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Is There Still a Day-of-the-Week Effect in the Real Estate Sector?

Abstract. *This study contributes to the ongoing debate on the persistence of stock market anomalies in equity markets (McLean and Pontiff, 2016; Jacobs and Müller, 2020) and concentrates on the day-of-the-week effect in the European real estate sector. Interest payments and settlement effects were discussed as the main factors to explain this anomaly in the past. Today the persistence is highly questionable concerning the dynamically adjusting economic and institutional environment. While previous research indicated a significant Monday and Friday effect in other sectors, literature can only support a Friday effect for real estate. Furthermore, the real estate sector has a lower level of mispricing, which makes it more difficult for an anomaly to survive (Bampinas et al., 2016). The data is splitted in three ten-year periods to analyze the effect's existence over the long term. Applying OLS and GARCH models, results reveal an evolution in a significant Friday effect for cross-country indices (Europe and Global). From 1990 to 2000, the effect is weak but significant. It gains in importance during the period 2000 to 2009. In the final period until 2020, the anomaly weakens again but does not disappear for cross-country indices. From a country-specific perspective, there is no pattern in the significance of the day-of-the-week effect. The real estate sector has a local business character. Therefore, country-specific effects are possible, but a pattern is not found. In conclusion, there is still a day-of-the-week effect in the real estate sector in Europe from a cross-country perspective.*

Keywords: *day-of-the-week-effect, real estate, GARCH, Friday effect, Monday effect, Weekend effect, stock market anomaly.*

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Чи все ще існує ефект дня тижня в секторі нерухомості?

Анотація. *Це дослідження сприяє дискусії про збереження аномалій фондового ринку на ринках акцій (Маклін і Понтіф, 2016; Якобс і Мюллер, 2020) і зосереджується на ефекті дня тижня в європейському секторі нерухомості. У попередніх дослідженнях як головні фактори, що пояснюють цю аномалію, обговорювалися процентні виплати та ефекти розрахунків. Сьогодні стійкість викликає великі сумніви з огляду на економічне та інституційне середовище, що динамічно змінюється. У той час як попередні дослідження показали значний ефект понеділка та п'ятниці в інших секторах, наукова література може підтвердити ефект п'ятниці лише для нерухомості. Крім того, сектор нерухомості має нижчий рівень неправильного ціноутворення, що ускладнює виживання аномалії (Бампінас та ін., 2016). В цьому дослідженні дані розділені на три десятирічні періоди, щоб проаналізувати існування ефекту в довгостроковій перспективі. Завдяки застосуванню моделей OLS і GARCH, виявлено еволюцію значного ефекту п'ятниці для індексів між країнами (Європа та світ). Моделі GARCH підтверджують послідовні докази ефекту п'ятниці для всього досліджуваного періоду. Проте з часом спостерігається еволюція ефекту дня тижня. У різні періоди значущими є різні дні тижня. Лише ефект п'ятниці залишається значущим у всі періоди. Зокрема, з 1990 по 2000 рік ефект був невиразний, але значний. У період з 2000 по 2009 рік він набирає важливості. В останній період до 2020 року аномалія знову слабшає, але не зникає для індексів між країнами. З точки зору конкретної країни, немає закономірності у значущості ефекту дня тижня. Підсумкові результати дослідження свідчать, що з точки зору міжнародної перспективи в секторі нерухомості в Європі все ще існує ефект дня тижня.*

Ключові слова: *ефект дня-тижня, нерухомість, узагальнена авторегресивна умовна гетероскедастичність (GARCH), ефект п'ятниці, ефект понеділка, ефект вихідного дня, аномалія фондового ринку.*

1. INTRODUCTION

Systematic seasonality leads to anomalies explained by reasonable compensation for settlement periods. The average return for days, weeks, and months has been studied comprehensively in previous literature. Seasonal patterns allow the development of profitable investment strategies to generate profits. There are several variants of this seasonal pattern: the "weekend effect", the "January effect", or the "day-of-the-week effect" (Jaffe & Westerfield, 1985; Seyhun, 1988; Dubois & Louvet, 1996). The day-of-the-week effect states a significantly different return for one day of the week compared to the remaining days (Dubois & Louvet, 1996).

Several empirical studies, for example, French (1980), Gibbons and Hess (1981), and Keim and Stambough (1984), reported that the daily return in the U.S. stock market is, on average, significantly higher on Friday while the Monday returns were significantly negative. The highest concentration of attention on this anomaly is from around 2000 to 2010 (Friday & Higgins, 2000; Lenkkeri et al., 2006).

On one side, contrary to the predominant opinion of the existence of a day-of-the-week effect, Bampinas et al. (2016) cast doubt on the results. They do not obtain a day with a significantly higher or lower return when studying the European real estate sector from 1990 to 2010 and conclude that daily seasonality seems subject to data mining criticism (Bampinas et al., 2016). On the other side, the ongoing debate on the persistence of stock market anomalies, as documented by Jacobs and Müller (2020), suggests that barriers to arbitrage trading can create segmented markets and that anomalies tend to represent mispricing instead of data mining.

Inconsistent findings make the day-of-the-week effect an often-discussed anomaly. In addition to discussing the existence of the day-of-the-week effect, researchers document a weakening of this anomaly (Board & Sutcliffe, 1988; Steeley, 2001). By following this trend, the day-of-the-week effect in 2000 might have disappeared.

