 625
Total Allemagne (1 société)	**643**		**514**	**1.0%**			
BEFIMMO	998	85%	790	1.5%	BE0003678894	53.31	18 715 440
COFINIMMO	1 376	100%	1 281	2.5%	BE0003593044	91.50	15 040 300
Total Belgique (2 sociétés)	**2 374**		**2 071**	**4.0%**			
FONCIERE DES REGIONS	3 047	45%	1 371	2.7%	FR0000064578	55.46	54 948 439
GECINA	4 793	35%	1 677	3.3%	FR0010040865	76.50	62 650 448
ICADE	3 251	45%	1 463	2.8%	FR0000035081	62.75	51 813 088
KLEPIERRE	4 534	50%	2 267	4.4%	FR0000121964	23.91	189 648 240
MERCIALYS	2 531	35%	886	1.7%	FR0010241638	27.50	92 022 826
SILIC	1 372	60%	823	1.6%	FR0000050916	78.69	17 439 704
UNIBAIL-RODAMCO SE	13 105	100%	7 762	15.0%	FR0000124711	142.75	91 806 889
Total France (7 sociétés)	**32 634**		**16 250**	**31.5%**			
BENI STABILI	797	50%	398	0.8%	IT0001389631	0.42	1 916 274 715
IMMOBILIARE GRANDE DISTRIBUZIONE	276	40%	110	0.2%	IT0003745889	0.89	309 249 261
Total Italie (2 sociétés)	**1 073**		**509**	**1.0%**			
CORIO	3 445	100%	3 445	6.7%	NL0000288967	37.33	92 291 961
EUROCOMMERCIAL	1 121	90%	1 006	2.0%	NL0000288876	27.36	40 996 505
NIEUWE STEEN INVESTMENTS	564	85%	344	0.7%	NL0000292324	9.34	60 361 376
VASTNED RETAIL	660	100%	660	1.3%	NL0000288918	35.69	18 495 220
WERELDHAVE	1 292	100%	1 292	2.5%	NL0000289213	59.59	21 679 608
Total Pays-Bas (5 sociétés)	**7 082**		**6 746**	**13.1%**			
BIG YELLOW GROUP	466	85%	396	0.8%	GB0002869419	3.58	129 958 711
BRITISH LAND	5 221	100%	5 221	10.1%	GB0001367019	5.87	888 929 178
CAPITAL SHOPPING CENTRES GROUP	3 417	70%	2 392	4.6%	GB0006834344	3.98	859 297 169
DERWENT LONDON	2 107	85%	1 788	3.5%	GB0002652740	20.73	101 640 982
GREAT PORTLAND ESTATES	1 357	95%	1 290	2.5%	GB00B01FLL16	4.34	312 676 149
HAMMERSON	3 252	100%	3 257	6.3%	GB0004065016	4.57	711 415 209
HANSTEEN	559	100%	559	1.1%	GB00B0PPFY88	0.88	638 833 250
LAND SECURITIES	6 314	95%	5 970	11.6%	GB0031809436	8.10	779 229 300
LONDON & STAMFORD PROPERTY	727	100%	727	1.4%	GB00B4WFW713	1.33	545 795 171
SEGRO	2 041	100%	2 041	4.0%	GB00B5ZN1N88	2.75	741 678 379
SHAFTESBURY	1 533	100%	1 533	3.0%	GB0007990962	6.12	250 498 809
WORKSPACE GROUP	394	80%	315	0.6%	GB00B67G5X01	2.73	144 091 418
Total Royaume-Uni (12 sociétés)	**27 390**		**25 490**	**49.4%**			
TOTAL (29 REIT)	**71 195**		**51 579**	**100%**			

Source : IEIF, EURONEXT et SixTelekurs

Source: http://www.ieif-indices.com/