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Indirect Real Estate investing : What influences the stock price of a Belgian Real Estate Investment Trust ?

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Real estate is the largest asset class globally, drawing significant interest from researchers to investigate its determinants. A substantial segment of this vast sector is indirect real estate investing through Real Estate Investment Trusts (REITs), which are companies that focus on acquiring and managing real estate assets. Given the increasing political and economic instability, coupled with a growing emphasis on environmental, social, and governance (ESG) factors, there is now an increase significance in examining these aspects.

This study aims to conduct a comprehensive literature review to identify the drivers influencing the stock price of REITs. Utilizing the knowledge form literature and applying it to quantitative data spanning from February 1st, 2000, to November 1st, 2023, the empirical research focuses on one specific company called "Cofinimmo SA", a Belgian Real Estate Investment trust (REIT). In this research, the thesis undertakes a Linear relationship Analysis, Multivariate Regressions, and Hypothesis testing, aimed at discovering the statistical significance of various factors, such as oil prices, Consumer Price Index (CPI), Market indexes, Unemployment rate and Interest rates, on Cofinimmo BV/SA stock price.

The thesis firsthand findings revealed that market indicators such as CAC40, DAX40 and NASDAQ have a positive statistically significant linear relationship on Cofinimmo SA. And concerning our secondhand findings, the Multivariate Regressions revealed that Cofinimmo SA can be explained through negatively-impacting Interest rates and the Market index CAC40 which exhibits a positive impact.

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Before delving into the core of this thesis, I would like to express my gratitude to all those who have supported and assisted me throughout its development.

First and foremost, I extend my deepest thanks to my thesis supervisor, Professor Leonardo Iania, for his invaluable advice and guidance, which kept me on the right path to completing this thesis.

I am also grateful to my parents, who have consistently supported me through the long and challenging journey of writing this thesis.

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1 Part I - Introduction and Real Estate Market Overview

The first Part of the master's thesis is divided into three chapters. Firstly the "Introduction and Motivations", secondly the "Real Estate Market Overview" that describes a global and Belgian perspective on the Real Estate market, and thirdly "Real Estate Investing", where is highlighted the differences between direct and indirect real estate investing.

1.1 Introduction and Motivations

With Real estate being the largest asset class on a global scale, representing an approximate total value of $379,700 billion at the end of 2022 (Torstein & Rushton, 2023) with a notable decade-long upwards trend. This thesis aims to provide a comprehensive exploration of the real estate market, highlighting the fundamental factors that influence this substantial asset class. It examines the market in its entirety, including both direct and indirect investment strategies. Direct investment refers to the traditional method of purchasing and managing physical properties, while indirect investment involves acquiring shares in real estate companies that themselves invests into real estate. The primary focus of this thesis will be on indirect Real Estate investing, particularly through the use of Real Estate Investment Trusts (REITs), which are well-known investment vehicles that allow individuals to invest in large-scale, income-producing real estate without directly owning the properties.

Real Estate Investment Trusts (REITs) have played an important role within the Belgian Real Estate market, while categorized as "Sociétés Immobilières Réglementées" (SIRs) under Belgian Law (Darimont, 2018), these entities showcase distinctive missions, investing across various real estate sectors, including residential, industrial, and other commercial activities.

My objective is to enhance my comprehension of the factors impacting the stock prices of Belgian Real Estate companies, with a specific emphasis on entities like "Cofinimmo SA", which is a real estate company listed on the "EURONEXT" stock Exchange. In times of economic turbulence, marked by events such as the war in Ukraine and fluctuations in interest

rates, the thesis seeks to understand and delve into variables such as inflation and oil prices, using methodologies that include Descriptive Statistics, Regression Analysis, and Hypothesis testing.

In this context, Cofinimmo BV/SA founded in 1983, has historically stood out as a market leader in terms of stock price performance. However, recent trends suggest a concerning downturn, with stock prices hitting record lows in 2024, prompting critical analysis of the underlying factors contributing to this decline. This study aims to delve into the determinants of REITs' stock prices within the Belgian market, shedding light on the intricate relationship between macroeconomic variables and REIT performance. By exploring academic literature and empirical analysis, the thesis seeks to discover the key drivers shaping stock price movements.

Moreover, recent market trends, including geopolitical conflicts and economic uncertainties, underscore the urgency of comprehensively examining the factors impacting REITs performance in Belgium. By addressing this gap, our study aims to contribute to the existing literature while offering insights for investors.

