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Time-varying beta risk of Turkish Real Estate Investment Trusts

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Abstract

This paper provides empirical evidence on the time varying behavior of beta for the publicly traded real estate companies (REITs) in Turkey using the last seven years of both weekly and daily data. In our sample period, Turkey's GDP growth rate has experienced a trend break. After the long lasting financial crisis of 2001, real GDP growth rate has increased gradually from 2002 to 2005, but it has subsequently decreased sharply until June 2009. We use the Diagonal BEKK covariance specification of the M-GARCH model (Engle and Kroner, 1995), the Schwert and Seguin (1990) model and the Kalman Filter algorithm with random walk parameterization in an attempt to evaluate time-varying behavior of REIT industry beta. We find that similar to the other emerging and developed REIT markets, Turkish REITs have a declining beta over the sample period. In order to investigate if REIT betas exhibit a diverse behavior under high and low economic growth periods, we determine two sub-periods and examine the change in average beta values in line with the GDP growth rate. Our empirical results suggest that REIT returns more closely track stock market in high-growth economic states. Hence, this article provides no evidence on the asymmetric time-varying behavior of REIT betas.

Key words: Time-varying betas, systematic risk, Real Estate Investment Trusts (REITs), Turkish Real Estate Investment Returns, Diagonal BEKK M-GARCH Model, Kalman filter.

JEL classification: G17; G30; C32; C51; C53.

1. Introduction

During the last four decades numerous studies have addressed the question of beta stability over time and concluded that country betas, sector betas, portfolio betas and individual equity betas have a time-varying nature. Recent studies have found evidence of beta instability both for the developed and developing countries including the US, Sweden, Korea, Finland, Malaysia, Hong Kong, India, and Turkey.[1] While empirical research on equity betas is common, the evidence on the instability of real estate portfolio betas is rather limited. Due to the increasing popularity of Real Estate Investment Trusts (REITs) as an alternative asset class for portfolio diversification purposes, examining the time-varying behavior of REIT betas has become a worthy area of empirical research since the early 1990s.

One way for investors to include real estate in their portfolios is to use REITs. REITs are a small but important part of the real estate capital market. As publicly traded real estate stocks, REITs offer individual and institutional investors liquidity and an opportunity to build diversified real estate portfolios more readily than through direct holdings. There is a clear trade-off, however. Although REITs offer stable underlying cash flow streams, REIT returns become highly volatile much like other publicly traded stocks (Sagalyn, 1990). Hence, REITs as a hybrid investment – part stock, part real estate – offer potential diversification benefits when included in investment portfolios, especially as a substitute for stocks.

Over the past decade, REITs has emerged as a new and important component of institutional investment portfolios in Turkey. The number of initial public offerings of REITs has increased from 5 publicly traded companies in 1998 to 14 companies in 2009, making it easier for institutional and individual investors to invest in real estate. The increased ability to add securitized real estate to portfolios and the corresponding interest of investors highlights the need to understand diversification potential of REIT industry.

This paper aims to explain the time-varying behavior of Turkish REIT beta (correlation between REITs and the general stock market) in an attempt to examine the diversification ability of REIT industry. We use seven years of both weekly and daily data from February 2002 to June 2009.

The legal framework for the Turkish REITs was introduced in 1995 by the Capital Market Board (CMB). This date is much earlier than those for France, UK, Japan, and several other developed economies. All income for the Turkish REITs including capital gains, portfolio management income, interest and dividend income is exempt from corporate tax. REITs do not have to pay out dividends, yet enjoy the exemption from paying corporate

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[1] See Blume (1971), Levy (1971), Black *et al.* (1972), Fama and Macbeth (1973), Kim and Zumwalt (1979), Sunder (1980), Alexander and Chervany (1980), Theobald (1981), Ohlson and Rosenberg (1982), Lee and Chen (1982), Kryzanowski and To (1984), Bos and Newbold (1984), Collins *et al.* (1987), Rahman *et al.* (1987), Faff, Lee and Fry (1992), Brooks *et al.* (1992), Kim (1993), Kok (1992,1994), Wells (1994), Bos *et al.* (1995), Pope and Warrington (1996), Cheng (1997), Brooks, Faff and Ariff (1998), Brooks *et al.* (1998, 2002), Ajay and Moonis (2003), Odabaşı (2002, 2003), Aygören and Sarıtaş (2007).

taxes since their legal foundation. Hence, having total flexibility in their dividend policy choices distinguishes fundamentally Turkish REITs from REITs in other countries. This article puts forth evidence on testing the time-varying trend of systematic risk for a newly and rapidly growing real estate sector with its distinguishing characteristics in a G-20 developing country.

Extant literature has observed an apparent decline in the REIT betas over time, implying that REITs' correlation with the general stock market has been decaying. McIntosh *et al*. (1991) were the first to identify a declining trend in EREIT betas during the 1974 through 1983 time period. Khoo *et al.* (1993) expand the McIntosh *et al.*'s sample period from 1970 to 1989, and provide additional evidence of a temporal decline in EREIT betas. Ghosh *et al.* (1996) point out the correlation between the REIT Index and the S&P 500 drops from 0.770 in 1985-1987 to 0.401 in 1994-1996 and conclude that the relationship between REITs and stock market and correspondingly the systematic risk of REITs is declining. Liang *et al.* (1995) find evidence of a declining trend for mortgage REITs, accompanied by significant return-generating regimes during the 1973 to 1989 period. The authors conclude that while the systematic risk for equity REITs are nearly stable, it declines significantly for mortgage REITs from 1970s to 1980s. Hoesli and Camilo (2007) also observe a decline in the correlation between REITs and the general market in the past years. Hoesli and Camilo (2007) examine the behavior of REIT betas in sixteen countries including US and the betas are generally found to decrease over the 1990-2004 period. The researchers determine two sub-periods and examine the change in average beta values. Their findings show that out of the sixteen countries studied, ten has a significant change in beta from the first sub-period to the second one and from the ten countries nine of them experience a decrease in their betas.

Overall, the empirical findings have revealed a common conclusion of declining REIT betas. This decline in the correlation between REITs and the general stock market can be accepted as a sign of a maturing REIT market that now more closely relates to the performance of the underlying real assets (Chatrath and Liang, 2000).

This paper uses the Diagonal BEKK covariance specification of the M-GARCH model (Engle and Kroner, 1995), the Schwert and Seguin (1990) model and the Kalman Filter algorithm with random walk parameterization in an attempt to evaluate the time-varying behavior of the Turkish REIT betas. Our empirical results point out that the Turkish REIT industry does not behave in a different way than the other emerging and developed REIT markets in terms of beta instability. In line with the recent indications of a decay in the worldwide REIT-stock market relationship, declining trend in Turkish REIT betas can be accepted as the tendency of REITs to be less sensitive to the market. Such a particular trend is of obvious importance to investors/portfolio managers concerned with diversifying into securitized real estate or insuring REIT holdings.