The focus lies on the real estate sector for multiple reasons to contribute to the discussion. First, Birz et al. (2022) argue that it is essential to analyze real estate separately because of institutional characteristics (Chan et al., 1990; Sa-Aadu et al., 2010; Devos et al., 2013). As a result, the real estate sector stands out because of a lower level of mispricing than other sectors, which makes it more difficult for an anomaly to survive (Bampinas et al., 2016). Second, its position as an outlier from the general stock market is also recognizable in the day-of-the-week literature. Results for the real estate sector differed from the rest in terms of significance for individual weekdays. Based on this inconsistency, an up-to-date perspective with modern statistical methods is lacking. Previous studies are mainly based on OLS regressions, and the period of the most recent analyses only goes until 2010. Considering all these aspects, it is unknown whether the day-of-the-week effect still exists. Building on GARCH models and a more recent period, this study addresses the research question: ***Is there still a day-of-the-week effect in the real estate sector?***

The paper proceeds as follows. Section 2 includes a comprehensive literature summary on seasonal patterns in various stock markets. Section 3 describes the dataset for the empirical analysis for the period from 03.01.1990 to 01.10.2020. The study searches for country- and cross-country-level patterns to include multiple perspectives on the European real estate sector. In the next section, 4 research methods are explained, which are used to derive empirical evidence. The datasets are estimated with three different GARCH models selected using the Schwarz Information Criterion. Section 5 provides a summary of the results, and section 6 concludes.

2. LITERATURE REVIEW

One of the first studies analyzing the day-of-the-week effect in real estate is from Redman et al. (1997). They that the day-of-the-week effect exists with a significantly higher return on Friday by focusing on the U.S. real estate segment with real estate investment trusts (REIT) from 1986 to 1993 (Redman et al.,1997). After 2000, many studies concentrated on seasonal patterns in global real estate markets. Friday and Higgins (2000) examine the daily returns of all publicly tradable REIT and all tradable mortgage REIT. From these two categories, a data set with equal weights is constructed for the period from 1970 to 1995. The results show that the return on Mondays is positive, while the return on Fridays is also positive. If Friday's return is negative, Monday's return is also negative (Friday & Higgins, 2000). These findings do not hold for mortgage REITs. Friday and Higgins (2000) conclude that if investors plan to sell their REITs on Friday, they can increase their profits by extending the holding until Monday. To this end, their findings strengthen the argument that REITs can be viewed more like stocks on a day-to-day basis.

Connors et al. (2002) support the Friday effect by examining the average daily return of REITs for existing calendar anomalies from 1994 to 1999 and using an equal-weighted, value-weighted, and broad market CRSP data set. As a result, the highest average return on Friday is obtained.

Another perspective on the day-of-the-week effect is created by Hardin et al. (2005), who compare the returns of REITs and the general stock market from 1994 to 2002. As a result, they show significant REITs seasonal patterns, but these patterns depend on the index selected for the REITs. Hardin et al. (2005) report that calendar anomalies are not detectable for an index weighted by market capitalization. In the next step, various European real estate stock market indices are examined by Lenkkeri et al. (2006) between 1990 and 2003. The authors find above-average returns for Friday for eight out of eleven European countries and conclude that there are profitable trading strategies to exploit seasonal patterns. These trading strategies are country-specific and not consistent from an overall perspective.

Lee and Ou (2010) examine MREITs from 2001 to 2007, estimating an OLS and a GARCH model to explore the day-of-the-week effect. The result for MREITs is positive for Tuesday and Friday and negative for Wednesday. In conclusion, Lee and Ou (2010) suggest that these findings affect the asset allocation and timing of securities issuance by listed firms.

One of the most recently published studies is by Bampinas et al. (2016), in which the authors examine twelve countries' global, European, and real estate indices. The period for this study is from 1990 to 2010, in which the day-of-the-week effect will be analyzed using different regressions. Bampinas et al. (2016) apply the GARCH, EGARCH, and GJR-GARCH models to determine the best estimate. A significantly higher return for Friday is present in half of the countries and the two cross-regional indexes. A significant impact on Monday is seen in three countries. In addition to the GARCH models, they run a moving regression for which Friday has a significant influence of 15.37% when using the GED distribution. The authors cast doubt on the day-of-the-week effect in European real estate markets and argue that seasonal patterns could result from data mining. This interpretation conflicts with Jacobs & Müller (2020), who suggest that barriers to arbitrage trading can create segmented markets and that anomalies survive due to mispricing rather than data mining.

However, the day-of-the-week effect varies with indexes and statistic methods, which makes it necessary to have a closer look at the methodology in the literature. Remarkably, only three sources in the literature overview apply GARCH models. Most of the literature focuses on OLS regression, which can lead to biases in time series analysis. In this case, the day-of-the-week effect could result from data mining biases, as Bampinas et al. (2016) conclude. Nevertheless, studies based on GARCH models produce contradictory results by supporting or rejecting the day-of-the-week effect. Furthermore, the time range is until 2010, which creates a research gap of more than ten years until now.

The evidence provides an inconsistent picture and raises doubts about seasonal patterns. Especially in the 1970s and 1980s, most studies obtained clear proof of seasonal anomalies. It was not until the mid-1990s that financial economists began to examine real estate markets, focusing on REITs. The evidence is inconclusive. On one side, Bampinas et al. (2016) cast doubts about the day-of-the-week effect due to errors in data mining. Conversely, Jacobs and Müller (2020) disagree and explain the anomaly with mispricing. The discussion has not ended, and most recent literature is inconsistent.

The literature research shows that it is time for a new perspective for two reasons. First, research methods are mainly based on OLS regressions, which can cause static biases like heteroscedasticity. Second, the literature declares a weakening of the day-of-the-week effect (Board & Sutcliffe, 1988; Steeley, 2001). Based on this time dependency, the anomaly could have changed or disappeared from the last research period until 2010. For this reason, a more recent data set and methodology is the starting point for the research.

