The Impact of Crises on Real Estate Investment Trusts in Europe: A Markov Switching Model Approach

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The Impact of Crises on Real Estate Investment Trusts in Europe: A Markov Switching Model Approach

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1 Introduction

Real Estate Investment Trusts (REITs) are specialised investment vehicles that allow investors to pool their funds into real estate portfolios, providing access to income-generating properties without direct ownership. REITs invest in various property sectors, such as residential, commercial, healthcare, and industrial. They must comply with specific regulations, such as distributing a significant portion of their income as dividends.

Since the 2000s, REITs have become increasingly significant in Europe, playing an important role in financial markets. Regulations have democratised real estate investments, allowing both institutional and retail investors to participate in the real estate market without the need for direct property ownership. Therefore, understanding the impact of crises on REITs is essential for investors and financial analysts.

Global financial crises, particularly the Subprime Crisis of 2007-2008, have severely affected REITs' performance. These crises caused major disruptions in financial markets, leading to sharp declines in asset prices and increased volatility. Additionally, the recent Energy Crisis and the Covid-19 pandemic have provided new data to analyse REITs' resistance and adaptability.

This study aims to analyse the specific impact of financial crises on REITs' performance by addressing two key questions:

How do crises affect the performance of Real Estate Investment Trusts? Are there significant differences in the impact of crises on Real Estate Investment Trusts across different countries or sectors?

The methodology for this thesis involves several key steps. First, the data collection, including monthly close prices of 13 REIT indices in Europe from November 1990 to November 2023. These indices represent major European countries and sectors within the REIT industry and are divided into two categories. The country category includes REIT indices from Belgium, France, Germany, the Netherlands, and the United Kingdom. The sector category covers the major REIT sectors, such as Diversified, Healthcare, Industrial, Office, Residential, and Retail. These categories, reflect different aspects of the REIT industry, allowing for comparisons of REIT performance across different economic environments and sectors.

Secondly, we will evaluate the performance of REITs using both a linear model and a non-linear model. Initially, we will apply the Fama-French Five Factors Model (Fama & French, 2015) to explore the linear relationships between REITs' returns and various risk factors, including market, size, value, profitability, and investment. This will provide a first understanding of the primary drivers of REITs' performance. Then, we will use a Markov Switching Model (Hamilton, 1989) to identify distinct regimes within the REIT industry. This approach will potentially highlight periods of crisis and provide a dynamic perspective on REITs' behavior.

The final step will involve performance measurement. We will use the coefficients derived from the Markov Switching Model to calculate the Information Ratio to adjust returns for systematic and specific risks across different regimes. This approach offers a comprehensive evaluation of REITs' performance during crises, considering the variation of these ratios between regimes.

Our study anticipates several significant findings. We expect the Markov Switching Model to reveal distinct regimes in the REIT industry, corresponding to periods of economic stability and crisis. The analysis will likely show that crises significantly impact REIT returns, with higher volatility and lower returns during recessions. Additionally, different REIT sectors and countries are expected to exhibit varying degrees of sensitivity to crises, providing insights into which segments are more resilient or vulnerable.

Moreover, the application of the Markov Switching Model is anticipated to reveal how the impact of risk premiums on REIT returns varies across different regimes. By distinguishing between high and low volatility periods, this model will highlight how market, size, and value risk premiums influence REIT performance differently during normal and crisis periods. Additionally, the exploration of profitability and investment factors in different regimes will provide deeper insights into the key drivers of REITs' performance.

This study offers a theoretical framework and methodologies to analyse the impact of crises on investment vehicles. While focused on REITs, the framework and approaches can be adapted for other investment vehicles, allowing researchers to highlight various characteristics and compare performance between crisis and non-crisis periods.

2 Literature review

2.1 History of Real Estate Investment Trusts

Real Estate Investment Trusts (REITs) were established in the United States in 1960 following legislation signed by the 34th president of the United States, Dwight D. Eisenhower. This legislative move was designed to enable all investors, especially smaller ones, to access income from the real estate industry. In other words, this legislation democratises real estate investments that were previously accessible only to wealthy individuals.

Brounen & Koning (2012) realised a study detailing the evolution of 50 years of REITs existence. Their research examines this market internationally and delves into the development of REITs in Europe, where the first REIT was launched in the Netherlands in 1969. This initiative was considered ahead of its time, with the next adoption not occurring until Belgium introduced the B-REIT in 1995. The start of the new millennium marked the beginning of the European REIT Boom, indicating a broader acceptance of the REIT model across Europe. In the following years, several other European countries, such as France (2003), Germany (2007), Italy (2007), United Kingdom (2007), and Spain (2009) established and implemented their own REIT regulations.

The landscape for REITs in Europe has been shaped by both significant opportunities and challenges. The commercial real estate sector is a key component of the European economy, and REITs have proven their value through effective management, high-quality assets, and strong investibility. For example, Dutch pension funds have invested heavily in listed real estate, surpassing the global average. Theoretical advantages such as diversification, risk-adjusted returns, and liquidity make a strong case for investing in REITs. This favorable environment is expected to support the growth and expansion of the European REIT market in the medium to long term (Hughes et al., 2013).

2.2 Characteristics of Real Estate Investment Trusts

REITs are specialised investment vehicles that enable individual and institutional investors to pool their funds in a portfolio of real estate assets. The characteristics and regulatory framework governing REITs in the United States are outlined in Section 856 of the Internal Revenue Code.[1] Often considered as the reference structure, the objective was to provide a way for investors to gain exposure to real estate markets with the liquidity, diversification, and tax benefits not typically available through direct real estate investments.

In the U.S., Real Estate Investment Trusts (REITs) are entities that primarily invest in and generate income from real estate assets. They are obligated to be listed on a stock exchange. To retain their REIT status, they must meet several requirements: distribute at least 90% of their taxable income as dividends, ensure that at least 75% of their assets are invested in real estate, cash, or treasuries, and comply with specific shareholder distribution criteria. These criteria include having a minimum of 100 shareholders and ensuring that no five shareholders own more than 50% of the shares.

In contrast, European REITs, while sharing the fundamental concept of investing in real estate, exhibit diverse characteristics across different countries. For example:

Belgian REITs: The structure is known as a Société d'Investissement à Capital Fixe Immobilière (SICAFI) or a B-REIT is required to be listed on a stock exchange. They have a leverage ceiling[2] of 65% of assets, and at least 80% of net income must be distributed as dividends.

[1] https://www.law.cornell.edu/uscode/text/26/856

[2] Regulatory limit on the maximum debt a REIT can hold relative to its total assets. This limit is designed to prevent excessive borrowing, ensuring the REIT maintains financial stability and reduces exposure to financial distress

Dutch REITs: The structure is known as a FBI (Fiscale Beleggingsinstelling). The Dutch REIT regime is required to be listed on a stock exchange. Additionally, Dutch REIT must distribute 100% of its taxable income as dividends to its shareholders.

French REITs: Société d'Investissement Immobilier cotées (SIIC), established in 2003, also requires mandatory listing on a stock exchange. They have no specific leverage ceiling, and 95% of their net income must be distributed to shareholders.

German REITs: Known as German Real Estate Investment Trust or G-REIT, require listing within two years on a stock exchange. Regulations allow only for internally managed structures and have a leverage limit of 60% of the book value of assets. The minimum required distribution of dividends is 90%.

Spanish REITs: Known as Sociedades Anónimas Cotizadas de Inversión en el Mercado Inmobiliario (SOCIMI) must distribute at least 80% of dividends from rental income if holding period requirements are met, with no specific shareholder composition rules.

United Kingdom REITs: The United Kingdom Real Estate Investment Trusts, required to be listed on a recognised stock exchange, are designed to offer a tax-efficient investment in UK real estate by distributing at least 90% of their income.

Even if European REITs exhibit diverse characteristics and regulatory requirements across countries, they fundamentally operate in the same way. All REITs in Europe focus on investing in income-producing real estate, must distribute a significant portion of their income as dividends, and are typically required to be listed on a stock exchange.

2.3 Types and Sectors of Real Estate Investment Trusts

Real Estate Investment Trusts (REITs) are primarily categorised into two types: Equity REITs and Mortgage REITs. Equity REITs, as previously defined, own and manage income-producing real estate, generating revenue through leasing spaces and collecting rents. Mortgage REITs, which are beyond the scope of this study, provide financing for income-producing real estate by purchasing or originating mortgages and mortgage-backed securities, earning income from the interest on these investments.

Real Estate Investment Trusts (REITs) in Europe are categorised into various sectors[3] based on the nature of the assets they invest in. These sectors include:

Diversified REITs: These REITs invest in a variety of property types without concentrating on a single type. For instance, their investment portfolio may include a mix of office, retail, residential, and industrial properties.

Healthcare REITs: Specialise in properties related to healthcare services, including hospitals, laboratories, nursing homes, and assisted living facilities. These REITs invest in real estate which is essential for providing medical services.

Hotel and Lodging REITs: Focus on the hospitality industry by investing in hotels, motels, and resorts. This sector benefits from tourism and business travel.

Industrial REITs: Invest in industrial properties, such as warehouses, distribution centres, and manufacturing facilities. These REITs are integral to supply chain and logistics operations.

Infrastructure REITs: These REITs invest in infrastructure assets like roads, bridges, tunnels, airports, and utilities. Infrastructure REITs play a critical role in supporting economic activity.

[3] Industry Classification Benchmark (Equity), v4.7, April 2024

Office REITs: Concentrate on office buildings and properties used for business purposes. These REITs lease space to various types of businesses and organisations.

Residential REITs: Invest in residential properties, including apartment buildings, manufactured homes, and student housing. These REITs address the housing needs of different populations.

Retail REITs: Focus on retail properties, such as shopping malls, shopping centres, and outlet centres. These REITs benefit from rental income generated by tenants.

Storage REITs: Specialise in self-storage facilities where individuals and businesses can rent space to store goods. This sector has grown due to smaller living spaces, and an increased need for secure storage solutions.

Timber REITs: Invest in timberland and engage in the harvesting and sale of timber. These REITs benefit from the demand for wood and paper products.

Other Specialty REITs: This category includes REITs that invest in unique or niche property types not covered by the other sectors. Examples include data centres, cell towers, and student housing.

Each of these sectors has distinct characteristics and operates within different segments of the real estate market, offering investors a range of options based on their investment objectives and risk tolerance. Despite sharing the common trait of long asset durations, Wheaton (1999) argues that real estate markets differ significantly across economic sectors. For example, he notes that industrial properties often have a strong correlation with economic fluctuations, whereas retail real estate sectors show minimal economic dependency.

2.4 Previous Studies on Real Estate Investment Trusts

2.4.1 Performances measurement

Multi-Factor Models often serve as the starting point for analysing REIT performance. Peterson & Hsieh (1997) demonstrated that the risk premium of REITs could be explained by the Three-Factor Model proposed by Fama & French (1993). However, these Multi-Factor Models can vary significantly, ranging from the basic CAPM (Brounen & Koning, 2012) to more complex models such as the extended versions of the Fama-French Model (Yiu et al., 2022).

Additionally, standard single-factor performance measures are commonly used to analyse REIT performance. Benefield et al. (2009) examined performance differences between REIT sectors using Jensen's Alpha (1968), the Treynor Index (1965), and the Sharpe Ratio (1966).

2.4.2 Early performances

Brounen & Koning (2012) examined the performance of British, Dutch, and French REITs, providing insights into the European market. Their findings indicate that while European REITs underperformed in earlier decades, there was a significant improvement in market performance during the 2000–2007 period, challenging the traditional dominance of North American REITs.

This significant improvement is also evident in the work of Sotelo & McGreal (2013), where individual European countries were analysed. The French SIICs regime serves as a prime example, with the French REITs index outperforming the Paris Euronext SBF CAC from 2003 to 2012 (Nappi, 2013). Similarly, the performance of Belgian REITs is notable, with a high average total return during the same period (Brounen, 2013). Dutch REITs, with their long-standing presence, have achieved a mature status and substantial market capitalisations.

2.4.3 Performances during Crisis of Real Estate Investment Trusts

A few years after the development of European REITs, the Subprime Crisis of 2007-2008 occurred, significantly impacting REIT performance. The crisis led to a sharp decline in the performance and market valuations of real estate sectors worldwide. Given their mandatory listing characteristic, European REITs were not insulated from stock market dynamics. Prior research by Chen et al. (2015) highlighted a significant positive correlation between stock returns and REIT returns, demonstrating that European REITs were more volatile than the overall market during the Subprime Crisis.

This positive correlation between stock returns and REIT returns has also been observed during other periods, such as the European Sovereign Debt Crisis (ESDC) from 2009 to 2012. Abuzayed et al. (2020) found a similar positive correlation during this period, suggesting that crises lead to a significant rise in REIT correlations with traditional stocks. As a consequence, European REITs face challenges in maintaining performance stability and providing diversification benefits to investors during times of economic turmoil.

2.4.4 Performance differences across REITs sectors

Comparing the performance of different REIT sectors is a common focus in research. Benefield et al. (2009) found that under favorable market conditions, diversified REITs tend to show relative strength and can outperform those specialised in a single sector.

Additionally, Demiralay & Kilincarslan (2022) investigated how various uncertainty measures (such as implied volatility, tail risk, economic policy uncertainty, and partisan conflict indices) affect the returns of U.S. REITs across different sectors. Using a Markov Switching Model, they discovered that the impact of these uncertainty measures on REIT returns varies significantly across sectors.

2.5 Crises

A financial crisis refers to a period of significant disruption in financial markets that is characterised by sharp declines in asset prices, and severe disruptions in financial institutions and markets. Financial crises can have profound effects on economies, leading to recessions, high unemployment, and widespread economic distress.

According to Claessens and Kose (2013), financial crises can be categorised into four main types: Currency Crises, Sudden Stops, Foreign and Domestic Debt Crises, and Banking Crises. While these crises are distinct in nature, they can often be interconnected, each possessing unique causes and economic implications. Claessens and Kose (2013) describe these four types of crises as follows:

Currency Crises

Currency crises occur when a country's currency rapidly loses value, often due to speculative attacks. These attacks typically happen when investors anticipate that a government cannot maintain its fixed or pegged exchange rate due to excessive fiscal deficits or other economic imbalances. Several models are used to explain currency crises. For instance, the first-generation models by Krugman (1979) and Flood and Garber (1984), explain that rational investors will hold a currency as long as they believe the government can uphold the exchange rate. However, once they anticipate devaluation, they start selling the currency, leading to a rapid diminution of the central bank's reserves and eventual collapse of the currency peg.

Sudden Stops

Sudden stops refer to a sudden halt in capital inflows, leading to severe liquidity crises. These events are

characterised by a sharp reduction in the availability of external financing, which often triggers balance sheet mismatches, especially in countries with large foreign currency liabilities. Sudden stops are typically associated with global financial shocks, which result in significant capital outflows and subsequent economic recessions.

Foreign and Domestic Debt Crises

Debt crises occur when a country can no longer meet its debt obligations, whether these are foreign or domestic. Foreign debt crises are often linked to the failure to generate sufficient foreign exchange to service debt, leading to defaults. Domestic debt crises, on the other hand, may involve defaults on local currency obligations, or hyperinflation. These crises are worsened by the lack of a global enforcement mechanism for sovereign debt, relying instead on the threat of sanctions or loss of future borrowing opportunities to ensure repayment.

Banking Crises

Banking crises involve the failure of financial institutions, often caused by runs on banks where investors withdraw their funds en masse due to fears of insolvency. Such crises can quickly spread through the banking sector, leading to general financial instability. Factors contributing to banking crises include high leverage, poor regulatory frameworks, or inadequate risk management practices within banks. The fragility of banks, due to their role in maturity transformation and liquidity provision, makes them particularly vulnerable to these crises.

2.6 Theoretical Framework

The theoretical framework section examines several key financial models and metrics essential for this study. The subsections cover concepts such as volatility, correlation, the Capital Asset Pricing Model, the Fama-French Three and Five Factors Models, the Markov Switching Model, and the Information Ratio. These models and metrics aim to understand asset return dynamics, identify regime changes in financial markets, and assess the risk of investments.

2.6.1 Volatility

Volatility refers to the degree of dispersion in the price movements of an asset. The most common way to measure this volatility is through the standard deviation, which indicates how far each price is from the mean price. The formula for standard deviation is:

$$\sigma = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(X_i - \mu)^2} \tag{1}$$

Where σ represents the standard deviation, N is the number of observations, X_i is each individual price, and μ is the mean price.

Another related measure is the variance, which is the square of the standard deviation:

$$\sigma^2 = \frac{1}{N}\sum_{i=1}^{N}(X_i - \mu)^2 \tag{2}$$

Where σ^2 represents the variance.

An asset with a high standard deviation, or variance, indicates greater dispersion in its prices, suggesting a higher level of volatility. This increased volatility typically signifies higher risk, as the asset's price is more likely to experience significant fluctuations. Conversely, an asset with lower volatility, indicated by a lower standard deviation or variance, suggests more stable price movements and, therefore, generally represents a lower risk. Investors often consider volatility as a key factor in assessing the risk-reward profile of an asset.

