TIME VARYING BETA ESTIMATION FOR TURKISH REAL ESTATE INVESTMENT TRUSTS:
AN ANALYSIS OF ALTERNATIVE MODELING TECHNIQUES

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ABSTRACT

TIME VARYING BETA ESTIMATION FOR TURKISH REAL ESTATE INVESTMENT TRUSTS (REITs):
AN ANALYSIS OF ALTERNATIVE MODELING TECHNIQUES

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This study investigates the time varying behavior of the betas (systematic risk) for the Turkish REIT sector in an attempt to identify whether the betas for the Turkish REITs are stable and if not whether the declining trend valid for the REIT betas of many developed and developing countries is also observed for the Turkish REITs. Three different techniques; namely, Diagonal BEKK (DBEKK) GARCH model, the Schwert and Seguin model and the Kalman Filter algorithm, are employed in order to estimate and analyze the time varying betas of the Turkish REIT sector over the period 2002-2009. The empirical results suggest that, similar to many other countries, betas are not stable in the Turkish REIT sector. The general view of a declining beta trend for the REITs appears to prevail for Turkish REITs as well, reinforcing the defensive characteristics of these publicly traded real estate companies. Comparing the relative forecast accuracy of the three techniques employed, Schwert and Seguin model performs the worst both for weekly and daily data; whereas the Kalman Filter and the DBEKK Garch models provide the lowest forecast errors for the weekly and the daily data, respectively. This study also shows that the use of the data sets with different frequency could lead to different empirical findings.

Key words: Beta estimation, REITs, Garch, Schwert and Seguin, Kalman Filter

ÖZ

TÜRK GAYRİMENKUL YATIRIM ORTAKLIKLARINDA (GYO) DEĞİŞKEN BETA TAHMİNİ:
ALTERNATİF MODELLEME TEKNİKLERİNİN ANALİZİ

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Bu çalışma, Türk GYOları için betanın (sistematik risk) durağan olup olmadığını, eğer değilse birçok gelişmiş ve gelişmekte olan ülke GYOları için geçerli olan azalma eğiliminin Türk GYO betalarında da gözlemlenip gözlemlenmediğini tespit etmek amacıyla Türk GYO sektörü betalarının (sistematik risk) zamana bağlı davranışı araştırmaktadır. Türk GYO sektörünün değişken beta katsayılarının 2002-2009 yılları arasında, günlük ve haftalık bazda, tahmin ve analiz edilmesi amacıyla üç ayrı teknik, Diagonal BEKK GARCH modeli, Schwert ve Seguin modeli ve Kalman Filtresi, kullanılmaktadır. Ampirik bulgular, diğer birçok ülkede olduğu gibi Türk GYO sektöründe de betanın durağan olmadığını ve GYO betalarının azalma eğiliminde olduğu genel görüşünün Türk GYOları için de geçerli olduğu sonucunu ortaya koymaktadır. Çalışmada kullanılan tekniklerin öngörü doğrulukları karşılaştırıldığında, her iki veri frekansı için Schwert ve Seguin modelinin en kötü performans gösteren model olduğu, Kalman Filtresi ve Diagonal Bekk Garch modellerinin ise sırasıyla haftalık ve günlük veri için en düşük öngörü hatalarına sahip modeller olduğu ortaya çıkmaktadır. Ayrıca, çalışmada ulaşılan sonuçlar farklı veri frekansı kullanılmasının farklı bulgulara yol açabileceğini de göstermektedir.

Anahtar Kelimeler: Beta tahmini, GYO, Garch, Schwert ve Seguin, Kalman Filtresi

To my parents

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CHAPTER 1

INTRODUCTION

1.1 Motivation of Research

Beta represents one of the most widely used concepts in finance. Beta is a measure of systematic risk, the non-diversifiable portion of the variability in returns in the Capital Asset Pricing Model (CAPM) originally developed by Sharpe and Lintner (1965). The CAPM hypothesis states that the relevant risk measure in holding a given security is the systematic risk or beta, because all other risk measures can be diversified away through portfolio diversification. Beta is used by financial economists and practitioners to estimate a stock's sensitivity to the overall market, to identify mispricing of a stock, to calculate the cost of capital, to apply various valuation models and to evaluate the performance of asset managers. In the context of the CAPM, beta is assumed to be constant over time and is estimated via ordinary least squares (OLS). However, inspired by theoretical arguments that the systematic risk of an asset depends on microeconomic as well as macroeconomic factors, various studies, e.g., Blume (1971), Fama and Macbeth (1973), Fabozzi and Francis (1978), Sunder (1980), Bos and Newbold (1984), Collins et al. (1987), Brooks, Faff and Lee (1992), Wells (1994), Bos and Fetherston (1995), Pope and Warrington (1996), Cheng (1997), Abuzar and Shah (2002), Odabaşı (2000, 2002, 2003), Aygören and Sarıtaş (2007), Oran and Soytaş (2008) and Tunçel (2009) have found evidence for the instability of beta.

While many papers have concentrated on testing the constancy of beta, only minor efforts have been made to explicitly model the stochastic behavior of it. Especially in emerging markets, research on beta modeling is very rare in the literature. In an attempt to fill this gap, a number of different techniques have emerged in the recent literature to model and estimate time-varying, or conditional beta. Three most commonly used techniques include the multivariate generalized ARCH (M-GARCH) model, (Bollerslev, 1990), the Schwert-Seguin model (Schwert and Seguin, 1990), and the Kalman Filter algorithm.

The M-GARCH model derives the time-series of beta indirectly from the estimates of both the time-varying conditional covariance of security and market returns and the time-varying conditional variance of market return. For modeling time-varying beta, the GARCH-based approach with different specifications of conditional variance has been utilized in various studies including, Braun et al. (1995), Giannopoulos (1995), McClain et al. (1996), Gonzales- Rivera (1996), Brooks et al. (1997b), Brooks et al. (1998), Lie et al. (2000), Faff et al. (2000), Brooks et al. (2002), Li (2003), Mergner (2005), Choudhry and Wu (2007) and Mergner and Bulla (2008).

The Schwert and Seguin model is a single-factor model of return heteroscedasticity, in that the conditional variance of market returns is obtained from a GARCH process and then used to generate the conditional beta series. Findings of Schwert and Seguin (1990) suggest that the inability of previous studies to validate the CAPM model may be due to their failure to account for the heteroscedasticity in stock returns. Other studies utilizing the Schwert and Seguin approach include Koutmos et al. (1994) and Episcopos (1996), Haddad (2007), Marti (2006) and Liow (2007).

The Kalman Filter approach recursively estimates the parameters including beta in the simple market model without looking at the behavior of return volatility. The structure of parameters can be explicitly modeled within this framework to follow any stochastic process. The Kalman Filter method has been used by Black et al. (1992), Wells (1994), Faff et al. (2000), Brooks et al. (2002), Hillier (2002), Yao and Gao (2004), Ebner and Neumann (2005) and Mergner and Bulla (2008).

In this study, the Diagonal BEKK (Engle and Kroner, 1995) covariance specification of the M-GARCH model, the Schwert and Seguin model and the Kalman Filter algorithm with random walk parameterization will be approached to model and to analyze the time-varying behavior of systematic risk, beta. For the purpose of the study, time varying betas for the real estate investment trust (REIT) sector in Turkey will be analyzed which is also in line with the argument that beta estimates for portfolios are more valuable for portfolio management than the individual betas, especially at the industry level (Yao and Gao, 2004).

The motivation behind the examination of the REIT sector is the different structure of REITs that distinguishes them from the other corporations whose shares are traded on the Istanbul Stock Exchange (ISE). Basically, REITs, the legal framework being introduced by the Capital Markets Board (CMB) of Turkey in 1995, are the publicly traded companies that buy, develop, manage and sell residential and commercial real assets as their primary business. Within very diverse investment opportunities, the REIT industry offers investors a broad range of alternatives including residential properties, office buildings, shopping centers, hotel, resorts, health care facilities …etc. REITs are founded to make real estate investments more liquid and available for all investors. In addition, investment in REIT industry provides investors with inflation hedging, high total return and professional management of real estate besides an excellent tax shelter. In Turkey, all income for the REITs including capital gains, portfolio management income, interest and dividend income is exempt from corporate tax and the REITs may distribute dividends free from withholding tax.

Despite their peculiar characteristics, Turkish REITs offer so far untested and unique angles for the literature of the systematic risk, or beta modeling. In fact, there exist studies only pertaining to testing the beta stability in the ISE stock market in general. However, the evidence on explicitly modeling and estimating beta is non-existent in Turkey for either the stocks or the sectors in ISE. To best of my knowledge this thesis puts forth evidence for the first time on modeling and estimating time varying betas for the Turkish REITs. Therefore, the thesis contributes to the literature not only by modeling systematic risk or beta in an emerging market, Turkey but also by analyzing the time varying betas of the REIT sector, a new sector with distinguishing characteristics.

The specific objectives of this study are:

(1) To model and estimate the time-varying betas of the Turkish REIT industry by applying the Diagonal BEKK GARCH model, the Schwert and Seguin model and the Kalman Filter algorithm.

(2) To make a comparative analysis of the behavior of the time-varying betas estimated by each technique and to compare the techniques in terms of their forecast accuracy.

(3) To make the analysis of the issue both on a daily and weekly basis in order to examine the effect of different data frequency on the results of the study.

In the light of the objectives specified above this thesis aims to determine whether the systematic risk (beta) of the publicly traded real estate companies (REITs) in Turkey is stable and if not, whether there is a declining trend of the betas as in many other developing and developed countries. To achieve this end and to provide the robustness of the study, a comparative analysis is held on employing different time-varying beta estimation techniques along with different data frequency.

1.2 Organization of Thesis

Chapter 1 presents the objectives of the thesis along with the research background. Chapter 2 reviews the literature on the beta instability, the behavior of the REIT betas and the modeling and estimation techniques of the time-varying betas. Chapter 3 describes the REIT sector in Turkey. Chapter 4 describes and analyzes the data. Chapter 5 presents the research methodology and the techniques utilized to model and estimate time-varying REIT betas. Chapter 6 reports the empirical results and analyzes the results. Finally, Chapter 7 presents the concluding remarks and provides recommendations for future research.

CHAPTER 2

A REVIEW OF THE LITERATURE ON TIME-VARYING BETAS

2.1 Studies Regarding Beta Instability

During the last three decades numerous studies have addressed the question of beta's stability over time. Blume (1971), in a pioneering effort, found that portfolio betas tend to regress toward the mean over time. Blume (1971) and Levy (1971) reported on the low correlations of OLS betas through time, concluding that the estimate of an individual firm's beta has low predictive power for decision making in the current period. Blume (1975) studied whether estimated betas exhibit a tendency to regress towards the great mean of all betas. Black, Jensen and Scholes (1972) and Fama and Macbeth (1973) also reported on the time varying nature of beta. Some have claimed that the longer the estimation periods, the more stable the estimates become (Baesel, 1974; Altman, et al., 1974; Blume, 1975; and Roenfeldt, 1978).

Black (1976) stated that beta is linked with leverage that changes with stock price, or with firm decisions (Mandelker and Rhee, 1984). Furthermore, Rosenberg and Guy (1976) identified links between macro data and firm beta. Fabozzi and Francis (1978, 1979) tested for randomly changing betas and for macroeconomic structural shifts in the mean level of beta and provided strong evidence to support instability of betas.

In addition to above studies, more recent works also have found evidence of beta instability for both developed and developing countries including the US, Turkey, Korea, Finland, Malaysia, Hong Kong, India, Sweden, and so on. For instance, the studies provided by Kim and Zumwalt (1979), Sunder (1980), Alexander and Chervany (1980), Theobald (1981), Chen (1982), Bos and Newbold (1984), Kryzanowski and To (1984), Rahman, Kryzanowski and Sim (1987), Collins *et al.*

(1987), Ledolter and Rayburn (1987), Faff, Lee and Fry (1992), Brooks, Faff and Lee (1992,1994), Kim (1993), Kok (1992,1994), Wells (1994), Bos and Fetherston (1995), Bos, Fetherston, Martıkainen and Perttunen (1995), Pope and Warrington (1996), Cheng (1997), Brooks, Faff and Arıff (1997), Brooks and Faff (1998), Abuzar and Shah (2002), Odabaşı (2000, 2002, 2003a, 2003b), Aygören and Sarıtaş (2007), Oran and Soytaş (2008) and Tunçel (2009) all share in common the observation that beta-coefficients are far from being stable.

In particular, the studies for Turkey are explained in detailed below:

Odabaşı (2000) investigated the stability of betas of 100 common stocks traded in the ISE for the period 1992-1997, utilizing both weekly and monthly return data of individual stocks and portfolios of different sizes. He concluded that as the period of estimation gets longer, more stability is observed. His results also imply that portfolios with 5 or more stocks tend to have more stability. Over approximately the same period and also employing weekly returns from the ISE, Odabaşı (2002) found that the stability of betas is comparable to those of developed countries but the percentage of instable betas seems lower for shorter estimation periods. Odabaşı (2003a) also worked with weekly returns in addition to monthly returns to test the stability of betas from a sample of 100 stocks and different sized portfolios. He discovered a significant difference between weekly and monthly betas. His results suggest that the interval period for which the betas appear stable are 2 years for weekly returns and 4 years for monthly returns. Hence, the estimation interval seems to have an influence on beta stability. In a similar study, Odabası (2003b) found that both return interval and estimation interval have an impact on betas, but not firms' sizes.

Aygören and Sarıtaş (2007) suggested correction methods for beta estimates, utilizing the monthly return data of 90 stocks listed on the ISE, for the sample period covering 1994-2004. They concluded that long time periods such as 8-9 years give better beta estimations.

Oran and Soytaş (2008) found evidence of significant relationships between market returns and both individual stock and portfolio returns. They also found evidence that these relationships do not seem to be stable.

Tunçel (2009) examined the existence of return interval effect in the ISE for the period 2000-2007. He concluded that beta stability is existence in the ISE and there is not any effect of estimation period on the stability, whereas there is a significant difference between weekly and daily betas in this period.

2.2 Studies Regarding the Behavior of the REIT Betas

The above literature showing evidence on beta instability, includes studies examining the country betas, sector betas, portfolio betas and individual stock betas in general. Apart from these, there are also studies mainly focusing on the behavior of the REIT betas in particular, constituting a small part of the literature especially in the developing countries.

Gyourko and Linneman (1988) used a modified CAPM to compare quarterly REITs return with the S&P 500 and bonds for the period 1972-1986. The empirical results showed significant positive correlations between REITs and the stock market. Sagalyn (1990) used quarterly data from 1973 to 1987 to estimate CAPM, and found a lower coefficient of determination between the S&P 500 and REITs during high growth periods when compared to low growth periods. In Sagalyn (1990), results of a Chow test shows the coefficients (betas) have significant structural change. Also, Glascock (1991) argued that REITs betas shift with market conditions: betas are higher during up markets and lower during down markets. The studies specified suggests the systematic risk, beta of CAPM, of REITs may not be constant.

Additionally, there are studies sharing a general view of a declining REIT beta. McIntosh, Liang and Tompkins (1991) were the first to detect a decline in EREIT

(Equity REIT) betas during the 1974 through 1983 time period. Khoo, Hartzell and Hoesli (1993) expanded the McIntosh, Liang and Tompkins sample period from 1970 to 1989, and they provided additional evidence of a temporal decline in EREIT betas. Ghosh, Miles and Sirmans (1996) indicated the correlation between the REIT Index and the S&P 500 drops from 0.770 in 1985-1987 to 0.401 in 1994-1996, showing the relation between REITs and stock market and the systematic risk of REITs can be time varying and decline. Liang, McIntosh and Webb (1995), Clayton and Mackinnon (2001 and 2003), Tsai, Chen and Sing (2007 and 2008) and Hoesli and Camilo (2007) are the others finding evidence of a declining trend in the REIT betas.

Specifically, Tsai, Chen and Sing (2007) explained the decline in REIT betas with a viewpoint of behavior finance: Investors might treat REITs like normal stocks result in REITs behave more like stocks than real estate. As time pass by, people more and more realize what REITs real are and the cash flow and the inflation-hedging characteristics of REITs are different to other securities. Therefore, the longer the real estate being securitized, the more investors realize what the asset securitization is, the more like underlying asset, real estate, they will behave. Similarly, Khoo, Hartzell, and Hoesli (1993) attribute the decline in REIT betas to the increasing information about securitized real estate as an asset class.

In addition, Hoesli and Camilo (2007) examined the behavior of REIT betas in sixteen countries including US and the betas were generally found to decrease over the 1990-2004 period. Two sub-periods (1990-1997 and 1997-2004) were determined and the change in average beta values was examined in their study. The findings showed that of the sixteen countries studied, ten present a significant change in beta from the first sub-period to the second one and from the ten countries whose betas differ from one sub-period to the other, nine of them experience a decrease in their betas.

2.3 Studies Regarding Beta Modeling and Estimation

A number of different techniques have emerged in the recent literature by which one may model and estimate time varying beta. Among those techniques suggested in the literature, two conceptually different modeling approaches can be identified: (i) *econometric models* modeling the time variation in beta as a function of observable economic variables and (ii) *time-series models* providing estimates of the beta series derived from possible internal structure in the data.

The idea of *econometric models* is to account for potential drivers of time-varying betas, and hence to integrate them into one model framework. In other words, the beta-coefficient is modeled and estimated as a function of economic variables that (theoretically) qualify for explaining its time variation. For example, Abell and Kreuger (1989) modeled beta in terms of various macroeconomic variables, such as interest rates, budget deficits, trade deficits, inflation and oil prices. Conceptually comparable studies are Shanken (1990) as well as Faff and Brooks (1998). On the other hand, *time-series models* provide the estimates of the beta series through time allowing to examine and analyze the time-varying behavior of the betas. Among the most prominent modeling techniques of time-series approaches are the multivariate generalized autoregressive conditional heteroscedasticity (M-GARCH) model, the Schwert and Seguin model and the Kalman filter algorithm. The studies regarding these time-varying beta estimation techniques are discussed in detail in the following sub-sections.

2.3.1 GARCH-based Conditional Beta Studies

The M-GARCH model, first proposed by Bollerslev (1990), derives the time-series of beta indirectly from estimates of both the time-varying conditional covariance of security and market returns and the time-varying conditional variance of market returns. The GARCH-based approach to modeling time-varying beta has been utilized in various studies including, Braun *et al*. (1995), Giannopoulos (1995), McClain *et al*. (1996), Gonzales- Rivera (1996), Brooks *et al*. (1997b), Brooks *et al.* (1998), Lie *et al*. (2000), Faff *et al*. (2000), Brooks *et al.* (2002), Li (2003), Marti (2006), Choudhry and Wu (2007) and Mergner and Bulla (2008).[1]

Braun *et al.* (1995) used a bivariate EGARCH model to estimate time-varying conditional betas of a set of size and industry portfolios. The data were US monthly returns over the period 1926 to 1990. They compared their EGARCH betas to those produced by rolling regressions, and conclude that the two measures are strikingly similar.

Giannopoulos (1995) used a bivariate GARCH-in-mean model to assess the time series properties of, first, the total risk of securities return and, second, the systematic and non-systematic components of total risk. The author tested weekly stock market returns for 13 countries over the period 1984 to 1993. The results obtained reveal that for most countries, approximately three-quarters of market volatility can be attributed to country specific events, while only one quarter may be attributed to the systematic factor. However, the systematic component of risk was unstable over time and in certain periods, such as the 1987 crash, international factors were a primary driving factor of total risk.

McClain *et al.* (1996) used a bivariate GARCH model to estimate risk in a group of US mining industry firms based on monthly return data over the period 1926 to 1990. Their general conclusion is that the mining industry is a high risk industry relative to the market and the risk is found to vary significantly through time based on the magnitude and variance of the conditional betas.

Gonzales-Rivera (1996) tested the conditional CAPM against the conditional residual risk model using weekly US computer industry stock price data over the period 1962–1987. Volatility in these models was captured using a bivariate GARCH-in-mean model which was shown to provide superior performance over a

[1] Note that some of the studies also include the utilization of Schwert and Seguin model and the Kalman Filter algorithm for the estimation of beta.

univariate GARCH specification. The results generated suggest that theories based on residual risk possess a superior capacity to explain the expected returns of a stock compared to the CAPM.

Brooks *et al.* (1997b) assessed the impact of regulatory change on risk and returns in the US banking sector, using daily data over the period 1976 to 1994. Systematic risk in this paper was captured by conditional betas which were estimated using a bivariate specification of the M-GARCH model. The 18 major US banks analyzed in this study indicated that the impact of regulatory change is case specific. Further, a sub-period comparison between point estimates of beta and the conditional beta revealed that the former potentially discards important information about the variability of beta.

Brooks *et al.* (1998) estimated conditional time-dependent betas for Australian industry portfolios using monthly data covering the period from January 1974 to March 1996. In this paper three techniques for the estimation of time varying betas were investigated: MGARCH model, Schwert and Seguin model and the Kalman filter. The evidence found in this paper, based on in-sample and out-sample forecast errors, overwhelmingly supports the Kalman filter approach.

Lie *et al.* (2000) applied the MGARCH and the Kalman filter approaches to modelling equity beta risk of a sample of fifteen Australian financial sector companies, for the period 1980-1996. Their study concluded that considerable variability of risk occurs throughout the sample period and the modeling techniques perform well and, in particular, Kalman filter approach is preferred.

Faff *et al.* (2000) estimated time varying systematic risk of 32 different UK industry sectors by EGARCH and a threshold ARCH (TARCH) specification of Garch-type models, Schwert and Seguin model and the Kalman filter, for the period 1969-1998. The results of their study overwhelmingly suggest that market model betas are unstable and betas estimated using the Kalman filter algorithm are consistently more efficient than all other methods. On the other hand, they also concluded that a combined method that incorporates the information contained in the conditional volatility of asset returns into the Kalman Filter algorithm would be considerably more powerful than the estimation method in isolation.

Brooks *et al.* (2002) investigated three different techniques for the estimation of a time-varying beta: a bivariate GARCH model, the Schwert and Seguin approach, and the Kalman filter method. These approaches were applied to a set of monthly Morgan Stanley country index data over the period 1970 to 1995 and their relative performances compared. In-sample forecast tests of the performance of each of these methods for generating conditional beta suggest that the GARCH-based estimates of risk generate the lowest forecast error although these are not necessarily significantly less than those generated by the other techniques considered.

Li (2003) studied the time-varying beta risk for New Zealand sector portfolios by analyzing daily data from January 3, 1997 to August 28, 2002. In this paper, the previous analyses of three major modeling techniques were extended to include the stochastic volatility model and the Schwert and Seguin approach based on the stochastic volatility model. Evidence generated clearly indicates that the betas of all the New Zealand industry portfolios are also unstable. It is found that, in the case of in-sample forecasting, the stochastic volatility model is the optimal technique, while the GARCH model is most favored for out-of-sample forecasting, unlike prior work on other countries which suggests that the Kalman filter approach is preferred.

Marti (2006) compared the accuracy of time-varying betas estimated with different techniques and assessed their impact on the results of cross-sectional tests of the CAPM. Tests are performed with monthly data from US industry portfolio over the period 1980-2005. The modeling techniques considered were the rolling regressions, GARCH models, the Kalman filter, the Schwert and Seguın model, a macroeconomic variables model and an asymmetric beta model. The results indicated that in times-series tests, the Kalman filter with a beta being specified as a random walk provides the most accurate results. Moreover, these betas provide supportive evidence on the validity of the conditional CAPM as they are statistically related to the cross-section of stock returns.