The record low stock prices observed in 2024 raised significant concerns about the resilience of Belgian REITs given external economic shocks. Understanding the underlying drivers of these price fluctuations is crucial for investors seeking to optimize their investment strategies and mitigate risks effectively using this asset class. Based on existing literature and theoretical frameworks, it can be hypothesized that macroeconomic factors such as Interest rates and Inflation negatively impact Belgian REITs' stock prices and Market Indices demonstrate some type of positive linear relationship between them.

Our methodology involves a comprehensive analysis of historical data from 01/02/2000 (incl.) to 01/11/2023 (incl.) using macroeconomic variables and Cofinimmo SA’s stock price. Through Linear relationship Analysis, Multivariate regressions and hypothesis testing, the thesis aims

to discover the statistical significance of various factors on Cofinimmo BV/SA stock price. Additionally, the thesis will conduct Linear Models Assumption Testing to ensure the robustness of our regression model and validate our findings.

The research question is: *"Indirect Real Estate investing: What influences the stock price of a Belgian Real Estate Investment Trust?"* This question seeks to provide Belgian investors with valuable insights into the drivers of real estate companies' stock prices, enabling them to make better-informed investment choices.

1.2 Real Estate Market Overview

The dynamics of the global Real Estate market are significantly impacted by various factors, particularly in today's context, with increasing emphasis on ESG considerations, evolving social structures, and advancing technologies (AI). In this Chapter, the thesis will delve into these factors by examining academic papers and reports.

1.2.1 Global Real Estate Market

As per the end of 2022, Real estate was worth more than the global equity and bond markets combined and was almost four times the size of global GDP approximating a total value of $379,700 billion (Torstein & Rushton, 2023). In comparison, the value of all the gold ever mined represents $12.2 trillion, which is a little over 3% of the value of global Real Estate. Within this immense asset class, which is Real Estate, just over three-quarters of the value is tied up in residential property, worth $287.6 trillion at the end of 2022. Commercial property accounts for around 13%, while agricultural land represents 11%.

As of today, approximately 55 percent of the world's population resides in urban areas (*Savills 2023 Climate Resilience*, 2023), with projections indicating a rise to 68 percent by 2050. These demographic shifts are reshaping the housing landscape globaly. Over the past two decades, the European population has surged by 34 million, yet there has been a decline in birth rates

and a delay in family formation, resulting in a notable increase in single-person households by 30%, leading to a growing demand for compact living spaces.

Additionally, given the fact that cities produce 80 percent of the global gross domestic product (GDP) (Savills 2023 Climate Resilience, n.d.), while also accounting for 70 percent of carbon emissions, “Environmental, Social, and Governance” (ESG) aspects must now be considered as an integral part of the investment. the growing demand and regulatory focus on real estate's.

From a macroeconomic perspective, although unemployment rates in Europe have hit record lows since 2008, the cost of homeownership has surged by 45% since 2013 (*Savills 2023 Climate Resilience*, n.d.), alongside an overall rise in living expenses. Consequently, the average age of first-time homebuyers has increased from 31 in 2013 to 34 presently, further driving demand for rental properties.

Additionally, there's a discernible shift in lifestyle preferences, particularly among Generation Z (people born between 1997 et 2010), who prioritize urban living, convenience, and travel experiences. This demographic trend is exemplified by the presence of 1.2 million digital nomads in Europe (*Savills 2023 Climate Resilience*, n.d.), with students, especially international ones which tends to surge during economic uncertainty. Furthermore, an aging population contributes to the rising demand for rental accommodations, with individuals over 65 expected to constitute 30% of the population in the next quarter-century.

Naturally, the Real Estate sector attracts a wide spectrum of investors, who can opt for direct investments in tangible properties or indirect investments through privately owned or publicly traded companies such as Real Estate Investment Trusts (REITs).

1.2.2 Belgian Real Estate market

Before delving into an exploration of the stock price determinants for a real estate investment company, specifically a Belgian REIT or "SIR", it is crucial to establish a contextual understanding of the broader Real Estate market in Belgium. To comprehend the trajectory of the Belgian Real Estate market (REM), the thesis study will examine key statistics from Belgium, drawing insightful comparisons with data from the Organization for Economic Co-operation and Development (OECD[1]).