3. DATASET

The dataset covers a time frame from 08.01.1990 to 01.10.2020, for which European indices are examined. Due to the time horizon of 30 years, the focus is additionally on different sub-periods according to global events, which have strongly influenced the world economy. The first data set begins on 08.01.1990 and ends on 31.12.2000, a period until the dot-com bubble burst. Thus, eleven years are included in this data set, containing 2605 observations for the individual indices, except Finland. There are 1805 observations for Finland.

Data set 2 covers the period from 01.01.2001 to 06.30.2009. The data contains the daily closing prices of the studied indices from 2477 days. The end date is set for the end of the world financial crisis and the stabilization of real estate prices. Furthermore, a concentration of research on the day-of-the-week effect takes place. Data set 3 refers to a period from 01.07.2009 to 01.10.2020, the end of the whole studied period. This dataset includes 2936 closing prices for all indices and covers a period until the COVID-19 pandemic shocked the stock market.

The individual data sets consist of the indices from the Financial Times Stock Exchange, European Public Real Estate Association, and National Association of Real Estate Investment Trusts (FTSE, EPRA, NAREIT). The data used for the analysis is retrieved from Thomson Reuters. Daily closing prices for the days Monday to Friday are the baseline for the empirical research. It should be noted that these are not synchronous for each country, especially for the European and American stock markets, because the trading hours and holidays are different. This non-synchrony could lead to underestimating the correlations (Martens & Poon, 2001).

Nevertheless, the daily closing prices are used to prove the day-of-the-week effect. Following Bampinas et al. (2016) to create comparable results, the research is based on different dimensions. First, a country-specific perspective of European countries is analyzed. Second, there is a focus on a cross-country index of Europe and third, a global index is the most generalized perspective. The analysis mainly focuses on the European countries and the cross-country index for Europe. Data from the following countries is analyzed: Belgium, Finland, France, Germany, Italy, Netherlands, Norway, Spain, Sweden, Switzerland, and the UK. In addition to the individual European countries, the FTSE EPRA NAREIT Developed Europe Total Return Index (European Index) is analyzed, which takes into account all countries entering the European Union. The individual countries are weighted in the European Index according to market capitalization. The composition, based on the size of the market capitalization of the European index, leads to a concentration on the countries Germany and Great Britain. Germany has a share of 31% and the United Kingdom 26% in this index. Sweden has the third-largest share, with 12%. (as of 01.10.2020)

In addition to the European index as a supra-regional index, the FTSE EPRA NAREIT Developed Total Return Index (referred to as the global index) is chosen. The largest share is held by American listed real estate stocks with 53%, followed by Japan with 11% and Germany with 6%. Europe has a total share of 18.59% in the global index. (as of 01.10.2020)

All indices are total return indices, quoted in euros and weighted according to the level of market capitalization. Since the index is examined for different countries, there are days without trading in these countries (e.g., variable public holidays). Following Savva et al. (2006), for these days without trading, the missing prices are replaced with the last price before the day without trading.

As many European countries' indices as possible are included to research to generate an overview of the European real estate market. However, this is impossible for some countries due to a lack of data availability. Thus, in addition to the European and global indices, eleven national data sets are examined with 8019 values, except Finland, where the data set is limited to 7240 observations.

4. RESEARCH METHODOLOGY

The analysis is based on logarithmic returns to make the different data sources comparable. The return is calculated as follows by using the closing prices P_t and P_{t-1}:

$$R_t = \ln\left(\frac{P_t}{P_{t-1}}\right) \qquad (1)$$

where R_t is the daily return in percent for each index, t describes the respective day for the return.

Basic Day-of-the-week Effect Model

To analyze the effect of each day, a model with five dummy variables representing each day is necessary. If the return is sought for any Monday, then the dummy variable for Monday takes the value one, and the other dummy variables take the value zero. Each variable represents one day of the week. The previous day's term is also called the autoregressive term AR (1). Following Lenkkeri et al. (2006), the model is described as follows:

$$R_t = \alpha_1 Mon_t + \alpha_2 Tue_t + \alpha_3 Wed_t + \alpha_4 Thu_t + \alpha_5 Fri_t + \alpha_6 R_{t-1} + \varepsilon_t \qquad (2)$$

where R_t is the calculated return in percent for the day, α_1-α_5 are the coefficients for each day estimated, Mon_t is the dummy variable for Monday, and so on. α_6 is the factor for the autoregressive term, R_{t-1} is the previous day's return, and ε_t is the random error term.

The purpose of this equation is to use OLS regression to detect existing anomalies, particularly for the day-of-the-week effect. For the detection of the day-of-the-week effect, the following hypothesis is to be investigated:

$$H_0: \alpha_1 = \alpha_2 = \alpha_3 = \alpha_4 = \alpha_5 = 0$$

This hypothesis states that no day of the week has a significant influence, and thus the day-of-the-week effect does not exist. If the p-value is smaller than 0.05, the coefficient significantly influences the data set, and the hypothesis will be rejected. Thus, evidence for the day-of-the-week effect exists.

GARCH Model

Different GARCH models, like the GARCH(1,1) model, are examined. Bera and Higgins (1993) report that GARCH(1,1) models are sufficient for a good fit for time series in capital markets and that more extended models are rarely needed.