2.6.2 Correlation

Correlation analysis is used to identify relationships between two variables. In this context, we aim to uncover any linear relationships between the returns of two different indices over time. For this purpose, we will use the Pearson correlation coefficient, defined as follows:

$$r_{xy} = \frac{\text{cov}(x, y)}{\sigma_x \sigma_y} \tag{3}$$

Where r_{xy} is the correlation coefficient, cov(x, y) is the covariance of the returns for indices x and y, σ_x is the standard deviation of the returns for index x, and σ_y is the standard deviation of the returns for index y.

A positive coefficient indicates that two countries or sectors tend to move in the same direction, while a negative value indicates they move in opposite directions. The Pearson coefficient ranges from -1 to 1, where these extremes represent perfect positive or negative correlations, respectively.

2.6.3 Capital Asset Pricing Model (CAPM)

The foundation of the Linear Multifactor Model is based on the Capital Asset Pricing Model (CAPM) developed by Sharpe (1964) and Lintner (1965). This financial model establishes a linear relation between the excess return of an investment over the risk-free rate and the excess return of a market portfolio. The CAPM formula can be expressed as follows:

$$R_{i,t} - R_{f,t} = \alpha + \beta_1 \cdot (MKT - R_f) + \varepsilon_{i,t} \tag{4}$$

Where $R_{i,t}$ is the return on a given investment i, and R_f the risk-free asset during time t. The β is the coefficients for the market risk premiums ($MKT - R_f$), α represents the intercept, and $\varepsilon_{i,t}$ the error term.

In other words, CAPM offers a framework to assess the relationship between the expected return of an asset and its risk, compared to a broader market. The formula outlines that the expected excess return of an asset can be determined by the product of the market's excess return ($MKT - R_f$) with a specific factor (β), which measures the sensitivity of the asset's return to market movement. In addition to this product, the intercept α represents extra return related to the asset itself rather than the market.

2.6.4 Fama-French Three Factors Model

The Fama-French Three Factors Model (Fama & French, 1992) is an extension of CAPM that aims to capture a better explanation of an investment's excess return by including market, size and value risk premiums. The model can be described as follows:

Market risk premium ($MKT - R_f$): Similar as explained in the CAPM model, the risk premium captures the overall market dynamics through the notion of excess return of the market.

Size risk premium (SMB): This risk premium, Small Minus Big, separates stocks according to the size of the companies. This distinction is made because stocks with smaller market capitalisations often perform better than those with larger market capitalisations.

Value risk premium (HML): High Minus Low, is a risk premium that categorises stocks according to their book-to-market ratio. Stocks with high book-to-market ratios are classified as value stocks, whereas those with low book-to-market ratios are considered as growth stocks.

The formula for the Fama-French Three Factors Model is expressed as follows:

$$R_{i,t} - R_{f,t} = \alpha + \beta_1 \cdot (MKT - R_f) + \beta_2 \cdot SMB + \beta_3 \cdot HML + \varepsilon_{i,t} \quad (5)$$

Where $R_{i,t}$ is the return on a given investment i, and R_f the risk-free asset during time t. The βs are respectively the coefficients for the following risk premiums: market ($MKT - R_f$), size (SMB), value (HML). α represents the intercept, and $\varepsilon_{i,t}$ the error term.

2.6.5 Fama-French Five Factors Model

A few years later, Fama & French (2015) developed a new model by adding two new risk premiums on the baseline of the Three Factors Model.

Profitability risk premium (RMW): Robust Minus Weak, this risk premium differentiates stocks based on the company's profitability. This categorisation is utilised because stocks from companies with higher operating profitability tend to have better returns compared to companies with lower operating profitability.

Investment risk premium (CMA): Conservative Minus Aggressive, is a risk premium that distinguishes stocks based on the investment style of the company. Stocks of companies that engage in more conservative investment practices are contrasted with those that pursue more aggressive investment strategies. This distinction is important because traditionally, companies with conservative investment practices tend to be more stable and potentially less risky.

The formula for the Fama-French Five Factors Model is expressed as follows:

$$R_{i,t} - R_{f,t} = \alpha + \beta_1 \cdot (MKT - R_f) + \beta_2 \cdot SMB + \beta_3 \cdot HML + \beta_4 \cdot RMW + \beta_5 \cdot CMA + \varepsilon_{i,t} \quad (6)$$

Where $R_{i,t}$ is the return on a given investment i, and R_f the risk-free asset during time t. The βs are respectively the coefficients for the following risk premiums: market ($MKT - R_f$), size (SMB), value (HML), profitability (RMW), and investment (CMA), α represents the intercept, and $\varepsilon_{i,t}$ the error term.

To summarise, the Fama-French Five Factors Model extends the scope of the traditional asset pricing models by incorporating a broader range of risk factors that affect investment returns. By including factors like profitability and investment style alongside market, size, and value risk, the model seeks to explain a greater portion of the variability in stock excess returns compared to its predecessors, such as the CAPM or the Three Factors Model. Consequently, this model not only increases explanatory power but also improves the prediction of future returns by accounting for a broader range of economic and financial nuances.

2.6.6 Markov Switching Model

The Markov Switching Model, introduced by Hamilton (1989), is a time series framework designed to detect changes in regime states within a dataset. This model is especially valuable for identifying transitions between varying market conditions, such as phases of high and low volatility. It functions by calculating the likelihood of moving between these regimes. In financial markets, a regime characterised by high volatility typically corresponds to a bear market, marked by low or negative returns, whereas a regime with low volatility is indicative of a bull market, associated with higher returns.

In the MSM framework, the model assumes that the time series can switch between different states or regimes, such as state 1 and state 2. The switching process follows a first-order Markov chain, meaning that the probability of transitioning to a new state depends only on the current state and not on the sequence of past states. Transition probabilities are defined as:

$$P_{ij} = P(S_t = j \mid S_{t-1} = i) \tag{7}$$

Where S_t denotes the state at time t.

Each state in the MSM has its own set of parameters for the time series model. For example, in a simple MSM for mean and variance, each state i would have its own mean μ_i and variance σ_i^2. The observed time series y_t is modeled as:

$$y_t = \mu_{S_t} + \epsilon_t \tag{8}$$

Where $\epsilon_t \sim N(0, \sigma_{S_t}^2)$ and S_t is the state at time t.

The parameters of the MSM, including the state-dependent parameters and the transition probabilities, are typically estimated using maximum likelihood estimation. The likelihood function incorporates the probabilities of observing the data given the model parameters and the probabilities of transitioning between states.

Applications of the MSM are diverse. In economics, it is used for identifying business cycle phases, analysing GDP growth rates, and modeling inflation dynamics. In finance, it is employed for modeling asset returns, volatility regimes, and detecting financial crises.

In summary, the Markov Switching Model is a robust tool for modeling time series with distinct regimes, providing valuable insights into the dynamics of the data. In our study, this approach proves relevance for examining the impact of Crises on Real Estate Investment Trusts (REITs).

2.6.7 Information Ratio

The Information Ratio is a valuable metric that evaluates the excess return of an investment relative to a benchmark per unit of specific risk. François & Hübner (2024) highlighted that the traditional Information Ratio can be decomposed into three distinct components: the Pure Information Ratio, the Misfit Information Ratio, and the Global Information Ratio. Each component provides unique insights into different aspects of the investment's performance and risk profile, offering a comprehensive framework for evaluation.

The "pure" Information Ratio (IR^{pure}) is the first key metric to compare and it is computed as follows:

$$IR^{pure} = \frac{R_P - R_B^{MF}}{\sigma(R_P - R_B^{MF})} = \frac{\alpha_P^{MF}}{\sigma_{\epsilon P}} \tag{9}$$

Where $R_P - R_B^{MF}$ stands for the abnormal return, and is equal to the intercept α_P^{MF}. On the denominator, $\sigma(R_P - R_B^{MF})$ computes $\sigma_{\epsilon P}$, the standard deviation of the residual terms for the portfolio.

The Misfit Information Ratio (IR^{misfit}) counts another aspect which is the inclusion of a self-reported specific benchmark. In this context, the misfit active return is calculated as the difference between the regression-based benchmark and the self-reported benchmark. It is defined as follows:

$$IR^{misfit} = \frac{R_B^{MF} - R_B}{\sigma(R_B^{MF} - R_B)} = \frac{\sum_{k=1}^{K}(\beta_{P,k} - \beta_{B,k})(\bar{F}_k - \bar{R}_f) - \alpha_B^{MF}}{\sqrt{\sigma^2\left(\sum_{k=1}^{K}(\beta_{P,k} - \beta_{B,k})(F_{k,t} - R_f)\right) + \sigma_{\epsilon_B}^2}} \tag{10}$$

Where R_B is the average returns, and α_B^{MF} the multifactor alpha for the self-reported benchmark. $\sigma(R_B^{MF} - R_B)$ stands for the "misfit active risk", and $\sigma_{\epsilon_B}^2 = \sigma^2(R_B - \alpha_B^{MF} - \bar{R}_f - \sum_{k=1}^{K}\beta_{B,k}(F_{k,t} - R_f))$ represents the variance of the residual term of the multifactor regression model applied to the benchmark portfolio.

The last component is the Global Information Ratio (IR^{global}). This ratio combines the pure and misfit active risks and returns:

$$IR^{global} = \frac{R_P - R_B}{\sigma(R_P - R_B)} \approx \frac{\alpha_P^{MF} - \alpha_B^{MF} + \sum_{k=1}^{K}(\beta_{P,k} - \beta_{B,k})(\bar{F}_k - \bar{R}_f)}{\sqrt{\sigma^2\left(\sum_{k=1}^{K}(\beta_{P,k} - \beta_{B,k})(F_{k,t} - R_f)\right) + \sigma_{\epsilon_P}^2 + \sigma_{\epsilon_B}^2}} \tag{11}$$

Where $\sigma(R_P - R_B)$ is the standard deviation of the difference in returns between the portfolio and the benchmark. $\sigma_{\epsilon_P}^2$ and $\sigma_{\epsilon_B}^2$ are the variances of the residual terms for the portfolio and the benchmark, respectively.

By evaluating both the alignment with the benchmark and the pure performance, the Global Information Ratio provides a comprehensive perspective on the investment's risk-adjusted return.

3 Data description

3.1 Data selection

Our dataset consists of monthly close prices of 13 REIT indices in Europe from November 1990 to November 2023. The indices selected are organised into two different categories: countries and sectors.

The first category represents the 5 major European countries in the REIT industry which include Belgium, France, Germany, Netherlands, and United Kingdom (UK). All these indices are part of the FTSE EPRA Nareit series, specific to each country. The FTSE EPRA Nareit indices are recognised benchmarks for measuring the performance of listed real estate companies and REITs worldwide. These indices are designed to represent general trends in real estate equities and are used by investors to evaluate the performance of the real estate market. Additionally, we included 2 reference indices: the FTSE EPRA Nareit Developed Europe and the FTSE EPRA Nareit Developed Europe Ex UK.

The second category represents the 6 major sectors (defined in section 2.3) present in Europe: Diversified, Healthcare, Industrial, Office, Retail, and Residential. These 6 indices are the different segments of the FTSE EPRA Nareit Developed Europe Index.

All these indices have been collected from Thomson Reuters databases[4]. For the different countries, we retrieved the close prices from November 1990 to December 2023. For the sector-specific indices, the data covers the period from July 2007 to December 2023. Using these monthly close prices, we calculated the continuously compounded returns $R_{i,t}$ for each index as follows:

$$R_{i,t} = (\ln(\text{Close}_{i,t}) - \ln(\text{Close}_{i,t-1})) \times 100 \tag{12}$$

Where $\text{Close}_{i,t}$ stands for the close price of index i, and month t.

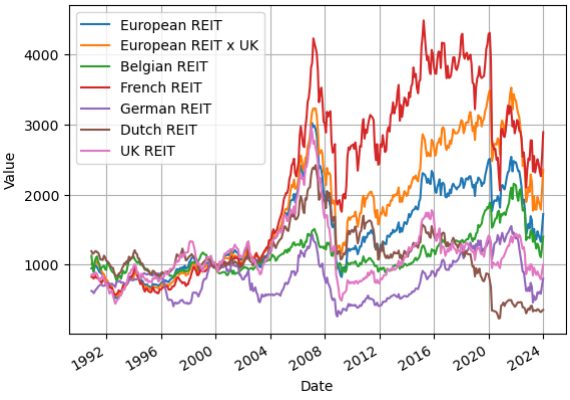

Figure 1: Close prices of REIT Indices (Countries)

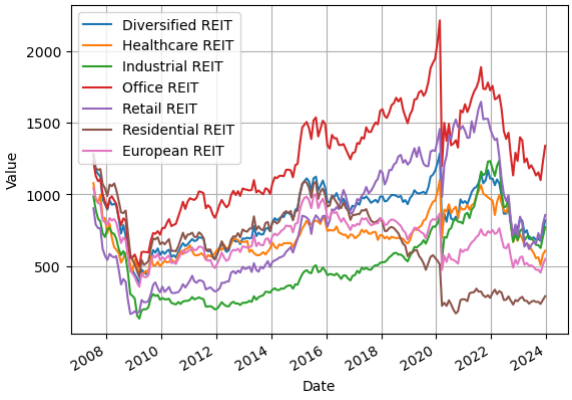

Figure 2: Close prices of REIT Indices (Sectors)

[4] https://eikon.refinitiv.com/

3.2 Crisis periods

We identified key crisis periods using data from the National Bureau of Economic Research (NBER) website[5]. To highlight country-specific crises, we also referenced the European Central Bank (ECB) report, particularly the paper by Lo Duca et al. (2017).

The period from 1990 to 2020 witnessed several significant economic crises, as mentioned by the National Bureau of Economic Research (NBER). The following list provides a detailed overview of these key events:

July 1990 to March 1991: The early 1990s recession was influenced by the Gulf War, high interest rates, and reduced consumer confidence. The economy contracted significantly, leading to rising unemployment and a slow recovery period.

March 2001 to November 2001: The early 2000s recession followed the burst of the dot-com bubble, resulting in significant losses in the tech sector and a slowdown in business investments. The 9/11 attacks further worsened economic uncertainty.

December 2007 to June 2009: The Great Recession, or Subprimes Crisis, was triggered by the collapse of the housing market and the financial crisis. It led to a severe global economic downturn, with massive job losses, bank failures, and substantial government interventions to stabilise the economy.

February 2020 to April 2020: The COVID-19 recession was a sudden and severe economic contraction caused by the global pandemic and lockdown measures. It resulted in unprecedented job losses, business closures, and a sharp decline in economic activity, prompting extensive fiscal and monetary support from governments and central banks.

While these crises primarily reflect the business cycle in the United States, their global impact makes them relevant to our analysis. Additionally, we include significant crises that impacted multiple European countries, based on the ECB report:

June 2010 to October 2013: The European Sovereign Debt Crisis significantly impacted several European countries, leading to considerable economic and financial distress. This period was characterised by severe fiscal challenges, important public debt levels, and the necessity for international financial aid. France and the Netherlands were particularly affected by high borrowing costs, while Germany provided crucial financial support to the afflicted countries.

Finally, we consider the recent Energy Crisis Impacting All European Countries:

February 2022: The invasion of Ukraine by Russia caused a major geopolitical crisis with economic consequences worldwide. It disturbed energy supplies and drove up commodity prices. This conflict intensified post-Covid inflation, significantly affecting global markets and economies.

[5] https://www.nber.org/research/data/us-business-cycle-expansions-and-contractions

4 Methodology

The primary objective of this study is to examine the impact of various crises on Real Estate Investment Trusts (REITs) in Europe. The analysis covers the period from 1990 to 2023, which is wide enough to include significant crises such as the Subprime Crisis, the European Sovereign Debt Crisis, the Covid-19 Crisis, and the recent Energy Crisis. Initially, the study examines a linear relationship using a Linear Multifactor Model. Subsequently, a Markov Switching Model is employed to identify different regime periods for European REITs. Finally, a Performance Measurement analysis evaluates the performance of REITs across the previously identified regimes.

4.1 Linear Multifactor Model

In the first part of our analysis, we utilise the Fama-French Five Factors Model, as detailed in the literature review (section 2.6.5). This model extends beyond traditional asset pricing frameworks by incorporating five distinct risk factors. The model is formulated as follows:

$$R_{i,t} - R_{f,t} = \alpha + \beta_1 \cdot (MKT - R_f) + \beta_2 \cdot SMB + \beta_3 \cdot HML + \beta_4 \cdot RMW + \beta_5 \cdot CMA + \varepsilon_{i,t} \quad (13)$$

Where, in our case, $R_{i,t}$ is the return on a given REIT index i, and R_f is our risk-free asset, the German Treasury Bill Rate during month t. The βs are respectively the coefficients for the following risk premiums: market ($MKT - R_f$), size (SMB), value (HML), profitability (RMW), and investment (CMA), α represents the intercept, and $\varepsilon_{i,t}$ the error term.