Two recent studies by Chatrath *et al.* (2000) and Chiang *et al.* (2004) focus on the asymmetric time-varying behavior of REIT betas. The asymmetric REIT beta puzzle is actually based upon two earlier works of Goldstein and Nelling (1999) and Sagalyn (1990). Goldstein and Nelling (1999) find that the returns on equity REITs have different risk and return properties in advancing and declining equity markets. In particular, the regression of equity REIT returns on the S&P 500 Index returns during advancing markets (i.e., when the index returns beat those of Treasury bills) produced a beta estimate that is significantly lower than that from the regression of equity REIT returns on the S&P 500 Index returns during declining markets. Similarly, Sagalyn (1990) finds a lower coefficient of determination between the S&P 500 and REITs during high growth periods when compared to low growth periods. The comparable results in Sagalyn (1990) and Goldstein and Nelling (1999) are worth noting since the asymmetry in the relationship between REITs and the market would certainly have important implications for portfolio managers in terms of the diversification potential for REITs.

Chatrath *et al.* (2000) tests three hypotheses that explore why the asymmetry in REIT betas occurs and conclude that the asymmetry in betas is not the result of declining REIT-market relationship or dividend effects. Instead, the pattern in REIT betas is similar to that noted for small capitalization stocks in general. Chiang *et al.* (2004) provide an extension of Chatrath *et al.*'s (2000) study and produce two main results. First, the asymmetry in REIT betas in the context of high- and low-growth economic states does not exist in their two-decade sample. Second, the asymmetry in betas in advancing and declining markets virtually disappears under the null of the Fama-French three-factor model. This result is robust to alternative regression specifications.

In order to investigate if Turkish REIT betas exhibit a diverse behavior under the changing economic conditions, we follow Sagalyn's (1990) methodology and define relatively high-growth and low-growth GDP-trend sub-periods. While, February/2002 to December/2005 is defined as the relatively *high growth* period, January/2006 to June/2009 is classified as the relatively *low growth*.[2] Over the past eight years, from 2002 to 2009, Turkey's economic performance has been exemplary, re-establishing itself following the 2001 financial crisis. The initial years of our sample (2002 to the end of 2005) can be considered as a recovery period of the Turkish

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[2] To study performance over the business cycle, changing economic conditions are tracked two ways. First, components of the cycle are defined in reference to peaks and troughs as established by the NBER. Second, the business cycle is divided into high-growth and low-growth GDP-trend periods (Sagalyn,1990, pp. 208). Sagalyn (1990) uses the high/low growth classification for examining the systematic risk and risk-adjusted returns of REITs for a couple of reasons. First, it is a better conceptual descriptor because business cycles refer more appropriately to fluctuations in economic activity than precise repititive cycyles of similar length. Second, with a GDP-based definition, the business cycle can be tracked as the data are released, independent of an agency's ex-post dating of cycle swings.

economy after the long lasting financial crisis of 2001 with visibly high GDP growth rates. The improvement in the economy continued with the decreases in the interest rates and in the inflation rate until the financial turmoil in April 2006, which resulted in a prompt increase in the overnight interest rates of Central Bank of Turkey (CBT) to prevent economic fluctuations and foreign exchange demand. The ongoing global financial crisis has also induced some negative externalities for the Turkish economy. Despite being one of the world's fastest growing countries, Turkey is now facing a number of economic challenges as a result of the global economic downturn.

Our findings show that over the first sub-period, from 2002 to 2005, Turkish REIT betas have a declining trend as the real economy grows. As the economic growth gradually declines and starts to contract over the second sub-period, REIT betas decrease considerably in value. Unlike the empirical results of Sagalyn (1990) and Golstein and Nelling (1999) we conclude that REITs have higher betas in high-growth economic states than in low-growth economic states in Turkey. Hence, we do not observe an asymmetry in Turkish REIT betas in the context of high- and low-growth economic states in our eight year sample.

The remainder of this paper is organized as follows. The next section briefly describes the Turkish REIT industry. Section 3 provides the data analysis and the empirical methodology. Section 4 offers a discussion of the empirical results. Finally, section 5 offers conclusions.

2. A Review of the Turkish REIT Industry

The introduction and still-ongoing growth of REITs represent one of the visible and important changes in the Turkish economy. Turkey established her REIT structure in 1995. This is recognition of the importance of the institutional real estate sector several years ahead of many developed countries. Further, it is a major step forward to bringing international and institutional standards and professionalism to the broader real estate industry and to also fostering foreign investments (Erol and Tirtiroglu, 2008).

In order to create a favorable formation and growth environment for the fledgling industry, authorities have provided REITs with some important tax incentives as well as flexibility in managing their portfolios. The 1998 amendment by Capital Market Board (CMB) has exempted REITs from both corporation and income taxes (see Aydinoglu, 2004). Besides, a key difference of Turkish REITs from those in other countries is that Turkish REITs do not have to pay out dividends on a regular basis.[3] REITs in US,

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[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).

U.K., Canada, Japan, Hong-Kong, and Singapore have a minimum payout ratio, ranging from 90% to 100% of their net income after taxes. This unique difference makes Turkish REITs' dividend withholding tax rate zero percent. 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).

According to the Article 5 of 1998 Communiqué, Turkish REITs may be founded (i) for a specific period to realize a certain project, (ii) for a specific or unlimited period to invest in specific areas, (iii) for a specific or unlimited period without any limitation of objectives. All Turkish REITs are of the third type, so they are not limited by a certain product type or geographic location but are still bound by the general principles set by the CMB. Currently, REITs must invest at a minimum 50% of their portfolios in real estate and real estate-backed securities. Earlier, this ratio was 75% (Article 27 of the 1998 Communiqué, see Aydinoglu, 2004). This reduction has given them further flexibility to construct a more diversified portfolio with short- and long-term fixed income securities.

As of June 30, 2009, there are 14 REITs in Turkey quoted on the Istanbul Stock Exchange (ISE). 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. 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. Over the last 6 years, 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.

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 has not paralleled this positive trend. While the aggregate NAV 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.[4] Discount to net asset value is prevalent at all periods except for a slight premium in 2005 (see Figure 1a). 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 1b demonstrates 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.

The price performance of REITs and the industrial, service and financial companies listed on the ISE are plotted in Figure 2. The performance of REITs is close to the market average (ISE-100 Price Index) between 2002 and 2004, above average in 2005 and below average after 2006. The decline in performance in 2006 is mainly due to the rapid increase in overnight interest rates of the 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 but REITs are still underperforming the ISE-100 Index. This indicates that REITs are discounted, and did not appreciate as much as common stocks in ISE. On the other hand, Figure 2 illustrates that REITs generally outperformed the industrial, service and investment trusts sectors between

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4 Real estate securities typically trade at a discount because information to correctly value assets is insufficient, trading volumes are thin, and management-agency factors influence marketability (Sagalyn, 1990).)

the years 2002 and 2008. However, after the financial crisis of 2008, performance of REITs was 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.