The equations below describe the GARCH(1,1) model, adapted from Bampinas et al. (2016). This model consists of two equations: the mean equation (3) and the variance equation (5). Equation (3) describes the equation of the day-of-the-week effect, for which the dummy variables and the coefficients are explained in the previous section. For the use of the mean equation in the GARCH model, variable AR terms are added, which are selected according to the best estimate when running the GARCH models. That is, whether no AR term AR(1) or AR(2) term is inserted depends on the selection according to the Schwarz Information criterion. The error term (4) is normally distributed.

$$R_t = \alpha_1 Mon_t + \alpha_2 Tue_t + \alpha_3 Wed_t + \alpha_4 Thu_t + \alpha_5 Fri_t + \sum \mu R_{t-1} + e_t \quad (3)$$

$$e_t \backslash \Omega_{t-1} \sim N(0, h_t) \quad (4)$$

$$h_t = \omega + \alpha e^2_{t-1} + \beta h_{t-1} \quad (5)$$

Equation (5) describes the variance equation of the GARCH(1,1) model, where h_t is the conditional variance, omega is the constant term, and $\beta h_{(t-1)}$ is the GARCH term, which represents the impact of new shocks on volatility. The ARCH term is present in the equation through $\alpha e^2_{(t-1)}$, which indicates how strongly volatility responds to market shocks.

The sum of alpha and beta must be less than 1 for the conditional variances to be stationary, for this omega must be greater than zero, alpha and beta greater than or equal to zero for the conditional variance to be strictly positive (Berra & Higgins, 1993).

EGARCH Model

The EGARCH model, unlike the GARCH model, is asymmetric. This asymmetric feature describes the market's volatility response to good or bad news. Following Nelson (1991), equation (5) is replaced by equation (6). The variance equation describes the simplest EGARCH model, the EGARCH(1,1) model. Through this new variance equation, the model forms an exponential GARCH process:

$$\log(h_t) = \omega + \alpha \left[\frac{|e_{t-1}|}{\sqrt{h_{t-1}}} \right] + \gamma \frac{e_{t-1}}{\sqrt{h_{t-1}}} + \beta \log(h_{t-1}) \quad (6)$$

where $\frac{|e_{t-1}|}{\sqrt{h_{t-1}}}$ represents the standardized shocks, gamma is the asymmetric term in the equation, and $\log(h_t)$ is the logarithm for the conditional variance. For β, the stability condition is $|\beta| < 1$. Asymmetry exists when γ takes the non-zero value.

The EGARCH model is intended to reveal asymmetric effects affecting volatility in the estimation.

GJR-GARCH Model

The GJR-GARCH model differs from the GARCH model in that an asymmetric effect is included in this model. It consists of two equations: the mean equation and the variance equation. The mean equation is described in equation (3) and is also used for this model. The variance equation is defined in equation (7) and includes an additional term compared to the variance equation of the GARCH model:

$$h_t = \omega + \alpha e^2_{t-1} + \gamma e^2_{t-1} I_{t-1} + \beta h_{t-1} \quad (7)$$

where $\gamma e^2_{t-1} I_{t-1}$ is the asymmetric term measuring the asymmetric influence. When γ is zero, the null hypothesis that bad news and good news have the same influence on the market can be accepted. For this case, the GJR-GARCH model is the standard GARCH model. If γ is non-zero, the null hypothesis must be rejected. Thus, two distinctions exist. If γ is greater than zero, bad news possesses a greater influence on the volatility of the market; if γ is less than zero, the positive news has a greater impact on the volatility of the market.

5. EMPIRICAL RESULTS

After the data is split into three periods, each period is analyzed separately. First, a descriptive analysis is done, and in the next step, OLS and GARCH models are trained. Data is presented index-specific.

Descriptive analysis

Two of the 13 indices examined have negative average returns from 1990 to the end of 2000. When reviewing the individual days of the week, five indices (Europe, Finland, Germany, Spain, United Kingdom) have a positive average return for Monday. Friday, the average return of nine indices (Europe, Global, France, Germany, Italy, Netherlands, Norway, Spain, and Sweden) is positive.

For data set 2, the descriptive statistics include data from 2001 to mid-2009 with 2477 observations per index. The means for Europe and the global index in this period are the highest of the three data sets. The following section investigates whether the days are significant for the second data set. It can be seen for the individual indices that all indices have a negative average return for Monday, and all indices have a positive average return for Friday.

The descriptive statistics for data set 3 summarise daily returns of 2937 days from mid-2009 to early October 2020. All countries except the Netherlands and Spain show a positive average return. In summary, of the 13 indices examined, two indices (Global and Finland) show a positive average return for Monday. For Friday, all indices reveal a positive average return. In detail, the European index has a negative average return for Monday and a positive average return for Friday. The global index shows a positive return for all days of the week except Thursday. For the countries with a negative average return across the data set, a positive average return is present for Spain only on Friday and the Netherlands on Tuesday and Thursday.

Finally, Table 1 presents the descriptive statistics for the whole period from January 1990 to the beginning of October 2020. The Netherlands, Norway, and Spain indices show a negative average daily return, while all other indices have a positive performance. The European and global indexes have a negative average daily return for Mondays and a positive return for Fridays. Only Finland has a positive average daily return for Mondays, and all other countries have a negative return. Friday is a day with a positive average return for all countries. Descriptive statistics indicate a positive Friday effect but also show the inconsistency between countries and periods.