Choudhry and Wu (2007) investigated the forecasting ability of four different GARCH models, and the Kalman filter method. The four GARCH models applied are the bivariate GARCH, BEKK GARCH, GARCH-GJR and the GARCH-X model. The authors also compared the forecasting ability of the GARCH models and the Kalman filter method. Forecast errors based on 20 UK company weekly stock return (based on time-varying beta) forecasts were employed to evaluate out-of-sample forecasting ability of both GARCH models and Kalman method. The findings of the study showed that measures of forecast errors overwhelmingly support the Kalman filter approach.

Mergner and Bulla (2008) investigated the time-varying behavior of systematic risk for 18 pan-European sectors. Using weekly data over the period 1987–2005, six different modeling techniques in addition to the standard constant coefficient model were employed: a bivariate t-GARCH(1,1) model, two Kalman filter-based approaches, a bivariate stochastic volatility model estimated via the efficient Monte Carlo likelihood technique as well as two Markov switching models. A comparison of ex-ante forecast performances of the different models indicate that the random walk process in connection with the Kalman filter is the preferred model to describe and forecast the time-varying behavior of sector betas in a European context.

2.3.2 Schwert and Seguin-based Conditional Beta Studies

As an alternative to the GARCH approach to estimating conditional betas, Schwert and Seguin (1990) proposed a single factor model of stock return heteroscedasticity and incorporate this into an augmented market model equation which provides estimates of time varying market risk. The authors tested monthly size-ranked US portfolios, over the sample period 1927 to 1986. Their findings suggest that the inability of previous studies to validate the CAPM model may be due to their failure to account for the heteroscedasticity in stock returns. In addition to the studies mentioned in section 2.3.1, other studies utilizing the Schwert and Seguin (1990) approach include Koutmos *et al.* (1994), Episcopos (1996), Haddad (2007) and Liow (2007).

Koutmos *et al.* (1994) applied the Schwert and Seguin method of conditional beta estimation to the stock indices of ten industrialized countries, using weekly data over the period 1976 to 1991. Their findings indicated that systematic risk is composed of a constant and a time-varying element and systematic risk for large capitalization markets varies inversely with world market volatility and vice versa.

Episcopos (1996) also used the Schwert and Seguin methodology to estimate time-varying betas for portfolios of Canadian stocks, using daily data over the period 1990 to 1994. The author concluded that time-varying betas differ markedly from constant betas and that the spread between betas of safe and risky sub-index portfolios may increase during periods of increased aggregate volatility in the market.

Haddad (2007) investigated the degree of return volatility persistence and time varying behavior of systematic risk of two Egyptian stock portfolios for the period 2001-2004, utilizing the Schwert and Seguin method. His findings suggested that small stocks portfolio exhibits difference in volatility persistence and time variability. There is also evidence that volatility persistence of each portfolio and its systematic risk are positively related and the systematic risks of different portfolios tend to move in a different direction during periods of increased market volatility.

Liow (2007) estimated two time-varying beta series (i.e. beta relative to the world real estate and beta relative to the world stock market) each from the time-varying volatility process, produced by the method of Schwert and Seguin (1990). The author found clustering, predictability, strong persistence and asymmetry in the conditional volatilities of national, regional and world real estate security markets. The results also indicated that the world real estate security market volatility has a positive impact on the time-varying real estate security market betas of Asia-Pacific, Hong Kong, Singapore and Malaysia, and a negative impact on the real estate security market betas of Europe and the UK.

2.3.3 Kalman Filter-based Conditional Beta Studies

The Kalman filter recursively estimates the beta series from an initial set of priors, generating a series of conditional alphas and betas in the market model. In addition to the studies mentioned in section 2.3.1, other studies utilizing the Kalman filter method include Black et al. (1992), Wells (1994), Hillier (2002), Yao and Gao (2004) and Ebner and Neumann (2005)

Black *et al.* (1992) used the Kalman method to test the performance of UK trusts over the period 1980 to 1989, based on monthly data. The authors found that trusts present investors with investment opportunities which outperform a buy and hold strategy.

Wells (1994) used the Kalman technique to estimate a dynamic version of the market model which allowed alfa and beta to have a relationship to their past values. The data studied was monthly returns for stocks trading on the Stockholm Stock Exchange over the period 1971 to 1991. Different relationships were tested and the results of this study found no clear victor, although the random walk model was somewhat preferred.

Hillier (2002) investigated three possible processes by which mutual fund betas may develop over time and impose three different time-varying models on mutual fund betas using the Kalman filter algorithm with a random coefficient with constant mean model , an AR(1) model and a random walk model. His findings, over all funds in the sample, showed an equal split between the random coefficient model and the random walk model.

Yao and Gao (2004) investigated the form of systematic risk of Australian industrial stock returns. They suggested several time-varying beta models, including random walk model, random coefficient model, ARMA(1,1) model and mean reverting model (or moving mean model) specifications of Kalman filter approach. They found that the industrial portfolio betas are unstable and the variation of industrial portfolio beta is either random or mean-reverting.

Ebner and Neumann (2005) evaluated a rolling regression, a random-walk Kalman filter and a flexible least square model for individual German stocks, for the estimation of beta. Their results supported the later model by improving considerably the accuracy of the beta estimations. They also found evidence that in spite of being widely used by the practitioners, and in academic research as well, the rolling regression is even worse than the constant beta estimated by OLS.

The following section includes an assessment of the findings of the studies summarized in this chapter and provides an evaluation of the review of the related literature in the current context of this study.

2.4 Concluding Remarks

This chapter indicates that there is a large body of literature on beta stability since the early 1970s. During the last three decades numerous studies, examining the country betas, sector betas, portfolio betas and individual stock betas, have found evidence of beta instability for both developed and developing countries. The existing studies for Turkey have basically investigated the stability of betas both for the individual common stocks and the common stock portfolios of different sizes. These studies examine the existence of beta instability in the ISE and the effect of the factors such as the sample period, return interval and portfolio size on the stability of the betas. Empirical findings indicate that the general view of beta instability is also observable for the Turkish stock market in general.

On the other hand, the existing literature on the beta instability lacks of evidence on explicit modeling and estimation of the time-varying beta. It is only after the 1990s when the studies suggesting different techniques for time-varying beta estimation come to the fore. The suggested techniques offer either modeling and estimating beta as a function of observable economic variables that (theoretically) qualify for explaining its time variation or modeling and estimating a beta series as a function of time via time-series models. Considering the studies employing time-series models as in the context of the current study, it is observed that the studies only include the application of the various models and comparison of the forecast performance of these models in terms of various criteria. However, these studies, mostly focusing on the model performance, do not go beyond that and do not provide any further analysis of the betas estimated by the different techniques. This thesis is an attempt to fill this gap in literature by analyzing the time-varying behavior of the betas in detail and assessing the trend of the betas within the framework of the general Turkish economy besides application of different modeling techniques and providing comparison criteria for their forecast performance.

This chapter also indicates that there are several other studies focusing on the behavior of the REIT betas in particular. Examining the time-series trend in REIT betas, these studies constitute a small and a newly improving area of the literature especially in the developing countries. With the increasing popularity of the REITs as an alternative asset class with distinguishing and defensive characteristics for portfolio formation, examining the time-varying behavior of systematic risk for the REITs and its determinants has become a worthy area of investigation. Especially, after the 1990s the studies regarding this issue have increased in number. The empirical findings have revealed a common conclusion of the instable, more specifically declining REIT betas. Indeed, these results strengthen the defensive characteristics of the REITs for many countries. However, these studies have reached such a conclusion either by modeling and estimating beta as a function of observable economic variables or by estimating the betas through sub-sample periods and examining whether the difference in the trend of betas pursued through these periods are statistically significant.

On the other hand, this study obtains beta series by the application of different techniques and determines the time-varying behavior of the REIT betas exactly through the whole sample period. The study enables to estimate betas and make a comparative analysis of different techniques on both daily and weekly basis instead of a sub-sample period basis. Hence, it would be possible to derive more fundamental conclusions for the risk behavior of the REITs relative to the market as a whole.

In fact, this thesis benefits from the three parts of the related literature; namely, the beta instability, the time-varying beta estimation techniques and the time-varying behavior of the REIT betas in particular. The thesis differs from the other studies in the sense that it does not focus on a certain part of the literature but rather incorporates all the parts providing a more conclusive analysis for the academicians, the practitioners and the potential investors. Moreover, to the best of my knowledge, this study is the first step in this direction for an emerging market, Turkey and for a newly developing sector, the REITs in Turkey.

CHAPTER 3

OVERVIEW OF THE REITS IN TURKEY

3.1 Roles of the REITs

Real estate has traditionally been a popular investment tool especially in highly inflationary economies such as Turkey as it provides a good hedge against inflation. However, in contrast to investing in traditional equity investments, investing in direct real estate requires a broad set of specialized skills, which can often be a severe challenge especially for smaller investors. Apart from specialized skills, small investors also cannot find adequate financing to invest in real estate (Yıldırım, 2008).

REITs were seen as a means to address this problem and achieve efficient integration of capital markets and the real estate market. Enabled the pooling and channeling of limited funds contributed by individuals to large scale projects, REITs provide the opportunity to individuals, who otherwise cannot afford to invest in real estate to finance and benefit from large scale projects. Moreover, when the investment needs to be liquidated, the difficulties of liquidation of a large scale real estate project will be eliminated through listing the shares in the stock exchange.

The creation of the REITs in the US in 1960 opened the door for making real estate investments more widely available to small investors and solved the illiquidity problem of the real estate. As of December, 2008, there are 136 REITs registered with the Securities and Exchange Commission (SEC) in the US that trade on one of the major stock exchanges. These REITs have combined market capitalization of 192 billion dollars with total assets exceeding 400 billion dollars. In addition, about 20 REITs are registered with the SEC but are not publicly traded; whereas, approximately 800 REITs are not registered with the SEC and are not traded on a stock exchange (NAREIT, 2009).

To sum up, REITs offer investors (NAREIT, 2009):

- Current income: usually stable and often provides an attractive return;
- Liquidity: shares of publicly traded REITs are readily converted into cash because they are traded on the major stock exchanges;
- Professional management: REIT managers are skilled, experienced real estate professionals;
- Portfolio diversification, which reduces risk.
- Performance Monitoring: a REIT's performance is monitored on a regular basis by independent directors of the REIT, independent analysts, independent auditors, and the business and financial media. This scrutiny provides the investor a measure of protection and more than one barometer of the REIT's financial condition.

In addition to the main advantages specified above, REITs also offer solutions for some country-specific issues. For example, inadequacy of capital in Turkey was one of the most important problems of Turkish real estate sector. Except for the publicly financed development projects, real estate sector had been developed by co-operatives and private construction companies with limited possibilities. In addition, due to the illiquid nature of real estate, the capital invested in land and buildings has not been contributed to the Turkish economic growth. REITs have entered the scene as a perfect tool to solve these capital and liquidity problem as well as to attract both small and large investors. REIT system was also a major step forward to bring international investment standards with reliable and quality information to Turkish real estate market in order to attract foreign investments (Tuhral, 2005).
In Turkey, REITs have another important role: Eliminating the unrecorded real estate market and bringing transparency and discipline to the broader real estate sector. REITs achieve this role in cooperation with appraisal firms. All transactions

and the portfolio valuations of REITs are based on appraisal reports. The appraisers are professional institutions certified by the Capital Markets Board (CMB). A large share of the real estate transactions in Turkey is unrecorded or “under-recorded”, meaning that the declared value of the transaction is substantially less than its market value, mainly in order to avoid taxes. This problem is targeted through the growth of REITs in scale and effectiveness (Aydınoğlu, 2004).

REITs are also seen as institutions that may overcome the problem of squatter, leading to disorganized, unhealthy development of the major Turkish cities. A healthy, well planned development is only possible through institutionalization of the real estate industry (Aydınoğlu, 2004).

3.2 Legal Framework of the Turkish REITs

CMB has set the first legal framework governing the real estate investment trust structure as a capital markets establishment in the *“Principles Communiqué Pertaining to Real Estate Investment Trusts*” (Communiqué) published on July 22, 1995. Within the context of developing market conditions, eight amendments have currently been made in order to regulate the activities and improve the operations of REITs. The last amended legislation was put into effect in July 2008.[2]

There are three main differences distinguishing REITs from other corporations whose shares are traded on the Istanbul Stock Exchange (ISE). First, their operations are governed by the Communiqué on the Real Estate Investment Trusts issued by the CMB. Second, they have tax exemption. In order to promote the formation and growth of the industry, REITs are exempted from both corporation and income taxes. Moreover, tax exemption applied to non-distributed profits of REITs provides REIT investors with an excellent tax shelter, hence increasing the demand for REIT stocks

[2] The most significant set of amendments to the initial regulations have been published on November 8, 1998 with the purpose of addressing the problems impeding the growth of REITs in Turkish Capital Markets. Practically on this date, the initial communiqué has been replaced by a new one, which is currently in effect with relatively minor amendments.

combined with exemption from capital gains tax for a holding period longer than 3 months. Third, contrary to the REIT structure of developed capital markets including United States, Turkish REITs are not required to pay out dividends on an annual basis. In other words, Turkish REITs have freedom to choose their dividend policy. REITs' complete freedom over their dividend policies may enhance their growth through 100% plowback of profits into new investments (Erol and Tirtiroğlu, 2007).[3] This is especially significant for emerging markets like Turkey, where the capital markets are relatively thin and outside capital is extremely scarce making it very expensive (Aydınoğlu, 2004). On the other hand, for US REITs the system is somehow different. To qualify as a REIT, US REITs have to pay out at least 90% of its taxable income as dividends to their shareholders. Because US REITs can only reinvest up to at most 10% of their annual profits back into their core business lines each year, Turkish REITs have a higher chance of rapid growth according to the US peers (Yıldırım, 2008).

3.2.1 Activities and Limitations of the Turkish REITs

Some key regulations of the Communiqué regarding the foundation and activities of REITs are listed below:

- The Communiqué has officially defined REITs as "Capital market institutions which can invest in real property, capital market instruments backed by real estate, real estate projects, rights backed by real estate and capital market instruments, which can found ordinary partnerships and engage in other activities allowed by this Communiqué."

- REITs may be founded

  a) For a specific period to realize a certain project

[3] The only dividend payout requirement for Turkish REITs is that the first dividend ratio cannot be less than 20% of the remaining distributable profit (the profit leftover after the necessary deductions of legal, tax, fund and financial payments, as well as prior year loss deductions, are made).

b) For a specific or unlimited period to invest in specific areas,

c) For a specific or unlimited period without any limitation of objectives.

The first type of REIT has a finite life and is either liquidated at the completion of the project for which it was established or transformed into one of the other two types both of which have perpetual lives. The second type of REIT specializes in a certain type of product or geographic region, while this is a popular model in developed economies such as US and Australia, none of the Turkish REITs currently traded are of this type. All Turkish REITs are of the third type, which is not limited by a certain product type or geographic region, but is still bound by the general principles set by the CMB.

- REITs may be founded instantaneously. Furthermore, existing corporations may amend their articles of incorporation to comply with the provisions of the Communiqué, thereby changing their status to real estate investment trusts. REITs must be founded with a minimum initial capital of 10 million TL. At least one of the founders of a REIT must be a "leader entrepreneur". A leader entrepreneur can be an individual, a group of individuals or institution, whose presence is intended to increase the credibility of the REIT. Accordingly, the leader entrepreneur holds a minimum of 20% ownership in the REIT's equity.

- Operations of REITs can be categorized into two main groups, namely real estate and capital markets instruments. As such, REITs can engage in the following activities:

  a) Purchase and sale of real estate for the purposes of generating capital gains or earning rental income.

  b) Purchase of land to realize capital gains or to develop projects by means of setting usufruct on real estate.

  c) Purchase and sale of capital market tools and reverse repo transactions with such tools.

d) Investing in capital market instruments based on real estate such as real estate certificates, asset backed securities and other similar securities accepted by the CMB.

e) Purchase of foreign real estate on condition of obtaining ownership, investment in companies established abroad provided that their field of operation is only the real estate and investment in foreign real estate backed securities.

f) Lease of real estate from third parties and renting them in return to generate rental income.

g) For hedging against risks, realize swap and forward transactions, write options for real estate backed securities.

- The following restrictions govern the operations of a REIT:

  a) REITs are not allowed to have control or management of any company in which it has invested. Moreover, they are not permitted to have more than 5% of either the total of issued capital or the voting rights.

  b) REITs are not permitted to invest in gold or valuable metals.

  c) REITs may not invest in capital market tools that are not quoted on the stock exchange or on any other organized market for the portfolio. Purchase and sale of capital market tools should be done through the stock exchange.

  d) REITs may not invest in commodity futures or in commodities.

  e) REITs may not sell marketable securities in short position or shall not lend marketable securities.

  f) Except for hedging purposes, REITs may not invest in financial derivatives.

  g) REITs may not invest in assets and rights that are subject to any kind of restrictions in transfer.

  h) REITs may not continuously make short term real estate purchasing and selling operations.

  i) REITs may not in any way be involved in construction of real estates and may not recruit personnel and equipment with this purpose. For these kinds of activities they have to sign contracts with contractors.

- REITs are obliged to invest a minimum of 50% of their portfolio in real estate and real estate backed securities. Earlier, this ratio was 75% in 1998 Communiqué. This reduction has given them further flexibility to construct a more diversified portfolio with short and long term fixed income securities and equity.

- REITs are obliged to float at least 49% of the total shares within one-year after the commercial legislation (in one year if their paid-in-capital is up 50 million TL, in 3 years if between 50 million-100 million TL and in five years if in excess of 100 million TL). The minimum public offering of 49% is intended as a control mechanism to create a balanced partnership structure and accordingly allow all shareholders, especially small shareholders to equally benefit from the profits generated from real estate markets (Yıldırım, 2008).

- REITs may borrow up to an amount three times as much as the total equity amount stated on their last balance sheet in order to meet short term fund demand or costs related to their portfolio.

- REITs' assets as well as rental rates for properties must be valued by an independent appraiser authorized by the CMB. Use of independent appraisers is of vital importance for the REITs. From the minority shareholder's perspective, independent appraisal is a protection in case of a conflict of interest with the management or controlling shareholders. From CMB's perspective, independent appraisal is crucial for the proper monitoring of compliance with the portfolio restrictions.

- REITs are subject to the following disclosure requirements:
  a) Appraisal reports: Any appraisal reports prepared pursuant to the CMB regulations must be sent to CMB within 6 business days.

b) Transactions in excess of 10% of the portfolio value: The REIT board of directors is required to disclose any investment decisions in excess of 10% of the portfolio value to CMB within 6 business days.

c) Portfolio table: Portfolio table, which exhibits the portfolio assets, acquisitions costs and latest appraisal values must be sent to the Istanbul Stock Exchange within 6 days following month end.

d) Independent auditor's report and financial statements: Financial statements such as balance sheet and income statement are prepared on a quarterly basis and are subjected to independent audit every six months. The financial statements and auditor's reports are submitted to CMB within 6 business days of completion. In addition, the same documents must be sent to the Istanbul Stock Exchange to be published in the daily bulletin within 10 weeks of the quarter end.

e) Annual report: Annual report has to be submitted to CMB within 6 days upon completion.

3.2.2 Taxation of the Turkish REITs

All income for the REITs including capital gains, portfolio management income, interest and dividend income is exempted from Turkish corporate tax. Furthermore, the REIT may distribute dividends free from withholding tax. Corporate tax exempt income of the REIT is subject to "exempt income withholding tax" irrespective of whether the income is actually distributed. The "exempt income withholding tax" rate is currently set at 0%. Therefore, investors who are outside the scope of Turkish tax, such as an overseas investor who may have treaty protection from Turkish tax on distributions, should be able to invest completely free of Turkish tax. This is in contrast to other REIT regimes where income and gains are exempt from local tax but dividends are subject to withholding tax and may not be treaty protected (Deloitte, 2009).

3.3 A Quantitative Review of the Turkish REITs

As of June 30, 2009, there are 14 publicly-traded REITs in Turkey quoted on the ISE. These are namely; Akmerkez, Alarko, Atakule, Doğuş GE, EGS, İş, Nurol, Özderici, Pera, Sağlam, Sinpaş, Vakıf, Yapı Kredi Koray and Y&Y. 13 REITs are quoted on the ISE National Market, whereas EGS REIT is quoted on the Watch-List Companies Market. As of June 30, 2009, the total portfolio value of the REITs amounted to 4,470 million TL, the net asset value totaled 4,251 million TL and the market capitalization added up to 1,928 million TL (see Figure 3-1). Specifically, the total portfolio value is defined as the total appraisal based market values of real estate, development projects and the liquid assets held in the portfolio. The net asset value (NAV) is defined as the sum of the total portfolio value and the non-portfolio liquid assets less the total debt. The market value, or market capitalization is the number of shares outstanding multiplied by the price per share on June 30, 2009. In the last 6 years after 2002, total NAV and portfolio values of REITs have increased more than 293%; while market capitalization has increased 469%. Notably, NAV and portfolio value of REITs have shown a continuous increase since 2002, however, market capitalization is somehow cyclical and sensitive that it increases and decreases according to economic environment.

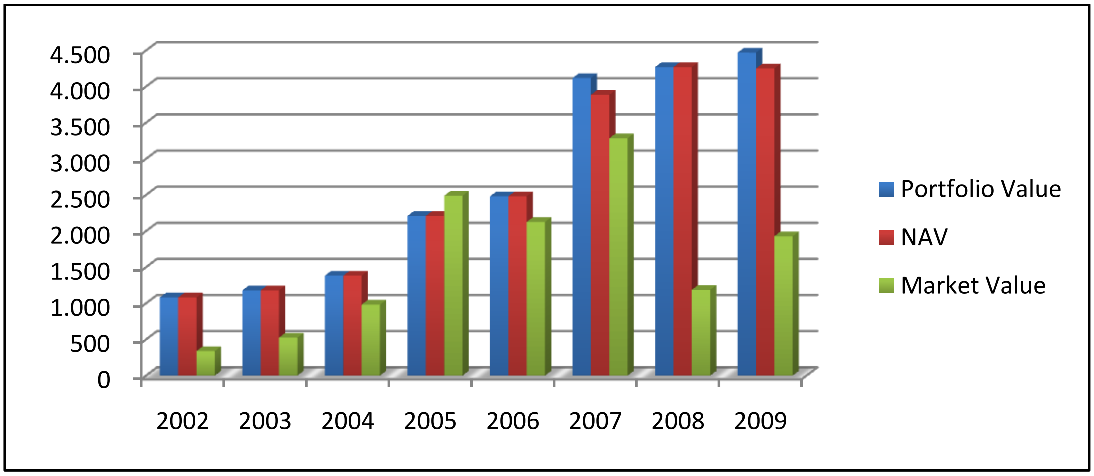

Figure 3 - 1 Comparison of Portfolio, Market and Net Asset Values (in million TL)
Source: *CMB of Turkey & ISE*

Compared to REIT markets in developed countries the REIT sector in Turkey is comparatively small, indicating an important growth potential. In addition to the 14 public REITs, there are 13 more REITs that have been established and have started operations, forming their portfolios and preparing for the initial public offerings. With the quotation of Akfen, Albayrak, Büyükhanlı, Martı, TSKB, İdealist, Kiler, Tuna, Torunlar, Mesa, Reysaş, Özak and Servet REITs to the ISE, there will be 27 REITs with a total net asset value higher than twice the current value (Alga, 2008). As seen in Figure 3-2, the total net asset value of the REITs has increased steadily, except for the period 2008-2009, the net asset value being stable in this period most probably due to the US sub-prime mortgage crisis and the global credit crunch.