3. Data analysis and methodology

The data used in this study are the weekly and daily total returns for the REIT industry and overall stock market compiled by the ISE covering the period 2002:02 to 2009:06.[5] REIT industry return and the proxy overall market return (ISEl-100 Index) are calculated by using 1794 daily and 374 weekly observations, respectively. ISE-100 Index consists of 100 companies, except for the investment trusts, traded on the stock market. ISE-REIT Index is comprised of the stocks of the real estate investment trusts traded on the ISE. The stock returns were calculated as the logarithm of the price differences of the consecutive index values and the excess returns are created by subtracting the risk free rate of interest from the returns. For the representative of risk-free rate, interest rate values for 3-months (91 days) maturity are produced by the yield curve estimated by the Nelson and Siegel (N&S) model. Data on interest rates are obtained from the ISE Bonds and Bills Market.

Table 1 presents the summary statistics for the daily and weekly return series of the REIT industry and overall market indices. Table 1 shows that both for the daily and weekly data, while market mean return is greater than the mean return of the REIT-Index, they 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) and that the market returns are less skewed than the REIT returns. Moreover, the Jarque-Bera test of normality fails for both return series.

Table A1 (see Appendix) shows the unit root (stationary) tests for the logarithm of the index values (or return series). This study uses four

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[5] It has been argued that daily return data is preferred to the lower frequency data like weekly and monthly returns because longer horizon returns can obscure transient responses to innovations which may last for a few days only. Contrary, 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.

commonly used unit root tests, 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 A1. 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.[6]

In order to detect the presence of autocorrelation in return series, we employ Ljung-Box-Pierce-Q Test and Breusch-Godfrey Serial Correlation LM Test. Whilst, the Ljung-Box Q or Q (r[7]) statistic can be employed to test the hypothesis that autocorrelations up to r^{th} lags are jointly significant, Breusch-Godfrey Serial Correlation LM Test is a Lagrange Multiplier test based on the regression of the OLS residuals on the lags of the residuals. Table A2 and A3 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. The level of significance for the degree of dependency is rather low in weekly market return series, and there is a lack of significant autocorrelation at higher lags.[7] 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.

The present work applies Diagonal BEKK Garch model as one of the techniques commonly used for the estimation of time varying betas. As the application of Garch-type models require the investigation of the existence of the Arch effect in the return series, we use ARCH-LM test developed by Engle (1982) in the pre-estimation data analysis. Table A4 shows that both for the daily and weekly return series there is significant Arch effect. The rejection of the null hypothesis of homoscedasticity in the residuals

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[6] 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.

[7] 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.

eventually shows that Garch models are applicable for the sample return series.[8]

To sum up, the preliminary data analysis indicates that the return series follow a fat tailed distribution. There is evidence of volatility clustering, especially for the high-frequency data, suggesting that the conditional variance varies over time. Thus, further examination of the stochastic properties of the return series is essential.

3.1. Methodology

The CAPM assumes that the systematic risk is constant through time. According to the one-factor CAPM, unconditional beta can be estimated via Ordinary Least Squares (OLS) as follows (Sharpe, 1964):

$$R_{i,t} = \alpha_i + \beta_i R_{M,t} + \varepsilon_{i,t} \quad (1)$$

$$\varepsilon_{i,t} \sim (0, \sigma_i^2), \;\; \beta_i = \frac{\text{cov}(R_M, R_i)}{\text{var}(R_M)} \quad (2)$$

where $R_{M,t}$ denotes the excess return of the stock market proxy (ISE-100 Index) and $R_{i,t}$ denotes the excess return of the REIT sector. The error terms $\varepsilon_{i,t}$ are assumed to have zero mean, constant variance and to be independently and identically distributed (IID). Following the market model with constant beta, this study uses three models in order to evaluate the time-varying behavior of beta for the Turkish REITs. These are; the Diagonal BEKK covariance specification of the M-GARCH model, the Schwert and Seguin model, and the Kalman Filter algorithm with random walk parameterization.[9]

Since modeling the co-movements of financial returns is of great practical importance in financial sector, researchers have extended their considerations to multivariate GARCH (MGARCH) models (Silvennoinen and Teräsvirta, 2008). Thus, we apply a bivariate version of the Garch model to estimate time varying betas by taking into account the co-movements of the REIT industry and the overall stock market returns. While the traditional CAPM assumes that returns are IID, it is well established in the empirical finance literature that this is not the case for returns in many

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[8] For the employment of ARCH-LM test, residuals obtained from the estimation of AR(1) models are used. 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. 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.

[9] When beta follows a random walk, any shock to an asset's systematic risk will persist indefinitely into the future. There is a sizeable body of literature beginning with Fisher (1971) and Kantor (1971) that asserts that beta follows a random walk. 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.

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:

$$\beta_{i,t} = \frac{\text{cov}(R_{i,t}, R_{M,t})}{\text{var}(R_{M,t})} \tag{3}$$

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. The first MGARCH model for the conditional covariance matrices was the so-called VEC model of Bollerslev *et al.* (1988) which is a straightforward generalization of the univariate GARCH model. This model is a very general one and also imposes positive definiteness of the conditional covariance matrix. In the extant literature, the two most popular parameterizations for the MGARCH models are the VEC and BEKK. In this study we implement the BEKK parameterization as the model has less parameters and the estimated covariance matrix will be positive definite, which is a requirement needed to guarantee non-negative estimated variances. The model has the following form:[10]

$$H_t = CC' + A'\varepsilon_{t-1}\varepsilon'_{t-1}A + B'H_{t-1}B \tag{4}$$

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. Finally, H_t is the time varying conditional variance covariance matrix at time t.

This can be expressed for the bivariate case of the BEKK as (Worthington and Higgs; 2006):

$$\begin{aligned} H_t = C'C + &\begin{pmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{pmatrix}' \begin{pmatrix} \varepsilon^2_{1,t-1} & \varepsilon_{1,t-1}\varepsilon_{2,t-1} \\ \varepsilon_{2,t-1}\varepsilon_{1,t-1} & \varepsilon^2_{2,t-1} \end{pmatrix} \begin{pmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{pmatrix} + \\ &\begin{pmatrix} b_{11} & b_{12} \\ b_{21} & b_{22} \end{pmatrix}' \begin{pmatrix} h_{11,t-1} & h_{12,t-1} \\ h_{21,t-1} & h_{22,t-1} \end{pmatrix} \begin{pmatrix} b_{11} & b_{12} \\ b_{21} & b_{22} \end{pmatrix} \end{aligned} \tag{5}$$

[10] 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 *et al.*, 2006) In this study BEKK(1,1,1) model is used with K=1.