The German Treasury Bill Rate during month t is retrieved on OECB' website[6], and all factor premiums are retrieved from the authors' website[7] of the Fama-French Five Factors Model.

4.2 Markov Switching Model

This research methodology is driven by the Markov switching model (Hamilton, 1989), a time series model that gives the transition probabilities between different regimes. According to prior work on the Markov switching model within REIT returns (Case et al. 2014), a high-volatility regime signifies a bear-market state with low excess returns, while a low-volatility regime indicates a bull-market state with high excess returns. A statistical analysis is performed to see if a two-state regime is the best possible fit for your analysis. In that case, we will assume the 2 following states:

- **Normal state:** positive return and low volatility regime.
- **Crisis state:** negative return and high volatility regime.

As a consequence, our previous equation (13) can be reformulated for the Markov switching model framework as follows:

$$R_{i,t} - R_{f,t} = \alpha + \sum_{k=1}^{5} \beta_{k,S_t}(\text{FACTORS}_k) + \eta_{i,t}, \quad \eta \sim N(0, \sigma^2_{S_t}) \quad (14)$$

Where $\sum_{k=1}^{5} \beta_{k,S_t}(\text{FACTORS}_k)$ represents the sum of all factors seen in the previous equation, $N(0, \sigma^2_{S_t})$

[6] http://data.oecd.org/interest/long-term-interest-rates.htm
[7] https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html

is a normal distribution with mean 0, and variance $\sigma^2_{S_t}$ and $S_t = \{1, 2\}$ refers to the unobservable state that follows the transition probability following a first-order Markov chain:

$$p = \begin{pmatrix} P_{11} & P_{21} \\ P_{12} & P_{22} \end{pmatrix} \tag{15}$$

with

$$\begin{aligned} P[S_t = 1|S_{t-1} = 1] = P_{11}, \quad P[S_t = 1|S_{t-1} = 2] = 1 - P_{11} = P_{12} \\ P[S_t = 2|S_{t-1} = 2] = P_{22}, \quad P[S_t = 2|S_{t-1} = 1] = 1 - P_{22} = P_{21}. \end{aligned}$$

We use a maximum likelihood process to estimate the Markov Switching Model:

$$f(R_{i,t}|S\Omega) = \frac{1}{\sqrt{2\pi\sigma^2_{S_t}}} \exp\left(-\frac{(R_{i,t} - R_{f,t} - \alpha - \sum_{k=1}^{5} \beta_{k,S_t}(\text{FACTORS}_k))^2}{2\sigma^2_{S_t}}\right) \tag{16}$$

Where S refers to the number of regimes, and Ω refers to the vector of parameters to be estimated. Finally, we take the log-likelihood function as follows:

$$L = \sum_{t=1}^{T} \log f(R_{i,t}|S\Omega) \tag{17}$$

4.3 Performance Measurement

Ultimately, the last step of our methodology involves performance analyses within the framework established in the previous sections. In this phase, we utilise the coefficients derived from our Markov Switching Model to adjust returns for both systematic and specific risks. This performance measurement is constructed based on the Multifactor Alpha concept, as detailed in the book *The Complete Guide to Portfolio Performance: Appraise, Analyze, Act* (François & Hübner, 2024). By incorporating these adjustments, we aim to provide a more accurate and nuanced assessment of REIT performance, accounting for the varying risk factors identified in our earlier analyses.

4.3.1 Multifactor Alpha

We can rewrite our Multifactor Model to define the Multifactor Alpha $\alpha^{MF}_{S_t}$ as follows:

$$\alpha^{MF}_{S_t} = R_{i,t} - \left[R_f + \sum_{k=1}^{5} \beta_{k,S_t}(\text{FACTORS}_k)\right] = R_{i,t} - R^{MF}_{b,S_t} \tag{18}$$

Where $\alpha^{MF}_{S_t}$ represents the coefficient and R^{MF}_{b,S_t} the average return of the regression-based benchmark. Both terms vary according to the regime S_t.

4.3.2 Information Ratio

The information ratio is a crucial metric for assessing the excess return of an investment relative to a benchmark per unit of specific risk. While François & Hübner (2024) highlighted that the traditional Information Ratio can be decomposed into three distinct components (the Pure Information Ratio, the Misfit Information Ratio, and the Global Information Ratio), this study focuses specifically on analysing the Pure Information Ratio and the Global Information Ratio.

The "pure" Information Ratio ($\text{IR}^{\text{pure}}_{S_t}$) is the first key metric to compare between the different regimes (S_t) and it is computed as follows:

$$\text{IR}^{\text{pure}}_{S_t} = \frac{R_{i,t} - R^{MF}_{b,S_t}}{\sigma(R_{i,t} - R^{MF}_{b,S_t})} = \frac{\alpha^{MF}_{S_t}}{\sigma(\alpha^{MF}_{S_t})} \tag{19}$$

Where $R_{i,t} - R^{MF}_{b,S_t}$ stands for our multifactor alpha $\alpha^{MF}_{S_t}$, and $\sigma(\alpha^{MF}_{S_t})$ is the standard deviation.

The Global Information Ratio ($\text{IR}^{\text{global}}_{S_t}$) combines the pure and misfit active risks and returns (as detailed in section 2.6.7):

$$\text{IR}^{\text{global}}_{S_t} = \frac{R_{i,t} - R_{B,St}}{\sigma(R_{i,t} - R_{B,St})} \approx \frac{\alpha^{MF}_{S_t} - \alpha^{MF}_{B,St} + \sum_{k=1}^{K}(\beta_{P,k} - \beta_{B,k})(\bar{F}_k - \bar{R}_f)}{\sqrt{\sigma^2\left(\sum_{k=1}^{K}(\beta_{P,k} - \beta_{B,k})(F_{k,t} - R_f)\right) + \sigma^2_{\epsilon_P} + \sigma^2_{\epsilon_B}}} \tag{20}$$

Where $\sigma(R_{i,t} - R_{B,St})$ is the standard deviation of the difference in returns between the REIT index and the benchmark. $\sigma^2_{\epsilon_P}$ and $\sigma^2_{\epsilon_B}$ are the variances of the residual terms for the REIT index and the benchmark, respectively. For our analyses, we have selected the European REIT index as the benchmark, applicable to both country-level and sector-level evaluations.

Conclusion

In conclusion, this study aims to assess the impact of Crises on Real Estate Investment Trusts (REITs) in Europe, within a broader historical context extended from 1990 to 2023. This period encompasses major financial disruptions including the Subprime Crisis, the European Sovereign Debt Crisis, and the COVID-19 pandemic.

Initially, we use the Fama-French Five Factors Model to explore linear relationships between risk factors and REIT returns. This will provide a foundational understanding of the influences of market, size, value, profitability, and investment factors on REIT performance.

Subsequently, the study adopts the Markov Switching Model to identify different regime states within the REIT market, capturing dynamic shifts in volatility and returns to be captured and analysed. This model enhances our understanding of how REITs react to different economic climates, specifically underlining how they perform under stress versus stable conditions.

Finally, the study conduct a Performance Measurement analysis using the previously estimated models. This will include calculating the Multifactor Alpha and the Information Ratio to assess the adjusted risk returns of REITs relative to both systematic and specific risks across different regimes.

Through these approaches, this research aims to understand the impact of crises on REITs in Europe, providing valuable insights for investors on managing real estate investments during periods of economic uncertainty.

5 Empirical Results and Discussions

5.1 Summary Statistics

Tables 1 and 2 present the summary statistics for the returns of the REIT country indices from 1990 to 2023 and the REIT sector indices from 2007 to 2023, respectively. Table 1 reveals modest positive mean returns for all countries, with the exception of the Dutch REITs, which exhibit a mean return of -0.306. Additionally, Dutch REIT returns are characterised by significant volatility, evidenced by the broadest range (minimum of -67.386 and maximum of 54.679) and the second-highest standard deviation (7.105).

Table 2, which concentrates on sectors, indicates that all sectors, except the Office sector, recorded negative mean returns. The Office sector stands out with a slight positive mean return of 0.044. The Residential sector, on the other hand, shows the most concerning figures with the lowest mean return of -0.752, the lowest minimum value of -82.408, and a median of -0.063.

Table 1: Summary Statistics of REIT Returns (Countries 1990 - 2023)

Statistic	Europe	Europe /UK	Belgian	Dutch	French	German	UK
Count	397	397	397	397	397	397	397
Mean	0.151	0.214	0.055	-0.306	0.315	0.063	0.039
Std	5.349	5.336	4.462	7.105	5.952	7.244	6.383
Min	-38.301	-37.760	-27.719	-67.387	-35.667	-51.768	-39.135
25%	-2.176	-1.978	-2.081	-2.962	-2.480	-2.860	-3.247
50%	0.227	0.477	0.294	-0.084	0.514	0.382	0.724
75%	3.257	2.982	2.186	3.241	3.578	3.603	3.780
Max	18.779	17.991	16.041	54.680	34.897	27.103	20.151

Note: ”Count” indicates the number of monthly returns. Std = standard deviation. All the values are expressed in percent. 25%, 50%, and 75% represent respectively the first quartile, median, and third quartile.

Table 2: Summary Statistics of REIT Returns (Sectors 2007 - 2023)

Statistic	Diversified	Healthcare	Industrial	Office	Residential	Retail	European
Count	197	197	197	197	197	197	197
Mean	-0.222	-0.291	-0.123	0.044	-0.752	-0.027	-0.324
Std	7.095	6.775	9.249	7.217	9.361	9.250	7.425
Min	-53.398	-45.414	-57.903	-61.320	-82.408	-46.504	-60.361
25%	-2.815	-3.168	-3.376	-2.906	-4.406	-3.858	-3.341
50%	0.188	0.186	0.540	0.565	-0.063	0.994	-0.256
75%	3.315	3.493	4.218	3.368	3.160	4.666	3.205
Max	22.498	24.606	35.486	22.371	34.913	36.136	22.916

Note: ”Count” indicates the number of monthly returns. Std = standard deviation. All the values are expressed in percent. 25%, 50%, and 75% represent respectively the first quartile, median, and third quartile.

Tables 3 and 4 provide summary statistics for model factors and risk-free rates across both country-based and sector-based periods. The distinctions between them are crucial and will impact our future analyses using the Linear Model and Markov Switching Model.

The average risk-free rate (RF) from 2007 to 2023, corresponding to the sector period, is notably lower than during the countries' period from 1990 to 2023. This simply reflects a broader trend of lower risk-free returns in more recent years. Consequently, these low rates are likely to have a smaller impact on REIT returns at the sector level compared to the impact of higher rates observed at the country level.

However, the advantage gained from lower risk-free rates might be offset by the generally lower mean returns observed at the sector level compared to those at the country level.

Table 3: Summary Statistics of Model Factors (Countries 1990 - 2023)

Statistic	Mkt-RF	SMB	HML	RMW	CMA	RF
Count	397	397	397	397	397	397
Mean	0.519	0.0233	0.288	0.363	0.124	0.219
Std	4.950	2.098	2.639	1.621	1.825	0.225
Min	-22.02	-7.33	-11.30	-5.40	-7.30	-0.05
25%	-2.48	-1.17	-1.15	-0.59	-0.75	0.0167
50%	0.77	0.11	0.33	0.45	0.03	0.20
75%	3.80	1.36	1.50	1.37	0.91	0.333
Max	16.62	8.83	12.09	6.40	8.77	0.825

Note: ”Count” indicates the number of monthly returns. Std = standard deviation. All values are expressed in percent. 25%, 50%, and 75% represent respectively the first quartile, median, and third quartile.

Table 4: Summary Statistics of Model Factors (Sectors 2007 - 2023)

Statistic	Mkt-RF	SMB	HML	RMW	CMA	RF
Count	197	197	197	197	197	197
Mean	0.327	0.016	-0.096	0.365	0.005	0.064
Std	5.704	1.837	2.867	1.653	1.582	0.131
Min	-22.02	-5.06	-11.30	-5.40	-4.39	-0.05
25%	-2.97	-1.14	-1.82	-0.62	-0.86	-0.025
50%	0.58	0.03	-0.36	0.49	-0.03	0.017
75%	4.34	1.25	1.46	1.45	0.91	0.092
Max	16.62	4.72	12.09	4.09	5.43	0.425

5.2 Correlation

Table 5, and Table 6 provide respectively the correlation matrices for the REIT Returns by countries and sectors. This analysis aims to offer valuable insights into the degree of interrelation among the performance of these investments.

Table 5: Correlation Matrix for REIT Returns (Countries)

	European REIT	Belgian REIT	Dutch REIT	French REIT	German REIT	UK REIT
European REIT	1.000	0.703	0.755	0.854	0.716	0.900
Belgian REIT	0.703	1.000	0.539	0.617	0.495	0.552
Dutch REIT	0.755	0.539	1.000	0.818	0.525	0.591
French REIT	0.854	0.617	0.818	1.000	0.602	0.675
German REIT	0.716	0.495	0.525	0.602	1.000	0.556
UK REIT	0.900	0.552	0.591	0.675	0.556	1.000

At the country level, the correlation matrix highlights significant positive correlations among the returns of REITs, showing that REIT markets across Europe generally exhibit synchronised movement. The European REIT index shows the highest correlation with other indices. For instance, a pronounced correlation of 0.900 between European and UK REITs is observed, indicating that trends in the broader European

REIT market are closely reflected in the UK. On the opposite, Germany shows the lowest correlations with neighboring countries, as evidenced by its relatively low correlations with Belgium (0.495) and the Netherlands (0.525). This suggests the influence of unique national factors or distinct market dynamics.

Table 6: Correlation Matrix for REIT Returns (Sectors)

	Diversified	Healthcare	Industrial	Office	Retail	Residential	European REIT
Diversified	1.000	0.674	0.809	0.946	0.821	0.869	0.971
Healthcare	0.674	1.000	0.590	0.725	0.534	0.552	0.684
Industrial	0.809	0.590	1.000	0.766	0.752	0.656	0.824
Office	0.946	0.725	0.766	1.000	0.792	0.869	0.953
Retail	0.821	0.534	0.752	0.792	1.000	0.664	0.789
Residential	0.869	0.552	0.656	0.869	0.664	1.000	0.916
European REIT	0.971	0.684	0.824	0.953	0.789	0.916	1.000

In the sector-specific correlation matrix, significant positive correlations among REIT returns also emerge, underscoring the pronounced influence of the Real Estate industry over specific sectors. After the European REIT index, which serves as a benchmark in this analysis, the Diversified REIT index exhibits the strongest correlations with its peers. This sector's correlation ranges from 0.674 with the Healthcare sector to 0.946 with the Office sector. The high correlation of the Diversified sector with other sectors was anticipated, as Diversified REITs invest in a variety of property types, reflecting broader market trends. Conversely, the Healthcare sector displays the least correlation with the Retail (0.534) and Residential (0.552) sectors, suggesting distinct dynamics within the Healthcare sector or potential divergences from other sectors.

Conclusion

In conclusion, the correlation analyses between countries and sectors demonstrate generally positive relationships without notable outliers, highlighting a relevant reliance on market and industry dynamics over pronounced sector diversification. This insight provides a basis for further analysis, particularly in identifying and exploring any divergences or unique patterns across countries or sectors.

5.3 Linear Model

As explained in the methodology, our research starts with a linear relationship as shown in table 7 (Countries) and table 8 (Sectors). For the countries, the R-squared values of each model range from low (0.188) to moderate (0.432) which suggests that the models capture a modest proportion of the variance in REITs' returns. However, the F-statistics are robust and significant, highlighting an overall model's validity.

Regarding the intercepts (α), all indices exhibit a negative value suggesting negative excess returns. However, only the European, Dutch, and UK REIT indices are statistically significant. The coefficients of the 3 first risk premiums (Mkt-RF, SMB, and HML) are all statistically significant at 99%, except for HML across Belgian, and German REITs. This first insight is in line with the results of Peterson and Hsieh (1997), highlighting that the Fama-French Three Factors Model significantly explains REITs' excess returns. The coefficients for market risk premium (Mkt-RF) range from 0.320 to 0.696 which underlines a positive dependency on the overall market. However, none of these values are higher than 1 suggesting that the REIT industry has a lower systematic risk than the overall market. Similarly, the size premium (SMB) exhibits a uniform positive influence across all REIT indices, This positive relation implies that smaller sizes outperform larger ones, suggesting that REITs tend to behave like small stocks. Regarding the value premium (HML), the majority of indices have significant positive coefficients, with Dutch REITs showing

the highest value at 0.955. This indicates that REITs typically have high book-to-market ratios and are classified as value stocks rather than growth stocks. On the opposite, the findings related to Belgian and German REITs are intriguing as their coefficients are near zero (0.134). However, these findings are not statistically significant, which limits the potential for further interpretation.

The coefficient for profitability (RMW) and investment (CMA) risk premiums are negatives across almost all countries, presenting a different contrast to typical results observed in traditional stocks. This opposition suggests that within the REIT industry, higher operating profitability does not correlate with better returns, and a conservative approach does not outperform an aggressive style. These results may be attributed to the unique characteristics of REITs. Their profitability dynamics are often affected by high expenses associated with real estate assets, and their capacity for reinvestment is constrained due to the requirement to distribute a high percentage of dividends. However, none of these coefficients, except the CMA of European REIT, are statistically significant. Therefore, it is difficult to conclude from these results.