Figure 3 - 2 *Development of Turkish REITs*
Source: *CMB of Turkey*

The following pie charts exhibit the net asset values, market values and the market shares based on these respective measures for the 14 public REITs as of June 30, 2009. Is REIT is the industry leader in net asset value terms with a 28% share of the total net assets, followed by Sinpaş REIT with a share of 25% and Akmerkez REIT with a share of 21%; whereas Sinpaş REIT is the industry leader in market value terms with a 28% share of total market capitalization, followed by Is REIT and Akmerkez REIT with shares of 25% and 19%, respectively. According to reports of the CMB of Turkey in June, 2009; the main part of NAV of the Is REIT and the Akmerkez REIT comes from the buildings; while Sinpaş REIT's NAV is portioned out between land and market securities. Despite the lower percentage of outstanding shares, the reason why Sinpaş REIT's market value is the highest may be its high share price (Yıldırım, 2008)

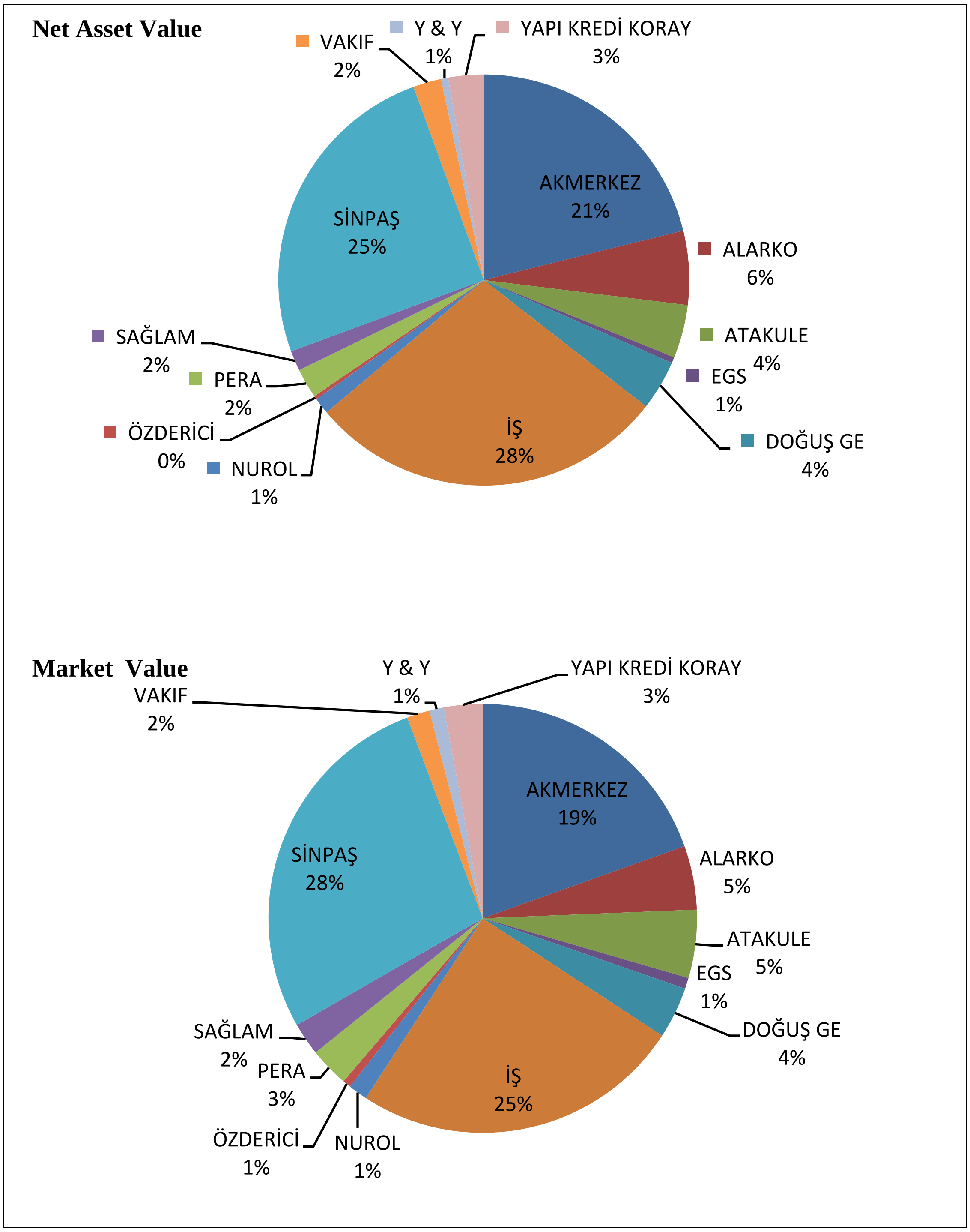

Figure 3 - 3 *Net Asset Values and Market Values of the REITs*
Source: *CMB of Turkey*

Taking a closer look at the portfolio structure of Turkish REITs (see Figure 3-4), it is seen that more than three quarters of the portfolio consists of real estate followed by development projects with a share of 5.64%, as of June 30, 2009. The remaining 8.84% is a combination of liquid assets such as short term government securities and reverse repurchased bond contracts. Examining the portfolio trends since December 2002 reveals that the share of real estate has increased steadily from 2002 to 2009, whereas share of development projects has decreased sharply in the same period. Although development projects constitute the 20.09% of the aggregate portfolio in 2003, only 5.64% share of the aggregate portfolio is composed of development projects in 2009. Even more striking is that there is a zero share of development projects in the aggregate portfolio in the years 2004 and 2005, increasing slightly thereafter. According to Aydınoğlu (2004), share of development projects, with 65.2% in 1999 and 43.9% in 2000, has decreased steeply due to the completion of ongoing projects in 2000 and 2001 and the reluctance of REIT managers to start new projects due to the economic crisis, followed by a recession in the early 2000s. The REIT managers, who have preferred to maintain liquid portfolios and take advantage of the high real interest rates in crisis years, once again start to fill up their development pipelines as the economic growth gains momentum. Moreover, in February, 2007 after the global turmoil of 2006, CBT has gradually decreased the overnight rates down to 15.25%, and loan interest rates started to show a downward trend as a result of the enactment of mortgage law in February, causing a revival in the sector.

Although the strategy of managing a liquid portfolio and using the income tax exemption to generate high returns has been very profitable for REITs and enabled those to come out of recessions with increased net asset values, the performance of REIT stocks have not paralleled this positive trend. While the aggregate net asset value of Turkish REITs has increased from 1,081 million TL to 4,251 million TL between 2002 and 2009, the aggregate market value has increased from 338.7 million TL to 1,928 million TL resulting in a 55% discount to net asset value. Discount to net asset value is prevalent at all periods except for a slight premium in 2005 (see Figure 3-5). The discount rate decreases steadily up to the year 2005 with the recovery of the economy, whereas it increases sharply between the years 2005 and 2006 and the years 2007 and 2008, mainly due to the turmoil in 2006 and financial crisis in 2008.

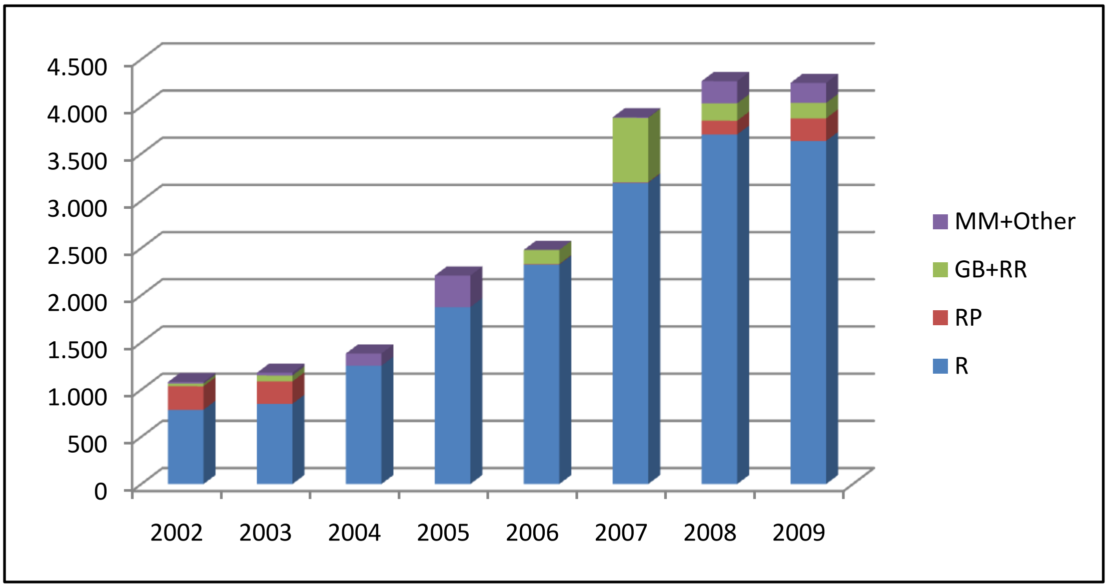

Figure 3 - 4 *Portfolio Breakdown of the REITs (in million TL)*
Source: *CMB of Turkey*
Note: R: Proportion of Real Estates in the Portfolio, RP: Proportion of Real Estate Projects in the Portfolio, GB: Proportion of Public Debt Instruments in the Portfolio, RR: Proportion of Reverse Repo in the Portfolio, MM: Proportion of Money Market Instruments in the Portfolio

Figure 3-6 represents that, over the period 2002-2006, Turkish REITs preferred to finance their portfolios with almost 100% equity. This ratio has slightly fluctuated after the year 2006 however the highest value it took appears to be 106% meaning that in this period, the maximum leverage of REITs is only 6% which is very low compared to many developed countries. On average, US REITs are financing their projects with about half debt and half equity (NAREIT, 2009). The equity financing behavior of Turkish REITs, which is mainly due to the accumulation of non-distributed dividends, significantly reduces the interest rate exposure and creates a much stronger and less volatile business operation.

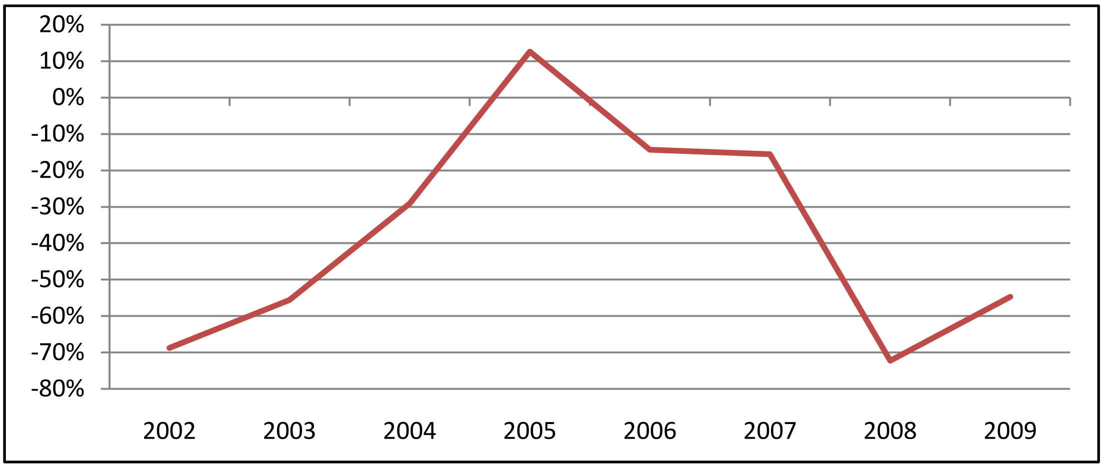

Figure 3 - 5 *REITs Premium/Discount to Net Asset Value*
Source: *CMB of Turkey and ISE*

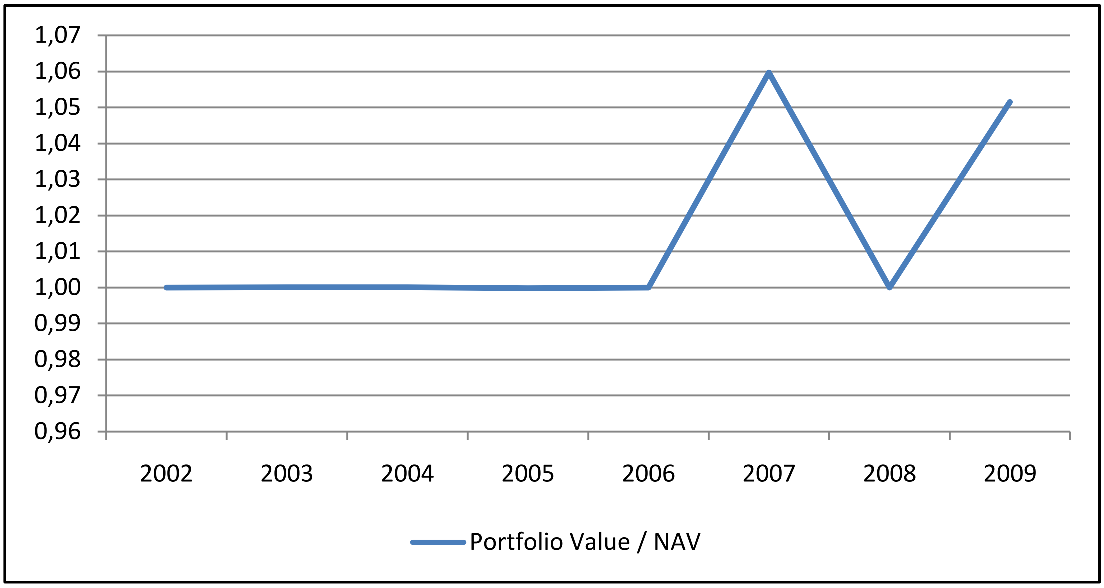

Figure 3 - 6 *REITs Portfolio Value/Net Asset Value*
Source: *CMB of Turkey*

Figure 3-7 demonstrates the price performance of REITs and the industrial, service and financial companies listed on the Istanbul Stock Exchange. The stock market performance of REITs is close to average (measured by the performance of ISE-National 100 Price Index) in 2004, above average in 2005 and below average after 2006. As was the case in 2005, within a positive economic context, the ISE-REIT

Index outperforms the ISE-National 100 Index. The decline in performance in 2006 is mainly due to the rapid increase in overnight interest rates of the Central Bank of Turkey (CBT) from 13.25% to 17.50% in order to prevent economic fluctuations and foreign exchange demand caused by global turmoil in May 2006. This rise has adversely affected housing loans, and because of increased costs, the demand for real estate has decreased. In 2007, CBT has gradually decreased the overnight rates down to 15.25% and loan interest rates started to show a downward trend as a result of the enactment of mortgage law in February, causing a revival in the sector and appreciation in REIT stocks. However, since the US sub-prime mortgage crisis and the global credit crunch in 2008 started a decline in real estate values, the investors remained cautious about real estate companies and the Turkish REIT market did not recover to its full extent. In the first quarter of 2008, negative global economic developments resulted in a major correction in global stock exchanges and ISE received its share (Alga, 2008). Local financial institutions even hardened mortgage origination requirements by slightly increasing mortgage rates. Recovery in the stock exchanges started to show itself in the first quarter of 2009, REITs still underperforming the ISE National 100 Index. This indicates that REITs are discounted, and did not appreciate as much as common stocks in ISE.

On the other hand, Figure 3-7 also shows that REITs generally outperformed the industrial, service and investment trusts sectors between the years 2002 and 2008. However, after the financial crisis of 2008, performance of REITs affected worse, even outperformed by the industrial and service sectors. Although REITs have occupied a small corner of the Turkish capital markets, their investment performance has been overall at par with that of the rest of the common equity market.

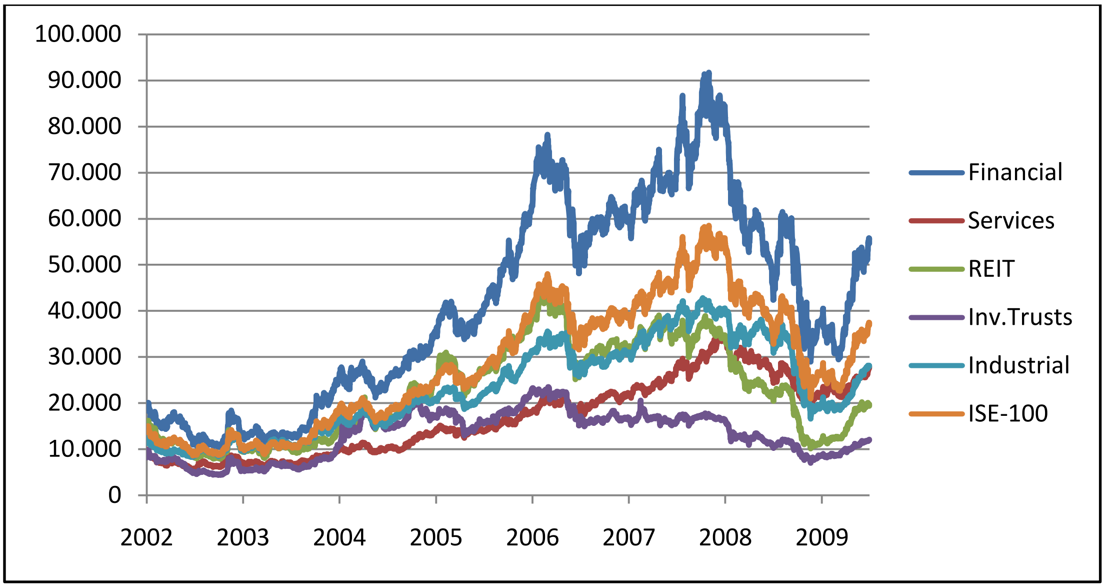

Figure 3 - 7 *Price performance of the main sectors in ISE***.**
Source: *ISE*

3.4 Concluding Remarks

This chapter presents an overview of the Turkish REIT industry. First, it provides general information about the roles of the REITs and the legal framework governing them. Then, this chapter presents a detailed analysis of the Turkish REITs on a quantitative basis.

Compared to REIT markets in developed countries the REIT sector in Turkey is comparatively small but indicates an important growth potential. In order to promote the formation and growth of the industry, the Turkish REITs are exempted from both corporation and income taxes. Moreover, contrary to the REIT structure of developed capital markets including United States, Turkish REITs are not required to pay out dividends on an annual basis. More specifically, Turkish REITs have complete freedom over their dividend policies which may enhance their growth through 100% plowback of profits into new investments. This advantage directs the Turkish REITs to the equity financing which reduces the interest rate exposure and creates a much stronger and less volatile business operation.

Although REITs have occupied a small corner of the Turkish capital markets and mostly they could not reflect the performance of their net asset values to that of the market values, their investment performance has been overall at par with that of the rest of the common equity market, even outperforming the industrial, service and investment trusts sectors most of the time during the sample period.

The next chapters aim to provide a detailed analysis of the risk behavior of the Turkish REIT industry, being a newly developing sector with such distinguishing characteristics, via the estimation of the time-varying betas with different modeling techniques.

CHAPTER 4

DATA ANALYSIS

4.1 Introduction

This study uses three sets of data: REIT sector return, market return and risk-free rate of interest. Both daily and weekly data, ranging from 01.02.2002 to 10.04.2009, are applied[4]. The rationale behind the analysis of the issue on both daily and weekly basis is primarily motivated by the different arguments in the existing literature. On the one hand, it has been argued that daily return data is preferred to the lower frequency data such as weekly and monthly returns because longer horizon returns can obscure transient responses to innovations which may last for a few days only. However, it is also countered that daily data are deemed to contain "too much noise" and is affected by the day of the week effect (Worthington and Higgs, 2006). Similarly, Cotter and Stevenson (2006) concluded that the use of daily data could lead to very contrasting empirical findings. Lower frequency data would appear to allow more time for the more substantial and intuitive relationships to come to the fore. It is possible that the use of higher frequency data masks more of these fundamental relationships. On these grounds, both daily and weekly data sets are employed in order to evaluate the effect of the frequency of data on the results of the present study.

For the calculation of the REIT return and the proxy market return, 1794 daily and 374 weekly observations of the closing values[5] for the ISE-REIT and ISE-National 100 price indices sourced from Istanbul Stock Exchange (ISE) are utilized, respectively. ISE National-100 Index (ISE100 Index) consists of 100 stocks which

[4] The data is drawn from the database of ISE.

[5] For the weekly data, the closing value for Friday of each week is used.

are selected amongst the companies, except investment trusts, traded on National Market in accordance with the criteria set by ISE.

Figure 4-1 presents the daily plots of the ISE100 and ISE All-share[6] price indices and the daily correlation between them, indicating that the indices move almost exactly together and the mean correlation coefficient between the indices for the sample period is 0.9997. ISE-REIT Index (REIT Index) is comprised of the stocks of the real estate investment trusts traded on National Market. The ISE Indices are weighted by the market capitalization of the tradable portion (the stocks registered as tradable by Central Registry Agency) of each constituent.

The returns for the REIT sector and the market are calculated as the log of the price differences of the consecutive index values and the excess returns[7] are created by subtracting the risk free rate of interest from the returns.

For the representative of risk-free rate, the interest rate values for 3-months (91 days) maturity produced by the yield curve which is estimated by the Nelson and Siegel (N&S) model are employed. The data used for the estimation of yield curve is obtained from the information included in the Government Debt Securities payable in Turkish Lira which are traded on the ISE Bonds and Bills Market.

Yield is the interest rate at which the present value of the cash flow at maturity is equal to its current price. While lots of bonds with various maturities are traded at ISE everyday, yield on a bond with a particular maturity would be unobservable unless any trade has been held for that bond, which results in “gaps between maturities”. Yield curves estimated by using limited number of securities gives the opportunity to develop expectations on the yields on such non-traded bonds with

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[6] The ISE All-share Price Index represents the price movements of all firms listed on the ISE.

[7] In this study “excess return” data is used for the analysis. In the following sections, however, “return” and “excess return” terms can be used interchangeably, with the same meaning.

particular maturities and so to measure the term structure of interest rates which describes the relationship between interest rates and time to maturity.

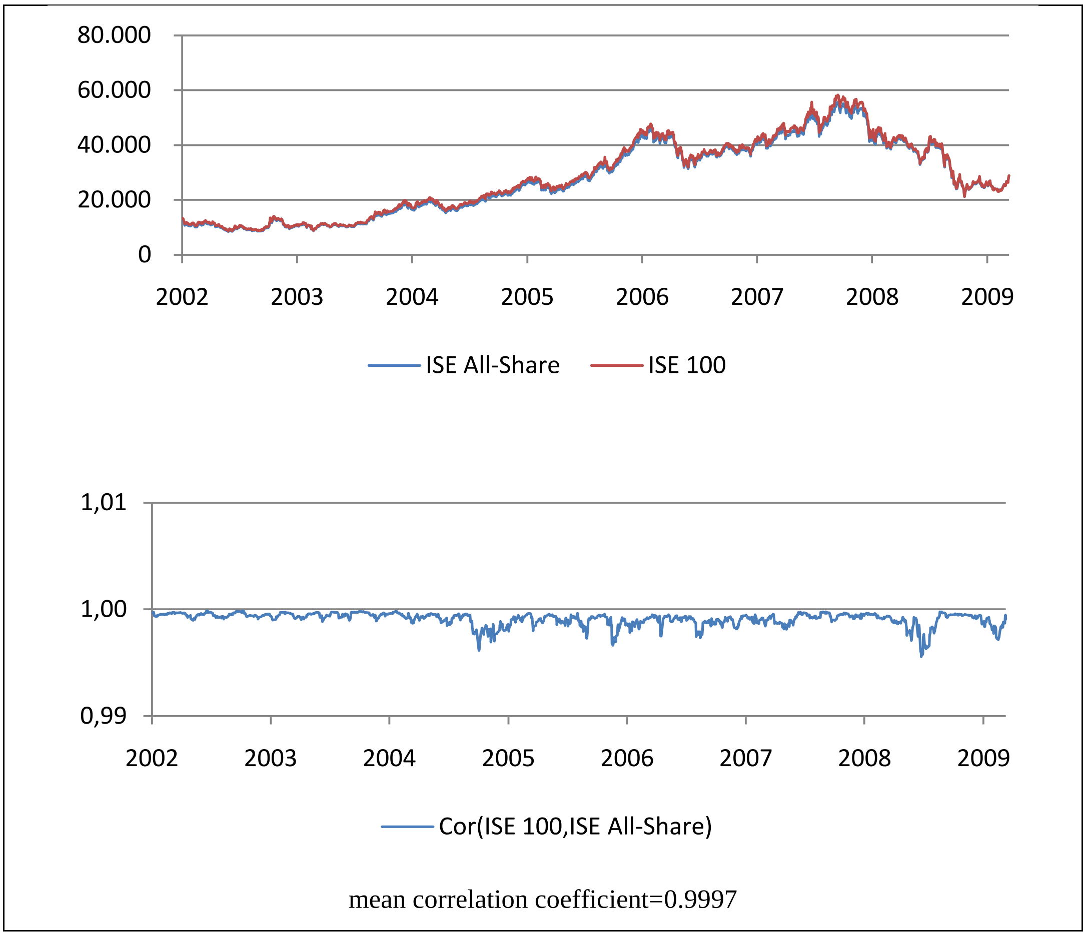

Figure 4 - 1 *Daily plots of the ISE100 and ISE All-share Price Indices and the correlation between the indices.*
Source: ISE
Note: Correlations are obtained from fitting the DBEKK Garch specification.