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 H_t, depends only on lagged values of itself and lagged values of ε_{1t} and ε_{2t} . The matrix representation of the bivariate DBEKK model is (See Chou *et al.,* 2009):

$$H_t = \begin{pmatrix} c_{11} & 0 \\ c_{21} & c_{22} \end{pmatrix} \begin{pmatrix} c_{11} & c_{21} \\ 0 & c_{22} \end{pmatrix} + \begin{pmatrix} a_{11} & 0 \\ 0 & c_{22} \end{pmatrix}' \begin{pmatrix} \varepsilon_{1,t-1}^2 & \varepsilon_{1,t-1}\varepsilon_{2,t-1} \\ \varepsilon_{2,t-1}\varepsilon_{1,t-1} & \varepsilon_{2,t-1}^2 \end{pmatrix} \begin{pmatrix} a_{11} & 0 \\ 0 & c_{22} \end{pmatrix} + \begin{pmatrix} b_{11} & 0 \\ 0 & b_{22} \end{pmatrix}' \begin{pmatrix} h_{11,t-1} & h_{12,t-1} \\ h_{21,t-1} & h_{22,t-1} \end{pmatrix} \begin{pmatrix} b_{11} & 0 \\ 0 & b_{22} \end{pmatrix} \quad (6)$$

equivalently,

$$\begin{aligned} h_{11,t} &= c_{11}^2 + a_{11}^2 \varepsilon_{1,t-1}^2 + b_{11}^2 h_{11,t-1} \\ h_{12,t} &= c_{11} c_{21} + a_{11} a_{22} \varepsilon_{1,t-1} \varepsilon_{2,t-1} + b_{11} b_{22} h_{12,t-1} \\ h_{22,t} &= \left(c_{21}^2 + c_{22}^2\right) + a_{22}^2 \varepsilon_{2,t-1}^2 + b_{22}^2 h_{22,t-1} \end{aligned} \quad (7)$$

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

As the second approach to modeling time-varying beta, we use Schwert and Seguin (1990) model, which states that the conditional beta, β_{it}^{SS}, of the REIT industry return series can be estimated as follows (Brooks *et al.;* 1998b and 2002 and Haddad; 2007):

$$\beta_{i,t}^{SS} = b_1 + b_2 / h_{M,t} \quad (8)$$

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

$$R_{i,t} = a_0 + b_1 R_{M,t} + b_2 r_{M,t} + \varepsilon_{i,t} \quad (9)$$ [11]

where $R_{i,t}$ is the REIT sector return, $R_{M,t}$ is the market return, $r_{M,t} = R_{M,t}/h_{M,t}$ and $\varepsilon_{i,t}$ 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. Note that in order to obtain $\beta_{i,t}^{SS}$ 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, *et al.* 2002).

[11] This is the general market model with $\beta_i = \beta_{it}^{SS}$

The third model uses Kalman filter method that recursively forecasts the conditional betas from an initial set of priors and generates a series of conditional intercepts and beta coefficients for the CAPM. The Kalman filter is an optimal filter when the model is linear and Gaussian, due to the fact that Kalman filter obeys the optimal updating rule where the variance is minimized by definition for each step. The Kalman filter estimates the conditional beta, using the following time varying market model (see Brooks *et al.*, 1998b and 2002):

$$R_{i,t} = \alpha_{i,t} + \beta_{i,t} R_{M,t} + \varepsilon_{i,t} \qquad \varepsilon_{i,t} \sim N(0,\Omega) \tag{10}$$

where $R_{i,t}$ and $R_{M,t}$ are the excess return on the REIT Index and the market proxy (ISE-100 Index) at time t, respectively and $\varepsilon_{i,t}$ is the disturbance term. Equation (10) 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. 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 a random walk process both for the betas and the alphas. The corresponding transition equation can be defined as:

$$\beta_{i,t} = \beta_{i,t-1} + \eta_{i,t} \qquad \eta_{i,t} \sim N(0,\delta)$$

$$\alpha_{i,t} = \alpha_{i,t-1} + \varphi_{i,t} \qquad \varphi_{i,t} \sim N(0,\kappa) \tag{11}$$

Equations (10) and (11) constitute a state space model. To implement the Kalman filter to this model one needs to set initial conditions only on $\beta_0 \sim N(\beta_0, P_0)$ and $\alpha_0 \sim N(\alpha_0, \rho_0)$ as $R_{M,t}$ is non-stochastic observations. Based on the prior condition, Kalman filter can recursively estimates the entire series of conditional betas.

In summary, the present study applies three techniques using different approaches for modeling beta in an attempt to avoid the dependence on a single model and to be able to compare and evaluate the different conclusions derived from each model. The M-GARCH model, (Bollerslev, 1990), the Schwert-Seguin model (Schwert and Seguin, 1990) and the Kalman Filter algorithm are the three most commonly used techniques in beta modeling literature. 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. 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. Finally, the Kalman Filter approach recursively estimates the parameters including beta in the simple market model (CAPM) without looking at the behavior of return volatility. Unlike the other two models, the Kalman Filter, applied recursively through time to construct forecasts and forecast variances by the knowledge of the present state and the future input, generates a series of betas in a direct way.

4. Empirical Results

This section initially presents the estimation results for the unconditional and conditional REIT market betas using four different models. Then, it provides a comparative analysis of the estimated time varying betas both for the entire sample period and sub-sample periods, respectively.

The one-factor model of Sharpe (1964) is estimated to examine the unconditional relationship between REIT returns and the ISE stock returns. That is, both weekly and daily REIT returns are regressed on the corresponding ISE-100 Index returns. Regression results reported in Table 2 demonstrates that α values are nearly zero and statistically insignificant. This is an expected result of the CAPM, for which the relevant risk measure in holding a given security is only the systematic risk, or beta. The market betas for REITs are 0.86 and 0.81 for weekly and daily data, respectively. With a high level of significance, the OLS results imply that REIT sector returns are highly sensitive to the stock market movements. The R^2 values range from 66% to 68%, indicating that the explanatory power of the model cannot be considered very low.

In order to examine the changes in beta values between 2002:02 and 2009:06, we also compare beta values at yearly intervals. The regression results presented in Table 3 show that the relationship between REIT returns and the ISE stock returns is decreasing over time. As the OLS estimation gives constant beta values for each year, it is difficult to examine the time trend of beta through the sample period. Accordingly, in an attempt to test for a time trend in market beta estimates, we use three alternative models. These are namely the Diagonal BEKK covariance specification of the M-GARCH model, the Schwert and Seguin model and the Kalman Filter algorithm with random walk parameterization.

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 volatility, involving 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[11] and conditional variance covariance

[11] 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

equations are presented in Table 4 and Table 5, for daily and weekly data series, respectively.

Mean equation findings show that the past REIT return series 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 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. Figures 3a and 3b plot the time varying beta series generated by each model for the daily and weekly beta series, respectively. The upper panels of each figure show that the daily DBEKK beta series, ranging between 0.35 and 1.41, does not provide an observable trend; whereas weekly DBEKK beta series, ranging between 0.55 and 1.09, indicates a well-defined declining trend.

Generating the Schwert and Seguin conditional beta series requires an estimate of the conditional variance series for the market return. As noted earlier, the conditional variance estimates provided by the DBEKK Garch model are used to construct the series $r_{M,t}=R_{M,t}/h_{M,t.}$ Following the construction of this series, Equation (9) is estimated by using the OLS methodology. Table 6 presents the estimation results of the regression and shows that b_2, the coefficient of the newly added variable $r_{M,t}$- market return per unit of volatility, is statistically significant[12], negative and small in magnitude. This result demonstrates that, consistent with the findings of Schwert and Seguin (1990) and Haddad (2007), market volatility has a positively significant but a small effect in magnitude on the REIT returns. Besides, 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 (see Brooks *et al* ; 1998b and 2002 and Faff *et al.*; 2000).