Table 1. **Descriptive statistics for whole data** (***, **, * = p < 1%, 5%, 10% significance level)

	Mean	**Min.**	**Max.**	**Std. Dev.**	**Skewn.**	**Kurt.**	**JB test**	**ADF**	**n**
Europe	0.00009	0.040	-0.053	0.004	-0.738	15.763	55153*	-18.15*	8019
Global	0.0001	0.036	-0.067	0.005	-0.844	16.157	58794*	-18.99*	8019
Belgium	0.0001	0.045	-0.053	0.004	-0.139	15.725	54125*	-20.13*	8019
Finland	0.0002	0.302	-0.244	0.013	1.849	133.208	243024*	-13.732*	7240
France	0.0001	0.074	-0.069	0.005	-0.079	19.325	89058*	-18.88*	8019
Germany	0.0001	0.060	-0.093	0.006	-0.609	19.759	94344*	-18.62*	8019
Italy	0.00003	0.077	-0.097	0.008	-0.571	15.444	52179*	-18.14*	8019
Netherlands	-0.000005	0.063	-0.097	0.006	-1.059	37.592	401325*	-18.53*	8019
Norway	-0.00008	0.113	-0.130	0.010	-0.480	27.851	206650*	-18.33*	8019
Spain	-0.0002	0.095	-0.146	0.009	-0.753	29.062	227712*	-19.30*	8019
Sweden	0.00008	0.057	-0.083	0.007	-0.379	12.327	29260*	-18.48*	8019
Switzerland	0.0001	0.050	-0.036	0.005	-0.007	9.617	14629*	-17.93*	8019
UK	0.00006	0.047	-0.093	0.006	-0.787	19.183	88371*	-18.58*	8019

OLS Regression

A test for heteroscedasticity is performed to test whether the OLS regression is a robust estimator. If heteroscedasticity is present, OLS regression is no longer robust. The results show that there is no constant variance in error terms for the global index, Germany, Italy, and Sweden. Heteroscedasticity is supported in multiple indices. Consequently, the focus lies on GARCH models to reduce the effect of heteroscedasticity.

GARCH Models

In the next step, GARCH, EGARCH, and GJR-GARCH models are trained. According to the Schwarz Information criteria, the best-fitting model is used for the final result. Table 2 (see appendix) presents the results for estimating the preferred GARCH model in data set 1 (1990 to 2000). GARCH models with insignificant asymmetric terms have been replaced by EGARCH (marked with a "b"). For Monday, a negatively significant value is reported for the Netherlands. The countries France and Sweden and the global index have a positively significant coefficient for Friday, as do the European index and Norway and Spain. In addition, Tuesday and Thursday are negative days with significant influence in Sweden. All added AR terms have a significant influence. All factors in the equations have a significant influence on the variance equation of the GARCH, EGARCH, and GJR-GARCH models.

For data set 2 (2000 to 2009), table 3 (see appendix) describes the most significant GARCH models. Monday has a significant positive influence on the European index, Belgium, Finland, and Sweden. Finland, Germany, Italy, Spain, the Netherlands, Switzerland, the United Kingdom, and the European index have a positive significant variable for Friday. Tuesday significantly influences Belgium, France, Norway, and Switzerland positively. For Norway, the variable has a negative impact on Tuesday and a positive effect for France and Sweden. Wednesday is positively significant for the European index, France, Italy, the Netherlands, Spain, and Sweden. The dummy variable for Thursday is positively significant for the European index, and for France, Italy, Spain, and Switzerland, the coefficients from the variance equations all represent a significant influence.

Table 4 (see appendix) describes the results of the best-estimated GARCH models for data set 3 (2009 to 2020). The dummy variable for Monday for the United Kingdom is the only one of the 13 indices with a significant negative effect. All other coefficients for Monday show no significance. Friday has a significant positive influence on the European and global index and Germany, Spain, Belgium, France, and Sweden. Tuesday is positively significant for the European and global index, Belgium, Sweden, and Great Britain. Wednesday is positively significant for Switzerland, Norway, Sweden, and Great Britain. A positive significant influence for Thursday is found in Switzerland, Italy, and Spain. For the variance equation, all coefficients have a significant impact.

In Table 5 (see appendix), the results of the GARCH models for the entire period of the study are presented. Monday has no significant influence on any of the thirteen indices examined. In contrast to Monday, Friday significantly influences every index in the data. For the other days, the following can be read – Tuesday of the Norwegian index has a negatively significant influence. Besides Norway, Friday of the European index and for the countries France, Germany, and Switzerland are positive. Wednesday positively impacts the European index, Sweden, Italy, the Netherlands, and Great Britain. Wednesday is positively significant for the global index and the countries Belgium and Switzerland. Thursday is positively significant for Switzerland, Italy, and France. All coefficient terms for the variance equation significantly impact each GARCH model. In summary, for the data set of the whole period for the supra-regional indices and the eleven countries, Fridays have a significant effect on returns. For Monday, not a single term is significant.

Evidence for the Day-of-the-week Effect

The data sets are estimated with different GARCH models in the second part of the empirical investigation. The examination of data set 1 (1990 to 2000) shows a presence of the Friday effect for the European and global indexes and four out of eleven countries. A significantly lower return is present in only one of the countries examined.

For data set 2 (2000 to 2009), the Friday effect is present for the European index and nine of the eleven countries studied, and thus, a significantly higher return than for the other days of the week. Monday is significant for the European index and three countries. However, this day of the week is positive for the four indexes and thus shows no presence of the Monday effect. These seasonal patterns result in significantly lower returns for Monday.