The standard way of measuring the term structure of interest rates is by means of the spot rate curve, or yield curve on zero-coupon bonds. The reason behind this is that yields-to-maturity on coupon-bearing bonds suffer from the ‘coupon-effect’ which implies that two bonds which are identical in every respect except for bearing different coupon-rates can have a different yield-to-maturity (Pooter, 2007). On this ground, the interest rates on coupon-bearing bonds were converted to the respective values they would take if they were yields to maturity on zero coupon bonds[8] and the yield curve on zero-coupon bonds estimated by N&S model is used for the determination of term structure of interest rates. The estimation method is based on minimizing the difference between the estimated and the actual prices. N&S model and the estimation procedure are explained in detail, in Appendix A.

This study employs two different computer software programs; namely, Eviews 6 and Matlab 7.1 in order to analyze the data sets and carry out estimations.

4.2 A Detailed Analysis of the Data Set

4.2.1 Time Series Plots of Return Series

Figure 4-2 represents the time series of returns on REIT and ISE100 Indices, computed during the period of 2002 and 2009. Over the same time period, both daily and weekly REIT and market index returns are plotted. Both data sets (daily and weekly) show that the returns are time-varying and the phenomenon of volatility clustering can be easily identified: long-lasting and persistent periods of returns with high magnitude (positive and negative) alternate with low volatility periods. As it is expected, REIT sector return and the overall market return follow a similar pattern over the sample time period.

[8] This process is done via applying the related Matlab commands for the Bootsrapping method. Bootstrapping is an iterative process which determines an appropriate discount rate associated with a unique maturity solving for the unknown 'zero' rate.

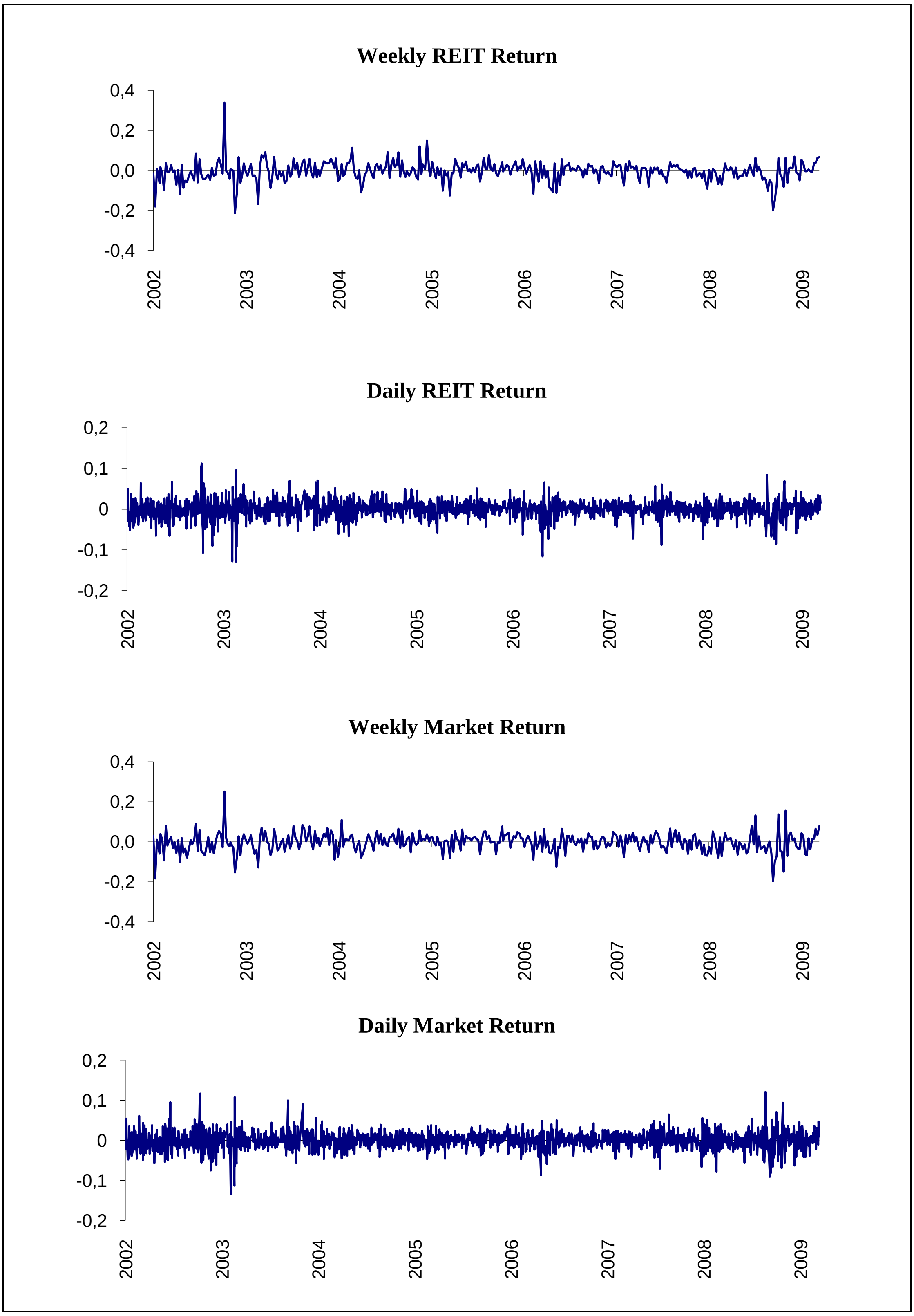

Figure 4 - 2 Time series plots for daily and weekly returns

4.2.2 Descriptive Statistics for the Return Series

Table 4-1 represents the descriptive statistics both for daily and weekly REIT and market returns in order to provide a general understanding of the nature of the return series. Both the daily and weekly data sets show that while the market mean return is greater than the mean return of the REIT-Index, both return series have a similar magnitude of unconditional volatility. The average of the returns is negative for all cases implying the fact that price series have decreased over the sample period. As usual features of financial time series, high kurtosis (heavy tails) and excess skewness are exhibited both for the daily and the weekly return series. It is important to note that the value of skewness is rather small for the series (daily and weekly), market returns being less skewed than the REIT returns. Moreover, the Jarque-Bera test of normality fails for both return series.

Table 4 - 1 Descriptive statistics of the return series

	Mean	*Median*	*Standart Deviation*	*Skewness*	*Kurtosis*	*Jarque-Bera*
Daily						
REIT	-0.0041	-0.0020	0.0219	0.2073	10.6646	918.1432 (0.0000)
Market	-0.0002	0.0003	0.0219	-0.0164	6.4755	903.0025 (0.0000)
Weekly						
REIT	-0.0006	0.0001	0.0491	-0.3591	6.7946	1114.8530 (0.0000)
Market	-0.0021	0.0020	0.0470	-0.0327	6.3318	173.0516 (0.0000)

4.2.3 Unit Root Tests

This study uses four commonly used unit root tests. Namely; Augmented Dickey Fuller (ADF), Phillips Perron (PP), Dickey Fuller GLS (DF-GLS) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests. The results of the unit root tests comprising the

(ADF) and (PP) *t*-statistics and *p*-values, (DF-GLS) and (KPSS) test statistics and the critical values at the 0.10, 0.05 and 0.01 levels are presented in Table 4-2.

The null hypothesis of a unit root is tested against the alternative of no unit root (stationary), for all of the tests except for the KPSS. On the other hand, the null hypothesis of no unit root is tested against the alternative of a unit root (non-stationary) for the KPSS test. The results depict that both daily and weekly data series are stationary (having no unit root) creating no need for data transformation.[9]

Table 4 - 2 *Unit root test statistics and p-values of the returns.*[10]

	ADF	*DF-GLS*	*PP*	*KPSS*
Daily				
	-39.2161	-3.0877	-39.2311	0.2944
REIT	(0.0000)	(0.0100)	(0.0000)	(0.0100)
	-41.2591	-5.3854	-41.2655	0.2086
Market	(0.0000)	(0.0100)	(0.0000)	(0.0100)
Weekly				
	-16.8227	-16.5012	-17.2440	0.1844
REIT	(0.0000)	(0,0100)	(0.0000)	(0.0100)
	-19.1732	-5.7245	-19.2326	0.1776
Market	(0.0000)	(0,0100)	(0.0000)	(0.0100)

Notes: Augmented Dickey Fuller (ADF), Phillips-Perron (PP) and Dickey Fuller GLS (DF-GLS) test hypotheses are H_0: unit root, H_1: no unit root (stationary). The Kwiatkowski, Philips, Schmidt and Shin (KPSS) test hypotheses are H_0: no unit root, H_1: unit root (non-stationary). The test critical values for the DF-GLS test statistic at the 0.01, 0.05 and 0.10 levels are -2.5663, -1.9410 and -1.6165, respectively. The asymptotic critical values for the KPSS LM test statistic at the 0.01, 0.05 and 0.10 levels are 0.7390, 0.4630 and 0.3470, respectively.

[9]This result is obvious by the rejection of the null hypothesis of the ADF, DF-GLS and the PP tests along with the non-rejection of the null hypothesis of the KPSS test.

[10] The represented test results are obtained from the test equations including intercept term only. The results of the test equations including both intercept and trend terms are not reported since they also give the same conclusion of the series being stationary.

4.2.4 Autocorrelation Tests

Autocorrelation refers to the correlation of a time series with its own past and future values. That is, the value of random variable under consideration at one period is correlated with the values of the random variable at earlier time periods. Autocorrelation is also called as serial correlation. For detecting the presence of autocorrelation in return series, this study employs Ljung-Box-Pierce-Q Test and Breusch-Godfrey Serial Correlation LM Test.

The Ljung-Box Q or Q (r[11]) statistic (Ljung and Box, 1978) can be employed to test the hypothesis that autocorrelations up to r^{th} lags are jointly significant. Breusch-Godfrey Serial Correlation LM Test (Breusch and Pagan, 1978) is a Lagrange Multiplier test based on the regression of the OLS residuals on the lags of the residuals and the original regressors in the model, testing the significance of the coefficients of the residuals.

Table 4-3 and Table 4-4 illustrate the test statistic values of the Ljung-Box Q (LBQ) Test and Breusch-Godfrey Serial Correlation LM (BG-LM) test, respectively. Regarding the frequency of the data set, test statistics for different lag numbers are presented for each data series. In particular, for the weekly data relatively small number of lags is employed in order to detect the presence of serial dependency. The results, for which the tests confirm each other, imply that daily/weekly REIT return series and daily market return series exhibit significant autocorrelation, whereas the level of significance for the degree of dependency is rather low in weekly market return series, even there is a lack of significant autocorrelation at higher lags.[12] In addition, both for the REIT and the market return series, the presence of dependencies is more apparent in the high frequency daily data series

[11] "r" represents the number of lags.

[12] For the weekly market return series, up to lag 2 LBQ test represents significant autocorrelation only at %10 level and BG-LM test represents significant autocorrelation at %1 level; whereas, up to lag 10, both LBQ test and BG-LM test show insignificant autocorrelation. Although not reported, higher lags (higher than 10) for weekly market return data are also applied but the result of insignificant autocorrelation still observed.

Table 4 - 3 *Autocorrelation test results of the LBQ Test*

	Q(10)	***Q(20)***
Daily		
REIT	46.764 (0.000)	69.523 (0.000)
Market	26.556 (0.003)	38.807 (0.007)
	Q(2)	***Q(10)***
Weekly		
REIT	12.670 (0.002)	46.764 (0.000)
Market	4.760 (0.093)	9.506 (0.485)

Note: *The null hypothesis of the test is, Ho: There is no serial dependence.*

Table 4 - 4 *Autocorrelation test results of the BG-LM Test.*

Daily				**Weekly**			
Breusch-Godfrey Serial Correlation LM Test for the REIT Return				*Breusch-Godfrey Serial Correlation LM Test for the REIT Return*			
F-statistic	3.360617	Prob. F(10,1782)	0.0002	F-statistic	8.491205	Prob. F(2,369)	0.0002
Obs*R-squared	32.27758	Prob. Chi-Square(10)	0.0004	Obs*R-squared	16.41121	Prob. Chi-Square(2)	0.0003
Breusch-Godfrey Serial Correlation LM Test for the REIT Return				*Breusch-Godfrey Serial Correlation LM Test for the REIT Return*			
F-statistic	2.718126	Prob. F(20,1772)	0.0001	F-statistic	3.247997	Prob. F(10,362)	0.0005 0.0013
Obs*R-squared	52.46974	Prob. Chi-Square(20)	0.0001	Obs*R-squared	28.9724	Prob. Chi-Square(10)	
Breusch-Godfrey Serial Correlation LM Test for the Market Return				*Breusch-Godfrey Serial Correlation LM Test for the Market Return*			
F-statistic	2.480017	Prob. F(10,1783)	0.0060	F-statistic	10.44441	Prob. F(2,370)	0.0000
Obs*R-squared	24.61085	Prob. Chi-Square(10)	0.0061	Obs*R-squared	19.17844	Prob. Chi-Square(2)	0.0001
Breusch-Godfrey Serial Correlation LM Test for the Market Return				*Breusch-Godfrey Serial Correlation LM Test for the Market Return*			
F-statistic	1.951738	Prob. F(20,1773)	0.0070	F-statistic	0,933432	Prob. F(10,363)	0,5023
Obs*R-squared	38.64625	Prob. F(20,1773)	0.0074	Obs*R-squared	9.376083	Prob. Chi-Square(10)	0,4968

Note: The null hypothesis of the test is, H_0: There is no serial dependence.

4.2.5 Arch Test

As specified before, one of the techniques applied in this study for the estimation of time varying betas is the Diagonal BEKK Garch model. The application of Garch-type models requires the investigation of the existence of the Arch effect in the return series. For this purpose, ARCH-LM test developed by Engle (1982) is used in the pre-estimation data analysis. The analysis results for each return series are presented in Table 4-5.

Table 4-5 shows that both for the daily and weekly return series, there exists a significant Arch effect. The rejection of the null hypothesis of homoscedasticity in the residuals eventually shows that Garch models are applicable for the sample return series.

For the employment of ARCH-LM test, residuals obtained from the estimation of AR(1) models are used. Moreover, higher order AR models are also applied; however, the results are not reported since there appears to be not an important change regarding the results of ARCH-LM test. Also, it is important to note that when Arch effect at all lags is investigated separately, for daily data series this effect is outstanding at all lags whereas for weekly data series Arch effect shows itself at higher lags of residuals.

Table 4 - 5 *ARCH – LM Test results for the REIT and the market returns*

Daily				**Weekly**			
Heteroskedasticity Test: ARCH for REIT Return				Heteroskedasticity Test: ARCH for REIT Return			
F-statistic	219.0403	Prob. F.	0.0000	F-statistic	2.9778	Prob. F.	0.0013
Obs*R-squared	195.3769	Prob, Chi-Square	0.0000	Obs*R-squared	28.2933	Prob, Chi-Square	0.0016
Heteroskedasticity Test: ARCH for Market Return				Heteroskedasticity Test: ARCH for Market Return			
F-statistic	39.2669	Prob. F.	0.0000	F-statistic	3.0898	Prob. F.	0.0009
Obs*R-squared	38.4670	Prob, Chi-Square	0.0000	Obs*R-squared	29.2927	Prob, Chi-Square	0.0011

Note: The null hypothesis for the test, H_0: Homoscedasticity in residuals, H_1: Heteroscedasticity in residuals.

CHAPTER 5

METHODOLOGY

5.1 Capital Asset Pricing Model and Unconditional Betas

The Capital Asset Pricing Model (CAPM) developed by Sharpe (1964) and Lintner (1965) states that the most important risk in holding a given security is the systematic risk (market risk), or beta. This is because all other risks, which are commonly called unique or unsystematic risk, can be diversified away through portfolio formation.

The risk of any individual asset is the risk that it adds to the market portfolio. Statistically, this risk can be measured by how much an asset moves with the market (called as the covariance). Beta is a standardized measure of this covariance and obtained by dividing the covariance of any asset's return with the return on a market index by the variance of the market return (Damadoran, 2002). The CAPM assumes that this measure of non-diversifiable risk, namely the beta coefficient (β), is constant through time.

The benchmark for time-varying betas is the excess return market model with constant coefficients where an asset's unconditional beta can be estimated via Ordinary Least Squares (OLS); as shown in Equation (1).

$$R_{it} = \alpha_i + \beta_i * R_{Mt} + \varepsilon_{it} \tag{1}$$

$$\varepsilon_{it} \sim (0, {\sigma_i}^2), \quad \beta_i = \frac{Cov(R_M, R_i)}{Var\,(R_M)} \tag{2}$$

In the present study, R_{Mt} denotes the excess return of the market proxy (ISE100 Index) and R_{it} denotes the excess return of the REIT sector. The error terms ε_{it} are assumed to have zero mean, constant variance, σ_i^2 and to be independently and identically distributed (IID). Following the Sharpe (1964) and Lintner (1965) version of the CAPM, where investors can borrow and lend at a risk-free rate, all returns are in excess over a risk-free interest rate.

5.2 Multivariate Garch Model and Conditional Betas

Modeling volatility in financial time series has been the object of much attention ever since the introduction of the Autoregressive Conditional Heteroscedasticity (ARCH) model in the seminal paper of Engle (1982). Subsequently, numerous variants and extensions of ARCH models have been proposed. While modeling volatility of the returns has been the main center of attention, understanding the co-movements of financial returns is of great practical importance. It is therefore important to extend the considerations to multivariate GARCH (MGARCH) models (Silvennoinen and Teräsvirta, 2008). To this end, a bivariate version of the Garch model is applied in the present study to estimate time varying betas, taking into account the co-movements of the REIT sector and the market returns.

While in the traditional CAPM returns are assumed to be IID, it is well established in the empirical finance literature that this is not the case for returns in many financial markets. Signs of autocorrelation and regularly observed volatility clusters contradict the assumption of independence and an identical return distribution over time. In this case the variance-covariance matrix of the REIT and market returns is time-dependent and a non-constant beta can be defined as:

$$\beta_{it} = \frac{Cov(R_{it}, R_{Mt})}{Var(R_{Mt})} \tag{3}$$

where the conditional beta is based on the calculation of the time-varying conditional covariance between the REIT sector returns and the overall market return and the time-varying conditional market variance.

For the estimation of time varying betas, the first methodological requirement is to specify a system of mean equations producing a return innovation ε_{it} with a conditional mean of zero before a Garch specification is determined. In this study, below specification (Equation 4) is used where the conditional return equation accommodates each market's own return and its return lagged one period[13]:

$$R_{it} = \alpha_{i1} + \alpha_{i2} * R_{i,t-1} + \varepsilon_{it}$$

$$R_{Mt} = \alpha_{m1} + \alpha_{m2} * R_{M,t-1} + \varepsilon_{mt} \tag{4}$$

$$\varepsilon_t \mid I_{t-1} \sim N(0, H_t)$$

where α_{i1} and α_{m1} represent the long-term drift coefficients, α_{i2} and α_{m2} represent the degree of mean spillover effect across time. The market information available at time t - 1 is represented by the information set I_{t-1}. The random error, ε_t is the innovation for each market at time t with its corresponding 2x2 conditional variance-covariance matrix, H_t with

$H_t = \begin{bmatrix} h_{11t} & h_{12t} \\ h_{21t} & h_{22t} \end{bmatrix}$, where H_t should depend on lagged errors ε_t (Arch effect) and on lagged conditional covariance matrices H_{t-1} (Garch effect).

$vec(H_t) = C + Avec(\varepsilon_{t-1}\varepsilon'_{t-1}) \; + Bvec(H_{t-1})$, is a general bi-variate of a GARCH(1,1)[14] variance-covariance specification.

---

[13] The set of mean equations is represented as in (4) in order to provide a general specification. However, the lagged term is not included in the mean equation of the market return used for time varying beta estimation since both the data analysis and the estimation results show that omitting the lagged term pertaining to market return increases the efficiency of the models, the issue of which is mentioned also in the section of emprical results.

[14] Garch (p,q) is the the general representation of the model, where p refers to the number of lags for the Garch term and q refers to the number of lags for the Arch term included in the variance covariance specification. In this study, p=q=1.

For the estimation of time varying betas, the second methodological requirement is to model the conditional variance and covariance structure of the returns, so that the time varying beta series, $\beta_{it} = \frac{Cov(R_{it}, R_{Mt})}{Var\,(R_{Mt})} = \frac{h_{12,t}}{h_{22,t}}$, could be estimated.

What then should the specification of the variance covariance matrix be? On one hand, it should be flexible enough to be able to represent the dynamics of the conditional variances and covariances. On the other hand, the specification should be parsimonious enough to allow for relatively easy estimation of the model and also allow for easy interpretation of the model parameters. Another feature that needs to be taken into account in the specification is imposing the positive definiteness (as covariance matrices need, by definition, to be positive definite). One possibility is to derive conditions under which the conditional covariance matrices implied by the model are positive definite, but this is often infeasible in practice. An alternative is to formulate the model in a way that positive definiteness is implied by the model structure (in addition to some simple constraints) (Silvennoinen and Teräsvirta, 2008).

The first MGARCH model for the conditional covariance matrices was the so-called VEC model of Bollerslev, Engle, and Wooldridge (1988) which is a straightforward generalization of the univariate GARCH model. This model is a very general one and also imposing positive definiteness of the conditional covariance matrix in this model is difficult. On this account, formulating parsimonious models with this feature has been the subject of the subsequent literature.

In the extant literature, the two most popular parameterizations for the MGARCH models are: VEC and BEKK. The BEKK parameterization is adopted for the purposes of this analysis, because this model is designed in such a way that it has less parameters and the estimated covariance matrix will be positive definite, which is a requirement needed to guarantee non-negative estimated variances.

5.2.1 Diagonal BEKK-Garch Model

A model that can be viewed as a restricted version of the VEC model is the Baba-Engle-Kraft-Kroner (BEKK) defined in Engle and Kroner (1995). It has the attractive property that the conditional covariance matrices are positive definite by construction. The quadratic forms of the matrices, A and B, enable to guarantee the positive definiteness of H_t. The model has the following form:

$$H_t = CC' + A'\varepsilon_{t-1}\varepsilon'_{t-1}A + B'H_{t-1}B \quad (5)$$[15]

where A and B are nxn parameter matrices, and C is lower triangular, being symmetric matrix of constants. The elements a_{jk} of the symmetric *nxn* matrix *A* measure the degree of innovation from market *k* to market *j*, and the elements b_{jk} of the symmetric *nxn* matrix *B* indicate the persistence in conditional volatility between market *k* and market *j*.