Using the estimated coefficient values for b_1 and b_2, the conditional beta series $\beta_{i,t}^{SS}$ ($=b_1+b_2/h_{M,t}$) is generated and the time series plots of the daily and weekly beta series are presented in Figures 3a and 3b, respectively. Similar to the daily DBEKK beta series, daily Schwert and Seguin beta series also does 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. Unlike the DBEKK betas, there is

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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.

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

a clear increasing trend in Schwert and Seguin beta series following July, 2007 after a relatively stable period.

As the third model, time varying Kalman betas are estimated by using different initial points both for the daily and weekly data. 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.[13] Figures 3a and 3b indicate 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 between January, 2003 and December, 2004 and also between April, 2005 and April, 2009. In the former case beta decreases from 1.27 to 0.75 and in the latter case it decreases from 0.94 to 0.55.

The descriptive statistics for the time varying beta series generated by each model are displayed in Table 7. Clearly, all three models have comparable mean values for the estimated betas. Further, mean conditional beta values are similar to the point estimate of beta provided by the one-factor model of Sharpe (1964), supporting the findings of Faff *et al*. (2000), Brooks *et al*. (1998a, 2002), and Li (2003). All beta series, exhibiting low kurtosis but excess skewness values, are rejected for normality with the Jarque-Bera statistics, at the 1% level. Table 7 also illustrates that Schwert Schwert model generates a narrower range of beta values compared to the ranges estimated by Garch and Kalman filter techniques. This finding is also consistent with the Faff *et al.* (2000) and Brooks *et al.'s* (2002) empirical results.

As a further comparison among the estimated beta series, we calculate the correlation coefficients between each conditional beta series over the sample period. Table 8 shows the correlation coefficient between each pair wise combination of beta series and indicates that Garch and Kalman Filter generated series display high degree of similarity especially for the weekly data and have little in common with the Schwert and Seguin beta series. It is worth noting that correlation between the models decreases sharply when the daily data is used.

Consequently, estimated beta series exhibit a time varying pattern supporting the general view of beta instability in the extant literature. DBEKK Garch and Kalman approaches that present a more similar trend of conditional betas than that of the Schwert and Seguin model is also supported by the correlation coefficients between the model estimates. In particular, for the weekly data, beta series of the DBEKK Garch and Kalman

[13] Independent from the initial point, 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 converge to the MSE estimators. The present study reports the estimation results for β_0=1, regarding the proximity of the value to the initial points of the other models and the point estimate of the OLS beta.

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. On the other hand, when the daily data is employed, declining trend in beta series becomes less obvious. Indeed, more frequent changes are observed especially for the DBEKK beta series.

Our finding of a declining trend in Turkish REIT betas over the period of 2002:02 to 2009:06 verifies the general view of declining REIT betas in the extant literature. In our sample period, the cumulative rate of real GDP growth reached 33.2% marking it as the longest stretch of uninterrupted growth episode in Turkey's history.[14] In general, our results indicate that REIT industry beta exhibits a declining trend during the high growth periods of the Turkish economy.

Over the past eight years, Turkey's economic performance has been exemplary, re-establishing itself following the 2001 financial crisis. More specifically, during the initial years of our sample -from 2002 to 2005- Turkish economy has experienced visibly high growth rates (see Figure 4). This period can be considered as a recovery period of the Turkish economy after the long lasting financial crises of 2000 and 2001.[15] The improvement in the economy continued with the decreases in the interest rates and in the inflation rate until the financial turmoil in April 2006, which resulted in a prompt increase in the overnight interest rates of CBT to prevent economic fluctuations and foreign exchange demand. The recent US sub-prime mortgage crisis has also induced some negative externalities for the Turkish economy. Despite being one of the world's fastest growing countries, Turkey is now facing a number of economic challenges as a result of the global economic downturn. Starting with the second quarter of 2007, economic growth has slowed down gradually and in the last quarter of 2008 GDP started to contract. As the global economic uncertainties intensified at the beginning of 2009, economic slowdown deepened. Figure 4 displays that the real GDP growth rate declines from 8.4% in 2005 to -8.63 in June 2009.

Following the asymmetric REIT beta puzzle discussion, we determine two sub-periods (2002:02- 2005:12 and 2006:01- 2009:06) and examine the change in average beta values in line with the GDP growth rate. In particular, we attempt to investigate if Turkish REIT betas exhibit a diverse behavior under high- and low- growth periods. The results reported in Table 9 show that REIT industry has a significant decrease in beta value from the first sub-period to the second one. In particular, while average beta values

[14] The cumulative rate of real GDP growth reached 41.83% from 2002 to 2008, excluding the first half of 2009.

[15] The Turkish economy started to recover with the help of increasing trust in the new economic policies and the positive trend in the domestic demand. Implementations 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 target.

range between 0.94-1.04 in 2002, the values decrease to 0.78– 0.88 range in 2005. Additionally, throughout the first sub-period the average beta values are in the range of 0.86 -0.94. Over the same time period, from 2002 to 2005, we observe an increasing trend in real GDP growth, measured by the two-period moving average (see Figure 4). Consequently, we find that REIT betas have a declining trend as the real economy grows.

In our study period, Turkey's GDP growth rate has experienced a trend break. In particular, real GDP growth has increased gradually from 2002 to 2005, but it has subsequently decreased sharply until June 2009 (Figure 4). The average beta value declines to the range of 0.67 – 0.81 over the second sub-period. Similarly, average real GDP growth rate declines from 7.33% to 0.975% between the sub-periods. Thus, as the economic growth gradually declines and starts to contract, REIT betas decrease in value as well.

As noted earlier, the estimation results of the Schwert-Seguin model differ considerably than those of the DBEKK Garch and Kalman approaches. Schwert-Seguin model results suggest that as the real GDP grows REIT beta value decreases steadily over the first sub-period. Contrary, as GDP growth slows down and the economy starts to contract beta value exhibits a relatively stable pattern with a remarkable increase in later times of the second sub-period. Briefly, REIT industry beta exhibits a declining (increasing) trend as the GDP growth increases (decreases).

Overall, unlike the empirical results of Sagalyn (1990) and Golstein and Nelling (1999), we find that REITs have higher betas in high-growth economic states than in low-growth economic states. We do not observe an asymmetry in Turkish REIT betas in the context of high and low growth economic states in our eight year sample.

5. Concluding Remarks:

Recently, a number of researchers have suggested that there has been a substantial shift in the nature of the REIT market in the last few years as the beta - correlation of returns on REITs with returns on the general market- has decreased over time. This paper aims to present evidence on the time-varying behavior of beta for the Turkish REITs using seven years of both weekly and daily data from February 2002 to June 2009.

The paper uses Diagonal BEKK covariance specification of the M-GARCH model, the Schwert and Seguin (1990) model and the Kalman Filter algorithm with random walk parameterization to evaluate the time-varying behavior of the Turkish REIT betas. Using the weekly data we find that the Turkish REIT industry behaves in a similar way to the other REIT markets in terms of beta instability. Specifically, a declining beta trend valid for US and many other countries appears to prevail for Turkish REITs as well. Declining beta implies diminishing correlation between REITs and the general stock market and can be accepted as a sign of a maturing REIT market that now more closely relates to the performance of the underlying real assets. In addition, as the beta decreases the REIT market becomes less sensitive to the general stock market. As a result, reducing the portfolio risk, REITs is of obvious importance to investors/portfolio managers. The daily beta series do not provide an observable trend over the sample period. Thus, the use of data with different frequency led us to find different empirical results.