Table 7: Results of the Linear Model (Countries)

	European REIT	Belgian REIT	Dutch REIT	French REIT	German REIT	UK REIT
	(1)	(2)	(3)	(4)	(5)	(6)
α	-0.476**	-0.313	-1.247***	-0.461*	-0.385	-0.662**
	(0.221)	(0.220)	(0.304)	(0.246)	(0.340)	(0.293)
β(Mkt-RF)	0.591***	0.320***	0.696***	0.646***	0.645***	0.617***
	(0.049)	(0.049)	(0.067)	(0.054)	(0.075)	(0.065)
β(SMB)	0.463***	0.285***	0.459***	0.496***	0.533***	0.440***
	(0.098)	(0.098)	(0.136)	(0.110)	(0.152)	(0.131)
β(HML)	0.436***	0.134	0.955***	0.621***	0.133	0.434***
	(0.125)	(0.125)	(0.172)	(0.139)	(0.192)	(0.166)
β(RMW)	-0.071	-0.177	0.251	0.060	-0.443*	0.045
	(0.161)	(0.160)	(0.222)	(0.180)	(0.248)	(0.214)
β(CMA)	-0.322**	-0.206	-0.218	-0.187	-0.223	-0.125
	(0.161)	(0.161)	(0.222)	(0.180)	(0.248)	(0.214)
Observations	396	396	396	396	396	396
R^2	0.432	0.188	0.389	0.426	0.265	0.298
Adjusted R^2	0.425	0.178	0.381	0.419	0.256	0.289
Res. Std. Error	4.060	4.044	5.596	4.528	6.248	5.391
	(df=390)	(df=390)	(df=390)	(df=390)	(df=390)	(df=390)
F Statistic	59.304***	18.074***	49.705***	57.995***	28.178***	33.104***
	(df=5; 390)	(df=5; 390)	(df=5; 390)	(df=5; 390)	(df=5; 390)	(df=5; 390)

Note: *p<0.1; **p<0.05; ***p<0.01. Values in parentheses represent the standard deviations.

Table 8: Results of the Linear Model (Sectors)

	Diversified REIT	Healthcare REIT	Industrial REIT	Office REIT	Residential REIT	Retail REIT	European REIT
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
α	-0.676*	-0.475	-0.293	-0.445	-0.288	-1.557***	-0.843*
	(0.409)	(0.477)	(0.602)	(0.427)	(0.556)	(0.542)	(0.436)
β(Mkt-RF)	0.450***	0.150	0.444***	0.463***	0.401***	0.544***	0.466***
	(0.087)	(0.101)	(0.128)	(0.091)	(0.118)	(0.115)	(0.093)
β(SMB)	1.047***	1.209***	0.757**	1.222***	1.472***	1.152***	1.055***
	(0.224)	(0.261)	(0.330)	(0.234)	(0.304)	(0.297)	(0.238)
β(HML)	1.212***	0.406	0.965**	1.107***	1.175***	2.126***	1.353***
	(0.265)	(0.309)	(0.391)	(0.277)	(0.360)	(0.352)	(0.282)
β(RMW)	0.844**	0.218	0.016	0.902**	0.386	1.943***	1.059**
	(0.391)	(0.455)	(0.575)	(0.408)	(0.531)	(0.518)	(0.416)
β(CMA)	-0.736**	-0.299	-1.460***	-0.380	-1.946***	-0.041	-0.465
	(0.364)	(0.424)	(0.535)	(0.380)	(0.494)	(0.482)	(0.387)
Observations	196	196	196	196	196	196	196
R^2	0.434	0.163	0.280	0.403	0.388	0.428	0.415
Adjusted R^2	0.419	0.141	0.261	0.387	0.372	0.413	0.400
Residual Std. Error	5.417 (df=190)	6.311 (df=190)	7.974 (df=190)	5.659 (df=190)	7.358 (df=190)	7.177 (df=190)	5.767 (df=190)
F Statistic	29.132***	7.385***	14.807***	25.658***	24.129***	28.445***	26.951***
(df=5; 190)	(df=5; 190)	(df=5; 190)	(df=5; 190)	(df=5; 190)			

Note: *p<0.1; **p<0.05; ***p<0.01. Values in parentheses represent the standard deviations.

Table 8 outlines the outcomes of the Linear Model for various sector indices, demonstrating generally weaker significance compared to the country-level analysis. Notably, the Healthcare REIT sector exhibits a low R-squared value of 0.141, with only the HML coefficient showing significance. The explanatory power of the model across other sectors is modest, with R-squared values ranging from 0.280 (Industrial) to 0.434 (Diversified).

Several results align with earlier observations at the country level. Specifically, the market (Mkt-RF), size (SMB), and value (HML) factors consistently show significant positive coefficients, which reinforce patterns previously identified in country-specific analyses. Moreover, the sector-based model displays more pronounced coefficients, with SMB values ranging from 0.757 to 1.472 and HML values from 0.965 to 2.126, suggesting a stronger impact of these factors within sector-specific contexts.

Contrasting with the findings at the country level, the factor loadings for profitability (RMW) across sectors are uniformly positive. Notably, the Retail sector presents a massive distinction with a statistically significant coefficient of 1,943. The European REIT index, which serves as a benchmark, supports this pattern with a statistically significant coefficient of 1.059. Contrary to our initial assumptions, these results indicate that REITs with higher operating profitability tend to correlate with better returns compared to less profitable companies.

Regarding the investment (CMA) risk premium, negative coefficients prevail across all sectors, reaffirming the results observed at the country level. However, these results are statistically significant in 3 sectors which are the Diversified, Industrial, and Residential sectors.

Conclusion

In conclusion, employing the Fama-French Five Factors Model on REIT indices yields a modest explanation of REIT excess returns. The first three factors, market, size, and value risk premiums, were the most significant in both analyses, consistently showing a positive impact on REIT returns, with nearly all coefficients being statistically significant.

On the opposite, the results for the two remaining factors, profitability, and investment, did not provide a clear explanation of their impact on REIT returns. While these risk premiums were negative but not statistically significant at the country level, the profitability coefficients were positive across almost all sectors, including the European REIT index. These variations indicate that the influences of these factors differ across contexts or periods, suggesting a nuanced interaction with REIT excess returns.

5.4 Markov Switching Model

In this section, we transition from a Linear Model to a Markov Switching Model to capture non-linear relationships. First, we determine the number of distinct regimes present within the REIT industry. Subsequently, we analyse the differences in coefficients between these regimes across all indices, offering insights into how these relationships vary in different market conditions. Finally, we explore the transition probabilities over time to understand the dynamics of regime shifts. Similar to the previous sections, this analysis will commence with the country indices and subsequently examine the sector level.

5.4.1 Countries

Table 9 presents durations, the Akaike Information Criterion (AIC), and the Bayesian Information Criterion (BIC) for models with two and three regimes. Across all REIT indices except the UK, the AIC generally supports the model with three regimes, while the BIC tends to favor the two-regime model. Regarding the durations, the two-regime model consistently indicates a longer Normal period compared to the Crisis period across all countries. In contrast, the results of the three-regime model vary significantly among countries, showing no clear trends and some notably short durations (as low as 1.00 months). As a consequence, the two-regime model seems to capture a more coherent representation of market dynamics.

Table 9: Comparison between number of regimes for Markov Switching Model (Countries)

REIT	Duration (2 Regimes)		AIC/BIC (2 Regimes)		Duration (3 Regimes)			AIC/BIC (3 Regimes)	
	(Normal)	(Crisis)	AIC	BIC	(Low)	(Normal)	(Crisis)	AIC	BIC
European	62.01	17.85	2181.31	2245.01	1.01	8.90	6.15	2167.71	2275.21
Belgian	100.55	57.33	2141.72	2205.42	42.59	16.24	22.60	2125.42	2232.92
Dutch	57.92	10.23	2326.04	2389.74	1.00	9.15	11.13	2312.25	2419.75
French	18.73	4.75	2273.77	2337.47	1.11	17.89	2.46	2261.97	2369.47
German	24.24	8.71	2472.03	2535.74	5.32	10.81	13.19	2452.30	2559.80
UK	21.50	6.52	2409.10	2472.80	1.00	1.26	5.20	2410.15	2517.64

Note: Duration indicates the average expected time in months in each regime. The smallest values of AIC and BIC for each REIT are highlighted.

Summary

Tables 10, 11, 12 and Figure 3 exhibit the outputs of the Markov Switching Model for the REIT indices across the countries studied. The classification of each regime is determined by examining the differences in means, variances, durations, and transition probabilities, as presented in Table 10.

In the first regime, labeled Normal, the mean excess returns are modestly positive, except for the Dutch REIT index which is negative. On the other hand, the second regime, labeled Crisis, exhibits negative mean excess returns. Variance levels in the Normal regime are relatively low, ranging from 7.67 to 16.87, while the Crisis regime is significantly higher, ranging from 16.44 to 71.19. Additionally, the expected duration in the Normal regime tends to be longer than that of the Crisis regime, indicating that Normal periods generally persist longer than the Crisis periods. These distinctions in mean excess returns, volatility, and duration clearly outline two distinct regimes within the REIT industry.

The last outcomes from Table 10 are the transition probabilities (P11, P12, P21, P22) which quantify the likelihood of remaining in the same state. The probabilities of staying within the same regime (P11, and P22) are close to 1, indicating high stability, while the probabilities of transitioning between regimes (P12, and P21) are generally near 0. Notably, the probability of remaining within the Normal regime is higher than the probability of staying within the Crisis regime, underscoring the persistence of the Normal regime.

Table 10: Summary of the Markov Switching Model (Countries)

	Mean (Normal)	Mean (Crisis)	Variance (Normal)	Variance (Crisis)	Duration (Normal)	Duration (Crisis)	P11	P12	P21	P22
European REIT	0.1106	-1.6106	10.3149	23.0199	62.01	17.85	0.9839	0.0560	0.0161	0.9440
Belgian REIT	0.0475	-0.4840	7.6749	35.1584	100.55	57.33	0.9901	0.0174	0.0100	0.9826
Dutch REIT	-0.4788	-1.7010	13.3364	62.0043	57.92	10.23	0.9827	0.0977	0.0173	0.9023
French REIT	0.1364	-2.0995	13.1572	16.4387	18.73	4.75	0.9466	0.2106	0.0534	0.7894
German REIT	0.3263	-1.6602	15.6210	71.1914	24.24	8.71	0.9587	0.1148	0.0413	0.8852
UK REIT	0.5093	-3.3866	16.8658	33.7901	21.50	6.52	0.9535	0.1533	0.0465	0.8467

Note: Duration indicates the average expected time in months in each regime. P_{ij} represents the transition probability from regime i to regime j (1 = Normal, 2 = Crisis).

Results of the Markov Switching Model

Table 11, and Table 12 present the outcomes of the Markov Switching Model applied to the REITs indices of European countries. These tables highlight the differences in the impact of the various factor premiums, as discussed in the Linear Model section, according to the regime.

As mentioned in the summary of the Markov Switching Model, the means excess returns (alpha α) are positives in the Normal regime across all indices (except for Dutch REIT) and negatives in all indices under Crisis conditions.

Observations of the market risk premium (Mkt-RF) reveal that all coefficients are positive and statistically significant in both regimes. It confirms our initial findings from the Linear Model analysis that REIT excess returns are positively correlated with the overall market. Additionally, these coefficients are notably higher during the Crisis regime, indicating a more pronounced impact from market dynamics in times of crisis. For instance, the market risk premium coefficient for the Dutch REIT rises from 0.413 to 1.466, highlighting an intensified relationship with the overall market during such periods. These increases in market risk during crisis periods are to be expected and have been empirically demonstrated by prior research, such as the study conducted by Karlsson & Hacker (2013).

While the size risk premium (SMB) was statistically significant across all models in the linear analysis, its significance diminishes drastically in the Markov Switching Model, except for the European REIT index where it remains statistically significant at least at the 10% level in both regimes. These coefficients show increases from 0.180 to 1.088, indicating that smaller REITs generally outperform larger ones, especially during crises. This trend is observable across most countries, with the exception of the French REITs which see a decrease from 0.382 to -0.199. Nevertheless, the absence of significant negative values aligns with our earlier linear model findings (where coefficients ranged from 0.285 to 0.533), suggesting that REITs tend to behave similarly to small-cap stocks.

Concerning the value risk premium (HML), the majority of coefficients are not statistically significant, indicating that categorising REIT companies as either value or growth stocks does not reliably predict their returns. The only significant coefficients are observed with Dutch REIT, which shows a significant increase from 0.362 to 1.386 from the Normal regime to the Crisis regime. This suggests that stocks with high book-to-market ratios tend to outperform those with low ratios, especially during crisis periods.

A regime-dependent pattern is evident for the profitability risk premium (RMW), with coefficients statistically significant exclusively in one regime. None of the indices show coefficients statistically significant in the Normal regime, while European, French, and German REITs, exhibit high negative values premium during crises, ranging from -1.487 to -2.125. These results suggest that REITs with lower operating profitability tend to deliver significantly higher returns compared to more robust companies during periods of crisis.

Similar to the value risk premium, the investment risk premium (CMA) also lacks statistically significant coefficients. This indicates that neither conservative nor aggressive investment strategies significantly influence excess returns across both regimes.

Table 11: Results of the Markov Switching Model (Countries, Part 1)

	European REIT		Belgian REIT		Dutch REIT	
	Normal	Crisis	Normal	Crisis	Normal	Crisis
α	0.1106	-1.6106**	0.0475	-0.4840	-0.4788**	-1.7010
	(0.230)	(0.773)	(0.184)	(0.682)	(0.232)	(1.144)
$\beta(Mkt - RF)$	0.4878***	0.7800***	0.1735***	0.4965***	0.4127***	1.4661***
	(0.055)	(0.146)	(0.044)	(0.124)	(0.054)	(0.259)
$\beta(SMB)$	0.1801*	1.0875***	-0.0399	0.9388***	0.0747	1.7641**
	(0.096)	(0.370)	(0.082)	(0.348)	(0.100)	(0.712)
$\beta(HML)$	0.2024	0.3749	0.0667	-0.1957	0.3625***	1.3864*
	(0.118)	(0.407)	(0.107)	(0.355)	(0.133)	(0.781)
$\beta(RMW)$	0.0624	-1.4871**	-0.1916	-0.7410	-0.0861	0.8042
	(0.156)	(0.649)	(0.130)	(0.547)	(0.161)	(1.268)
$\beta(CMA)$	-0.1420	0.0492	-0.0721	-0.0836	-0.2059	2.5158**
	(0.155)	(0.533)	(0.132)	(0.486)	(0.159)	(1.203)
σ^2	10.3149***	23.0199***	7.6749***	35.1584***	13.3364***	62.0043***
	(0.860)	(4.159)	(0.686)	(5.235)	(1.233)	(12.912)
Note:	*p<0.1; **p<0.05; ***p<0.01. Values in ( ) represent the st. deviations.					

Table 12: Results of the Markov Switching Model (Countries, Part 2)

	French REIT		German REIT		UK REIT	
	Normal	Crisis	Normal	Crisis	Normal	Crisis
α	0.1364	-2.0995***	0.3263	-1.6602	0.5093	-3.3866***
	(0.256)	(0.709)	(0.296)	(1.463)	(0.320)	(0.908)
$\beta(Mkt - RF)$	0.5486***	0.7509***	0.3647***	0.9451***	0.4349***	0.9303***
	(0.060)	(0.143)	(0.109)	(0.204)	(0.070)	(0.163)
$\beta(SMB)$	0.3824***	-0.1989	0.2597	1.2748**	0.0794	1.0658***
	(0.109)	(0.309)	(0.187)	(0.504)	(0.125)	(0.366)
$\beta(HML)$	0.1408	1.9182***	-0.0001	-0.0919	-0.0157	0.5482
	(0.130)	(0.423)	(0.391)	(0.486)	(0.162)	(0.446)
$\beta(RMW)$	0.1504	-1.1606**	0.0850	-2.1251***	0.1414	-0.9142
	(0.178)	(0.552)	(0.334)	(0.695)	(0.199)	(0.717)
$\beta(CMA)$	0.0946	-1.3215**	0.1696	-0.7932	0.3542	-0.4874
	(0.170)	(0.594)	(0.457)	(1.251)	(0.226)	(0.617)
σ^2	13.1572***	16.4387***	15.6210***	71.1914***	16.8658***	33.7901***
	(1.337)	(3.761)	(4.639)	(13.616)	(1.701)	(6.144)
Note:	*p<0.1; **p<0.05; ***p<0.01. Values in ( ) represent the st. deviations.					

Transition Probabilities

Figure 3 displays the smoothed state probabilities for each regime across the REIT indices. Additionally, it highlights the significant economic events such as the recession periods identified by the National

Bureau of Economic Research (NBER), the European Sovereign Debt Crisis, and the date of the invasion of Ukraine, all marked in grey.