Estimation of Dataset 3 (2009 to 2020) yields a Friday effect for the two cross-regional indexes and six of the eleven countries examined. The Monday effect is only present for the United Kingdom in this dataset. It is noticeable that when these whole period results are compared with the results of the sub-datasets from year to year, a weakening of the seasonal anomalies can be seen. In data set 2, significantly more indices exhibit seasonal patterns than in the last data set 3. Steeley (2001) already concludes this weakening of the day-of-the-week effect for the British stock market.

The empirical investigation for the whole period shows that Friday is significant for all thirteen indices examined. Furthermore, it can be seen that Friday has a highly significant effect on most of the indices. The Friday effect is present for the two supra-national indices and six out of eleven countries.

Especially Monday has no significant impact on any index. Thus, the Monday effect is not present for any index. A weakening of the day-of-the-week effect with increasing duration of the examined time, which can be seen in the estimation of the OLS regression, is not recognizable with the GARCH models.

To summarize, the results do not show a country-specific pattern for the day-of-week effect in the sample. These results are also demonstrated by Bampinas et al. (2016); the Monday effect is not detectable for the European real estate sector, and the Friday effect is not observable for all countries from 1990 to 2010. Lenkerri et al. (2006) show the same seasonal patterns in their study that a day-of-the-week effect is detectable only for respective countries and not all countries. The evident existence of the day-of-the-week effect, as proven and documented by many authors before 2000, cannot be established with this empirical study. Instead, study results are similar to those found in more recent studies after 2000.

As part of the day-of-the-week effect, only the Friday effect stays significant in all European and global indices investigations. The evaluation of this effect shows similarities to the concentration of research. Likewise, there is a maximum during the period 2000 to 2009. In the most recent period until 2020, the effect weakens but does not disappear. Table 6 summarizes the day-of-the-week effect in the European index for all data sets.

Table 6. **Results of GARCH models for European real estate** (***,**,* = p < 1%, 5%, 10% significant level. Numbers in parentheses indicate p-values. a and b denote GJR-GARCH and EGARCH model, respectively)

Variable	1990 - 2000[b]	2000 - 2009[a]	2010 - 2020[a]	1990 - 2020[a]
Mean Equation				
Monday	0.0000	0.0002***	-0.0001	0.00003
	(0.97)	(0.06)	(0.47)	(0.63)
Tuesday	0.0000	0.0002	0.0003**	0.0001***
	(0.85)	(0.22)	(0.03)	(0.06)
Wednesday	0.0000	0.0002**	0.0002	0.0002**
	(0.44)	(0.04)	(0.11)	(0.02)
Thursday	-0.0001	0.0002**	0.0001	0.00005
	(0.22)	(0.08)	(0.38)	(0.44)
Friday	0.0002**	0.0006*	0.0003**	0.0004*
	(0.01)	(0.00)	(0.02)	(0.00)
AR(1)	0.0910*	0.090*		0.083*
	(0.00)	(0.00)		(0.00)
AR(2)	0.0650*			
	(0.00)			
Variance Equation				
omega	-0.57*	0.000*	0.000*	0.000*
	(0.00)	(0.00)	(0.00)	(0.00)
alpha	0.15*	0.0056*	0.055*	0.062*
	(0.00)	(0.00)	(0.00)	(0.00)
beta	0.968*	0.911*	0.856*	0.899*
	(0.00)	(0.00)	(0.00)	(0.00)
gamma	-0.18**	0.049*	0.055*	0.061*
	(0.01)	(0.00)	(0.00)	(0.00)
SE of reg	0.002	0.005	0.005	0.004
Adj. R^2	0.002	0.0003	0.00007	0.006
n	2605	2477	2937	8019

Influence of Countries on the European Real Estate Index

The European index highly depends on real estate companies from Germany and the United Kingdom. These two countries are weighted with more than 50 % in the examined European index (as of 01.10.2020).

The estimation with the GARCH models for the whole period shows that Germany and Great Britain have a Friday effect, as does the European index. Consequently, the two largest countries can initiate this Friday effect in the indice since not every country has a positive Friday effect.

In data set 1, the European index has a positive significant effect for Friday, which only the European index has and not the countries Germany and Great Britain.

For data set 2, the estimation for the European index and the countries Germany and Great Britain results in a positive Friday effect. However, it should be noted that Germany and Great Britain are not the only countries with a positive Friday effect. Therefore, it can also be assumed that the Friday effect of the European index depends on several countries and not only on Germany and Great Britain.

The estimation of the GARCH models in data set 3 shows a Friday effect for the European index and Germany but not Great Britain. Beyond Germany, there are other countries where Friday shows significant return patterns. Therefore, it cannot be assumed that only Great Britain and Germany influenced the European index. According to the literature, the day-of-the-week effect is not constant over countries and periods.

6. CONCLUSION

This paper contributes to the ongoing debate on the persistence of stock market anomalies in global equity markets (McLean & Pontiff, 2016; Jacobs & Müller, 2020) and concentrates on the day-of-the-week effect in the real estate market from 1990 to 2020. The empirical investigation is carried out for the whole period and three sub-datasets. The data sets are estimated by OLS regressions and GARCH models to exclude heteroscedasticity.

The GARCH models support the consistent evidence for the Friday effect for the entire period. However, there is an evolution of the day-of-the-week effect over time. In different periods, different weekdays are significant. Only the Friday effect stays significant in all periods. After a maximum in the period 2000 to 2009, there is a weakening in the last period. The impact of the day-of-the-week anomaly seems connected to public attention. After the research hype decreased, the effect also weakened but did not disappear from 2009 to 2020. The Friday effect still influences the real estate sector. The significance of other weekdays is changing during the periods without a pattern.