Several studies including Chatrath *et al.* (2000), Chiang *et al.* (2004), Sagalyn (1990) and Goldstein and Nelling (1999) focus on the asymmetric time-varying behavior of REIT betas. The discussion of REIT beta puzzle points out that REIT betas are found to be lower (higher) during periods of high (low) economic growth states and when the general stock market is advancing (declining). In an attempt to investigate if Turkish REIT betas exhibit a diverse behavior under high and low economic growth periods, following Sagalyn's (1990) article, we determine two sub-periods and examine the change in average beta values in line with the GDP growth rate. During the period studied, Turkey's GDP growth rate has experienced a trend break. That is, real GDP growth has increased gradually from 2002 to 2005, but it has subsequently decreased sharply until June 2009. Our findings suggest that REIT returns more closely track stock market in high-growth economic states than in low-growth economic states. Hence, we do not observe an asymmetry in Turkish REIT betas in the context of different economic growth states in our eight year sample.

Figure 1a
REITs Premium/Discount to Net Asset Value

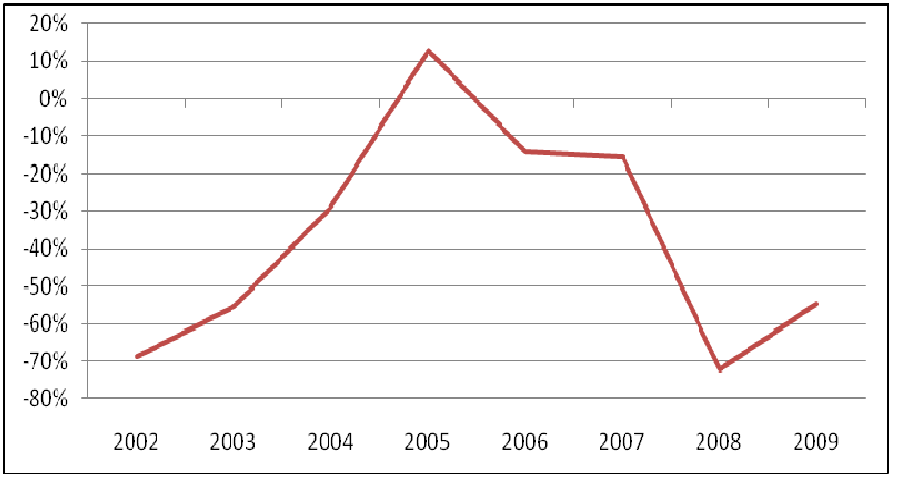
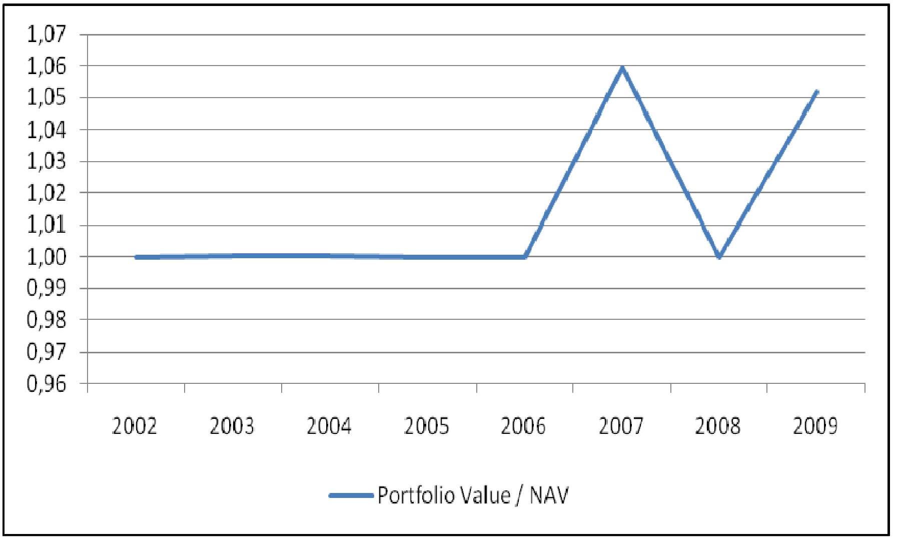
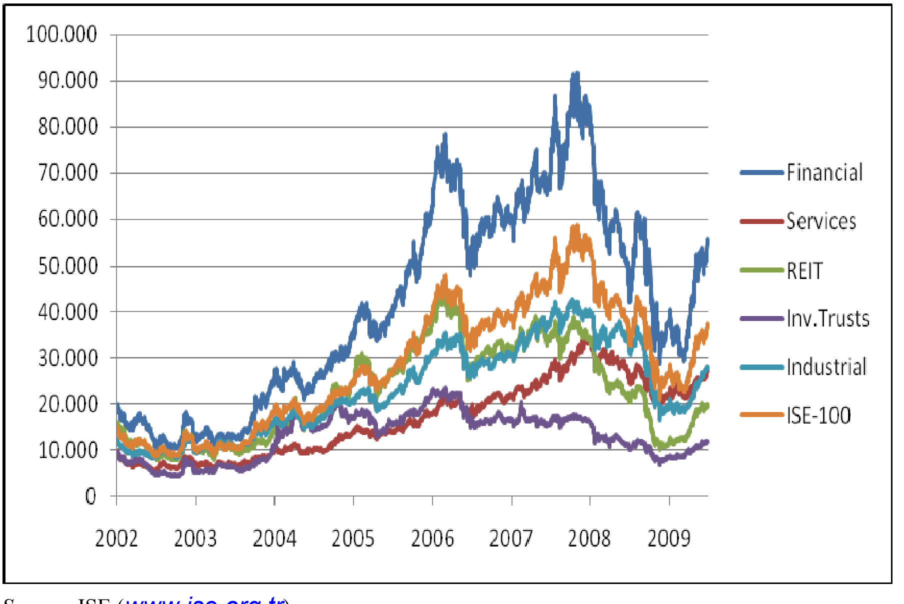


Figure 1b
REITs Portfolio Value/Net Asset Value



Source: CMB of Turkey and ISE

Figure 2
Price performance of the main sectors in ISE



Source: ISE (www.ise.org.tr).