Generally, consistent patterns are evident across all countries during periods of crisis mentioned by the NBER. For example, the transition probabilities for the Crisis regime began to rise slightly from 0 around the year 2006 and reached the maximum of 1 during the peak of the Subprime Crisis in December 2007. The European and Belgian indices display the smoothest movement until the peak of this crisis. In contrast, the French REITs show not a gradual increase but rather sharp fluctuations from 2006 to 2010. This may be due to the strong performances of the French index relative to its peers during 2006 when it recorded historically highest returns.

A significant shift to the Crisis regime also occurred during the Covid-19 crisis, reaching a peak in February 2020 across nearly all countries. Germany was the notable exception, as it did not reach a crisis transition probability of 1.

Regarding the last crisis of your period studied, the Energy Crisis, a pronounced shift from a Normal to a Crisis regime is observed across all countries. For the majority of countries, this transition occurred closely after the invasion of Ukraine on February 24, 2022. An exception was the Belgian REIT index, which has displayed a continuous crisis transition probability of 1 since its last rise during the Covid-19 crisis, suggesting that Belgium remained in the Crisis regime since then.

In 2023, there were notable variations. Indices for Belgian, German, and European REITs maintained high probabilities, close to 1, of staying in the Crisis regime. Indices for French and UK REITs showed transition probabilities for the Normal regime ranging from 0.30 to 0.50, indicating a potential shift from the Crisis to the Normal regime. Conversely, the Dutch REITs index seems to have completely transitioned out of the crisis regime.

Additionally, several countries, including France, Germany, and the UK, have experienced more frequent regime transitions compared to their peers, suggesting a higher prevalence of Crisis regimes in these countries.

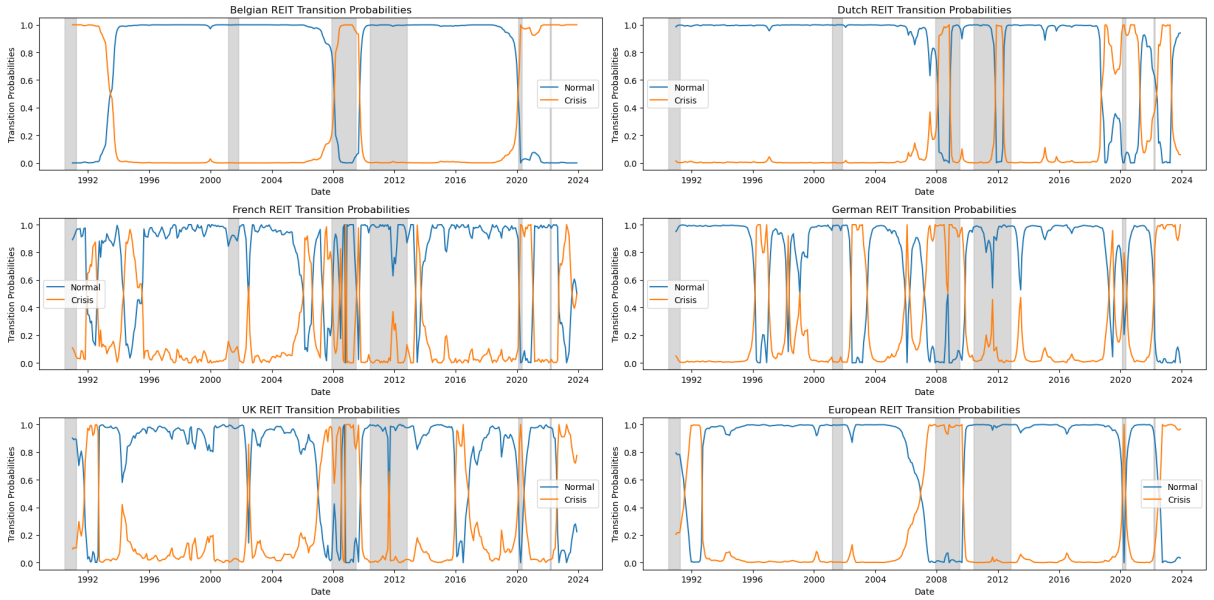

Figure 3: Smoothed Transition Probabilities (Countries)

Note: A larger version of these graphs is available in Figure 11 in the appendices.

Robustness test

Figure 4 displays a comparison of the smoothed transition probabilities for Crisis regimes within our two different models: the two-regime model and the three-regime model (including Low, Normal, and Crisis regimes). Despite variations in the number of regimes, consistency observed between these models can highlight robustness affirming our previous analysis.

The transition probabilities in both models tend to peak simultaneously during major crisis periods. For instance, in response to the Subprime Crisis and the Covid-19 Crisis, both models show a marked increase in crisis probabilities across most indices. This alignment indicates that the basic dynamics captured by the Markov Switching Model are consistent, irrespective of whether a two or three-regime framework is applied.

In more recent years, the Belgian REITs have shown distinct behaviors between the two-regime and three-regime models. This difference suggests that the inclusion of an additional regime in the three-regime model might better capture transitional states that are more probable than those of a full crisis. For example, our previous analyses using the two-regime Markov Switching Model indicated that Belgian REITs remained in a crisis state from Covid-19 to the Energy Crisis. However, in the three-regime model, there is a noticeable drop to zero in the crisis transition probabilities between these two periods.

For the Dutch and German REITs, the three-regime model displays a smoother transition pattern compared to the two-regime models. This observation suggests that the addition of an intermediate regime in the three-regime model may more effectively capture transitional states beyond the Normal-Crisis regime.

In the case of the European REITs index, the three-regime model shows a sharp reaction to potential crises. For example, there was a significant increase around the time of the dot-com bubble, which was nearly absent in the two-regime model.

Despite these differences, the transition probabilities for the Crisis regime across both models exhibit similar movements and demonstrate a strong correlation, underscoring the reliability of our analysis. This consistency affirms that even with the simplified two-regime model, we are able to capture the essential dynamics of how REIT indices respond to crises, thus reinforcing the robustness of our analytical approach.

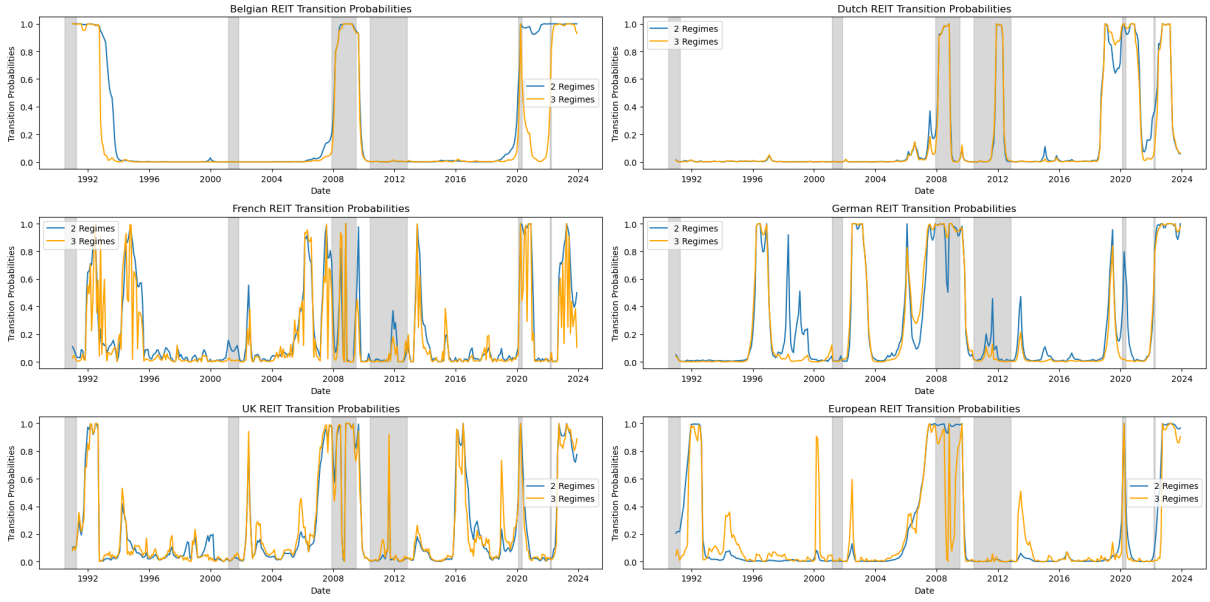

Figure 4: Crisis Transition Probabilities for 2 and 3 regimes Model (Countries)

5.4.2 Sectors

Summary

Tables 13, 14, 15, and Figure 5 present the results of the Markov Switching Model for the REIT indices across sectors. Table 13 shows that the characteristics that distinguished the two regimes across countries are also observed across sectors in this model. Explicitly, the Normal regime is characterised by higher returns, lower variances, and longer durations compared to the Crisis regime.

Similar to the country indices, the sector indices generally exhibit positive mean excess returns during the Normal regime, with the exceptions being the Residential sector (-0.741) and the European REIT index (-0.080). It is important to note, however, that direct comparisons between these categories should be approached with caution. This caution is due to the shorter timeframe used for the sector analysis, which begins in 2007, rather than 1990, potentially affecting the comparability of the results.

At the sector level, the difference in variances across sectors is highly pronounced. For instance, the variance for diversified REITs rises from 12.360 to 36.853 when switching between regimes, whereas the variance for industrial REITs rises significantly from 22.644 to 150.458 during a regime switch. This indicates that some sectors experience considerably greater volatility during crisis periods compared to others.

Table 13: Summary of the Markov Switching Model (Sectors)

	Mean (Normal)	Mean (Crisis)	Variance (Normal)	Variance (Crisis)	Duration (Normal)	Duration (Crisis)	P11	P12	P21	P22
Diversified REIT	0.4909	-2.5572	12.3607	36.8531	38.60	15.59	0.9741	0.0641	0.0259	0.9359
Healthcare REIT	0.8694	-2.3925	11.1225	66.2845	18.44	8.61	0.9458	0.1161	0.0542	0.8839
Industrial REIT	0.6050	-5.8097	22.6441	150.4579	27.43	3.49	0.9635	0.2864	0.0365	0.7136
Office REIT	0.6505	-2.2092	11.9149	49.2148	39.59	15.61	0.9747	0.0640	0.0253	0.9360
Residential REIT	-0.7412	-4.4466	19.0350	95.3330	62.58	16.94	0.9840	0.0590	0.0160	0.9410
Retail REIT	0.9508	-0.8344	20.2410	66.7429	29.07	25.67	0.9656	0.0390	0.0344	0.9610
European REIT	-0.0797	-3.1465	15.6994	58.3783	41.78	8.29	0.9761	0.1206	0.0239	0.8794

Note: Duration indicates the average expected time in months in each regime. P_{ij} represents the transition probability from regime i to regime j (1 = Normal, 2 = Crisis).

Results of Markov Switching Model

Table 14, and Table 15 display the results of the Markov Switching Model applied to the REITs indices across our sectors. Similar to the country-level, these tables highlight the differences in the impact of the various factor premiums according to the different regimes.

The trend observed at the country level, where the market risk premium (Mkt-RF) displayed only positive coefficients that were higher during crisis periods than in normal times, persists across the sector model. Notably, the Industrial sector exhibits the most pronounced sensitivity to market conditions during crisis periods, with a coefficient slightly above 1 (1.028). On the opposite, the Residential sector shows a reduction in its coefficient from 0.555 to 0.347 during crises. However, these coefficients are only statistically significant in the normal regime, making it challenging to definitively assess this variation. Additionally, the Healthcare sector shows non-significant results for the Mkt-RF coefficients, indicating a less clear impact of market risk factors in this sector.

The coefficient for the size risk premium (SMB), which was statistically significant across all sectors in the linear analysis, now shows significance only during the crisis period. Only the Industrial and Residential REIT sectors continue to exhibit significant results in both regimes. With coefficients ranging from 1.942 to 2.708 across all sectors, these findings suggest that smaller REITs typically outperform larger ones during crisis periods.

While the country-level analysis did not show significant outputs for the value risk premium (HML), the Diversified and Residential sectors display significant coefficients in both regimes. With consistently positive values, these results indicate that companies with higher book-to-market ratios generally outperform those with lower ratios, particularly during crises. Similarly, the European REIT index shows significant coefficients that increase from 0.675 to 2.245, further supporting this trend.

The profitability risk premium (RMW), which was statistically significant during the linear model analysis, now shows significance in only one Normal regime and three Crisis regimes. However, there is a considerable variation in direction across different sectors. The Residential (3.548) and European (1.996) indices demonstrate positive coefficients, indicating a beneficial impact of profitability on these sectors. On the opposite, the Industrial sector exhibits a significantly negative coefficient of -5.848, suggesting that profitability has a pronounced negative influence on the Industrial sector. The magnitude of this coefficient (RMW) for the Industrial sector is the most responsive factor loading across the entire table.

Variations are also evident in the investment risk premium (CMA) across different sectors. The Industrial and Retail sectors consistently display negative coefficients in both regimes, suggesting a preference for aggressive investment strategies. In contrast, the Office sector, which experiences less severe negative mean excess returns during crises, shows a negative coefficient of -1.037 in the Normal regime and a positive coefficient of 1.402 during the Crisis regime. These results may imply a strategic shift in investment approaches depending on the prevailing economic conditions.

Table 14: Results of the Markov Switching Model (Sectors, Part 1)

	Diversified REIT		Healthcare REIT		Industrial REIT		Office REIT	
	Normal	Crisis	Normal	Crisis	Normal	Crisis	Normal	Crisis
α	0.4909	-2.5572***	0.8694**	-2.3925**	0.6050	-5.8097*	0.6505*	-2.2092*
	(0.327)	(0.946)	(0.351)	(1.204)	(0.404)	(3.217)	(0.369)	(1.136)
$\beta(MKT-RF)$	0.2998***	0.8032***	-0.0148	0.4085	0.2514***	1.0280**	0.3056***	0.7548***
	(0.073)	(0.180)	(0.076)	(0.284)	(0.095)	(0.480)	(0.078)	(0.212)
$\beta(SMB)$	0.0049	2.1271***	0.0458	2.5853***	0.4738**	1.9419*	0.1680	2.3648***
	(0.231)	(0.393)	(0.200)	(0.591)	(0.239)	(1.136)	(0.316)	(0.498)
$\beta(HML)$	0.4706*	1.4466***	-0.4621*	0.5748	0.1703	0.2731	0.2236	1.3579**
	(0.244)	(0.487)	(0.242)	(0.831)	(0.294)	(1.323)	(0.296)	(0.553)
$\beta(RMW)$	-0.0229	1.1040	-0.6762**	-0.6832	-0.2314	-5.8478**	-0.1442	1.4813
	(0.329)	(0.785)	(0.331)	(1.197)	(0.403)	(2.699)	(0.364)	(0.971)
$\beta(CMA)$	-1.3076***	1.0800	-0.2505	-0.5171	-0.9722**	-3.6265**	-1.0374***	1.4022*
	(0.350)	(0.686)	(0.312)	(1.421)	(0.402)	(1.746)	(0.401)	(0.825)
σ^2	12.3607***	36.8531***	11.1225***	66.2845***	22.6441***	150.4579***	11.9149***	49.2148***
	(1.643)	(7.710)	(1.622)	(13.448)	(2.681)	(50.045)	(2.028)	(11.741)

Note: *p<0.1; **p<0.05; ***p<0.01. Values in ( ) represent the st. deviations.

Table 15: Results of the Markov Switching Model (Sectors, Part 2)

	Residential REIT		Retail REIT		European REIT	
	Normal	Crisis	Normal	Crisis	Normal	Crisis
α	-0.7412*	-4.4466***	0.9508*	-0.8344	-0.0797	-3.1465**
	(0.387)	(1.601)	(0.475)	(1.024)	(0.348)	(1.540)
$\beta(MKT-RF)$	0.5547***	0.3474	0.1825	0.4941***	0.3700***	0.5517
	(0.092)	(0.307)	(0.142)	(0.182)	(0.082)	(0.349)
$\beta(SMB)$	0.5109**	2.6947***	0.1777	2.4037***	0.2594	2.7085***
	(0.237)	(0.760)	(0.321)	(0.472)	(0.218)	(0.684)
$\beta(HML)$	0.6318**	3.6213***	-0.2439	1.6660***	0.6745***	2.2450***
	(0.319)	(0.796)	(0.401)	(0.526)	(0.257)	(0.810)
$\beta(RMW)$	0.5795	3.5482***	-0.2762	-0.4001	0.1829	1.9958*
	(0.413)	(1.310)	(0.542)	(0.868)	(0.350)	(1.196)
$\beta(CMA)$	-0.6968	0.5534	-1.0637**	-1.9637***	-1.0837***	0.9386
	(0.432)	(1.058)	(0.521)	(0.754)	(0.388)	(1.034)
σ^2	19.0350***	95.3330***	20.2410***	66.7429***	15.6994***	58.3783***
	(2.375)	(21.015)	(4.942)	(12.511)	(1.947)	(16.018)
Note:			*p<0.1; **p<0.05; ***p<0.01. Values in ( ) represent the st. deviations.			