Furthermore, the day-of-the-week effect in different European countries is unsystematic and changes between periods. The real estate sector has a local business character. Therefore, country-specific effects are possible, but a pattern is not found.

To summarize, the day-of-the-week effect is mainly represented through the Friday effect, which is constantly significant in cross-country indices for the European and global real estate stock market. As an avenue for future research, the question of further weakening the day-of-the-week effect can be posed. In addition, research can focus on the analysis of country-specific differences. Furthermore, there is a possible causality between research concentration and the impact of the Friday effect. However, this paper indicates that the day-of-the-week anomaly still exists in the European real estate sector from a cross-country perspective.

Appendix

The appendix presents the comprehensive results of the GARCH, EGARCH and GJR GARCH calculation. The best-fitting model is chosen for each index according to the Schwarz Criteria. The use of GJR GARCH models for an index is marked by an "a". EGARCH is marked with a "b". Redundant variables are left out in the models.

Table 2. **GARCH, EGARCH, GJR-GARCH Output for Data Set 1 1990 to 2000**

	Europe[b]	Global[a]	Belgium[a]	Finland	France	Germany[a]	Italy	Netherlands
Mean Equation								
Monday	0.000003	-0.0002	-0.0002	-0.0004	-0.0001	-0.00002	-0.0001	-0.0002**
	(0.97)	(0.16)	(0.17)	(0.64)	(0.23)	(0.90)	(0.66)	(0.01)
Tuesday	0.00001	0.00002	0.00005	-0.0002	0.0001	0.00008	-0.0004	-0.000005
	(0.85)	(0.87)	(0.72)	(0.89)	(0.44)	(0.66)	(0.13)	(0.95)
Wednesday	0.00007	0.0002	-0.0001	-0.0007	-0.0000	0.00009	-0.0004	0.0002
	(0.44)	(0.23)	(0.40)	(0.42)	(0.81)	(0.64)	(0.85)	(0.10)
Thursday	-0.000121	-0.00004	0.00003	-0.0003	0.0001	-0.00006	0.0003	-0.00006
	(0.22)	(0.82)	(0.88)	(0.67)	(0.43)	(0.78)	(0.25)	(0.56)
Friday	0.0002**	0.0005*	0.0002	0.0005	0.0006*	0.0002	0.0001	0.0004
	(0.01)	(0.00)	(0.12)	(0.53)	(0.00)	(0.26)	(0.95)	(0.66)
AR(1)	0.091*	0.153*	-0.143*	-0.041**				0.108*
	(0.00)	(0.00)	(0.00)	(0.03)				(0.00)
AR(2)	0.065*			-0.103*				
	(0.00)			(0.00)				
Variance Equation								
omega	-0.57*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
alpha	0.15*	0.045*	0.084*	0.023*	0.17*	0.023*	0.16*	0.26*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
beta	0.968*	0.83*	0.837*	0.976*	0.63*	0.95*	0.80*	0.30*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
gamma	-0.18**	0.093*	0.104*			0.049*		
	(0.01)	(0.00)	(0.00)			(0.00)		
SE of reg	0.002	0.004	0.005	0.022	0.003	0.005	0.006	0.003
Adj. R^2	0.002	0.02	0.03	0.011	0.004	-0.002	-0.0008	0.001
n	2605	2605	2605	1826	2605	2605	2605	2605

***,**,* = p < 1%, 5%, and 10% significant level, numbers in parentheses indicate p-values. A and b denote GJR-GARCH and EGARCH model, respectively.

Table 3. **GARCH, EGARCH, GJR-GARCH Output for Data Set 2 2000 to 2009**

	Europe[a]	Global[a]	Belgium[a]	Finland	France[b]	Germany[b]	Italy[b]	Netherlands[a]
Mean Equation								
Monday	0.0002***	0.0001	0.0003**	0.0005***	0.0002	-0.0003	0.0002	0.0001
	(0.06)	(0.36)	(0.02)	(0.06)	(0.17)	(0.21)	(0.41)	(0.24)
Tuesday	0.0002	0.00006	0.0004*	0.0002	0.0003***	0.0002	-0.0002	0.0002
	(0.22)	(0.68)	(0.00)	(0.48)	(0.08)	(0.20)	(0.45)	(0.11)
Wednesday	0.0002**	0.0001	0.0002	0.00006	0.0005*	-0.00002	0.0007*	0.0003**
	(0.04)	(0.47)	(0.12)	(0.83)	(0.00)	(0.90)	(0.00)	(0.04)
Thursday	0.0002**	0.0001	0.0001	-0.00007	0.0004**	0.0003	0.0006**	0.0001
	(0.08)	(0.38)	(0.24)	(0.77)	(0.01)	(0.12)	(0.01)	(0.31)
Friday	0.0006*	0.0003	0.00003	0.0009*	0.0007*	0.0006*	0.0004***	0.0005*
	(0.00)	(0.12)	(0.80)	(0.00)	(0.00)	(0.00)	(0.05)	(0.00)
AR(1)	0.090*	0.102*	-0.122*	-0.091*				0.086*
	(0.00)	(0.00)	(0.00)	(0.00)				(0.00)
AR(2)								
Variance Equation								
omega	0.000*	0.000*	0.000*	0.000*	0.000*	-0.364*	-0.483*	0.000*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
alpha	0.0056*	0.018*	0.034*	0.058*	0.194*	0.242*	0.287*	0.070*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
beta	0.911*	0.919*	0.946*	0.933*	0.979*	0.982*	0.972*	0.891*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
gamma	0.049*	0.087*	0.038*		-0.054*	-0.053*	-0.022**	0.061*
	(0.00)	(0.00)	(0.00)		(0.00)	(0.00)	(0.01)	(0.00)
SE of reg	0.005	0.005	0.005	0.008	0.006	0.008	0.008	0.005
Adj. R^2	0.0003	-0.003	-0.004	-0.004	-0.003	-0.001	-0.004	0.0009
n	2477	2477	2477	2477	2477	2477	2477	2477

***,**,* = p < 1%, 5%, and 10% significant level, numbers in parentheses indicate p-values. A and b denote GJR-GARCH and EGARCH model., respectively.