Overall, it can be seen in Figure 1 below, from a study made by the OECD (OECD, 2023), that there is, in real terms[2], a very large increase of the House Price Index (HPI[3]) from 1970 to 2023. However, when looking more into the details, a negative variations can be noticed in 1982, which can be linked to the economic recessions happening around that time. Then, from 1985 to 2008, a golden age can be seen with a more or less constant growth (nearly increasing by a factor of 10) in the real Estate prices which was abruptly stopped by the 2008 subprime crisis. In a broader perspective, furthermore, it can be underlined that the Belgian REM[4] followed approximately the same trend as did the OECD countries average. However, the 2008 crisis had much more impact on the OECD than for the Belgian REM.

[1] Organization for Economic Cooperation and Development, composed of more than 38 countries.
[2] Ratio of the nominal house price index to the consumers' expenditure deflator
[3] The real house price index is given by the ratio of the nominal house price index to the consumers' expenditure deflator in each country from the OECD national accounts database. Both indices are seasonally adjusted.
[4] Real Estate market

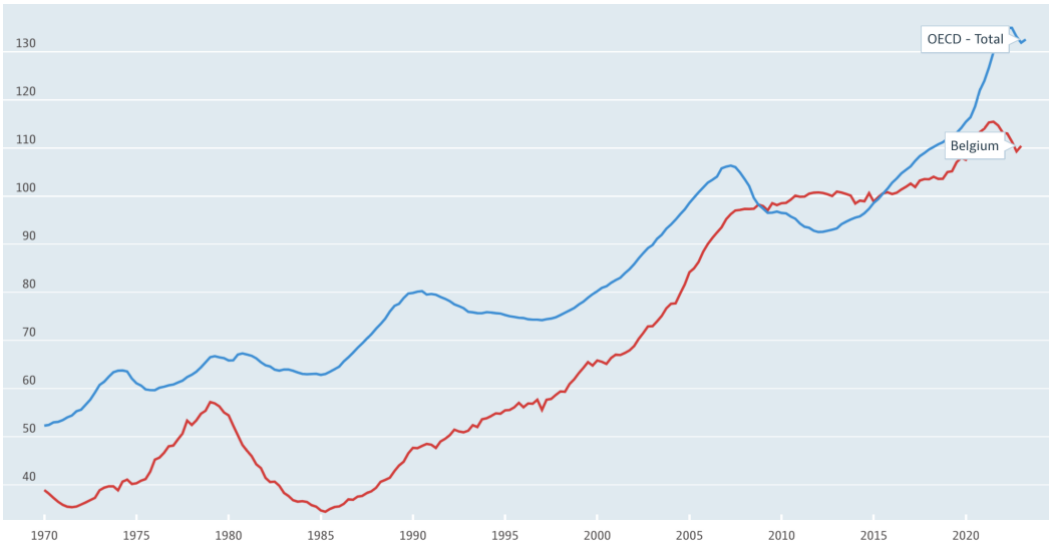


Figure 1 - The Real house price index (HPI) from Q1 1970 to Q2 2023

The Belgian REM has not only varied across time, but has also prices variations within the country, with some regions and parts of Belgium that have higher Real Estate prices as was shown by the Belgian Official Statistical Center (Statbel, 2023). Indeed, what the thesis discovered in Figure 2 is that the Flemish region (on the upper half) demonstrates higher median prices than the lower half which represents Wallonia. Additionally, The Brussels region (at the center) and its surroundings have the most concentration of blue meaning that the properties[5] have median price of at least 325.000,00€. A study made by notary's (Notaire.be, 2023) computed the median price for appartements and Houses according to its region, and that Wallonia has the lower overall prices (See Figure 3 below).