Transition Probabilities

Figure 5 displays the smoothed transition probabilities for both regimes across each REIT index. Similar to observations at the country level, consistent patterns emerge across sectors during crisis periods. For example, at the end of 2019, the transition probabilities for the Crisis regime in all sector indices were near zero, but they increased directly to 1 with the onset of the Covid-19 crisis.

A comparable movement occurred during the Energy Crisis. All sector indices experienced a sharp increase in transition probabilities from 0 to 1 around the time of Ukraine's invasion in February 2022. The Residential REIT indices, however, displayed a distinct pattern. This sector appeared to remain in the Crisis regime since the Covid-19 crisis. There was a slight decrease in the smoothed transition probabilities for the Crisis regime to 0.8 near the end of 2021, but these probabilities returned to 1 just before the invasion occurred.

The final section of each graph provides insights into the current status of each sector, revealing notable differences. Along with the European REIT index, our benchmark, the Diversified, Industrial, Office, and Residential sectors have fully transitioned out of the crisis regime. In contrast, the Healthcare and Retail sectors appear to remain in a crisis regime, with a transition probability of continuing in this state above 0.8.

In general, sector indices tend to exhibit smoother movements in transition probabilities compared to the Markov Switching Model applied at the country level. This analysis of sectors shows significant movements during the major crises identified by the NBER, but there appears to be limited fluctuation in the periods between these crises. This may indicate that while sector indices are reactive during significant crises, they remain relatively stable in more neutral or less turbulent times.

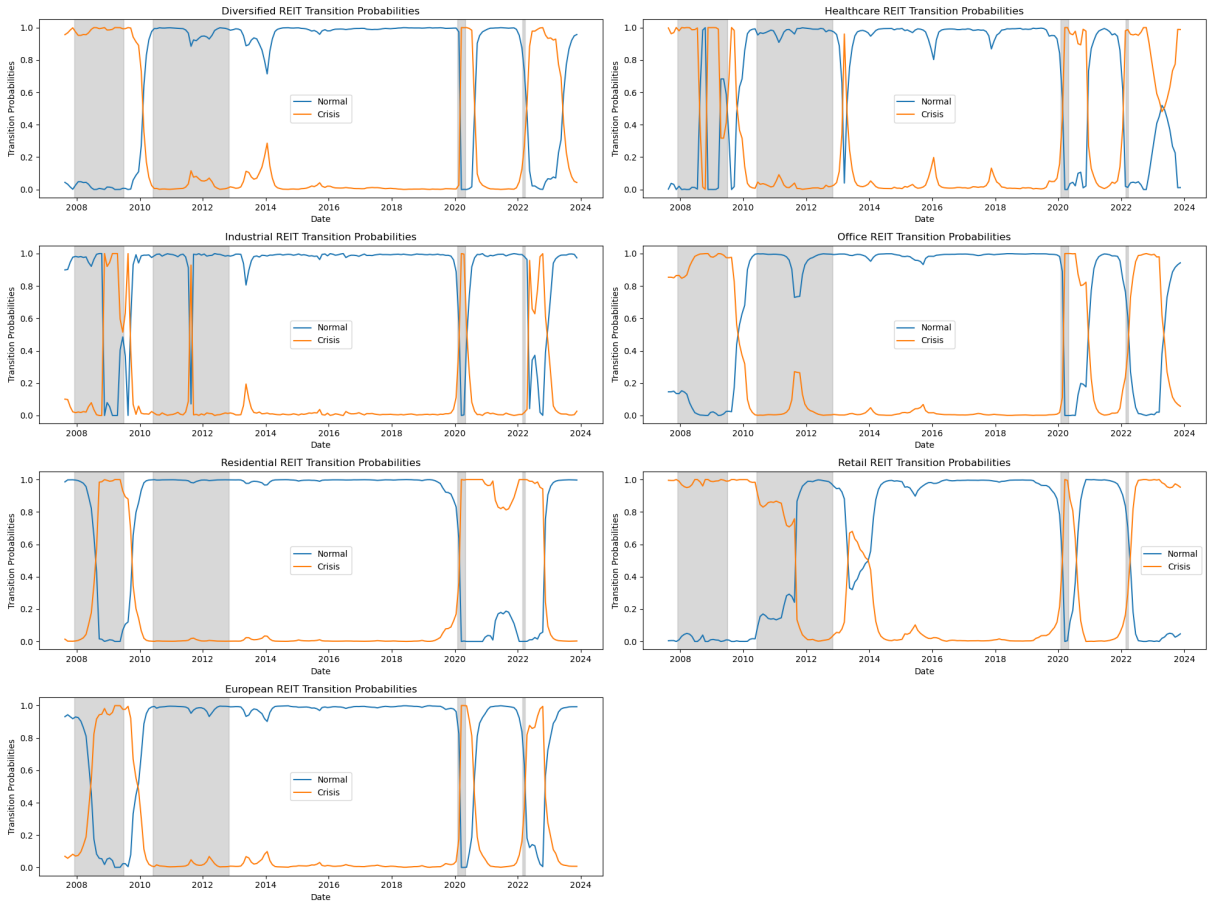

Figure 5: Smoothed Transition Probabilities (Sectors)

Note: A larger version of these graphs is available in Figure 12 in the appendices.

Robustness test

Similar to the analysis at the country level, a robustness check can be performed by comparing the Crisis regimes between the two-regime model and the three-regime model. Figure 6 illustrates this comparison through the smoothed transition probabilities across all sector indices.

Generally, the Crisis transition probabilities in the three-regime model tend to align and correlate with those of the two-regime model. For example, the Healthcare, Industrial, and Residential sectors display almost perfectly similar patterns across both models.

The Diversified, Office, and European indices also demonstrate a high correlation between the crisis transition probabilities across both models. However, there are notable fluctuations within the three-regime model, with the Diversified sector experiencing significant movement between 2013 and 2014, and the Office sector showing fluctuations from mid-2014 to 2016.

On the opposite, the comparison of the two-state and three-state regimes for the Retail REIT index is completely different from the others. It is the only index, including those of countries, that shows no correlation between the models at all. With a closer examination of the three-regime model for this sector, it is evident that the Normal and Crisis regimes are the most volatile, while the Low regime tends to remain close to zero (cf. Figure 14 in the Appendices).

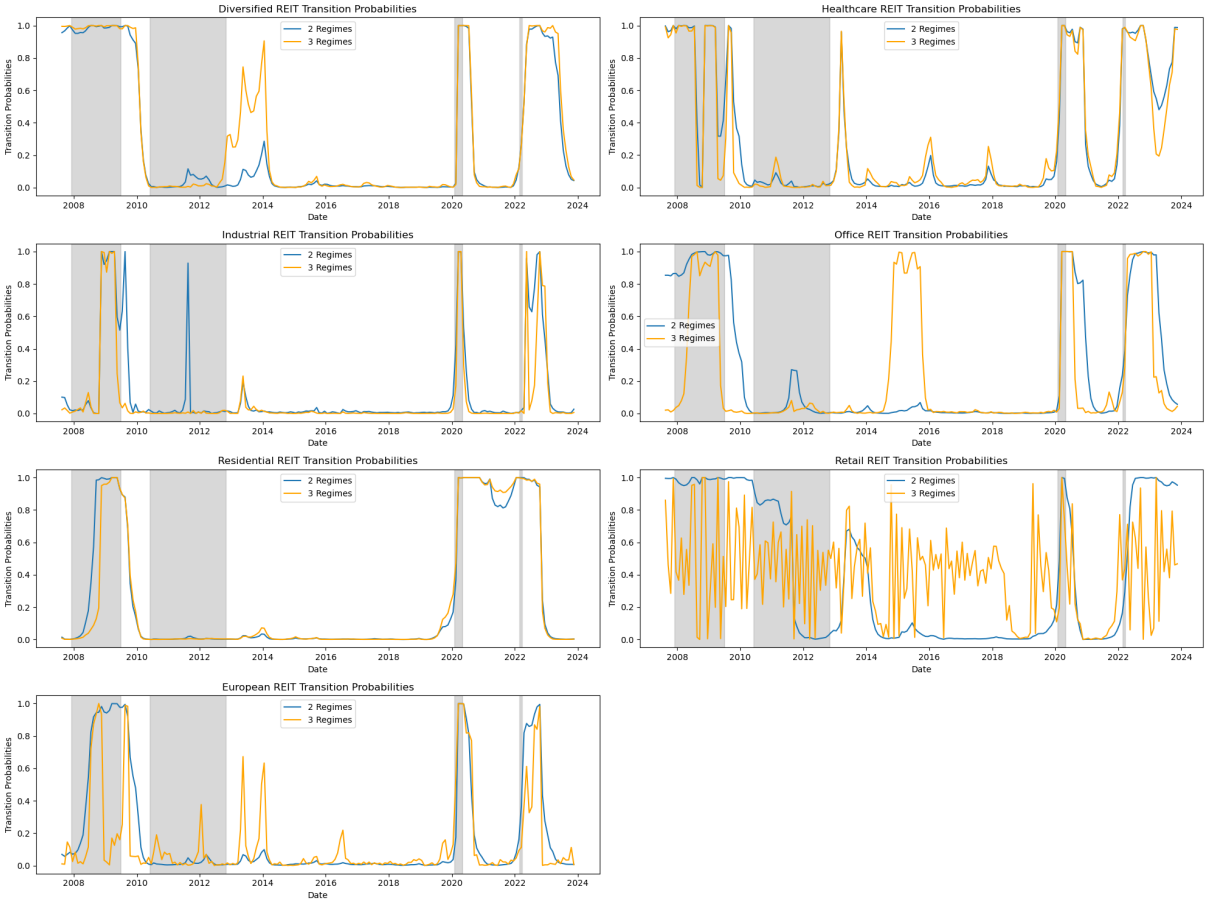

Figure 6: Crisis Transition Probabilities for 2 and 3 regimes Model (Sectors)

Conclusion

In conclusion, the application of the Markov Switching Model to REIT indices across various countries and sectors has effectively captured the dynamics of two distinct market regimes: the Normal regime and the Crisis regime. The Normal regime is characterised by relatively stable and positive returns, whereas the Crisis regime is associated with high volatility and significantly negative returns.

These findings reinforce the insights gained from the Linear Model analysis, illustrating the state's dependence on certain risk premiums. Specifically, the market, and size risk premiums show increased sensitivity and significant fluctuations during crisis periods, highlighting their critical role in these crisis periods. The value risk premium also follows this trend, though its significance is less pronounced, appearing in only a few models.

Regarding the profitability risk premium, especially significant in the Crisis regime, it generally shows a negative impact on excess returns in most countries and sectors. However, it has a contrasting positive effect in specific sectors like Industrial. Similarly, the investment risk premium typically has a negative influence in sectors such as Industrial and Retail but demonstrates a shift from negative to positive impacts in the Office sector during regime transitions.

5.5 Performance Measurement

The next concept to explore is performance measurement using the Information Ratio. This metric evaluates an investment's excess return per unit of specific risk. We examine both the Pure Information Ratio and the Global Information Ratio, providing analysis independently and relative to a benchmark. By analysing these ratios, we aim to gain a nuanced understanding of REIT performance across countries and sectors in both Normal and Crisis regimes.

5.5.1 Pure Information Ratio

First, we will examine the Pure Information Ratio, as detailed in Table 16. This table presents the ratios for both country and sector indices during Normal and Crisis regimes. The annualised results, shown in parentheses, are also graphically represented in Figure 7.

As previously mentioned, the Pure Information Ratio is calculated as the intercept divided by the standard deviation. Therefore, the rankings from worst to best based on Pure Information Ratios generally correspond to those of the mean excess returns, as detailed in Tables 10 and 13.

However, variations emerge when indices exhibit significant differences in volatility levels. For example, in the Normal regimes, the Retail sector (which recorded the highest mean excess return at 0.951, followed by the Healthcare sector at 0.869) displays a lower annualised Pure Information Ratio (0.732) compared to the Healthcare sector (0.903). This difference is attributed to the higher variance observed in the Retail sector (20.241) compared to the Healthcare sector (11.122).

During Crisis regimes, all indices exhibit negative annualised Pure Information Ratios, reflecting the challenging market conditions. For example, the UK REIT index shifts from a positive ratio of 0.430 in the Normal regime to a negative -2.018 during the Crisis regime, indicating severe underperformance relative to its risk. Notably, the UK has the best ratio in the Normal regime but also the worst in the Crisis regime.

Sector indices also display notable declines in Pure Information Ratios during the Crisis regime. For instance, the Industrial sector experiences one of the highest drops, from 0.440 in the Normal regime to -1.641 during the Crisis regime.

Table 16: Pure Information Ratios (Countries and Sectors)

Country	Normal	(Y)	Crisis	(Y)	**Sector**	Normal	(Y)	Crisis	(Y)
European	0.034	(0.119)	-0.336	(-1.163)	Diversified	0.140	(0.484)	-0.421	(-1.459)
Belgian	0.017	(0.059)	-0.082	(-0.283)	Healthcare	0.261	(0.903)	-0.294	(-1.018)
Dutch	-0.131	(-0.454)	-0.216	(-0.748)	Industrial	0.127	(0.440)	-0.474	(-1.641)
French	0.038	(0.130)	-0.518	(-1.794)	Office	0.188	(0.653)	-0.315	(-1.091)
German	0.083	(0.286)	-0.197	(-0.682)	Residential	-0.170	(-0.588)	-0.455	(-1.578)
UK	0.124	(0.430)	-0.583	(-2.018)	Retail	0.211	(0.732)	-0.102	(-0.354)
					European	-0.020	(-0.070)	-0.412	(-1.427)

Note: The columns (Y) represent the annualised Pure Information Ratios (results multiplied by $\sqrt{12}$)

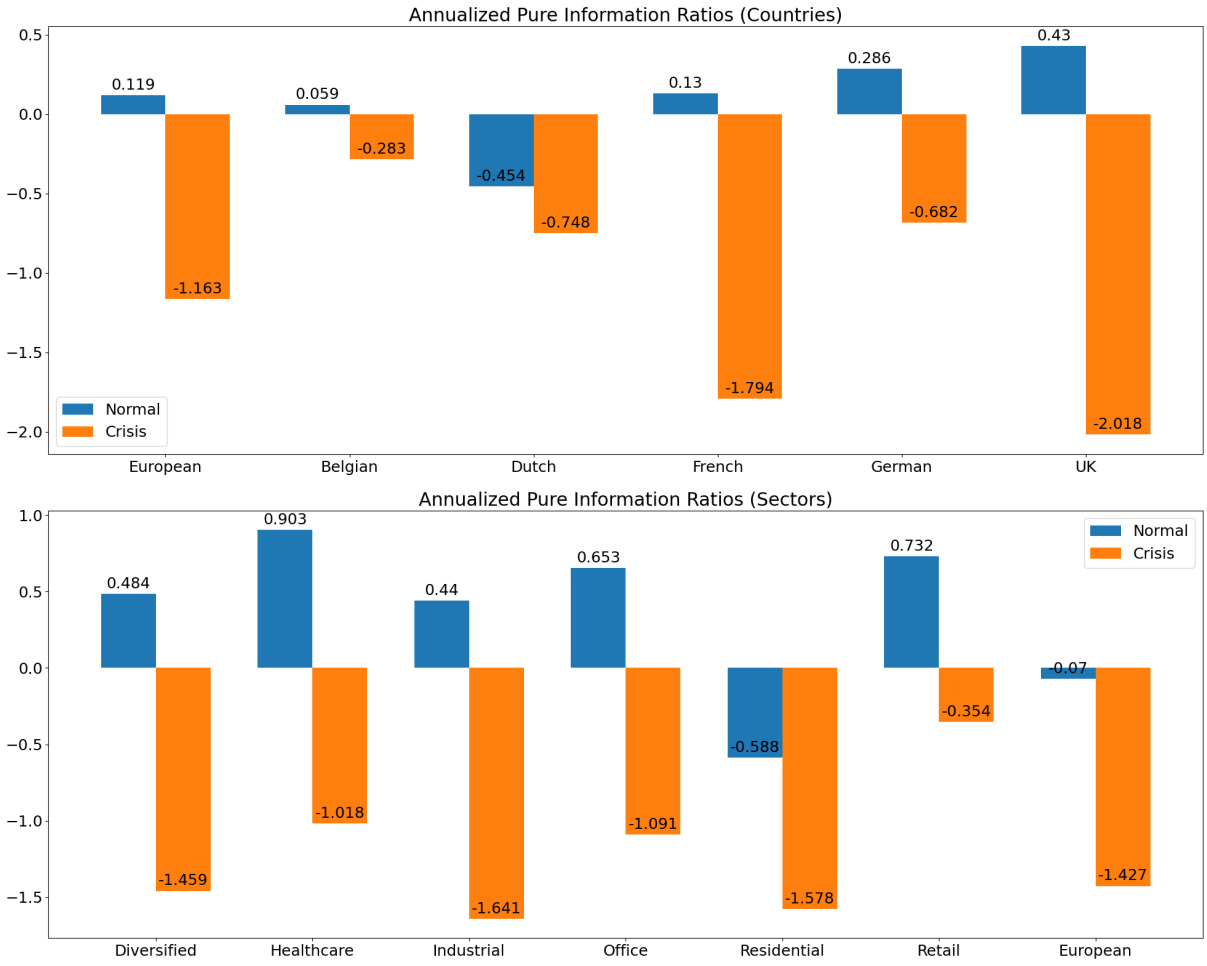

Figure 7: Annualised Pure Information Ratios (Countries and Sectors)

5.5.2 Global Information Ratio

Next, we analyse the Global Information Ratio, as shown in Table 17, which presents these ratios for both country and sector indices during Normal and Crisis regimes. The annualised results, indicated in parentheses, are also graphically represented in Figure 8. The Global Information Ratio offers a better perspective by considering the alignment of the index with the benchmark, the European REIT index.