This can be expressed for the bivariate case of the BEKK as[16]:

$$H_t = C'C + \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix}' \begin{bmatrix} \varepsilon^2_{1,t-1} & \varepsilon_{1,t-1}\varepsilon_{2,t-1} \\ \varepsilon_{2,t-1}\varepsilon_{1,t-1} & \varepsilon^2_{2,t-1} \end{bmatrix} \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix} + \begin{bmatrix} b_{11} & b_{12} \\ b_{21} & b_{22} \end{bmatrix}' \begin{bmatrix} h_{11,t-1} & h_{12,t-1} \\ h_{21,t-1} & h_{22,t-1} \end{bmatrix} \begin{bmatrix} b_{11} & b_{12} \\ b_{21} & b_{22} \end{bmatrix} \quad (6)$$

In this parameterization, the parameters c_{jk}, a_{jk} and b_{jk} cannot be interpreted on an individual basis: "instead, the functions of the parameters which form the intercept terms and the coefficients of the lagged variance, covariance, and error terms are of interest" (Kearney and Patton, 2000). The parameters of the BEKK model do not represent directly the impact of the different lagged terms on the elements of Ht.

[15] The general version of the model is a BEKK(1,1,K) model defined as:

$$H_1 = CC' + \sum_{k=1}^{K} A'_k \varepsilon_{t-1}\varepsilon'_{t-1}A_k + \sum_{k=1}^{K} B'_k H_{t-1}B_k$$

where the summation limit K determines the generality of the process (see Bauwens, Laurent and Rombouts, 2006) In this study BEKK(1,1,1) model is used with K=1.

[16] See Worthington and Higgs, 2006.

Also, the parameters, easily diverge when a model of the type of the full-rank BEKK model is adopted. In the related literature, the Diagonal BEKK model is more popular due to its property of convergence of parameters used in empirical research. Particularly, the Diagonal BEKK is more well-organized in estimating than the full BEKK model, when the number of samples is a constraint (Chou, Wu and Liu, 2009). On these grounds, the Diagonal BEKK (hereafter DBEKK) form of the parameterization is adopted in this study for the ease of direct interpretation of the estimated parameters and the property of convergence of parameters. Namely, the matrices, A and B, are diagonal and the elements of the variance covariance matrix Ht, depends only on lagged values of itself and lagged values of ε_{1t} and ε_{2t} . The matrix representation of the bi-variate DBEKK model is shown below[17]:

$$H_t = \begin{bmatrix} c_{11} & 0 \\ c_{21} & c_{22} \end{bmatrix} \begin{bmatrix} c_{11} & c_{21} \\ 0 & c_{22} \end{bmatrix} + \begin{bmatrix} a_{11} & 0 \\ 0 & a_{22} \end{bmatrix}' \begin{bmatrix} \varepsilon^2{}_{1,t-1} & \varepsilon_{1,t-1}\varepsilon_{2,t-1} \\ \varepsilon_{2,t-1}\varepsilon_{1,t-1} & \varepsilon^2{}_{2,t-1} \end{bmatrix} \begin{bmatrix} a_{11} & 0 \\ 0 & a_{22} \end{bmatrix} + \begin{bmatrix} b_{11} & 0 \\ 0 & b_{22} \end{bmatrix}' \begin{bmatrix} h_{11,t-1} & h_{12,t-1} \\ h_{21,t-1} & h_{22,t-1} \end{bmatrix} \begin{bmatrix} b_{11} & 0 \\ 0 & b_{22} \end{bmatrix} \quad (7)$$

equivalently,

$$h_{11,t} = c_{11}^2 + a_{11}^2 \varepsilon_{1,t-1}^2 + b_{11}^2 h_{11,t-1}$$
$$h_{12,t} = c_{11} c_{21} + a_{11} a_{22} \varepsilon_{1,t-1} \varepsilon_{2,t-1} + b_{11} b_{22} h_{12,t-1}$$
$$h_{12,t} = (c_{21}^2 + c_{22}^2) + a_{22}^2 \varepsilon_{2,t-1}^2 + b_{22}^2 h_{22,t-1} \quad (8)$$

In the bi-variate DBEKK model there are seven parameters to be estimated and the conditional covariance matrices (that are positive definite by construction) are guaranteed to be stationary if $a_{ii}^2+b_{ii}^2<1$, for i= 1,2 (Engle and Kroner, 1995)

[17] See Chou, Wu and Liu (2009).

5.3 Schwert and Seguin Model and Conditional Betas

The second approach to modeling time-varying betas is proposed by Schwert and Seguin (1990). Applying their idea in the current context involves the estimation of the conditional beta (${\beta_{it}}^{SS}$) of the REIT sector return series as follows[18]:

$$ {\beta_{it}}^{SS} = b_1 + b_2 \,/\, h_{Mt} \tag{9} $$

where h_{Mt} refers to the conditional variance of the market return, b_1 and b_2 are regression coefficients of the following equation:

$$ R_{it} = a_0 + b_1 * R_{Mt} + b_2 * r_{Mt} + \varepsilon_{it} \; ^{19} \tag{10} $$

where R_{it} is the REIT sector return, R_{Mt} is the market return, $r_{Mt}=R_{Mt}/h_{Mt}$ and ε_{it} is the error term.

Thus, according to Equation (9), time varying beta consists of a constant term and a time varying component. A positive b_2 indicates an inverse relationship between beta and the aggregate market volatility, whereas a negative b_2 indicates a positive relationship.

In order to obtain β_{it}^{SS} series of the Schwert and Seguin model, conditional variance series of the market return generated by the DBEKK model (h_{22t}) is used for the aggregate market volatility (Brooks, Faff and Mckenzie, 2002).

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[18] See Brooks, Faff and Mckenzie (1998 and 2002) and Haddad (2007).

[19] Notice that the this is the general market model with $\beta_i=\beta_{it}^{SS}$

5.4 Kalman Filter Algorithm and Conditional Betas

5.4.1 An Introduction to Kalman Filter

In the engineering literature of the 1960s, an important notion called ‘state space’ was developed by control engineers to describe systems that vary through time. The general form of a state space model defines an observation (or measurement) equation and a transition (or state) equation, which together express the structure and dynamics of a system (Choudhry and Wu, 2007). The measurement equation describes the relation between observed variables (data) and unobserved state variables. And transition equation describes the dynamics of the state variables based on a minimum set of information from the past such that the future behavior of the system can be completely described by the knowledge of the present state and the future input (Yao and Gao, 2004)

The Kalman filter method, originally developed by Kalman (1960) within the context of linear systems, is an iterative computational algorithm designed to calculate forecasts and forecast variances for time series models. It can be applied to any time series model which can be written in “state space” form.

The Kalman filter is applied recursively through time to construct forecasts and forecast variances. Each step of the process allows the next observation to be forecasted based on the previous observation and the forecast of the previous observation. That is, each consecutive forecast is found by updating the previous forecast. The update rules for each forecast are weighted averages of the previous observation and the previous forecast error. The intriguing feature of the Kalman filter is that the weights in the update rules are chosen to ensure that the forecast variances are minimized. These weights, referred to collectively as the Kalman gain. The Kalman filter is important because it may be applied in real time. That is, as each value of the time series is observed, the forecast for the next observation can be computed (Hyndman and Snyder, 2001)

5.4.2 Kalman Filter Conditional Betas

A state space model can be used to incorporate unobserved variables into, and estimate them along with, the observable model to impose a time-varying structure of the CAPM beta (Faff *et al.*, 2000). Additionally, the structure of the time-varying beta can be explicitly modeled within the Kalman filter framework. Kalman filter recursively forecasts the conditional betas from an initial set of priors, generates a series of conditional intercepts and beta coefficients for the CAPM.

The Kalman filter estimates the conditional beta, using the following time varying market model[20]:

$$R_{it} = \alpha_{it} + \beta_{it} * R_{Mt} + \varepsilon_{it} \qquad \varepsilon_{it} \sim N(0, \Omega) \qquad (11)$$

where R_{it} and R_{Mt} are the excess return on the REIT Index and the market proxy (ISE-100 Index) at time t, respectively and ε_{it} is the disturbance term. Equation (11) represents the observation/measurement equation of the state space model, which is similar to the CAPM model.

The form of the transition equation depends on the form of stochastic process that betas are assumed to follow. In other words, the transition equation can be flexible, such as using a random walk, random coefficients or a moving mean model. There is a sizeable body of literature beginning with Fisher (1971) and Kantor (1971) that asserts that beta follows a random walk (Wells, 1996). According to Faff et al. (2000), the random walk gives the best characterization of the time-varying beta, while AR(1) and random coefficient forms of transition equation encounter the difficulty of convergence for some return series.

The present study considers the form of random walk for both the betas and the alphas, and thus the corresponding transition equation as follows:

[20] See Brooks, Faff and Mckenzie (1998 and 2002).

$$\beta_{it} = \beta_{it-1} + \eta_{it} \qquad \eta_{it} \sim N(0,\delta) \tag{12}$$

$$\alpha_{it} = \alpha_{it-1} + \varphi_{it} \qquad \varphi_{it} \sim N(0,\kappa)$$

Equations (11) and (12) constitute a state space model. To implement the Kalman filter to this model one needs to set initial conditions, expressed by

$$\beta_0 \sim N(\beta_0, P_0)\ ,\ \ \alpha_0 \sim N(\alpha_0, \rho_0)$$

Based on the prior condition, Kalman filter can recursively estimates the entire series of conditional betas.

5.4.3 Derivation of the Kalman Filter

Consider the following system[21]:

$$y_t = Z_t x_t + \varepsilon_t \tag{13}$$

$$x_t = T x_{t-1} + D + \omega_t \tag{14}$$

Equation (13) is known in the literature as the measurement or observation equation. It presents the part of the system that can physically be measured. Here, excess returns to the REITs and excess returns to the market are indeed observed. Equation (14) is known as the state equation. The equation describes the dynamics of the state variables; in the current context, the unobservable betas which will be estimated by the Kalman Filter. Z_t is a matrix of known or unknown, constant or time varying coefficients, here (1xn) matrix of the observable time varying values of excess returns to the market; matrix *T*, the state transition matrix, and *D* are likewise known or unknown matrixes, y_t is the excess return to the REITs and x_t is the vector of state variables, namely the betas. Finally, ε_t is $N(0,\sigma^2)$ while ω_t is multivariate normal with an expected value of zero and a covariance matrix of Q. Note that in the case of a random walk beta, the matrixes, *T* and *D*, will be scalar with T=1 and D=0.

[21] The Kalman Filter derivation relies on Hamilton (1994) and Wells (1996).

The derivation of the Kalman filter rests on the assumption that the disturbances are normally distributed. The disturbances in both the measurement and transition equations are taken to be serially uncorrelated. Furthermore, they are uncorrelated with each other for all the time periods, and with the initial state vector, x_0. Then, the algorithm gives an optimal estimation in the sense that it minimizes the mean square error (MSE).

The Kalman Filter (basic filter) consists of the prediction and updating, two steps[22]:

Prediction: Treating period t–1 as the initial period, the estimate of the state and its covariance at time t, conditional on information available at t–1, are:

$$x_{t|t-1} = Tx_{t-1} + D$$
$$P_{t|t-1} = TP_{t-1}T' + Q \tag{15}$$

When the new observation and corresponding Z_t are available, the one-step-ahead prediction error, υ_t, and its variance, f_t, can be obtained by:

$$\upsilon_{t|t-1} = y_t - y_{t|t-1} = y_t - Z_t x_{t|t-1}$$
$$f_{t|t-1} = Z_t P_{t|t-1} Z'_t + \sigma^2 \tag{16}$$

Updating: The prediction error contains new information about x_t beyond that contained in $x_{t|t-1}$. Thus, after observing y_t, a more accurate inference can be made of x_t. $x_{t|t}$, an inference of x_t based on information up to time t, would be of the following form:

$$x_{t|t} = x_{t|t-1} + P_{t|t-1} Z'_t \upsilon_{t|t-1} / f_{t|t-1} = x_{t|t-1} + K_t \upsilon_{t|t-1} \tag{17}$$

[22] See Yao and Gao (2004).

where $\{K_t\}$ is the weight assigned to new information about x_t contained in the prediction error. Similarly,

$$P_{t|t} = P_{t|t-1} - P_{t|t-1}Z'_t Z_t P_{t|t-1}/f_t = P_{t|t-1} - K_t Z_t P_{t|t-1} \qquad (18)$$

where each $K_t = P_{t|t-1}Z'_t/f_{t|t-1}$ is the Kalman gain, which determines the weight assigned to information about x_t contained in the prediction error. Inspection of the Kalman gain equation shows that if the measurement noise is large, *f* will be large, so *K* will be small and we will not give much credibility to the measurement *y* when computing the next x. On the other hand, if the measurement noise is small, *f* will be small, so *K* will be large and we will give a lot of credibility to the measurement when computing the next. As the estimation advances, the Kalman Filter will correct the initial values in P_t and the results will anyway converge to the MSE estimators.

Using the Kalman filter to estimate the time varying betas has two main benefits. First, the calculation is recursive. Although the current estimates are based on the whole past history of measurement, there is no need for expanding memory and the extra observations available for the regression. Second, the Kalman filter converges quickly, no matter whether the underlying model is (Yao and Gao, 2004).

This section presents a summary and the basic logic of the derivation of the Kalman Filter. A more detailed and theoretic derivation can be found in Hamilton (1994). In addition, the derivation, proposed by Arnold, Bertus and Godbey (2008), in a univariate context, for a simplified approach to understanding the Kalman Filter is presented in Appendix B.

5.5 Assessing the Performance of Alternative Time Varying Beta Estimation Techniques in terms of the Forecast Accuracy

In an attempt to differentiate between the techniques applied for estimating the time varying betas, two measures of forecast accuracy; namely, the Mean Absolute

Forecasting Error (MAE) and the Mean Square Forecasting Error (MSE) are employed. However, it is important to note that the criteria mentioned here cannot be used as the only determinant for evaluating the overall performance of the models, which requires a more detailed analysis and is out of the scope of this study. MAE and MSE can rather be useful to evaluate and compare the respective in-sample forecasts and give a general understanding for the relative performance of the models in terms of their forecast accuracy.

For this analysis the following methodology is employed[23]:

The series R_{it} may be forecast in-sample $\hat{R}_{it}$ using the market model, i.e.

$$\hat{R}_{it} = \alpha_i + \beta_{it} R_{Mt} \tag{19}$$

where β_{it} is provided by each of the three techniques previously described (i.e. $\beta_{it}^{Bekk}, \beta_{it}^{Kalman}, \beta_{it}^{SS}$) and R_{Mt} is the market return, as usual. A conditional intercept coefficient series is generated by the Kalman Filter approach and for the DBEKK Garch and Schwert and Seguin approach, may be estimated as:

$$\alpha_i = \bar{R}_{it} - \bar{\beta}_{it} \bar{R}_{Mt} \tag{20}$$

i.e. α_i is equal to the mean REIT return less the mean conditional beta times the mean market return. Having forecasted $\hat{R}_{it}$ using each of the conditional beta series, one may assess their accuracy using the measures of forecast error which compare the forecasts to actual. MAE and MSE are defined as:

$$MAE = \sum_{t=1}^{T} \frac{|\hat{R}_{it} - R_{it}|}{T} \quad , \qquad MSE = \sum_{t=1}^{T} \frac{(\hat{R}_{it} - R_{it})^2}{T} \tag{21}$$

[23] See Brooks, Faff and Mckenzie (1998 and 2002).

The forecast quality is inversely related to the size of these two error measures. A potential problem with the use of MAE is that it weighs all errors equally. An alternative approach is the mean square forecasting error (MSE) approach where the use of a squared term in the equation places a heavier penalty on outliers than the MAE measure.

CHAPTER 6

EMPIRICAL RESULTS

This chapter presents the empirical results under three different sections. The first section provides estimation results of the three techniques explained in the previous chapter; namely, the DBEKK Garch model, Schwert and Seguin model and the Kalman Filter in addition to the OLS estimation results of the market model. The starting point of this section is the estimation of the unconditional betas for the REITs via the classical market model regression equation of the CAPM. Following the market model with constant beta, this section continues with the results of the time-varying beta estimation techniques. Different than the Kalman Filter and the Schwert and Seguin model, the DBEKK Garch model also provides a comparative analysis of the volatility pattern of the REIT return and the market return besides estimating the conditional betas and hence provides some hidden characteristics regarding the relationship between the REIT sector and the market.

The second section provides a detailed and comparative analysis of the time varying betas estimated by each technique. The analysis is divided into two parts in an attempt to examine both the entire sample period and sub-sample periods separately. In addition, this section presents the descriptive statistics for the time varying beta series generated by each technique and the differences and similarities among the beta series. It also examines the time-varying behavior of betas by assessing the findings within the general economic environment in Turkey and the findings of the existing studies in the related literature. Finally, the last section evaluates the performance of the estimation techniques in terms of their forecast accuracy, using two main criteria; namely, the MAE and the MSE.

6.1 Estimation Results

6.1.1 Market Model (OLS) Estimation Results

Table 6-1 shows the results of the OLS estimation of the market model with constant beta. As can be seen, α values for both data sets are near zero and statistically insignificant, an expected result of the CAPM, for which the relevant risk measure in holding a given security is only the systematic risk, or beta, because all other risk measures can be diversified away through portfolio formation.

Before examining the β values, it will be appropriate to give way to the interpretation of the beta. Beta can be interpreted in different ways. Firstly, beta is the tendency of a security's returns to respond to swings in the market. A beta of 1 indicates that the security's returns will move with the market; in other words, returns of the security fluctuate by exactly the same degree as returns on market as a whole. A beta of less than 1 means that the security will be less volatile than the market. A beta of greater than 1 indicates that the security's returns will be more volatile than the market. Secondly, beta affects a potential investor's required rate of return. The higher the beta, the higher the rate of return and hence the lower the stock value for existing shareholders. Thirdly, low beta indicates that the underlying asset can be useful in reducing the portfolio risk. Higher beta indicates that the underlying asset should not be used to reduce portfolio risk. Thus, it provides inferior diversification benefits. On these grounds, the stability of a risky security's market beta is important when the potential investors use the beta measure for evaluating the performance of the underlying asset, like the REIT stock.

Looking at Table 6-1 again, β values obtained from OLS estimation are 0.86 and 0.81 for weekly and daily data, respectively; showing a high level of significance and a relatively high sensitivity of the REIT sector to the general market movements, with a positive relation. In addition, R-square, indicating the explanatory power of the model, takes values around %66, which can not be considered very low.

Table 6 - 1 *OLS estimation results of the market model:* $\boldsymbol{R_{it} = \alpha_i + \beta_i * R_{Mt} + \varepsilon_{it}}$

Weekly	Coefficient	Std. Error	t-Statistic	Prob.
α	-0.002280	0.001439	-1.584483	0.1139
β	0.862514	0.030622	28.16630	0.0000
R-squared	*0.680780*			

Daily	Coefficient	Std. Error	t-Statistic	Prob.
α	-0.000419	0.000302	-1.388690	0.1651
β	0.810725	0.013782	58.82670	0.0000
R-squared	*0.658834*			

As can be seen from Table 6 - 1, both beta values are less than 1 indicating that the REIT sector is less volatile than the market as a whole and hence it can provide some diversification benefits for the investor[24]. However, it would be less conclusive to make such an interpretation of a single beta value for the whole sample period. In order to examine the changes in beta values between years, the weekly and daily beta values for each year of the sample period are represented in Table 6-2. Table 6-2 indicates that the estimated beta values differ between the years and there is a decline in betas from 2002 to 2009, which in turn leads to suspect the beta is not constant. However, since the OLS estimation gives constant beta values for each year, it is still difficult to examine the time trend of beta through the sample period, the issue of which is targeted in the following sections by employing different time series models.

[24] It should be noted that the diversification benefits may not be large in magnitude since beta values are slightly smaller than 1.

Table 6 - 2 *OLS beta values for each year of the sample period*

Beta	2002	2003	2004	2005	2006	2007	2008	2009
Weekly	1.0953	0.9533	0.7642	0.8964	0.8354	0.6868	0.6513	0.6115
Daily	0.9119	0.8471	0.8367	0.8106	0.8769	0.7559	0.6733	0.6898

Figure 6-1 represents the time series plots of the daily and the weekly residuals obtained from the regression of the market model. A time varying structure of residuals can be observed from the figure, particularly for the weekly data.

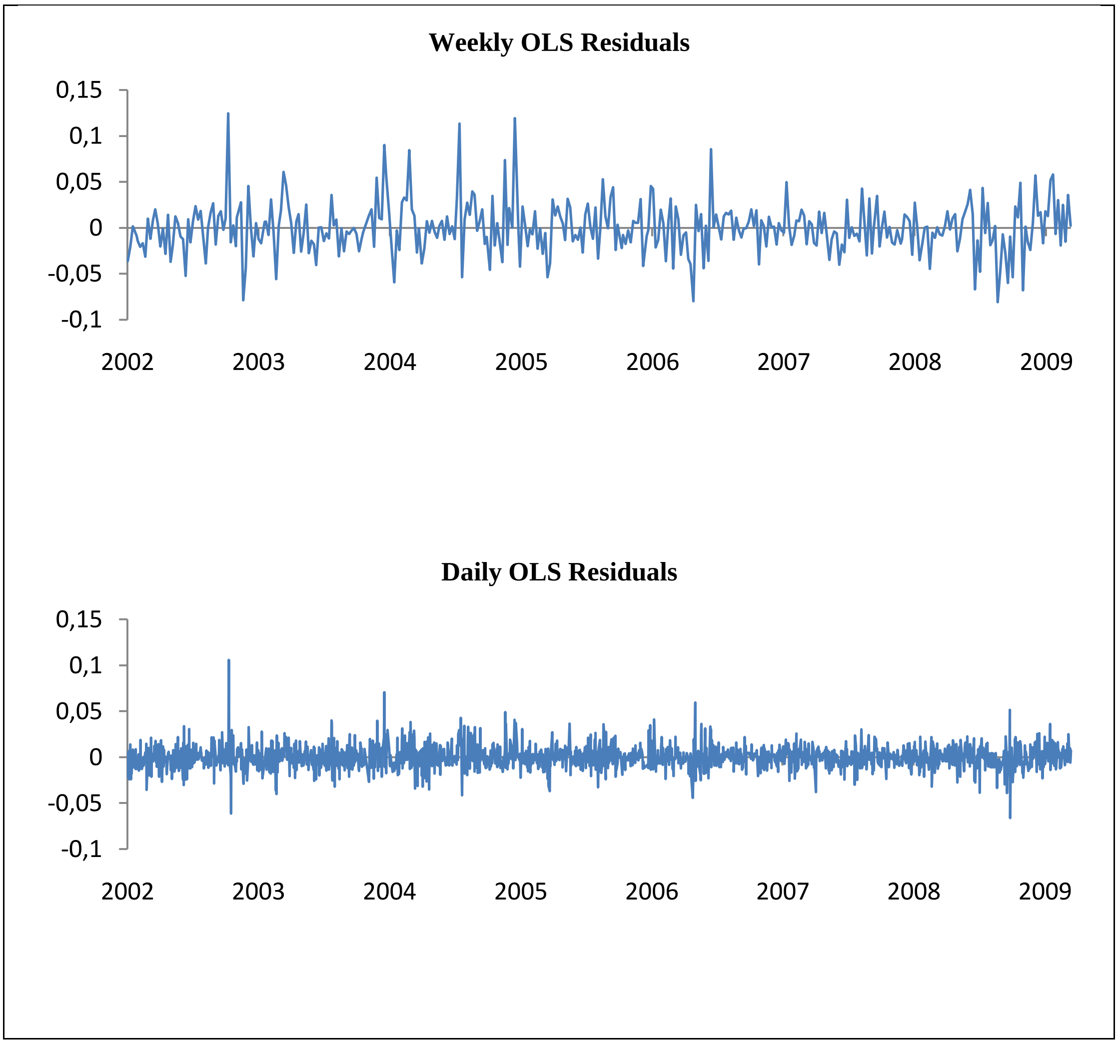

Figure 6 - 1 *OLS residuals of the market model*

6.1.2 DBEKK Garch Estimation Results[25]

DBEKK Garch model not only allows an estimation of the time varying betas through the estimation of time-varying correlations and covariances but also provides an analysis of the volatility, implying the impact of the lagged volatility and innovation on the current volatility. This allows an investor to incorporate time-varying volatility and correlations in their portfolio formation decisions.