Region	Median House Price	Median Apartment Price
Brussels-Capital Region	€ 476,500	€ 245,000
Flanders	€ 325,000	€ 240,800
Wallonia	€ 200,000	€ 180,000

Figure 2 - Median Prices by Region

[5] In this case, the reference is made according to Houses with 2 or 3 outside walls (excluding apartments, etc)

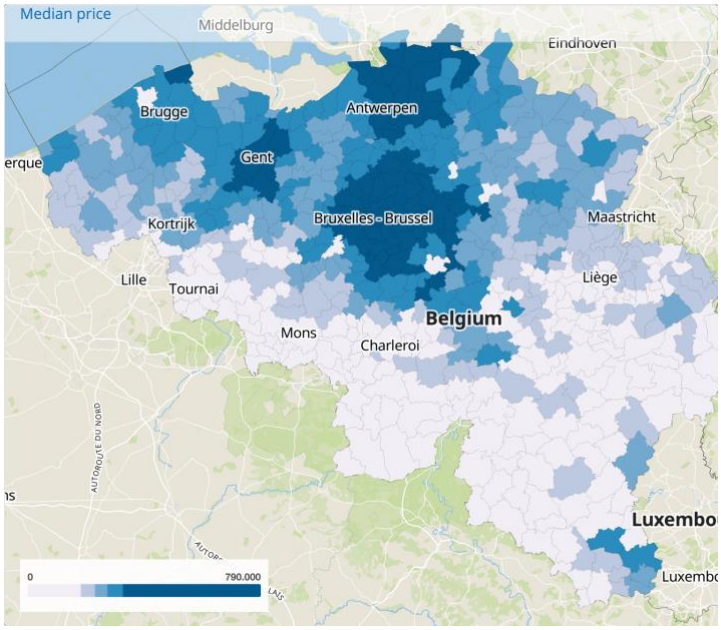


Figure 3 - The Median House prices in 2022 across Belgium

Warisse and Reusens (2018) studied how house prices in Belgium affect the economy. They found that house prices generally go up over time, except during two periods: the early 1980s and the 2008 economic crisis. Rising property values have made households wealthier, especially due to increasing land prices in the Flemish Region. Factors like lower mortgage rates and changes in real estate taxes have also contributed to higher property values.

The study (Warisse & Reusens, 2018) shows that rising house prices impact private consumption by affecting savings and rental costs. Additionally, they can encourage investments in new residential constructions, although this effect is less pronounced in Belgium due to regulations and population density. Finally, the study highlights the risks of growing household debt from mortgages and the need for monitoring housing market dynamics to ensure financial stability.

1.2.3 Environmental, Social and Governance (ESG)

In this section, the thesis will first explore the environmental aspects in light of the new European policy (Commission, 2023), and then shift our focus to the social and governance aspect, particularly regarding inequalities around taxation (Domènech-Arumí & Gobbi, 2023).

The recently reached political agreement (Commission, 2023) between the European Parliament and the Council aimed at enhancing energy performance standards for buildings within the European Union (EU). This initiative is of importance in the broader context of the energy transition and the achievement of the goals of the European Green Deal. The agreement in question seeks to reduce greenhouse gas emissions and energy consumption from buildings across the EU, while promoting renovation and decarbonization of the buildings.

The revised directive on energy performance of buildings (EPBD) proposes a series of measures to improve the energy performance of buildings, particularly those with lower performance. These measures include the establishment of national trajectories for reducing primary energy consumption in residential and non-residential buildings, as well as the introduction of minimum energy performance standards for non-residential buildings.

Furthermore, the revised directive provides significant improvements regarding energy performance certificates, aiming to provide citizens with clearer and more transparent information on building energy performance. Financing measures are also envisaged to encourage building renovation and reduce energy poverty, while ensuring protection for tenants against disproportionate rent increases. The directive also aims to promoting sustainable mobility by introducing requirements for pre-wiring for electric vehicles, charging points, bicycle parking spaces, zero-emission buildings and solar energy.

Now, taking into account the Social and Governance aspect, the thesis found that a Belgian research conducted by Domènech-Arumí & Gobbi (2023) has utilized cadastral data to

generate innovative estimations and insights regarding housing inequality in Belgium. The study involved an extensive analysis, measuring both housing value and spatial inequality, spanning from the national level down to neighborhood scales, and across different time periods. Their findings indicate that although housing value inequality in Belgium is relatively modest, as evidenced by a Gini coefficient of 0.25 (with 0 reflecting perfect equality and 1 extreme inequality), significant variations exist both among and within municipalities.

Furthermore, our research suggests that housing value inequality serves as a valuable indicator of income inequality. Furthermore, the investigation delved into the effects of recent fiscal policy reforms, specifically the reduction in house registration fees in Flanders, on housing inequality dynamics. They observed that a reduction of three percentage points in fees corresponded to an average price increase of 3% and a decrease of 0.8% in housing inequality. Notably, the analysis uncovered significant geographical variations in the effects of this policy reform (which comes from the fact that belgian has 3 regions, 3 communities and 3 languages).