Table 4. **GARCH, EGARCH, GJR-GARCH Output for Data Set 3 2009 to 2020**

	Europe[a]	**Global[a]**	**Belgium[b]**	**Finland[a]**	**France[a]**	**Germany[b]**	**Italy[a]**	**Netherlands[a]**
Mean Equation								
Monday	-0.0001	0.00002	0.0001	0.0002	-0.00003	-0.00006	-0.00005	-0.0002
	(0.47)	(0.86)	(0.40)	(0.29)	(0.85)	(0.74)	(0.83)	(0.21)
Tuesday	0.0003**	0.0002***	0.0003**	0.00009	0.0001	0.0002	-0.00008	0.0002
	(0.03)	(0.06)	(0.04)	(0.69)	(0.43)	(0.23)	(0.75)	(0.37)
Wednesday	0.0002	0.0002	0.0002	0.0003	0.00003	0.0002	-0.0001	-0.0003
	(0.11)	(0.11)	(0.11)	(0.17)	(0.89)	(0.23)	(0.70)	(0.14)
Thursday	0.0001	0.00008	0.00003	-0.00008	0.000002	0.0001	0.0005***	-0.0002
	(0.38)	(0.50)	(0.78)	(0.71)	(0.99)	(0.40)	(0.07)	(0.35)
Friday	0.0003**	0.0003**	0.0003**	0.0002	0.0005**	0.0007*	0.0001	0.0001
	(0.02)	(0.01)	(0.01)	(0.30)	(0.01)	(0.00)	(0.64)	(0.59)
AR(1)		0.135*		0.018				0.06*
		(0.00)		(0.40)				(0.00)
AR(2)								
Variance Equation								
omega	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
alpha	0.055*	0.059*	0.042*	0.037*	0.036*	0.161*	0.049*	0.025*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
beta	0.856*	0.831*	0.851*	0.88*	0.88*	0.972*	0.85*	0.89*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
gamma	0.055*	0.138*	0.133*	0.086*	0.12*	-0.081*	0.12*	0.13*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
SE of reg	0.005	0.004	0.004	0.006	0.006	0.005	0.008	0.008
Adj. R^2	0.00007	0.007	0.0001	-0.00001	-0.0001	-0.0003	0.001	0.004
n	2937	2937	2937	2937	2937	2937	2937	2937

***,**,* = p < 1%, 5%, and 10% significant level, numbers in parentheses indicate p-values. A and b denote GJR-GARCH and EGARCH model, respectively.

Table 5. **GARCH, EGARCH, GJR-GARCH output for whole period**

	Europe[a]	Global[a]	Belgium[a]	Finland[a]	France[a]	Germany[a]	Italy[b]	Netherlands[a]
Mean Equation								
Monday	0.00003	0.000001	0.0001	0.0002	-0.00006	-0.00004	0.00004	-0.0001
	(0.63)	(0.99)	(0.13)	(0.30)	(0.45)	(0.71)	(0.74)	(0.15)
Tuesday	0.0001***	0.0001	0.0003*	0.00002	0.0002***	0.0002***	-0.0001	0.00009
	(0.06)	(0.18)	(0.00)	(0.92)	(0.05)	(0.05)	(0.30)	(0.21)
Wednesday	0.0002**	0.0002***	0.0001***	0.00001	0.0001	0.0001	0.0002**	0.0002**
	(0.02)	(0.06)	(0.08)	(0.61)	(0.26)	(0.28)	(0.04)	(0.03)
Thursday	0.00005	0.00006	0.00009	-0.00007	0.0002**	0.00004	0.0006*	-0.0000004
	(0.44)	(0.43)	(0.25)	(0.69)	(0.02)	(0.68)	(0.00)	(0.99)
Friday	0.0004*	0.0004*	0.0002**	0.0004**	0.0006*	0.0004*	0.0003**	0.0002*
	(0.00)	(0.00)	(0.01)	(0.03)	(0.00)	(0.00)	(0.02)	(0.00)
AR(1)	0.083*	0.13*	-0.10*	-0.039*				0.078*
	(0.00)	(0.00)	(0.00)	(0.00)				(0.00)
AR(2)								
Variance Equation								
omega	0.000*	0.000*	0.000*	0.000*	0.000*	0.000*	-0.574*	0.000*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
alpha	0.062*	0.042*	0.045*	0.009*	0.067*	0.042*	0.255*	0.063*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
beta	0.899*	0.885*	0.906*	0.98*	0.877*	0.908*	0.961*	0.89*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
gamma	0.061*	0.087*	0.083*	0.011*	0.074*	0.080*	-0.036*	0.074*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
SE of reg	0.004	0.005	0.004	0.013	0.005	0.006	0.008	0.006
Adj. R^2	0.006	0.006	0.005	0.00004	0.0009	0.0004	-0.0006	0.003
n	8019	8019	8019	7240	8019	8019	8019	8019

***,**,* = p < 1%, 5%, and 10% significant level, numbers in parentheses indicate p-values. A and b denote GJR-GARCH and EGARCH model. respectively.

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