Table 1
Descriptive statistics of the return series

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

Table 2
OLS estimation results of the market model $R_{it} = \alpha_i + \beta_i R_{Mt} + \varepsilon_{it}$

Weekly	Coefficient	Std. Error	t-Statistics	Prob.
α	-0.002280	0.001439	-1.584483	0.1139
β	0.862514	0.030622	28.16630	0.0000
R-squared	0.680780			
Daily				
α	-0.000419	0.000302	-1.388690	0.1651
β	0.810725	0.013782	58.82670	0.0000
R-squared	0.658834			

Table 3
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

Table 4

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

Table 5
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

	Coefficient	Std. Error	z-Statistic	Prob.
	Tranformed Variance Coefficients			
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 3a
Daily Beta Series Estimated by DBEKK, Schwert and Seguin and Kalman Filter Methods

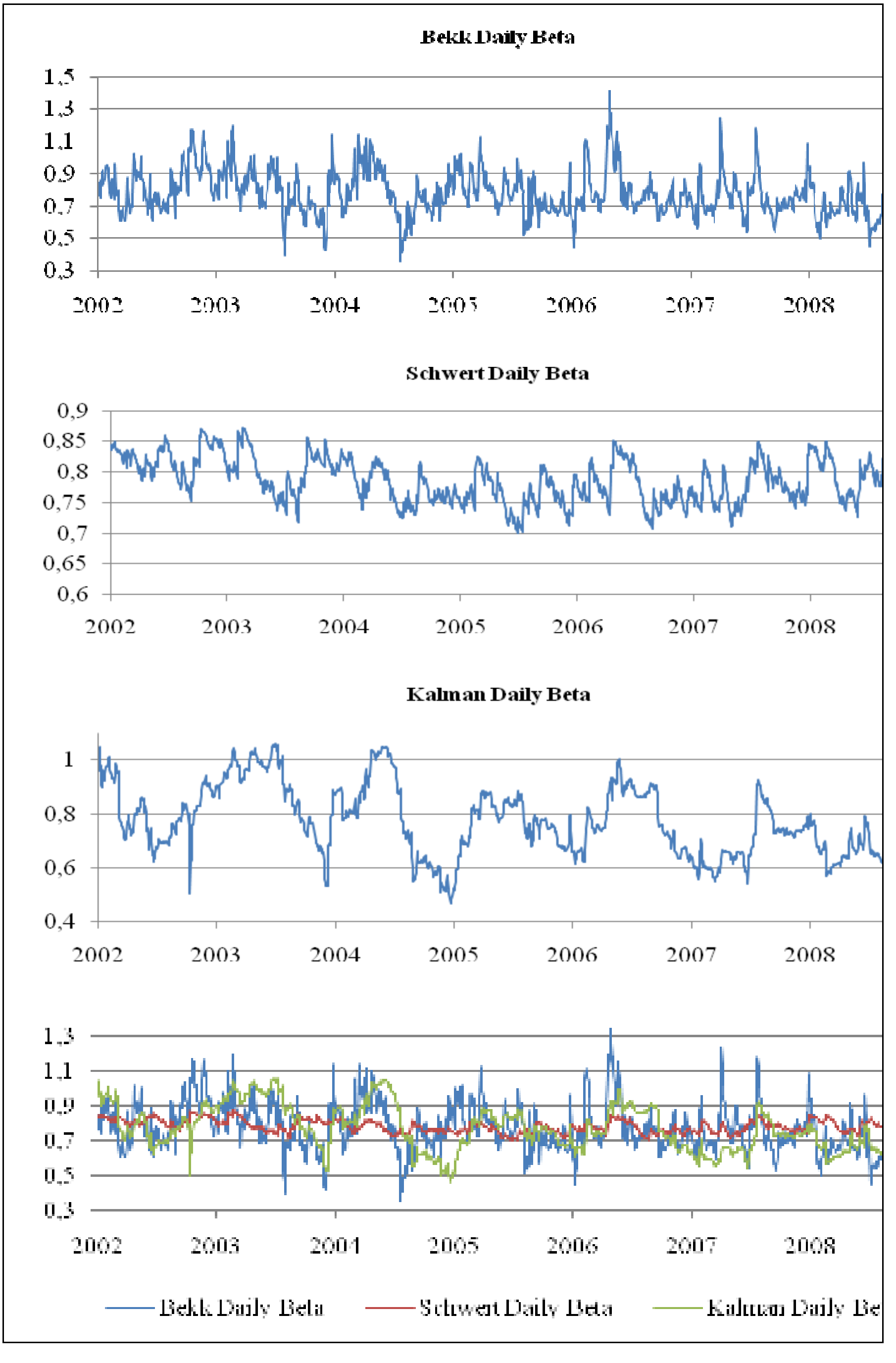


Figure 3b
Weekly Beta Series Estimated by DBEKK, Schwert and Seguin and Kalman Filter Methods