In summary, the acknowledgment of ESG factors is vital and has now become a fundamental element of the real estate framework within the EU. While this agreement signifies a substantial challenge in tackling climate change and promoting a more environmentally sustainable economy within the EU, it's essential to recognize that issues of inequality and tax policies concerning real estate also have considerable influence on social and governance aspects.

1.3 Real Estate Investing

In this chapter, the thesis will delve into the distinctions and similarities between direct real estate investing and indirect methods. Furthermore, the thesis will go in more details into understanding the nature of Real Estate Investment Trusts (REITs) and elucidate why they represent a compelling investment opportunity.

1.3.1 Direct Real Estate

Direct real estate investing involves purchasing the ownership rights to physical properties such as houses or commercial spaces. Usufruct, derived from the Latin words 'usus' (use) and 'fructus' (fruit), is the right to use a property and enjoy its benefits. When an individual holds both the usufruct and the bare ownership of a property, they have full ownership. The primary avenue through which individuals generate income from direct real estate is by renting out the properties and receiving consistent rental payments from tenants.

Additionally, there exists an opportunity for profit when the property appreciates in value, called “Capital gains”, allowing for its sale at a higher price. On a global scale, a well-known metric called “PROPERTY YIELDS” is used as a metric to compute the return on this type of investment, it calculated by dividing the annual rental income by the property's value and multiplying the result by 100 (which does not take in account capital appreciation). Examining the data presented below, PROPERTY YIELDS in Western countries typically range between 3.5% and 5% (*Savills 2023 Climate Resilience*, n.d.).

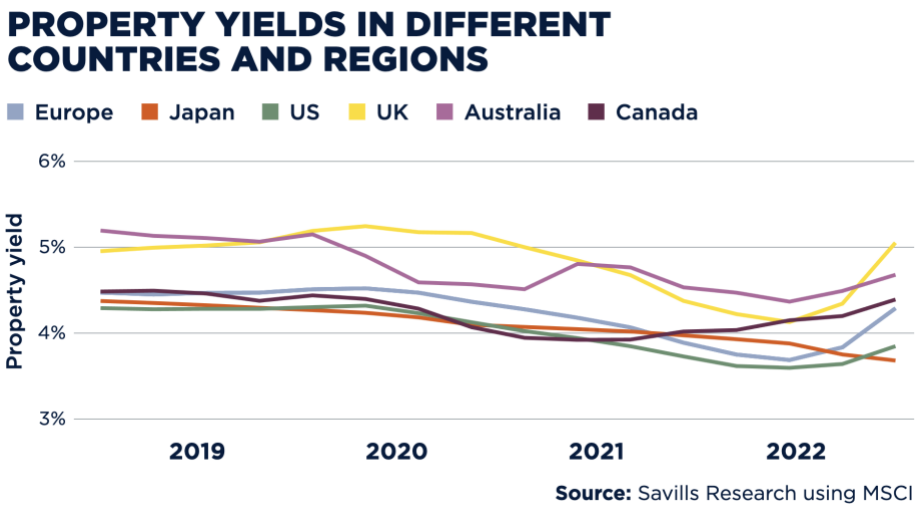


Figure 4 - PROPERTY YIELDS (Savills 2023 Climate Resilience, n.d.).

1.3.2 Indirect Real Estate

Indirect real estate investment occurs when investors allocate funds to companies that, in turn, invest in real estate properties. Instead of directly owning physical Real Estate assets,

investors hold shares in these companies. There are two primary avenues for indirect Real Estate investment: *Publicly listed companies* and *Privately owned enterprises* (Wikipedia, 2024). For example, Publicly listed options include Real Estate Investment Trusts (REITs) (also known as "Sociétés Immobilières Réglementées" in Belgian law), while Private Equity Real Estate (PERE) involves owning equity of a privately owned company (Caliber, 2023).

Indirect real estate investments are characterized by the following key features:

- **Liquidity:** The funds are much more liquid than direct real estate investing where one needs much more time to sell the asset (find a potential owner, sign paperwork, etc) instead of just selling the stock on an exchange using an online broker.
- **Active Management:** The funds are actively managed by experienced real estate professionals.
- **Diversification:** The funds typically invest in a diversified portfolio of real estate assets, including office buildings, industrial properties, retail properties, and multifamily apartments. This diversification helps to reduce overall Portfolio variance.
- **High-Return potential:** The funds have the flexibility to invest in higher-risk, higher-return opportunities and have the ability to hold properties for extended periods, which can allow them to capture capital appreciation over time.