- The maximum likelihood estimation results of the DBEKK model, including the estimated coefficients and the probability values for the conditional mean return[26] and conditional variance covariance equations are presented in Table 6-3 and Table 6-4, respectively for daily and weekly data series. The remarkable findings are listed as follows:

  - Mean equation findings show that past series return of the REITs have a positive and significant impact on the current returns of the sector. The appropriate coefficients (c(2)s) are highly significant for both data series, having a larger magnitude and smaller *p*-value for the weekly return of the REITs.

  - The estimated coefficients for the conditional variance covariance equations quantify the effects of the lagged own innovations and lagged own volatility persistence on the own volatility of the REIT sector and the market in general. To start with, the own innovation or Arch

[25] The model is fitted assuming unconditional normality and allowing for fat-tails, an unconditional t-distribution. There are no discernable differences between the two cases and the former values are only reported.

[26] For the mean return equation of the market, the lagged term is not included in the equation due to the low level of serial dependency present at the first lag of the market proxy. Also, when the lagged-term included market mean return equation is employed in the system; the coefficient of this term appears to be insignificant, decreasing also the level of significance of the coefficient of the lagged REIT return and some of the variance equation coefficients in the system. For these reasons, the specification without the lagged term is used for the market mean return equation and the results of the former are not reported.

spillovers (the elements of the diagonal matrix, A) for the REITs and the market return, both daily and weekly, are significant, indicating the presence of significant Arch effects, while the lagged volatility or Garch spillovers (the elements of the diagonal matrix, B) are not only significant but also much larger in magnitude, indicating the presence of significant and high level of Garch effects. For example, for the daily REIT return series, respective innovation and volatility spillovers are 0.3457 and 0.9058; whereas for the weekly REIT return series innovation and volatility spillovers are 0.0945 and 0.9863 respectively, being larger than those of daily series. That is, one unit increase in the lagged weekly volatility of the REIT returns results in an increase of 0.9863 units in current volatility.

- The high and significant level of Garch effect shows the presence of volatility persistence in the markets. Also, the relatively larger magnitude of Garch effect than the Arch effect depicts that past volatility shocks have a larger effect on future volatility than the past innovations have.

- When the daily and weekly estimation results are compared, differences are apparent in the sense that for the daily series, Arch effect is larger and Garch effect is smaller for the REIT return series relative to market return, whereas for the weekly data series the condition is the reverse. The common point is that the magnitude of Garch effect is relatively large and that of Arch effect is relatively small for both return series when the daily data is used.

- The covariance stationarity condition described in section 5.2.1 is satisfied for all cases.

- Figure 6-2 and 6-3 give information about the time series structure of the conditional variance-covariance-correlation series and the beta series[27] estimated by the DBEKK model. Time varying beta series is constructed by the division of the estimated conditional covariance between REIT and the market return by the variance of the market return. The remarkable findings are listed as follows:

    - Variance and covariance series of the REITs and the market exhibit a very similar pattern, both for weekly and daily data. However, the pattern of weekly series is dissimilar to daily series and the trend of beta is more discernable for the weekly series as expected due to the aggregation of the data.

    - Examining the weekly data, both the market return and the REIT return variances are declining sharply between 2002 and 2004, which is not a surprising result considering that this period witnessed an improving economy hence a decreasing volatility in the overall market after the long lasting financial crises of 2000 and 2001. From the year 2004 up to the financial crisis of 2008 variances are nearly stable; except for the slight increase in April, 2006 due to the global turmoil which resulted in a prompt increase in the overnight interest rates of CBT to prevent economic fluctuations and foreign exchange demand. On the other hand, the increase in the variances is more outstanding in June, 2008 with the effect of global financial crisis. The important point is that the increase in market return variance between the period June, 2008 and December, 2008 is much bigger than the increase in REIT return variance, showing that market return variance is much higher and hence market return is more volatile than the REIT return during the crisis period.

[27] Although time series plots of betas are given in this section, the detailed analysis is presented in the next section.

- Daily conditional correlation plot between the REIT sector and the market represents positive correlation coefficients with frequently observed sharp decrease and increases. On the other hand, for the weekly data series, positive correlation coefficients show relatively high values and a decreasing trend through the sample period. In particular, a continuous decline in correlation between 2002 and 2004 is outstanding with a decrease of correlation coefficient from 0.98 to 0.75. Continuously declining correlation between the REIT return and the market return indicates that due to the lower correlation with market, real estate investment (REIT industry) can be used for portfolio diversification purposes since low correlation is good for portfolio risk reduction.

- In general, daily DBEKK beta series, ranging between 0.35 and 1.41, do not provide an observable trend; whereas weekly DBEKK beta series, ranging between 0.55 and 1.09, indicate a well-defined declining trend.

Table 6 - 3 *Daily DBEKK Garch Estimation Results*

Estimated Mean Equations :
$ER_{REİT}$=c(1)+c(2)* $ER_{REİT}$(-1)
ER_{ISE100}=c(3)
Estimation Method: ARCH Maximum Likelihood (Marquardt)
Covariance specification: **Diagonal BEKK**

Sample: 2 1794
Included observations: 1793
Pre-sample covariance: back-cast (parameter =0.7)

	Coefficient	Std. Error	z-Statistic	Prob.
C(1)	0.000126	0.000437	0.289219	0.7724
C(2)	0.042719	0.012193	3.503490	0.0005
C(3)	0.000695	0.000445	1.560330	0.1187
	Variance Equation Coefficients			
C(4)	0.005271	0.000276	19.09600	0.0000
C(5)	0.003574	0.000265	13.48981	0.0000
C(6)	0.002464	0.000264	9.328314	0.0000
C(7)	0.345726	0.012745	27.12628	0.0000
C(8)	0.278711	0.013227	21.07200	0.0000
C(9)	0.905809	0.005303	170.8094	0.0000
C(10)	0.938537	0.005363	175.0167	0.0000

Log likelihood	9818.693	Schwarz criterion	-10.91047
Avg. log likelihood	2.738063	Hannan-Quinn criter.	-10.92979
Akaike info criterion	-10.94110		

Covariance specification: BEKK
GARCH = M + A1*RESID(-1)*RESID(-1)'*A1 + B1*GARCH(-1)*B1

Tranformed Variance Coefficients

	Coefficient	Std. Error	z-Statistic	Prob.
M(1,1)	2.78E-05	2.91E-06	9.548001	0.0000
M(1,2)	1.88E-05	2.18E-06	8.648145	0.0000
M(2,2)	1.88E-05	2.87E-06	6.577317	0.0000
A1(1,1)	0.345726	0.012745	27.12628	0.0000
A1(2,2)	0.278711	0.013227	21.07200	0.0000
B1(1,1)	0.905809	0.005303	170.8094	0.0000
B1(2,2)	0.938537	0.005363	175.0167	0.0000

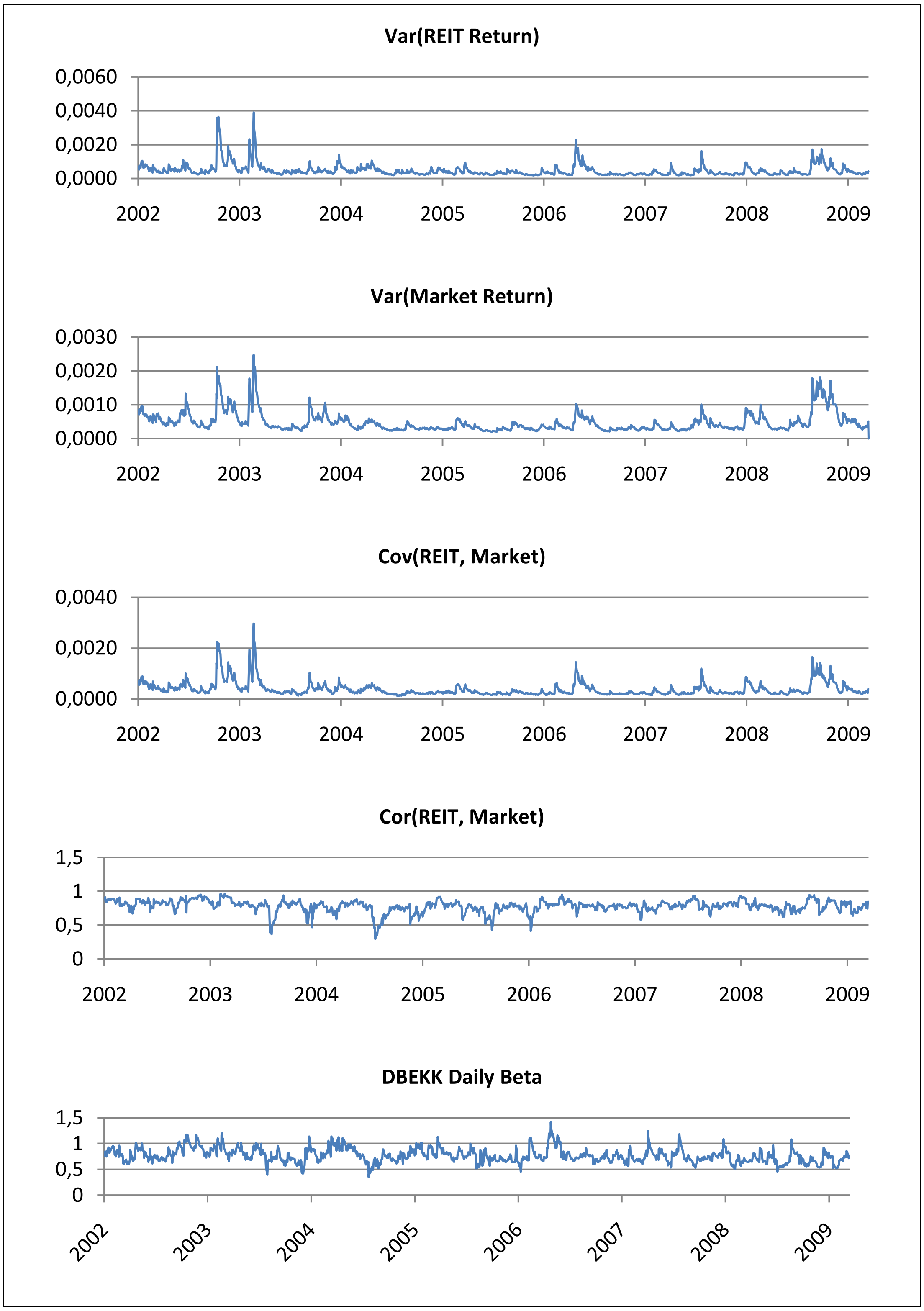

Figure 6 - 2 *Daily Variance-Covariance-Correlation and Beta Series estimated by the Diagonal BEKK Garch*

Table 6 - 4 *Weekly DBEKK Garch Estimation Results*

Estimated Equations :
$ER_{REİT}=c(1)+c(2)*ER_{REİT}(-1)$
$ER_{ISE100}=c(3)$

Estimation Method: ARCH Maximum Likelihood (Marquardt)
Covariance specification: **Diagonal BEKK**
Sample: 2 374
Included observations: 373
Presample covariance: backcast (parameter =0.7)

	Coefficient	Std. Error	z-Statistic	Prob.
C(1)	-0.002829	0.002564	-1.103001	0.2700
C(2)	0.102012	0.023332	4.372229	0.0000
C(3)	-0.000425	0.002275	-0.186815	0.8518
Variance Equation Coefficients				
C(4)	0.005240	0.000553	9.469172	0.0000
C(5)	0.005808	0.000972	5.977126	0.0000
C(6)	0.003191	0.000719	4.435291	0.0000
C(7)	0.094530	0.020010	4.724220	0.0000
C(8)	0.152144	0.021055	7.225963	0.0000
C(9)	0.986330	0.001975	499.4678	0.0000
C(10)	0.975319	0.004801	203.1415	0.0000

Log likelihood	1461.539	Schwarz criterion	-7.677913
Avg. log likelihood	1.959167	Hannan-Quinn criter.	-7.741301
Akaike info criterion	-7.783049		

Covariance specification: BEKK
GARCH = M + A1*RESID(-1)*RESID(-1)'*A1 + B1*GARCH(-1)*B1

Tranformed Variance Coefficients

	Coefficient	Std. Error	z-Statistic	Prob.
M(1,1)	2.75E-05	5.80E-06	4.734586	0.0000
M(1,2)	3.04E-05	7.27E-06	4.183139	0.0000
M(2,2)	4.39E-05	1.36E-05	3.235061	0.0012
A1(1,1)	0.094530	0.020010	4.724220	0.0000
A1(2,2)	0.152144	0.021055	7.225963	0.0000
B1(1,1)	0.986330	0.001975	499.4678	0.0000
B1(2,2)	0.975319	0.004801	203.1415	0.0000

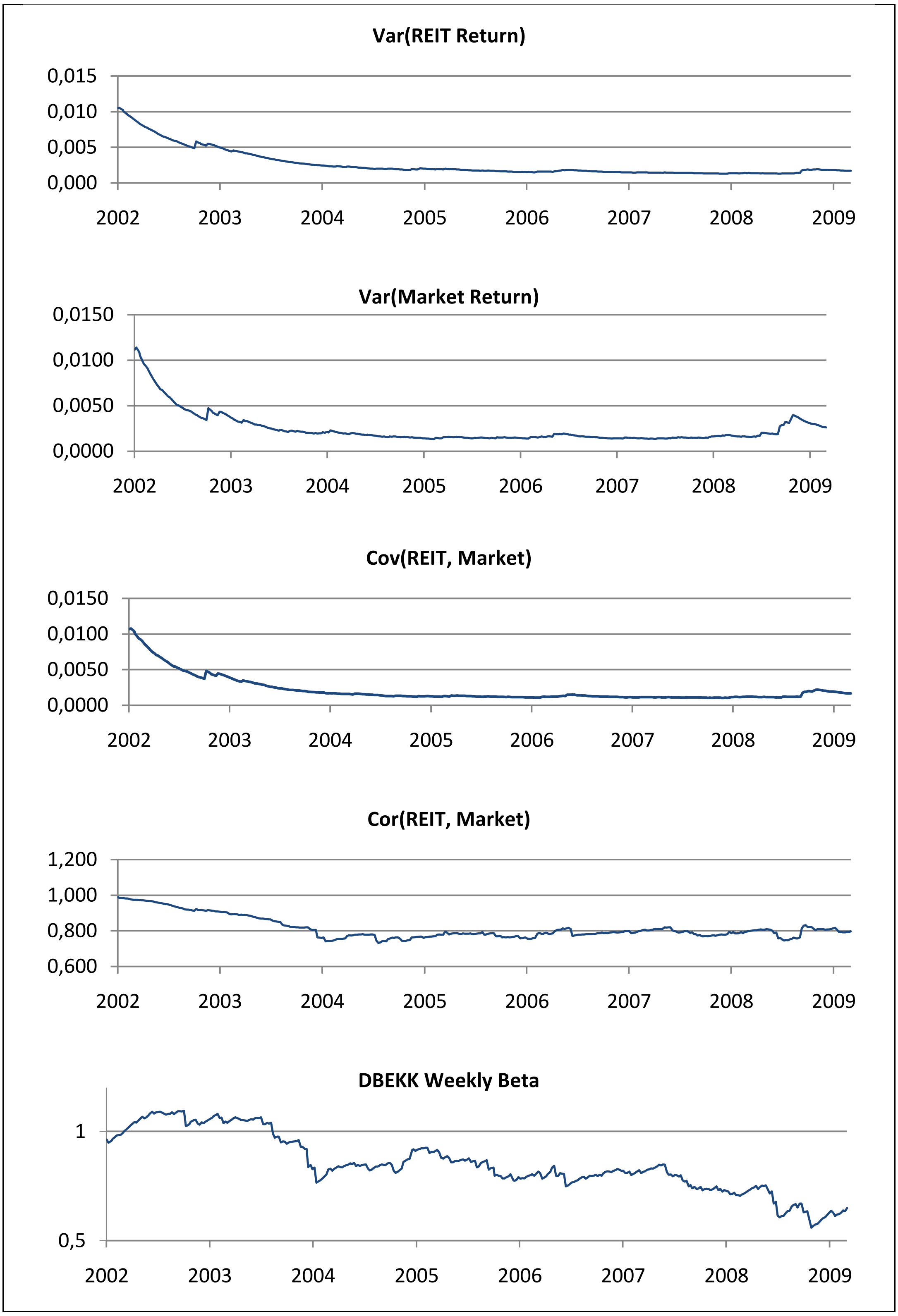

Figure 6 - 3 *Weekly Variance-Covariance-Correlation and Beta Series estimated by the Diagonal BEKK Garch Model*

6.1.3 Schwert and Seguin Model Estimation Results

Generating the Schwert and Seguin conditional beta series requires an estimate of the conditional variance series for the market return. The conditional variance estimates provided by the DBEKK Garch model, the results of which reported in the previous section, are used to construct the series $r_{Mt}=R_{Mt}/h_{Mt.}$ Following the construction of this series, regression equation (10) is estimated by using the OLS methodology.

Table 6-5 represents the estimation results of the regression, indicating that b_2, the coefficient of the newly added variable r_{Mt-} market return per unit of volatility, is statistically significant[28], negative and small in magnitude. This in turn shows that market volatility has a positively significant but a small effect in magnitude on the REIT return, consistent with the findings of Schwert and Seguin (1990) and Haddad (2007). In addition, it should be noted that like in the studies of Brooks *et al* (1998, 2002) and Faff *et al.* (2000), the inclusion of the b_2 term added little to the explanatory power of this regression equation in comparison to the market model, when R^2 values are considered.

Table 6 - 5 *Daily and weekly estimation results of the Schwert and Seguin model:* $R_{it}=a_0+b_1*R_{Mt}+b2*r_{Mt}+\varepsilon it$

Daily					**Weekly**				
Variable	Coefficient	Std. Error	t-Statistic	Prob.	Variable	Coefficient	Std. Error	t-Statistic	Prob.
a0	-0.0004	0.0003	-1.2758	0.2022	a0	-0.0020	0.0014	-1.3952	0.1638
b1	0.8883	0.0316	28.1397	0.0000	b1	0.9864	0.0662	14.9075	0.0000
b2	0.0000	0.0000	-2.7389	0.0062	b2	-0.0003	0.0001	-2.0860	0.0377
R-squared	0.6605		Akaike info criterion	-5.8838	R-squared	0.6859		Akaike info criterion	4.3303
Adjusted R-squared	0.6601		Schwarz criterion	-5.8746	Adjusted R-squared	0.6842		Schwarz criterion	-4.2988

[28] For the daily data significant at 1% level, whereas for the weekly data significant at 5% level.

Using the estimated coefficient values for b_1 and b_2, the conditional beta series β_{it}^{SS} ($=b_1+b_2/h_{Mt}$) is generated and the time series plots of the weekly and daily beta series are presented in Figure 6-4. Like daily DBEKK beta series, daily Schwert and Seguin beta series also do not provide an observable pattern. On the other hand, the weekly Schwert and Seguin beta series has a declining trend between January, 2002 and March, 2005 and unlike DBEKK betas, an increasing trend following July, 2007 after a relatively stable period. Moreover, both for daily and weekly data, Schwert and Seguin beta series have a narrower range compared to the DBEKK series.

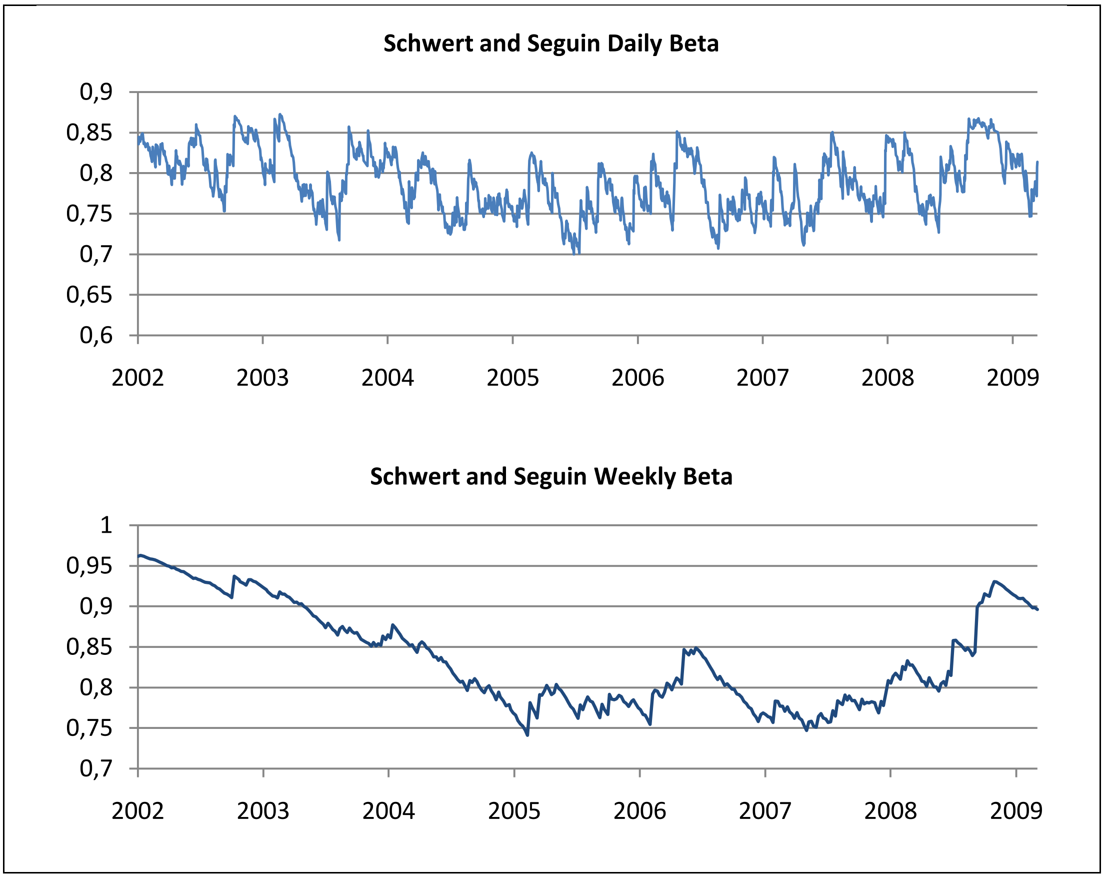

Figure 6 - 4 *Daily and Weekly Beta Series of Schwert and Seguin Model*

6.1.4 Kalman Filter Estimation Results

For both daily and weekly data, three different series of time varying Kalman betas, estimated by using different initial points, are represented in Figure 6-5. Initial points are chosen arbitrarily from a range of values between -1 and 1 but they are assigned to take both extreme and average values in the range so that robustness of the estimation is provided. The inspection of the figure shows that whatever the value of the initial point is, Kalman filter produces the same results for the estimation of time varying betas, except for the very beginning of the sample period. When the estimation advances, the Kalman filter corrects the initial values and the results anyway converges to the MSE estimators, as mentioned earlier.[29]

Figure 6-5 also indicates that daily Kalman beta series (β_0=1) exhibits a stable pattern within a range of 0.46 and 1.05; whereas weekly Kalman beta series has a declining trend like the DBEKK series. For the weekly Kalman betas, two different declining trends are observable for the two periods January, 2003-December, 2004 and April, 2005-April, 2009, respectively. In the former case beta decreases from 1.27 to 0.75, whereas in the latter case beta decreases from 0.94 to 0.55.