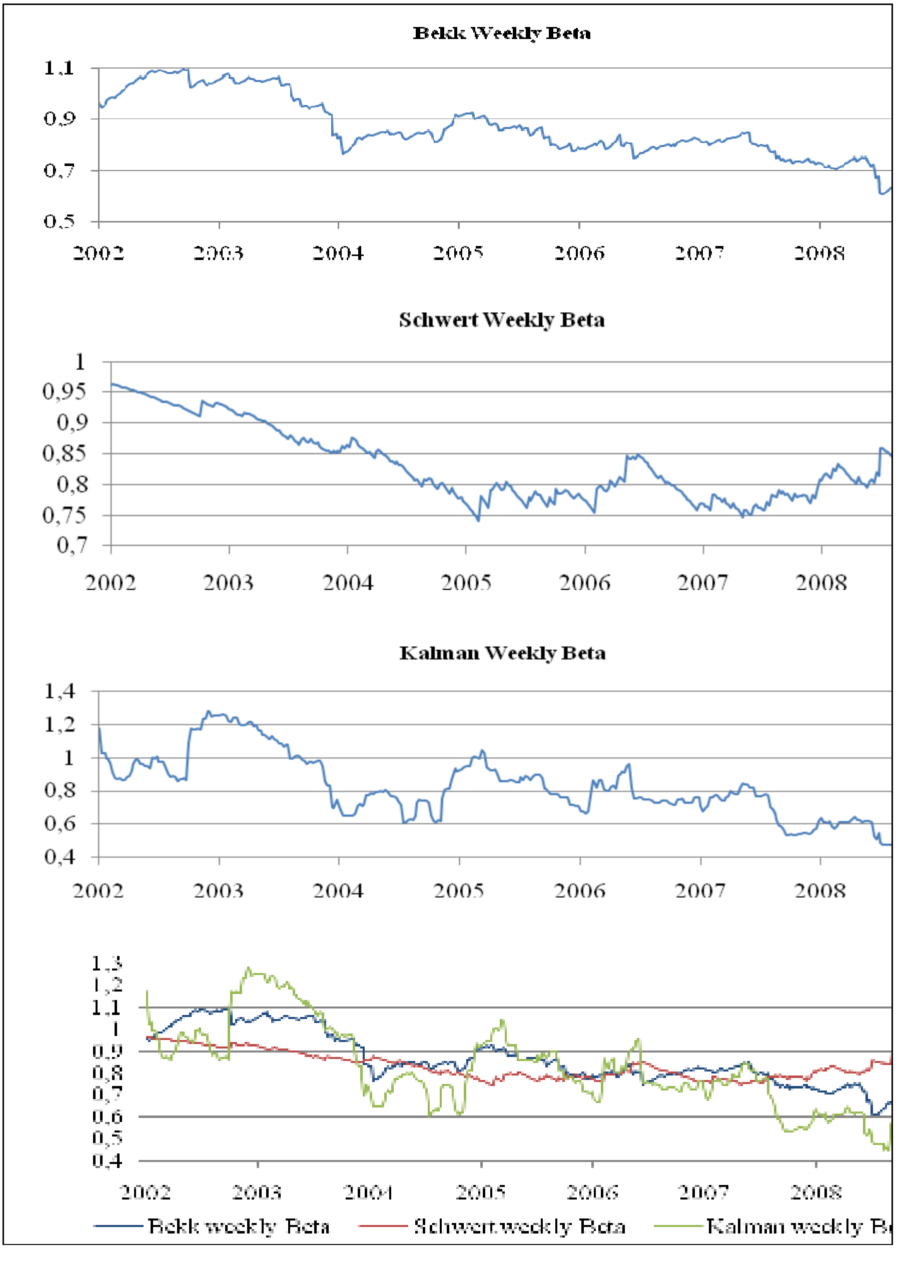


Table 6

Daily and weekly estimation results of the Schwert and Seguin model

$$R_{it} = a_0 + b_1 R_{Mt} + b_2 r_{Mt} + \varepsilon_{it}$$

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

Table 7

Descriptive statistics for the time varying beta series

Weekly	**Mean**	**Median**	**Variance**	**Skewness**	**Kurtosis**	**Jarque-Bera**	**Prob**
$Beta^{BEKK}$	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**	**Prob**
$Beta^{BEKK}$	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

Table 8

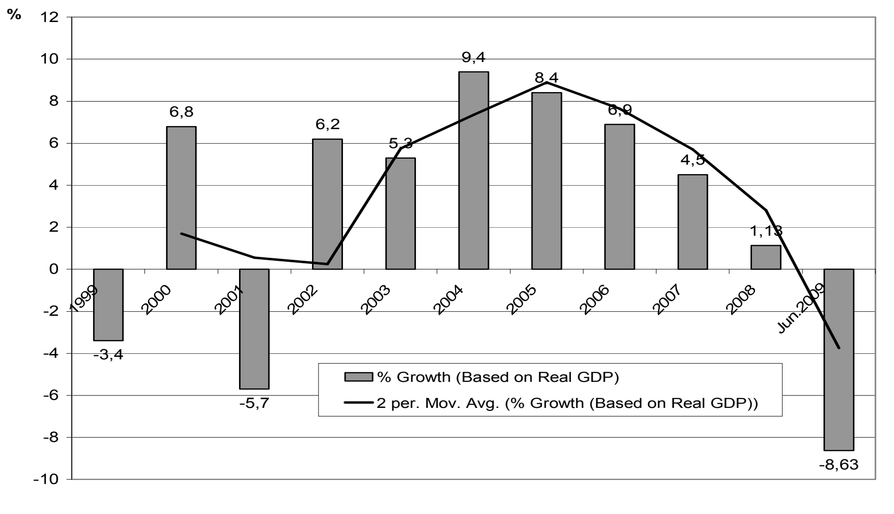
Correlation coefficients between each beta series

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

Table 9
Average Beta Values for the 2002-2005 and 2006-2009 June Sub-periods

	Average Beta Value			**Average real GDP growth rate (%)**
	DBEKK model	Schwert-Seguin model	Kalman Filter model	
2002/Feb.	1.043	0.939	0.980	6.20
2003	1.026	0.892	1.123	5.30
2004	0.837	0.831	0.719	9.40
2005	0.867	0.779	0.884	8.40
2002/Feb -2005	0.939	0.858	0.923	7.33
2006	0.794	0.803	0.775	6.90
2007	0.794	0.770	0.707	4.50
2008	0.670	0.855	0.567	1.18
2009/June	0.621	0.910	0.555	-8.63
2006- 2009/June	0.746	0.814	0.673	0.975

Figure 4
Real GDP Growth Rate in Turkish Economy: 1999 to June 2009



Source: GDP Growth –Turkey (%); The Turkish Statistical Institute (TurkStat).

TurkStat announced the new series of GDP on 8 March 2008. Figure 4 plots real economic growth rates (based on GDP- production approach) between 1999 and June, 2009. The old accounts, based on the 1968 UN system of accounts, did not adequately attempt to assess the sizeable informal sector. The new system is in line with European System of Accounts (ESA-95) methods and includes more comprehensive coverage of the housing and manufacturing sectors.

APPENDIX

Table A1

Unit root test statistics and p-values of the returns.[8]

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

Table A2

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.

[8] 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.

Table A3

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
Obs*R-squared	52.46974	Prob. Chi-Square(20)	0.0001	Obs*R-squared	28.9724	Prob. Chi-Square(10)	0.0013
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.

Table A4

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.

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Özet

Gayrimenkul yatırım ortaklıkları'nın değişken beta katsayısı

Bu makalede, Türkiye'de halka arz edilen gayrimenkul şirketlerinin (GYO'ların) sistematik riskinin -beta katsayısının- zamanla nasıl değiştiği son yedi yıla ait günlük ve haftalık veriler kullanılarak ampirik olarak test edilmiştir. Çalışmanın örneklem periyodunda Türkiye reel GSYİH'daki büyüme oranında önemli bir yapısal kırılma gözlenmiştir. Şubat 2001 finansal krizininin uzun süren etkileri sonunda reel GSYİH'daki büyüme 2002-2005 yılları arasında kademeli olarak artmış, Aralık 2005-Haziran 2009 arasında ise büyüme hızlı bir şekilde düşmüştür. Makalede, Diagonal BEKK M-GARCH modeli, Schwert-Seguin (1990) modeli ve rassal yürüyüş serilerine dayalı Kalman Filtresi modeli kullanılarak, gayrimenkul sektörü beta katsayısının zamanla nasıl bir değişim gösterdiği analiz edilmiştir. Çalışmanın sonuçlarına göre, Türk GYO sektörü beta katsayısı örneklem periyodu süresince azalmaktadır. Bu sonuç, diğer gelişmekte olan ülkelerin ve gelişmiş ülkelerin GYO sektörleri için elde edilen sonuçlarla benzerlik göstermektedir. Reel GSYİH'daki yüksek büyüme hızı ve düşük büyüme hızı dönemlerinde, GYO beta katsayısının farklı bir davranış izleyip izlemediğini anlamak amacıyla iki farklı alt örneklem dönemi tanımlanmış ve her dönem için beta katsayıları tahmin edilmiştir. Dönemler arası beta katsayısında gözlemlenen değişimler reel GSYİH'daki büyüme hızı değişimlerine parallel olarak incelenmiş ve yorumlanmıştır. Elde edilen analiz sonuçlarına göre, reel GSYİH'daki büyüme hızının yüksek olduğu dönemlerde GYO sektörü getirileri hisse senedi piyasası getirilerini daha yakından takip etmektedir. Diğer bir deyişle, Türk GYO sektörü beta katsayısı son yedi yılın verileri gözönüne alındığında asimetrik bir davranış sergilememektedir.

Anahtar kelimeler: Değişken beta katsayısı, sistematik risk, Gayrimenkul Yatırım Ortaklıkları (GYO), gayrimenkul yatırımları getirisi, Diagonal BEKK M-GARCH modeli, Kalman filtresi.

JEL kodları: G17; G30; C32; C51; C53.