Indirect real estate investments are made in a variety of real estate asset classes, including (Investopedia, 2022):

- **Office Buildings:** Office buildings are a traditional and stable form of real estate investment. They offer the potential for high income returns and capital appreciation.
- **Industrial Properties:** Industrial properties are less sensitive to economic cycles than office buildings, they are typically used for manufacturing, distribution, and warehousing.
- **Retail Properties:** Retail properties can be a good investment for investors who are looking for stable income returns, they typically consist of shopping centers, malls, and specialty retail stores.

- **Multifamily Apartments:** Multifamily apartments are a good investment for investors who are looking for high capital appreciation.

To obtain a comprehensive global perspective, referencing a 2024 report by BlackRock (BlackRock, 2024), the thesis observed significant fluctuations in REIT returns since 2015, particularly influenced by events such as the Ukraine conflict, Gaza situation, energy crisis, and the COVID-19 pandemic. However, despite these fluctuations, when considering annualized returns, REITs rank fourth among various asset classes, including European, U.S., and Chinese equities, commodities, and others.

2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	Annualised
Japan equities 9.9%	High yield 14.3%	China equities 54.3%	Cash 1.9%	U.S. equities 31.6%	China equities 29.7%	Commodities 38.5%	Commodities 22%	U.S. equities 27.1%	Japan equities 7.8%	U.S. equities 12.6%
U.S. equities 1.3%	Infrastructure 12.4%	EM equities 37.8%	DM gov. debt -0.4%	Infrastructure 27%	U.S. equities 21.4%	REITs 32.5%	Cash 1.3%	Japan equities 20.8%	U.S. equities 7%	Japan equities 6.6%
Emerging debt 1.2%	U.S. equities 11.6%	Europe equities 26.2%	IG credit -3.5%	Europe equities 24.6%	EM equities 18.7%	U.S. equities 27%	Infrastructure -0.2%	Europe equities 20.7%	Commodities 5.2%	Infrastructure 5%
REITs 0.6%	EM equities 11.6%	Japan equities 24.4%	High yield -4.1%	REITs 24.5%	Japan equities 14.9%	Europe equities 17%	High yield -12.7%	High yield 14%	Europe equities 1.5%	REITs 4.7%
Cash 0.1%	Emerging debt 10.2%	U.S. equities 21.9%	U.S. equities -4.5%	China equities 23.7%	IG credit 10.1%	Infrastructure 11.9%	Europe equities -14.5%	REITs 11.5%	Cash 0.8%	Europe equities 4.6%
Europe equities -2.3%	Commodities 9.7%	Infrastructure 20.1%	Emerging debt -4.6%	Japan equities 20.1%	DM gov. debt 9.5%	Japan equities 2%	IG credit -16.1%	Emerging debt 10.5%	High yield 0.6%	EM equities 3.4%
High yield -2.7%	REITs 6.9%	High yield 10.4%	REITs -4.8%	EM equities 18.9%	High yield 7%	High yield 1%	Japan equities -16.3%	EM equities 10.3%	EM equities -0.1%	High yield 3.4%
DM gov. debt -3.3%	IG credit 6%	Emerging debt 9.3%	Infrastructure -9.5%	Emerging debt 14.4%	Europe equities 5.9%	Cash 0%	Emerging debt -16.5%	IG credit 10.2%	Emerging debt -0.5%	Emerging debt 2.8%
IG credit -3.8%	Japan equities 2.7%	IG credit 9.3%	Commodities -10.7%	High yield 12.6%	Emerging debt 5.9%	Emerging debt -1.5%	DM gov. debt -17.5%	Infrastructure 6.8%	IG credit -1.6%	IG credit 1.6%
China equities -7.6%	DM gov. debt 1.7%	REITs 8.6%	Japan equities -12.6%	IG credit 11.8%	Cash 0.7%	IG credit -2.1%	U.S. equities -19.5%	Cash 5.1%	DM gov. debt -3.1%	Cash 1.3%
Infrastructure -11.5%	China equities 1.1%	DM gov. debt 7.3%	EM equities -14.2%	Commodities 11.8%	Infrastructure -5.8%	EM equities -2.2%	EM equities -19.7%	DM gov. debt 4.2%	Infrastructure -3.1%	China equities 1.2%
EM equities -14.6%	Cash 0.4%	Commodities 1.7%	Europe equities -14.3%	DM gov. debt 5.6%	REITs -8.1%	DM gov. debt -6.6%	China equities -21.8%	Commodities 0%	China equities -3.1%	Commodities 0.5%
Commodities -23.4%	Europe equities 0.2%	Cash 0.8%	China equities -18.7%	Cash 2.3%	Commodities -9.3%	China equities -21.6%	REITs -23.6%	China equities -11%	REITs -3.6%	DM gov. debt -0.9%