Regarding the countries, a clear contrast appears between Belgian REITs and UK REITs. The Belgian index shows a small negative ratio during Normal regimes (-0.052) and a positive Global Information Ratio (0.512) during Crisis periods. Conversely, the UK index shows a positive ratio during the Normal regime (0.265) and a negative ratio (-0.816) during Crisis regimes. Relative to our benchmark, Belgian REITs perform better during Crisis regimes but not during Normal regimes, while the opposite is true for UK REITs.

At the sector level, the findings are more homogeneous between regimes, with four indices showing positive Global Information Ratios in both regimes, and the Residential sector displays negative ratios in both. However, the Industrial sector is the only one to experience a drastic change, with its Global Information Ratio dropping from a positive value (0.383) in Normal regimes to a negative value (-0.638) during Crisis regimes. This significant decline underscores the sector's sensitivity to economic downturns and volatility.

Table 17: Global Information Ratios (Countries and Sectors)

Country	Normal	(Y)	Crisis	(Y)	**Sector**	Normal	(Y)	Crisis	(Y)
European	0.000	(0.000)	0.000	(0.000)	Diversified	0.108	(0.373)	0.060	(0.209)
Belgian	-0.015	(-0.052)	0.148	(0.512)	Healthcare	0.183	(0.635)	0.068	(0.234)
Dutch	-0.121	(-0.420)	-0.010	(-0.034)	Industrial	0.111	(0.383)	-0.184	(-0.638)
French	0.005	(0.018)	-0.078	(-0.270)	Office	0.139	(0.481)	0.090	(0.313)
German	0.042	(0.147)	-0.005	(-0.018)	Residential	-0.112	(-0.389)	-0.105	(-0.363)
UK	0.076	(0.265)	-0.236	(-0.816)	Retail	0.172	(0.595)	0.207	(0.716)
					European	0.000	(0.000)	0.000	(0.000)

Note: The columns (Y) represent the annualised Global Information Ratios (results multiplied per $\sqrt{12}$). The zeros in the "European" rows are expected since the European REIT index serves as the benchmark.

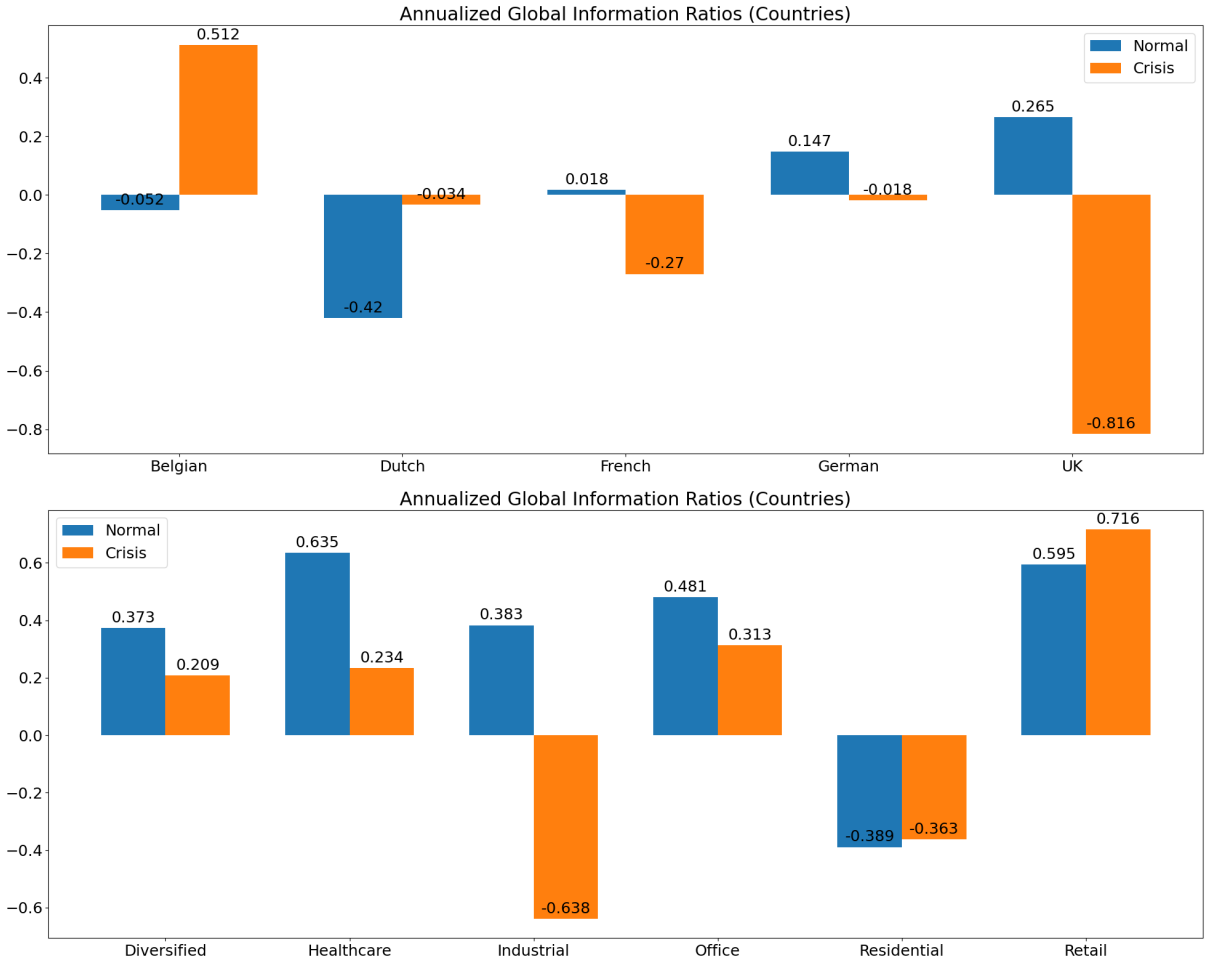

Figure 8: Annualised Global Information Ratios (Countries and Sectors)

5.6 Discussion

This section discusses the findings of our analysis, aiming to connect the insights gained from the literature review with the empirical results. The goal is to provide a comprehensive discussion that underscores significant findings and addresses the research questions.

Additionally, this section explores the limitations of our study. It discusses how these constraints might impact the interpretation of the results. This critical evaluation helps contextualise the findings and suggest areas for future research.

Findings

The primary research question addresses how crises affect the performance of REITs in Europe. Guidolin and Bianchi (2014) have shown that the Markov Switching Model is particularly effective at capturing the pronounced dynamics of bull and bear markets within REIT returns. Our study similarly observes these dynamics. The Markov Switching Model identifies two distinct regimes: Normal and Crisis. The findings reveal that, with few exceptions, all indices are highly responsive to crisis periods, consistently exhibiting regime switches. This suggests that the REIT industry is highly influenced by the economic environment and is unlikely to serve as a safe haven during recessions.

Furthermore, our findings on market, size, and value risk premiums somewhat align with previous literature (e.g., Peterson & Hsieh, 1997; Karlsson & Hacker, 2013; Demiralay & Kilincarslan, 2022). The positive factor loadings, particularly pronounced during crisis regimes and almost always statistically significant, highlight the increased sensitivity of REITs to broader market dynamics during economic downturns. These results reinforce the notion that the REIT industry is highly sensitive to market movements, and this sector does not escape from the stock fluctuations. Additionally, the findings indicate that European REITs tend to exhibit characteristics of small-cap stocks, especially during crisis periods. Regarding the value risk premium, only the Diversified and Residential sectors support the belief that REITs deliver better returns as value stocks rather than growth stocks.

The results concerning the profitability and investment risk premiums are less clear-cut. Profitability appears to be regime-dependent, with significant values principally observed during crisis regimes. The findings are nuanced, as the European index indicates lower profitability in country-level analyses but higher profitability in sector-level analyses. Regarding investment strategies, only the Industrial and Retail sectors across all indices favor aggressive investment approaches.

The second part of the research question aims to highlight differences across countries and sectors. At the country level, our findings indicate that certain countries, notably France, Germany, and the UK, experience more frequent regime switches, signifying a higher exposure to crisis regimes compared to the European benchmark. This suggests that national economic conditions or regulatory environments may play a role in influencing REIT resilience. In contrast, at the sector level, all indices show limited movements between crises, indicating better resilience during normal regimes and fewer distinctions between sectors.

Additional differences are evident at the sector-level. For example, the Industrial sector exhibits extremely high volatility and negative returns during crises compared to other sectors. Moreover, this sector shows the strongest market dependence, suggesting a large correlation with economic fluctuations, which aligns with Wheaton's (1999) findings.

Performance measurement reveals significant variations in the performance of REIT indices. For instance, the Retail sector has the highest mean excess returns but exhibits lower Pure Information Ratios than the Healthcare sector due to higher variance. The Global Information Ratio indicates that Belgian REITs outperform the benchmark during crises but not in normal times, whereas UK REITs exhibit the opposite pattern. At the sector level, the Industrial sector shows the most pronounced decline in the

Global Information Ratio during crises, highlighting its sensitivity to economic recessions.

Overall, the smoothed transition probabilities reveal significant differences in the current states of various indices, highlighting how sectors and countries are differently affected by ongoing economic conditions. For instance, all countries seem to remain in crisis regimes, with the exception of Dutch REITs, which have fully transitioned out of this state. However, at the sector level, only the Healthcare and Retail sectors continue to remain in a crisis regime (as of December 2023).

Limitations

The Fama-French Five Factors model captures only a modest proportion of the variance in REITs' excess returns, its selection remains a topic for discussion. Both linear and non-linear models indicate significant impacts for the first three risk premiums. In contrast, profitability and investment risk premiums appear to be the least significant factors. For future research, a valuable approach could be to start with the Fama-French Three Factors model and incorporate additional factors beyond the remaining two proposed by the original authors. This approach would control for the three primary risk premiums, which have a significant impact while allowing for the exploration of the effects of other factors.

Moreover, this study uses REIT indices instead of analysing individual REITs directly. Indices serve as benchmarks for performance measurement, offering a useful estimate of market trends and sector performance. However, this approach may result in biased performance assessments and might not accurately represent the specific investment strategies or risk profiles of individual REITs.

6 Conclusion

This study offered valuable insights into the impact of various crises on the performance of Real Estate Investment Trusts (REITs) in Europe from 1990 to 2023. By employing both country-level and sector-level analyses, the study provided a comprehensive exploration of the European REIT industry. This detailed subdivision revealed notable differences across European countries and sectors, which do not always follow the same trends.

Despite these differences, we affirm the main idea that each index moves relatively in the same direction. This is evidenced by the generally important correlation between the returns of different countries and sectors highlighted in this study.

By using the Fama-French Five Factor Model, we confirmed the explanatory power of market, size, and value risk premiums on REITs' excess returns, aligning with previous studies. By keeping the methodology of this study mostly unchanged, substituting the Fama-French Five Factors with other linear models can help explore new relationships between various factors and REITs' excess returns.

The use of the Markov Switching Model enabled the identification of distinct patterns between normal and crisis regimes. This model effectively captured the dynamics of different market conditions, emphasising the state-dependent nature of certain risk premiums.

Relative to the European REIT benchmark, this study found that countries and sectors performed differently, producing positive or negative Information Ratios that were not predetermined by the regime.

Overall, our findings underscore the critical role of economic regimes in influencing REIT returns and offer valuable insights for various stakeholders in understanding and navigating the complexities of the European REIT market.

7 Appendices

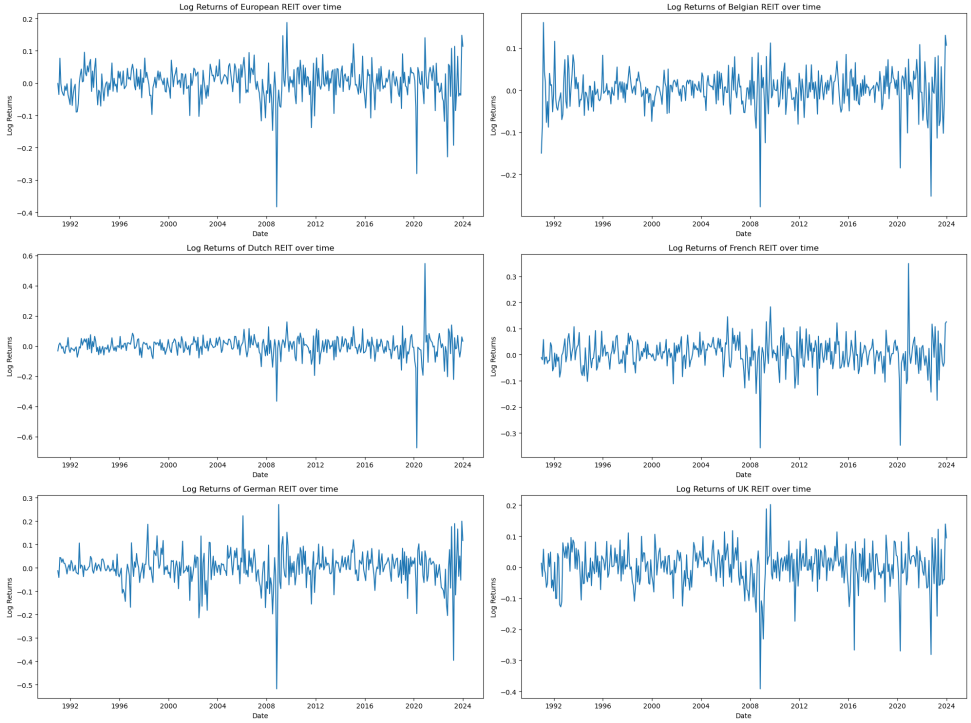

Figure 9: Logarithmic Returns of REIT Indices (Countries)

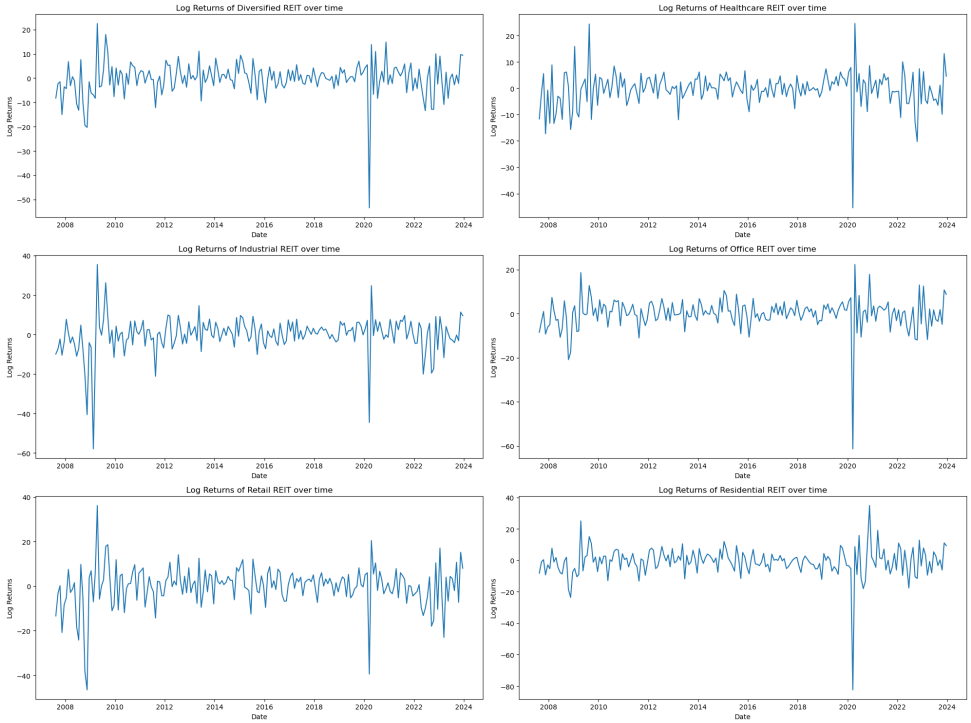

Figure 10: Logarithmic Returns of REIT Indices (Sectors)