[29] For the rest of the analysis the estimation results for β_0=1 are reported, regarding the proximity of the value to the initial points of the other models and the point estimate of the OLS beta.

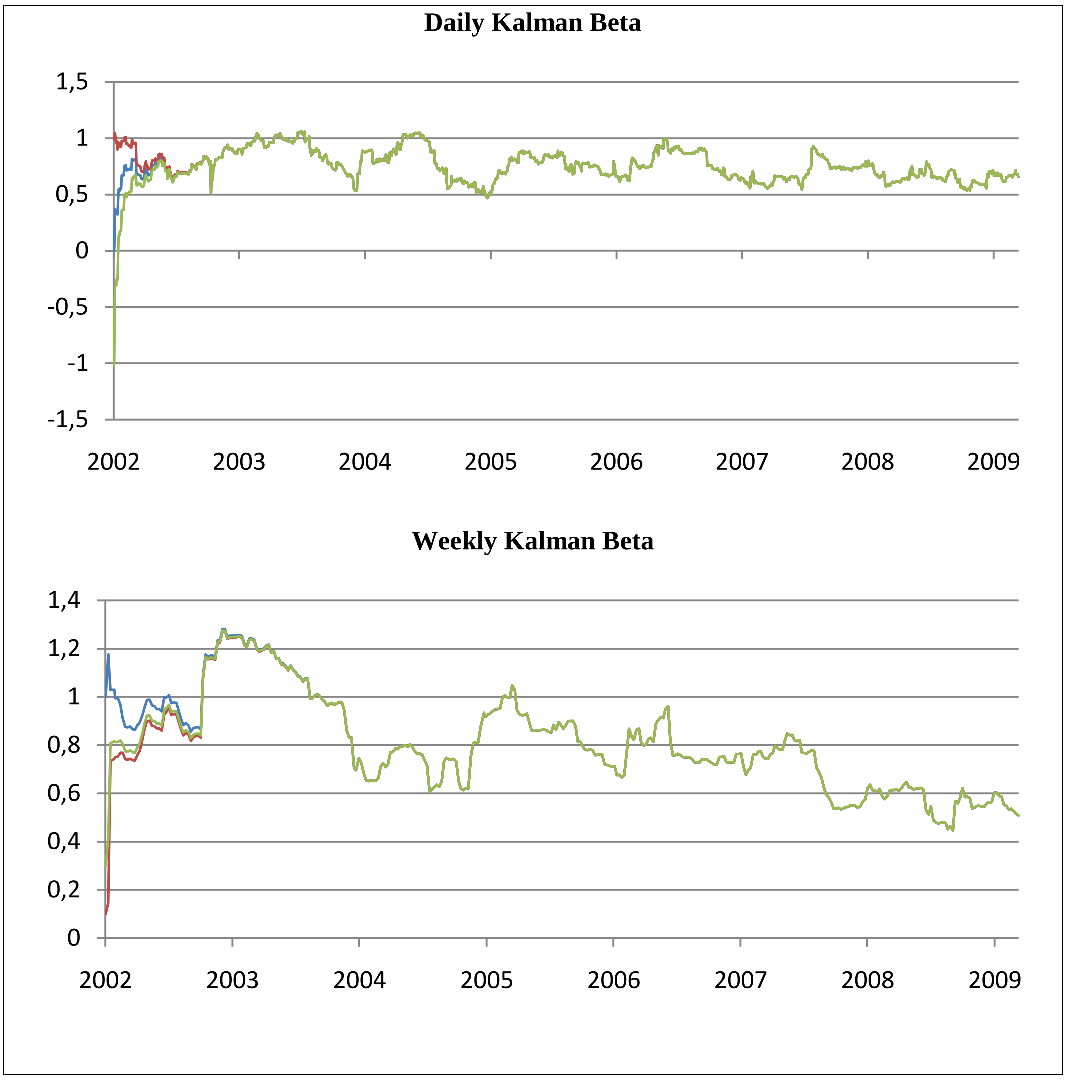

Figure 6 - 5 *Daily and Weekly Beta Series of Kalman Filter with different initial points*

6.2 Analysis of the Time Varying Betas

This section provides a comparative analysis of the time varying betas generated by DBEKK Garch, Schwert and Seguin and Kalman Filter techniques. The analysis is divided into two parts for examining the entire sample period and sub-sample periods separately.

6.2.1 Entire Sample Period: 2002-2009

In this part, firstly, the descriptive statistics for the time varying beta series are presented. Secondly, correlation coefficients are calculated as another measure for the differences and similarities among the beta series. Thirdly, the behavior of betas through time is examined in general.

The basic statistics presented in Table 6-6 indicate that the DBEKK Garch model, Schwert and Seguin model and Kalman Filter approaches to estimating conditional beta appear to provide similar parameterizations of risk when comparing their mean values. Further, these mean conditional beta values are similar to the point estimate of beta provided by the market model, supporting the findings of Faff *et al*. (2000), Brooks *et al*. (1998, 2002), and Li (2003). Also, all of the beta series, exhibiting low kurtosis but excess skewness values, are rejected for normality with the Jarque-Bera statistics, at the 1% level. [30]

Table 6 - 6 *Descriptive statistics for the time varying beta series*

Weekly	**Mean**	**Median**	**Variance**	**Skewness**	**Kurtosis**	**Jarque-Bera**	**Probability**
$Beta^{BEKK}$	0.8505	0.8287	0.0173	0.1824	2.3819	8.0056	0.0183
$Beta^{Schwert\&Seguin}$	0.8376	0.8180	0.0038	0.4549	1.8609	33.0310	0.0000
$Beta^{KALMAN}$	0.8082	0.7786	0.0384	0.4972	2.6517	17.2560	0.0002
Daily	**Mean**	**Median**	**Variance**	**Skewness**	**Kurtosis**	**Jarque-Bera**	**Probability**
$Beta^{BEKK}$	0.7720	0.7554	0.0190	0.5974	3.7132	144.6416	0.0000
$Beta^{Schwert\&Seguin}$	0.7891	0.7869	0.0014	0.1146	2.1515	57.7074	0.0000
$Beta^{KALMAN}$	0.7657	0.7474	0.0173	0.3140	2.2217	74.7232	0.0000

Weekly	**$Beta^{BEKK}$**	**$Beta^{Schwert\&Seguin}$**	**$Beta^{KALMAN}$**	**$Beta^{OLS}$**
Mean (low/high)	0.8505 (0.5597- 1.0940)	0.8376 (0.7413-0.9629)	0.8082 (0.4462-1.2813)	0.8625
Daily	**$Beta^{BEKK}$**	**$Beta^{Schwert\&Seguin}$**	**$Beta^{KALMAN}$**	**$Beta^{OLS}$**
Mean (low/high)	0.7720 (0.3503-1.4123)	0.7891 (0.6999 - 0.8728)	0.7657 (0.4670-1.0590)	0.8107

[30] Daily $Beta^{BEKK}$ series has a slightly high kurtosis value with 3.71.

However, this simplistic comparison disguises the utility provided by the conditional beta approach in terms of the information contained in the time series. When considering the range and the variance of the time varying beta values, differences are apparent as the daily betas of DBEKK Garch model vary more in time compared to the Kalman approach; whereas the weekly betas produced by Kalman Filter vary more in time compared to the DBEKK Garch model[31] and the Schwert and Seguin technique exhibits the lowest degree of variation, in both cases. The range of beta values produced by this technique is quite narrow, the weekly range being 0.74-0.96 and the daily range being 0.70- 0.87. This finding is also consistent with the findings of Faff *et al.* (2000) and Brooks *et al.* (2002), showing that Schwert and Seguin technique generates a narrower range compared to the range of betas estimated by Garch and Kalman filter techniques.

Further proof of these differences and similarities among the beta series may be obtained by considering the correlation coefficients between each conditional beta series ($Beta^{BEKK}$, $Beta^{Schwert\&Seguin}$ and $Beta^{KALMAN}$) over the sample period. To the extent to which the correlation coefficient is less than unity, suggests that each of the techniques used to estimate conditional betas generate dissimilar results. Table 6-7 representing the correlation coefficient between each pair wise combination of beta series indicates that Garch and Kalman generated series, having high degree of similarity especially for the weekly data series, have little in common with the Schwert and Seguin generated beta series, which is also a common finding of the studies of Faff *et al.* (2000) and Brooks *et al.* (1998, 2002). In addition, it is worth to note that correlation between the models decreases sharply when the daily data is used.

[31] At this point, it should be noted that the degree of variation in DBEKK betas increases when the daily data is used. In the suspect of the effect of the noise in the daily data on the estimation results of Garch model, also the moving average process (MA(7)) is applied to the daily data for the estimation of the conditional betas. However, there appears to be not a discernable change in the resulting range and variance of the DBEKK conditional betas; so the findings are not reported.

Table 6 - 7 *Correlation coefficients between each beta series*

Correlation (Weekly)	$Beta^{BEKK}$	$Beta^{Schwert\&Seguin}$	$Beta^{KALMAN}$
$Beta^{BEKK}$	1		
$Beta^{Schwert\&Seguin}$	0.4069	1	
$Beta^{KALMAN}$	0.8841	0.3757	1

Correlation (Daily)	$Beta^{BEKK}$	$Beta^{Schwert\&Seguin}$	$Beta^{KALMAN}$
$Beta^{BEKK}$	1		
$Beta^{Schwert\&Seguin}$	0.2381	1	
$Beta^{KALMAN}$	0.4990	0.0984	1

Figure 6-6 and 6-7 plot the time varying beta series generated by each technique, for the daily and weekly data series, respectively. In general, betas exhibit a time varying pattern supporting the general view of beta instability in the extant literature. DBEKK Garch and Kalman approaches present a more similar trend of conditional betas than that of the Schwert and Seguin model. This finding is also supported by the correlation coefficients between the models. In particular, for the weekly data, beta series of the DBEKK Garch and Kalman techniques exhibit a declining pattern, whereas Schwert and Seguin time varying betas show a relatively stable pattern, with a remarkable increase in latter times of the sample period. This finding of a declining trend in the betas generated by the DBEKK Garch and Kalman approaches verifies the general view of a declining REIT beta (Liang, McIntosh and Webb, 1995; Khoo, Hartzell and Hoesli, 1993; Ghosh, Miles and Sirmans, 1996; Mcintosh, Liang and Tompkins, 1991; Clayton and Mackinnon, 2001 and 2003; Tsai, Chen and Sing, 2007 and 2008). On the other hand, when the daily data is employed, declining trend in beta becomes less obvious but more frequent changes are observed, which is valid especially for the DBEKK beta series. Unlike the other beta series, the variance of the DBEKK betas increases when the daily data is used. Also, as mentioned before, the daily betas of DBEKK Garch model vary more in time compared to those of Kalman approach although the situation is the reverse for the weekly series.

Considering the weekly betas generated by DBEKK and Kalman approaches, the decline in beta values represent that the REIT sector is becoming less risky than the overall market through time. Although small increases are observed after the crisis period of 2008, betas still take the lowest values regarding the sample period[32]. The declining betas reinforce the defensive characteristic of REITs in volatile stock markets. Tsai, Chen and Sing (2007) explain the decline in REIT betas with a viewpoint of behavior finance: Investors might treat REITs like normal stocks result in REITs behave more like stocks than real estate. As time pass by, people more and more realize what REITs real are and the cash flow and the inflation-hedging characteristics of $REIT_S$ are different to other securities. Therefore, the longer the real estate being securitized, the more investors realize what the asset securitization is, the more like underlying asset, real estate, they will behave. Similarly, Khoo, Hartzell, and Hoesli (1993) attribute the decline in REIT betas to the increasing information about securitized real estate as an asset class.

In the period 2002 -2004, for the Kalman and DBEKK techniques, the average weekly beta values are 1.05 and 1.03, respectively; whereas in the period 2007-2009 the corresponding values are 0.56 and 0.68[33]. Moreover, as shown in Table 6-6, the Kalman and DBEKK mean beta values for the whole sample period are 0.80 and 0.85, respectively. The findings of Tsai, Chen and Sing (2007) show that the average value of betas for the US REITs is 0.67 for the period 1972-1980, decreasing to 0.50 in the period 1981-1990 and to 0.36 in the period 1990-2007[34]. In addition, Hoesli and Camilo (2007) examine the behavior of betas in sixteen countries including US and the betas are generally found to decrease over the 1990-2004 period. Two sub-periods (1990-1997 and 1997-2004) are determined and the change in average beta values is examined in their study. The findings show that of the sixteen countries studied, ten present a significant change in beta from the first sub-period to the

[32] In this sense, conditional betas of Schwert and Seguin model, differs from the other models as mentioned earlier.

[33] A detailed sub-period analysis will be held on section 6.2.2.

[34] Note that NAREIT Return Index data is used in the study of Tsai, Chen and Sing, 2007.

second one. Australia, Germany, Hong Kong, Italy, New Zealand, and Switzerland are the six countries for which the betas are not significantly different between the two sub-periods. From the ten countries whose betas differ from one sub-period to the other, nine of them experience a decrease in their betas. The only exception is Singapore, whose beta has increased from the first sub-period to the second sub-period. Table 6-8 represents the mean beta values of these countries for the sub-sample periods.

Table 6 - 8 *Findings of the Hoesli and Camilo (2007) regarding the mean beta values of different countries*

	1990-1997	1997-2004
Belgium	0.73	0.19
Canada	1.27	0.39
France	0.52	0.24
Japan	1.16	0.75
Netherlands	0.57	0.32
Singapore	1.34	1.65
Spain	1.10	0.55
Sweden	1.64	0.25
UK	1.06	0.52
US	0.59	0.22

Despite the differences in sample period and the methodology used for estimation of betas, the results of the above studies can still be a good reference (albeit not conclusive) for the comparison of Turkish REIT betas with those of other countries. As mentioned before, the decreasing beta trend valid for US and many other countries appears to prevail for Turkey as well. However, Turkish REIT betas tend to take higher values on average relative to the REIT betas of the countries above excluding Japan and Singapore.

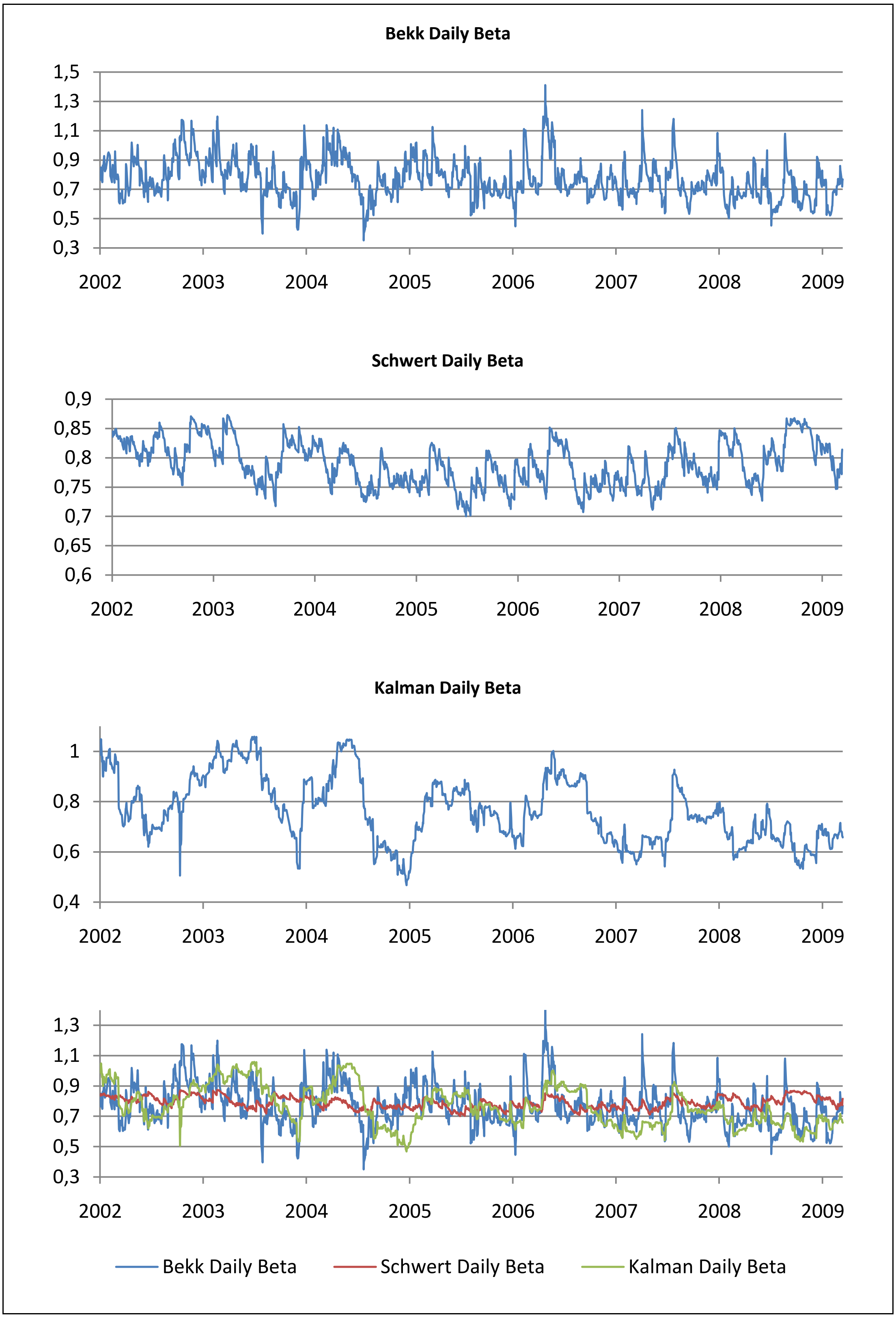

Figure 6 - 6 *Daily Beta Series Estimated by DBEKK, Schwert and Seguin and Kalman FilterMethods*

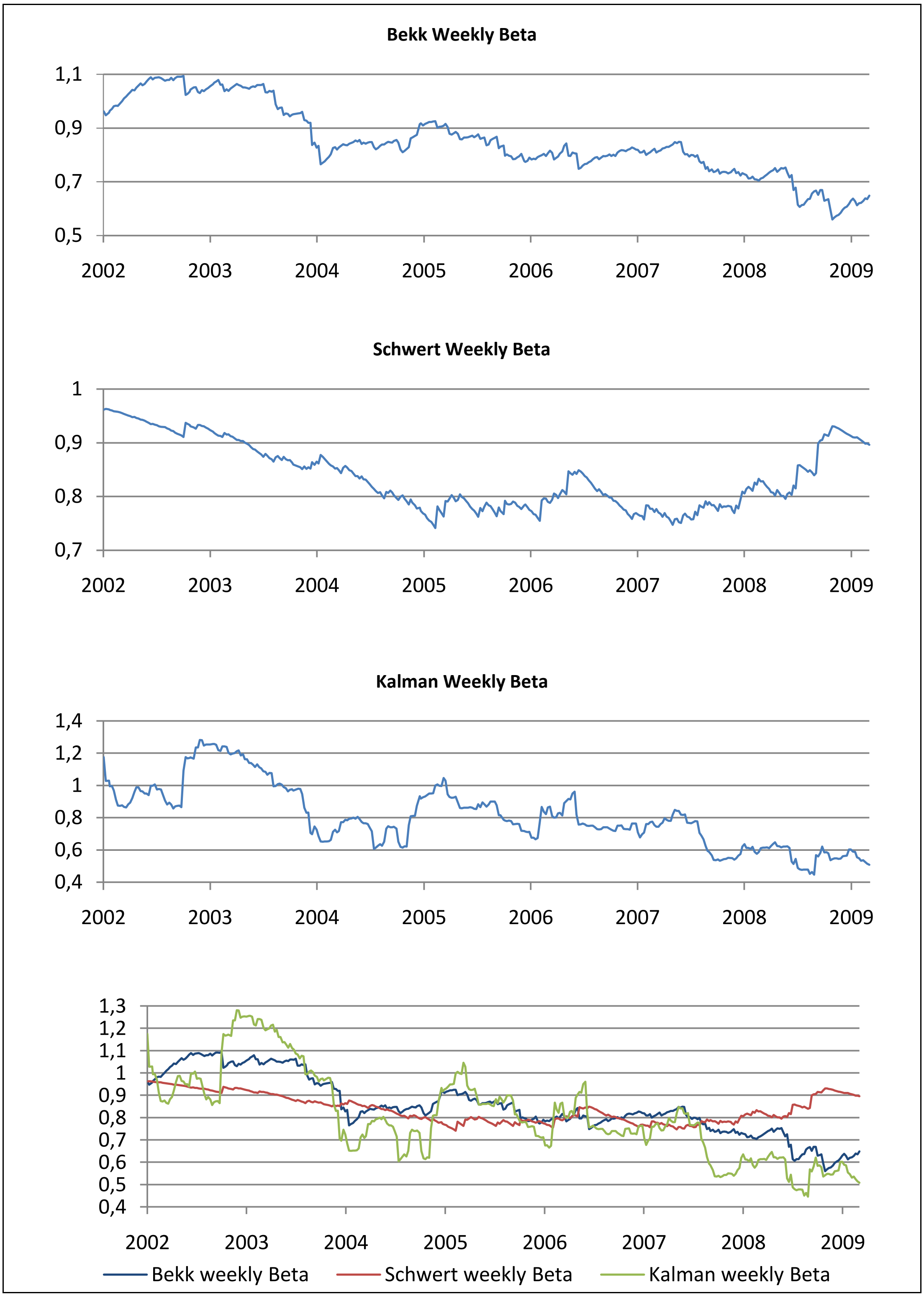

Figure 6 - 7 *Weekly Beta Series Estimated by DBEKK, Schwert and Seguin and Kalman Filter Methods*

6.2.2 Sub-Sample Periods: 2002-2004, 2004-2007 and 2007-2009

In order to give a deeper understanding of the behavior of time varying betas, the sample period is divided into 3 parts, 2002-2004, 2004-2007 and 2007-2009,[35] examining the time series pattern observed for the conditional betas in Figure 6-6 and 6-7. Then, the average of the betas for each period is calculated, the overall results of which are depicted in Figure 6-8. First of all, the change in conditional betas between the periods is more apparent for the weekly data, whereas the daily beta series implies a more stable pattern. Second, considering the weekly data, although a declining pattern is prevalent for all periods for the DBEKK and the Kalman betas, there is a reduction in the slopes of the solid lines after the period 2004-2007, indicating that beta values exhibit a decrease on average, in 2007-2009, which is less than that of the previous period. On the other hand, Schwert and Seguin model generated beta values exhibit an increase in 2007-2009, unlike the other models. Third, both the range and the trend of DBEKK betas change with the frequency of the data[36], whereas Schwert and Seguin betas and the Kalman betas follow the same pattern for both weekly and daily data although the range of values becomes smaller for the daily series.