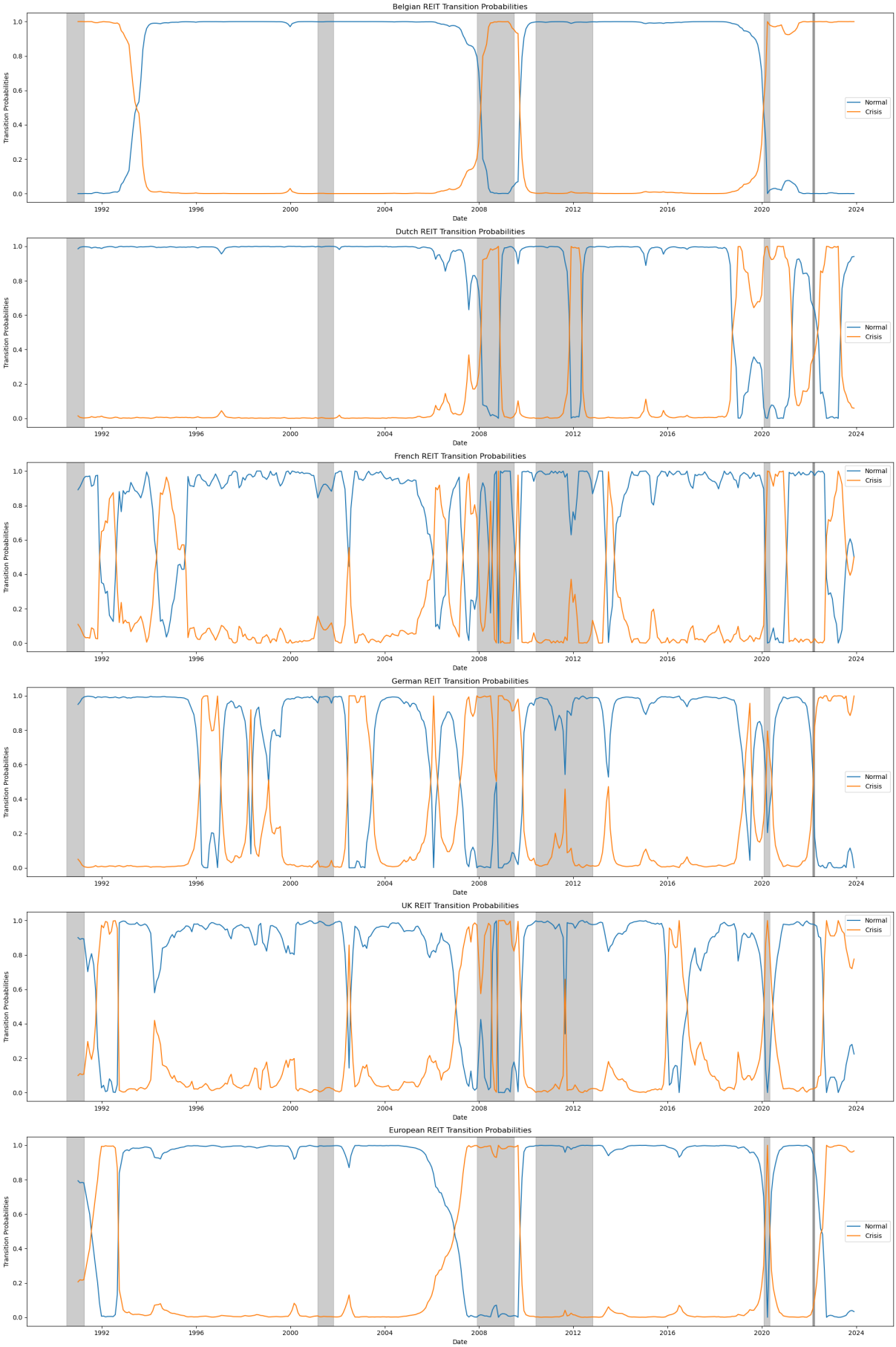

Figure 11: Smoothed Transition Probabilities (Countries)

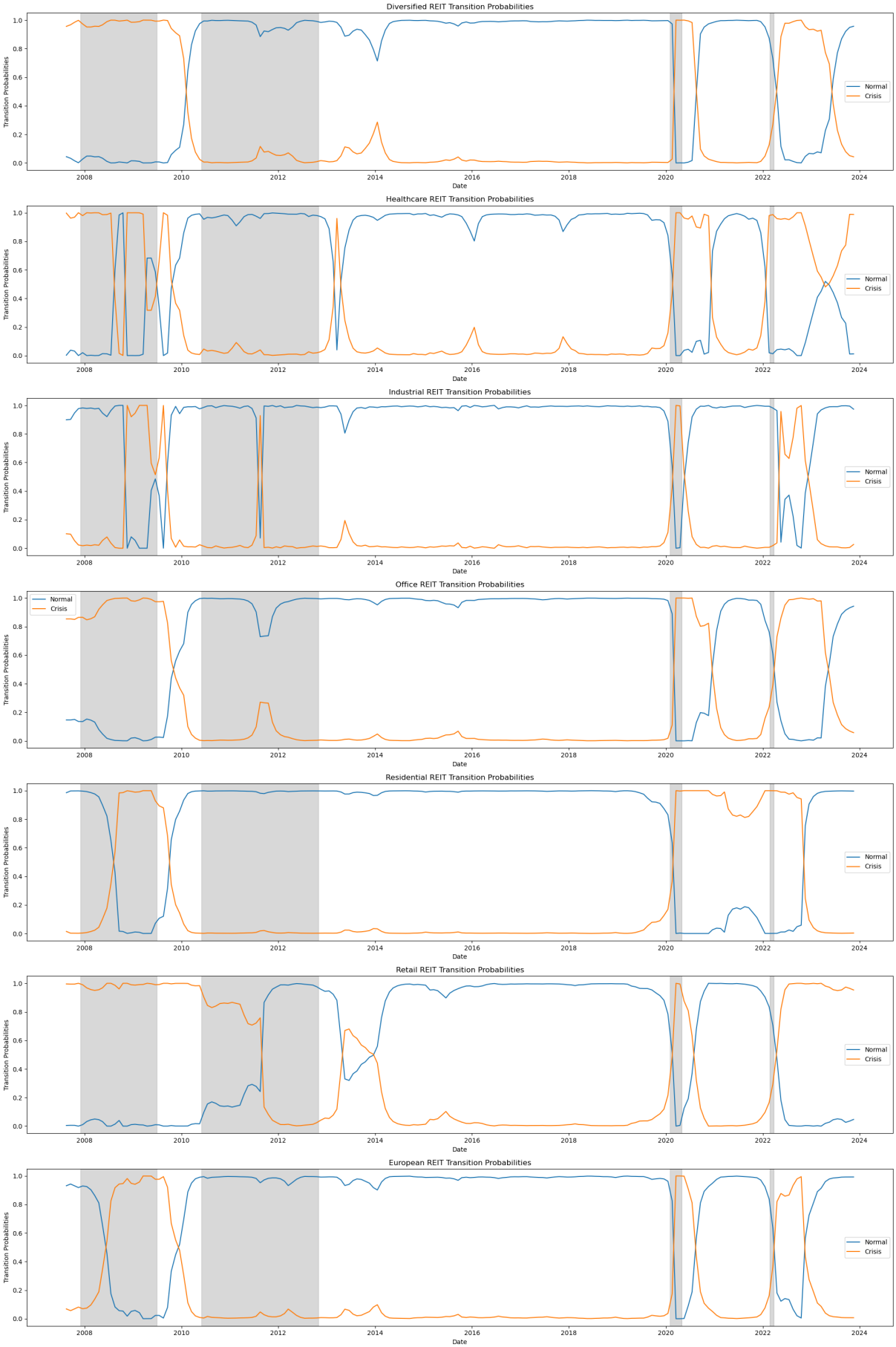

Figure 12: Smoothed Transition Probabilities (Sectors)

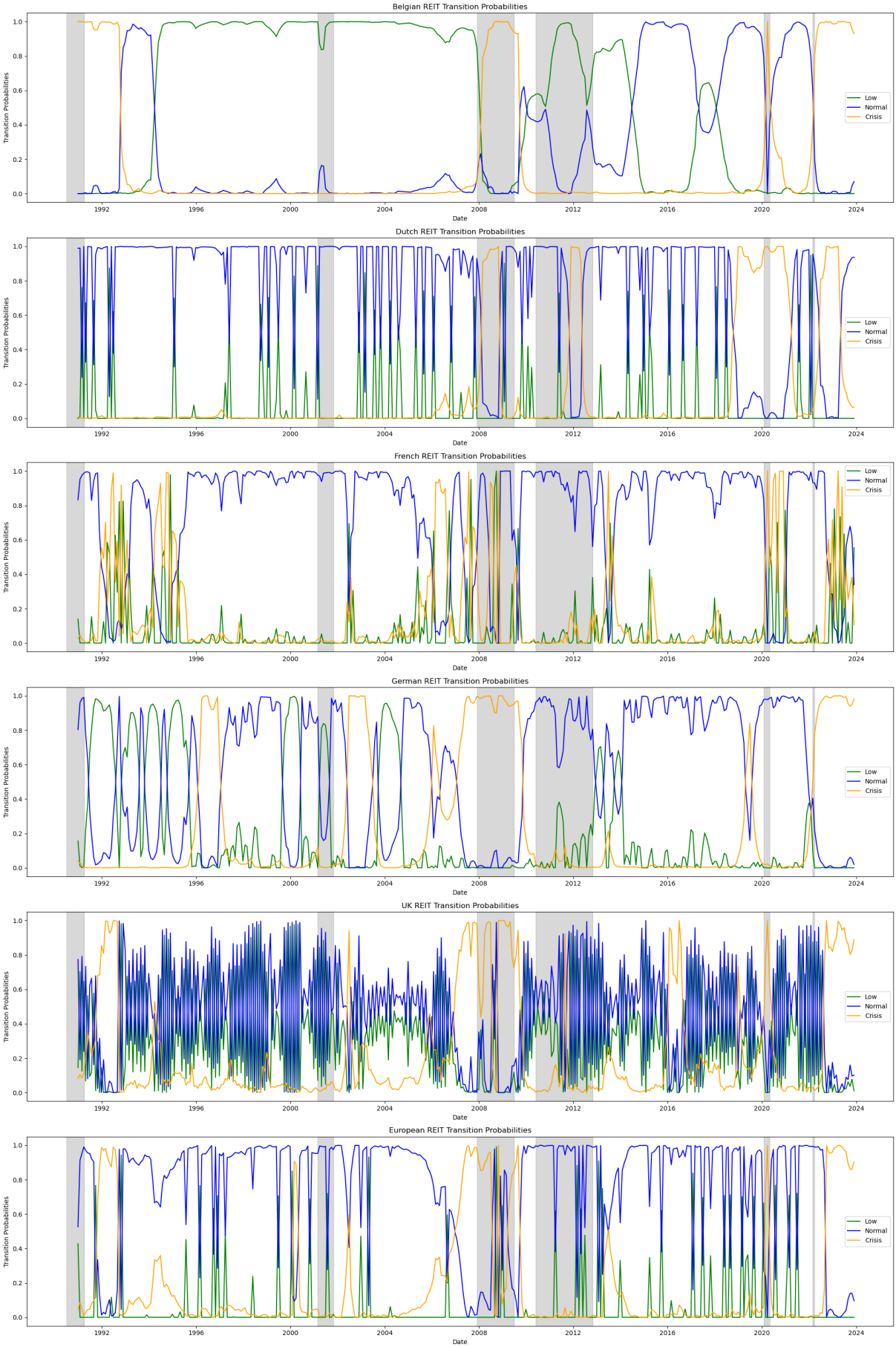

Figure 13: Smoothed Transition Probabilities for 3 Regimes (Countries)

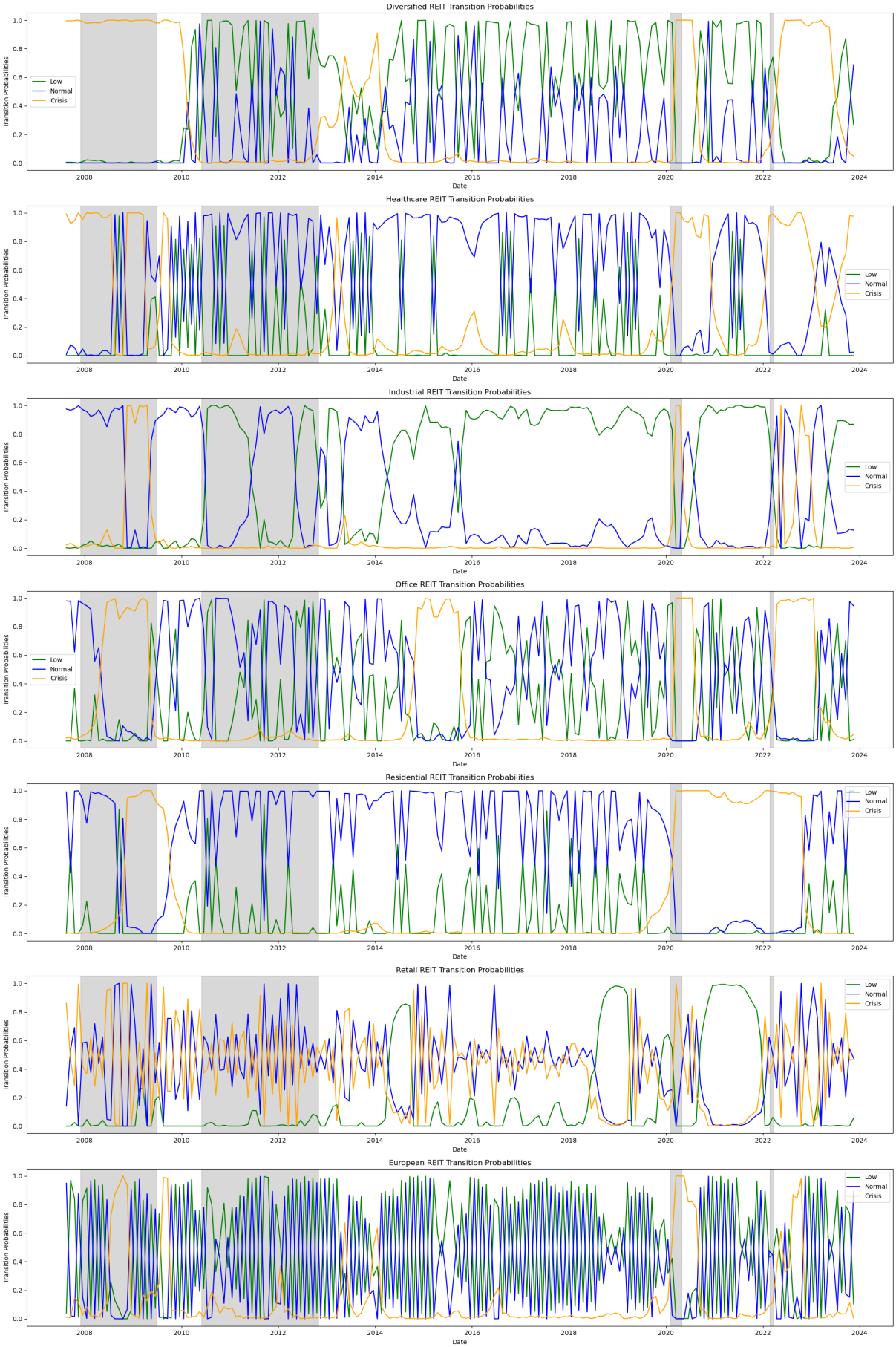

Figure 14: Smoothed Transition Probabilities for 3 Regimes (Sectors)

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9 Executive Summary

This study investigates the effects of financial crises on Real Estate Investment Trusts (REITs) in Europe from 1990 to 2023, focusing on their performance across various country indices (Belgium, France, Germany, the Netherlands, and the UK) and sector indices (Diversified, Healthcare, Industrial, Office, Residential, and Retail). The analyses were performed using several methods, including both linear and non-linear models, as well as performance measurement.

Firstly, the Fama-French Five Factors Model is used to analyse the linear relationship between REIT returns and factors such as market, size, value, profitability, and investment. The findings reveal that market, size, and value premiums significantly influence REIT excess returns, whereas the profitability and investment factors have less explanatory power.

Then, the Markov Switching Model is used to identify two regimes (Normal and Crisis) within the REIT industry. The results show that REIT returns are highly responsive to crisis periods, with varying levels of sensitivity across different sectors and countries. For instance, the French, German, and UK REIT indices experience more frequent regime changes, indicating a higher prevalence of Crisis regimes. Additionally, the findings confirm the linear model insights, emphasising the impact of risk premiums during crisis periods.

Lastly, performance measurement reveals significant variations among REIT indices. The Global Information Ratio, for instance, indicates that Belgian REITs outperform the benchmark during crises but not in normal times, whereas UK REITs display the opposite trend. At the sector level, the Industrial sector shows the most significant decline in the Global Information Ratio during crises, highlighting its vulnerability to economic recessions.

In conclusion, this study highlights the substantial impact of economic regimes on REIT returns, offering valuable insights for stakeholders aiming to understand and navigate the complexities of the European REIT market.

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