Table 6 - 9 provides a further insight into the analysis of beta showing that most of the betas are clustered below unity implying again that the REIT sector is less risky than the market, in general. When considering the weekly beta series, 19.84% of DBEKK betas and 14.48% of the Kalman betas take values above unity; whereas all of the Schwert and Seguin betas are clustered below unity. This result is also valid for the daily data but with different magnitude of percentages depending on the sample size.

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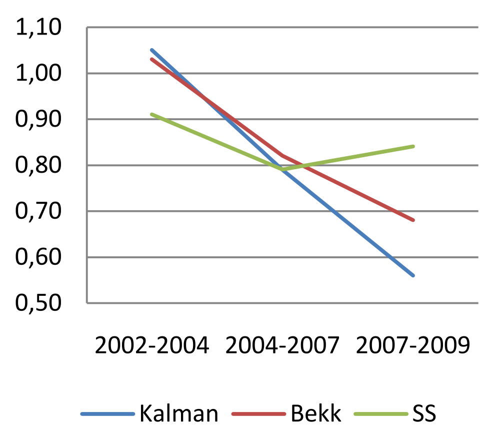
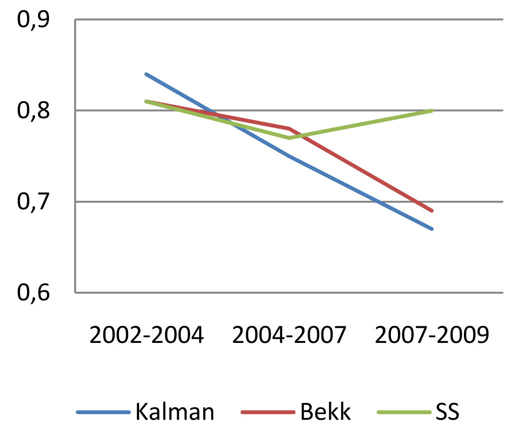
[35] 2004-2009 period is seperated into two parts from the date of September, 2007.

[36] Change in trend of beta here, refers to not a change in declining values but rather a change in slope of the solid lines.





Weekly	Beta^{KALMAN}	Beta^{BEKK}	Beta$^{S\&S}$
2002-2004	1.05	1.03	0.91
2004-2007	0.79	0.82	0.79
2007-2009	0.56	0.68	0.84

Daily	Beta^{KALMAN}	Beta^{BEKK}	Beta$^{S\&S}$
2002-2004	0.84	0.81	0.81
2004-2007	0.75	0.78	0.77
2007-2009	0.67	0.69	0.8

Figure 6 - 8 *Average of the beta values for the periods 2002-2004, 2004-2007 and 2007-2009*

Table 6 - 9 *Percentage and average of the values of the betas above unity*

Weekly	Beta^{BEKK}	Beta$^{Schwert\&Seguin}$	Beta^{KALMAN}
Values>1 for the sample period	19.84%	0.00%	14.48%
Values>1 for the period 2002-2004	19.84%	0.00%	13.67%
Average of the values>1	1.05	0.00	1.15

Daily	Beta^{BEKK}	Beta$^{Schwert\&Seguin}$	Beta^{KALMAN}
Values>1 for the sample period	6.58%	0.00%	5.02%
Values>1 for the period 2002-2004	3.46%	0.00%	4.96%
Average of the values>1	1.09	0.00	1.03

Looking again the time-series plots of betas in Figure 6-6 and 6-7, especially the period 2002-2004 exhibits high increases with beta values greater than one[37]. Regarding this issue, the percentages of beta values above unity pertaining only to this period are also included in Table 6-9. The results imply that beta values above unity are mainly sourced from the values observed in the period of 2002-2004[38]. This period is considered to be a recovery period of the real estate market and the economy in general after the crises of 2000 and 2001. The economy started to recover with the help of increasing trust in the new economic policies and the positive trend in the domestic demand. Healthy implementation of the economic program enabled the economy to get stronger, Turkish Lira to appreciate against foreign currency, interest rates to decrease, and markets to become more optimistic about macro economic targets. However, it is important to note that even during this period, the REIT sector does not behave so much aggressively relative to the market as Table 6-9 indicates. The average of the beta values above unity is not higher than 1.15 in any case and as Figure 6-7 shows, betas tend to decline following the year 2003. That is, REIT sector becomes more risky than the market in some periods under consideration but the deviation is not so high in magnitude. After the year 2003 the improvement in the economic environment continued with the decreases in the interest rates and in the inflation rate. Within this positive economic context, the declining pattern of the REIT betas appears to continue with slight fluctuations; in particular, increases are observed during the global turmoil in 2006 and the global financial crisis in 2008. However, during the crisis period of 2008 not only the REIT sector seems to be less risky than the market but also the deviation of beta values from unity is relatively high compared to the good times of the economy, with the beta values ranging between 0.56-0.69 on average.

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[37] Schwert and Seguin model is excluded from this analysis since all of the betas of the model are clustered below unity.

[38] Note that all of the weekly DBEKK betas above unity take place in this period.

6.3 Comparison of the Results on the Time Varying Beta Estimation Techniques

The evidence presented thus far clearly indicates that although there are similarities; differences also exist between the β_{it} series generated by using each of the three techniques. Therefore, it is important to rank these approaches to establish which technique generates the relatively more accurate forecast. As described in section 5.5 MAE and MSE are useful instruments to compare the forecast accuracy of the models.

For the analysis, REIT return series in sample $(\hat{R}_{it})$ are forecast and the forecast error produced by each technique is compared. To this end estimates of α_i are generated as described in section 5.5 and R_{it} subsequently forecast in-sample using these α_i estimates, R_{Mt} and each β_{it} *s*eries. The forecasts of R_{it} are then compared to the actual R_{it} and the summary MAE and MSE measures are calculated. The results of this procedure are presented in Table 6-10. To test the robustness of the results to the error measure chosen, two measures are employed and the same results are evident.

Examining Table 6-10, β_{it} series generated by OLS estimation produces the highest forecast errors in all cases showing that time varying beta models perform better than the OLS model. On the other hand, among the time varying beta models, Schwert and Seguin model performs the worst in terms of the forecast accuracy, supporting the findings of Faff *et al.* (2000) and Brooks *et al.* (1998, 2002); whereas Kalman Filter and the DBEKK Garch models provides the lowest forecast errors for the weekly and the daily data, respectively. The findings of Lie *et al.* (2000), Faff *et al.* (2000), Mergner and Bulla (2008) and Marti (2006) indicate that the Kalman filter algorithm gives more accurate results and is preferred to other techniques, whereas Brooks *et al.* (2002) finds evidence in favor of the Garch models for the accuracy of the time varying beta estimation results.

Table 6 - 10 *Forecast errors for the methods of estimating conditional betas*

Weekly	**MAE**	**MSE**
DBEKK Garch	19.4987	0.7079
Kalman Filter	19.3103	0.6978
Schwert and Seguin	19.8296	0.7565
OLS	19.9889	0.7653
Daily	**MAE**	**MSE**
DBEKK Garch	9.2269	0.1596
Kalman Filter	9.2528	0.1618
Schwert and Seguin	9.3893	0.1624
OLS	9.4154	0.1631

Note: The values are multiplied by 1000.

CHAPTER 7

CONCLUDING REMARKS AND SUGGESTIONS FOR FUTURE RESEARCH

7.1 Concluding Remarks

While there is now a considerable body of research in developed and developing countries that has revealed clear evidence of beta instability, only a small proportion of the resulting studies examine the important associated issues of systematic risk estimation and modeling. Likewise in Turkey, there are studies only aiming to test the beta stability in the ISE stock market, in general. However, the evidence on explicitly modeling and estimating beta is non-existent in Turkey for either the stocks or the sectors in ISE. This thesis aims to fill this gap in the literature by exploring the issue of estimating time varying betas for the REIT sector in Turkey, with the employment and comparison of different techniques; namely, the DBEKK GARCH model, the Schwert and Seguin model and the Kalman Filter algorithm.

This study has conducted an exploratory investigation of these issues using the data of the ISE-REIT and ISE-100 price indices and the interest rate values for 3-months maturity obtained from the N&S yield curve over the period 2002 and 2009. Both daily and weekly data sets are employed in order to evaluate the effect of the frequency of data on the results of the study.

The empirical findings of the study reveal that:

- The Turkish market is not different than the other emerging and developed markets in terms of beta instability. Moreover, the weekly estimation results illustrate that the declining beta trend valid for US and many other countries appears to prevail for Turkish REITs as well, reinforcing the defensive characteristic of the REITs in volatile stock markets. In the extant literature, the decline in the betas of REIT sector is mostly attributed to the increasing information about securitized real estate as an asset class. According to this view, as time passes by, people more and more realize what REITs real are and the characteristics of REITs are different to other securities. Therefore, the longer the real estate being securitized, the more investors realize what the asset securitization is, the more like underlying asset, real estate, they will behave. This hypothesis may be valid also for the Turkish REITs, the legal framework being introduced in 1995, with their tax break and dividend policy advantages over the other corporations listed in ISE.

The findings for weekly data also suggest some other hidden characteristics that appear noteworthy regarding the relationship between REIT and the overall stock markets:

- Correlation between REITs and the overall market tends to decline over the sample period, providing diversification opportunities for the potential investors.

- The declining trend in correlation is apparent also in the variances of both the market return and REIT return; however REIT return tends to be less volatile than the market return during the crisis period of 2008.

▪ Although all three approaches used for modeling and estimating time-varying betas are successful in characterizing the time-varying systematic risk of REIT industry in Turkey, there are also differences between each approach. DBEKK Garch and Kalman generated beta series, having high degree of similarity especially for the weekly data series have little in common with the Schwert and Seguin generated beta series, supporting the findings of Faff et al. (2000) and Brooks et al. (1998, 2002).

- The in-sample forecast accuracy of the various techniques suggest that independent from the utilized modeling approach, the extent to which REIT sector returns can be explained by the movements of the overall market is always higher for time-varying betas than in connection with standard OLS. This also implies the confirmation of previous findings that sector betas are not stable over time.

- The comparison of the in-sample forecast accuracy of each conditional beta technique indicates that among the time varying beta models, Schwert and Seguin model performs the worst in terms of the forecast accuracy, whereas Kalman Filter and the DBEKK Garch models provides the lowest forecast errors for the weekly and the daily data, respectively.

- Similar with the findings of Cotter and Stevenson (2006), the results of this study also indicate that the use of data sets with different frequency could lead to different empirical findings. In particular, weekly data appears to allow more time for the more substantial and intuitive relationships to come to the fore and hence it allows to derive more fundamental conclusions for the behavior of time-varying betas. It is possible that the use of daily data masks more of these fundamental relationships.

It is well-known that two basic objectives of the institutional investors for holding REIT stocks in their asset portfolios are: 1) protecting their wealth against inflation (inflation-hedging property of real estate companies) and 2) benefiting from the diversification opportunities that the REITs provide. As mentioned before, Turkish REITs, as traded assets with liquidity, are likely to have some advantages over the ISE listed common stocks. Not paying corporate taxes along with some other tax benefits and having access to 100% of profits, especially under high inflationary conditions, give REIT managers a lot of inexpensive capital for investment and asset management purposes. Thus, it is expected that these tax break and dividend policy advantages contribute positively to REITs' higher inflation-hedging ability compared to the ISE common stocks. This expectation is supported by the empirical findings of a recent study by Erol and Tirtiroğlu (2007).

Moreover, this study sheds light on the other side of the issue: the diversification benefits. The findings reveal that the declining REIT beta trend and the declining correlation with the overall market reinforce the defensive characteristics of the Turkish REITs and correspondingly enable them to provide superior diversification benefits for the potential investors.

Declining beta trend valid for the REITs of the other developing and developed countries also prevails for the Turkish REITs. However, Turkish REITs seem to have higher beta values on average. It is possible to conclude that the Turkish REITs seem be more risky compared with the other country REITs in general. Turkish REIT industry, making up approximately 1% of the total Turkish stock market capitalization, is a small and a newly developing sector of the Turkish financial markets. Considering the sample period, it is observed that the REITs in Turkey do not exhibit an aggressive risk pattern and seems to be less volatile relative to the overall market although they are found to be more risky than the REITs of the many other countries. Thus, it is expected that the beta values of the REITs in Turkey will converge to those of other countries as the number of REITs increase and as the more investors realize what the real estate asset securitization is and what the advantages of investing in REITs are.

7.2 Suggestions for Future Research

Since the literature of the systematic risk modeling for the REITs does not provide any evidence for Turkey, this thesis appears to be the first step in this direction and primarily illustrative in nature. It leaves the way open for an extended investigation of many issues remained unsolved.

The methodology used in this study for modeling and estimating time-varying betas can be extended in a couple of directions. A future study utilizing different covariance specifications for the M-Garch model or different parameterizations of beta for the Kalman Filter algorithm and comparing forecast performance of the respective models would be a worthy investigation area. Regarding this issue, Faff et al. (2000) propose that a combined method that incorporates the information contained in the conditional volatility of asset returns (as characterized by various Garch models) into the Kalman Filter algorithm would be considerably more powerful than any one estimation method in isolation. Moreover, non-standard procedures such as Stochastic Volatility and Markov Switching could also be applied for the modeling of time-varying beta.

In this study, the time-varying systematic risk of the REIT sector in Turkey is analyzed in isolation. Inclusion of other sectors in ISE such as industry, service and financial sectors will enhance the validity and the implications of the present study.

The findings of the present study prevail that the betas for the REIT sector in Turkey exhibit a declining trend as in the other developing and developed countries. The analysis is implemented on a sector basis. Another way to improve the findings of this study is to conduct the analysis on a firm basis and investigate the behavior and determinants of systematic risk for each REIT in Turkey. To identify the determinants of systematic risk, most previous empirical studies have investigated the relationship between the systematic risk measured by beta and the financial variables such as liquidity, financial leverage, profitability, dividend payout, firm size and growth. Many of these studies employed cross-firm data and use exogenous factors to explain the time-varying behavior of systematic risk. Some steps into this direction have been made by Abell and Krueger (1989) and Andersen et al. (2005) who link betas to macroeconomic variables and by Liodakis et al. (2003) who use firm fundamentals, momentum and liquidity data as determinants of time-varying betas. Similar studies for Turkey will be valuable in nature; however, the small sample size, the low frequency of data (quarterly) and the short sample period will be the main limitations of such a research for Turkey.

Recent studies have documented an “asymmetric REIT-beta puzzle” based on the findings showing that REITs have different risk and return characteristics in advancing and declining economies. Glascock (1991) argues that REITs betas shift with market conditions: betas are higher during up markets and lower during down markets. Tsai, Chen and Sing (2007) conclude that REIT returns are significantly and negatively related to excess market return in periods of high volatility. To examine this relationship between the REIT-beta and the general economy for Turkey poses itself as another important and interesting future research question.

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APPENDIX A

Some basic definitions are given before the examination of the Nelson and Siegel Model.

Interest Rate Basics

Let $B(t,T)$ denote the present value at the time t of 1 currency unit payable bond with maturity T, and let $R(t,T)$ be the continuously compounded rate of return (i.e. yield to maturity) that causes B(T,T)=1. Then $B(t,T)$ satisfies

$$B(t,T)e^{R(t,T)(T-t)} = 1 \tag{A.1}$$

$R(t,T)$ is known as the yield curve for a constant t. Solving the equation (A.1) for $R(t,T)$, we get

$$R(t,T) = -\frac{1}{T-t} lnB(t,T) \tag{A.2}$$

We denote $r(t)$ as the short rate (i.e. instantaneous interest rate) which is the yield on currently maturing bond.

$$r(t) = \lim_{T\to t} R(t,T) \tag{A.3}$$

Money market account is a security that is worth 1 currency unit at time t=0 and earns the short rate at any given time. Then the value of money market account

$$B(t) = e^{\int_0^t r(s)ds} \tag{A.4}$$

We denote the forward rate by *f(t,T₁,T₂). It is the rate agreed on time t, starting at time* T_1 and maturing at time T_2. Then it follows that

$$e^{R(t,T_2)(T_2-t)} = e^{R(t,T)(T_1-t)}e^{f(t,T1,T2)(T_2-T_1)} \tag{A.5}$$

Solving the equation (A.5) for $f(t,T_1,T_2)$ and applying the definition in (A.2), we get

$$f(t,T_1,T_2) = \frac{1}{T_2-T_1} ln\frac{B(t,T_1)}{B(t,T_2)} \tag{A.6}$$

Instantaneous presentation of the above equation (A.6) is

$$e^{R(t,T)(T-t)} = e^{\int_t^T f(s)ds} \tag{A.7}$$

Then it implies that

$$f(t,T) = -\frac{\partial}{\partial T} lnB(t,T) \tag{A.8}$$

$$= R(t,T) + (T-t)\frac{\partial R(t,T)}{\partial T} \tag{A.9}$$

Nelson and Siegel Model

Nelson and Siegel (1987) proposed to fit the term structure using a flexible, smooth parametric function. They demonstrated that their proposed model is capable of capturing many of the typically observed shapes that the yield curve assumes over time.

Motivation for Nelson-Siegel model comes from the expectations hypothesis. According to the expectations hypothesis, forward rates will behave in such a way that there is no arbitrage opportunity in the market. In other words, the theory suggests that implied forward rates are the rationally expected spot rates of the future periods. Nelson and Siegel (1987) propose that if spot rates are generated by a differential equation, then implied forward rates will be the solutions to this equation.

Given the forward curve, we can determine the spot rate (or yield) on a zero-coupon bond with τ periods to maturity, denoted by $r(\tau)$, by taking the equally weighted average over the forward rates.

Nelson and Siegel assumes the following form for the forward rate curve.

$$f(\tau) = \beta_0 + \beta_1 e^{-\tau/\beta_3} + \beta_2 \left(\frac{\tau}{\beta_3}\right) e^{-\tau/\beta_3} \qquad \text{(A.10)}$$

Whre $\tau = T - t$. Then the spot rate is the average of forward rate curve.

$$r(\tau) = \beta_0 + (\beta_1 + \beta_{2)} \left(\frac{\beta_3}{\tau}\right)(1 - e^{-\tau/\beta_3}) + \beta_2 e^{-\tau/\beta_3} \qquad \text{(A.11)}$$

Where $\qquad \lim_{\tau\to\infty} = \beta_0 \qquad \lim_{\tau\to 0} = \beta_0 + \beta_1$

We select the parameter set $\beta = (\beta_0, \beta_1, \beta_2, \beta_3)$ parameters by

$$\min_\beta [B(T) - B^{NS}(T)]'[B(T) - B^{NS}(T)] \qquad \text{(A.12)}$$

Where $(B^{NS}(T))$ is the discount bond price imposed by the yield rate produced by the Nelson-Siegel model for a given T. Notice that for small values of $-\tau/\beta_3$, the expression $e^{-\tau/\beta_3}$ could be written in discrete from as $1 - \tau/\beta_3$. Then the equation (A.11) takes the following form for shorter maturities,

$$r(\tau) = r(0) + \frac{\beta_2}{\beta_3}\tau \qquad \text{(A.13)}$$

This is nothing but a linear interpolation between 0 and the following knot k with $0 < \tau < k$. We first linearly interpolated the data between the rate for the shortest maturity and the rate for the closest days to maturity to 90 days. In this way, we get rid of the ambigious fluctuation of the interest rate for the first days.

APPENDIX B

Derivation of the Kalman Filter Algorithm- ***A Simplified Approach Proposed by Arnold, Bertus and Godbey (2008)***

There are two basic building blocks of a Kalman filter, the measurement equation and the transition equation. The measurement equation relates an unobserved variable (X_t) to an observable variable (Y_t). The simplified measurement equation is of the form:

$$Y_t = m * X_t + \varepsilon_t \tag{B.1}$$

where ε_t has a mean of zero and a variance of r_t and m is a constant.

The transition equation is based on a model that allows the unobserved variable to change through time. The simplified transition equation is of the form:

$$X_{t+1} = a * X_t + \theta_t \tag{B.2}$$

θ_t has a mean of zero and a variance of q_t and a is a constant.

To begin deriving the Kalman filter algorithm, insert an initial value X_0 into Eq. (B.2) (the transition equation) for X_t , X_0 has a mean of μ_0 and a standard deviation of s_0. It should be noted that e_t , θ_t and X_0 are uncorrelated. (Note: these variables are also uncorrelated relative to lagged variables.)

Equation (B.2) becomes:

$$X_{1P} = a * X_0 + \theta_0 \tag{B.3}$$

where X_{1P} is the predicted value for X_1.

X_{1P} is inserted into Eq. (B.1) (the measurement equation) to get a predicted value for Y_1, call it Y_{1P}:

$$Y_{1P} = m * X_{1P} + \varepsilon_1 = m * [a * X_0 + \theta_0] + \varepsilon_1 \tag{B.4}$$

When Y_1 actually occurs, the error, Y_{1E}, is computed by subtracting Y_{1P} from Y_1:

$$Y_{1E} = Y_1 - Y_{1P} \tag{B.5}$$

The error can now be incorporated into the prediction for X_1. To distinguish the adjusted predicted value of X_1 from the predicted value of X_1 in Eq. (B.3), the adjusted predicted value is called X_{1P-ADJ}:

$$\begin{aligned} X_{1P-ADJ} &= X_{1P} + k_1 * Y_{1E} \\ &= X_{1P} + k_1[Y_1 - Y_{1P}] \\ &= X_{1P} + k_1[Y_1 - m * X_{1P} - \varepsilon_1] \\ &= X_{1P}[1 - m * k_1] + k_1 * Y_1 - k_1 * \varepsilon_1 \end{aligned} \tag{B.6}$$

where k_1 is the Kalman gain, which will be determined shortly.

The Kalman gain variable is determined by taking the partial derivative of the variance of X_{1P-ADJ} relative to k_1 in order to minimize the variance based on k_1 (i.e., the partial derivative is set to zero and then one finds a solution for k_1). For ease of exposition, let p_1 be the variance of $X_{1P.}$ (technically, p_1 equals: $(a * \sigma_0)^2 + q_0$). The solution for the Kalman gain is as follows:

$$Var(X_{1P-ADJ}) = p_1 * [1 - m * k_1]^2 + {k_1}^2 * r_1 \tag{B.7}$$

$$\frac{\partial Var\,(X_{1P-ADJ})}{\partial k_1} = -2m * [1 - m * k_1] * p_1 + 2k_1 * r_1 = 0 \tag{B.8}$$

$$\therefore k_1 = \frac{p_1 * m}{p_1 * m + r_1} = Cov(X_{1P}, Y_{1P})/Var(Y_{1P}) \tag{B.9}$$

Notice, the Kalman gain is equivalent to a β-coefficient from a linear regression with X_{1P} as the dependent variable and Y_{1P} as the independent variable. Note that one would have a sufficient set of data to perform such a regression, but the idea that a β-coefficient is set to reduce error in a regression is equivalent to the idea of the Kalman gain being set to reduce variance in the adjusted predicted value for X_1.

The next step is to use X_{1P-ADJ} in the transition equation (Equation (B.2)) for X_t and start the process over again to find equivalent values when t = 2.

It is important to note the advantages of X_{1P-ADJ} over X_{1P}. Recall that the variance for X_{1P} is p_1. Substituting Eq. (B.9) into Eq. (B.7), the variance of X_{1P-ADJ} is:

$$Var\left(X_{1P-ADJ}\right) = p_1 * \left[\frac{1}{1+\frac{r_1}{p_1 * m^2}}\right] + {k_1}^2 * r_1 \tag{B.10}$$

The portion of the equation that pertains to the variance of X_{1P}, i.e., p_1, has a bracketed term that is less than one (and is further reduced because the "less than one quantity" is squared). This means that the portion of the variance attributed to estimating X_1 has been reduced by using X_{1P-ADJ} instead of X_{1P}.