Key: Lowest return ---------- highest return

Figure 5 - Returns by asset class (BlackRock, 2024)

1.3.3 European REITs

The thesis will now explore the European REITs market and analyze the most invested sectors within this asset class. As illustrated in the figure below from the European Public Real Estate Association (EPRA), residential properties take the lead as the most prominent investment

sector within the European REITs market, with absolute values reaching around €200 billion in 2022. Following closely behind is the office sector, valued at €175 billion. However, there has been a noticeable decline in the retail sector from 2018 to 2022, with figures settling around €150 billion. Interestingly, both the industrial and healthcare sectors have experienced a consistent increase in market share (*European Listed Real Estate: Property Portfolio Analysis*, n.d.).

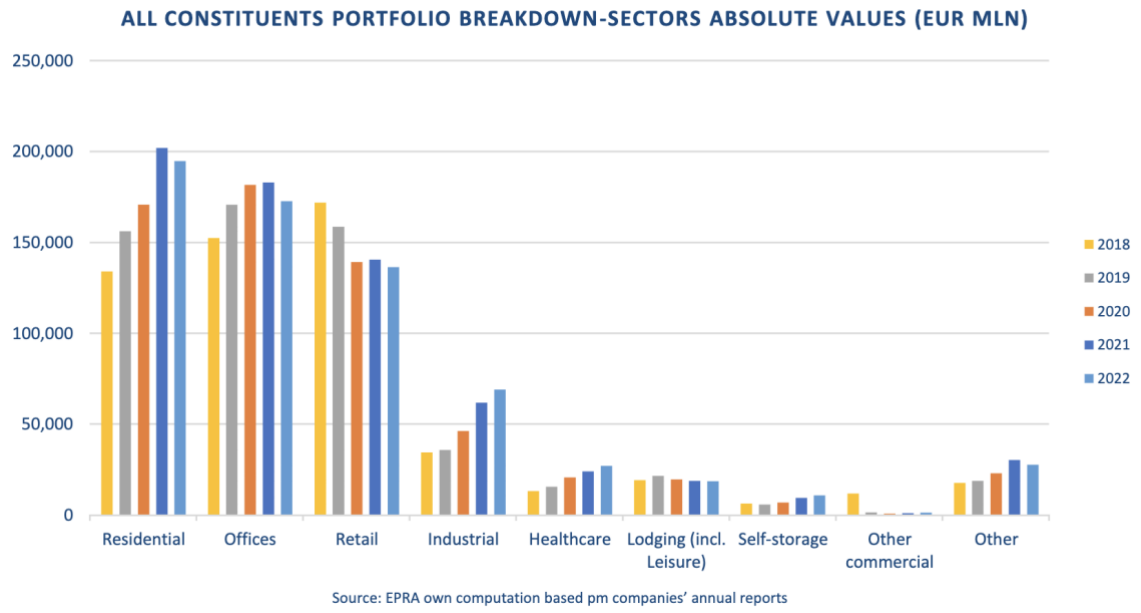


Figure 6 - EU-REIT Sectors

The analysis conducted by the European Public Real Estate Association (*European Listed Real Estate: Property Portfolio Analysis*, n.d.) delves into the distribution of market share among countries investing in REITs. Notably, Germany emerged as the dominant player in the European landscape, commanding a significant portion of the market, constituting approximately one-quarter of the total market share. Following closely behind is the United Kingdom, which holds just under one-fifth of the market share. France comes next with a market share of around 14 percent. However, it's worth highlighting that Belgium occupies a comparatively smaller portion of the market, accounting for approximately 2.25% of the total market share.

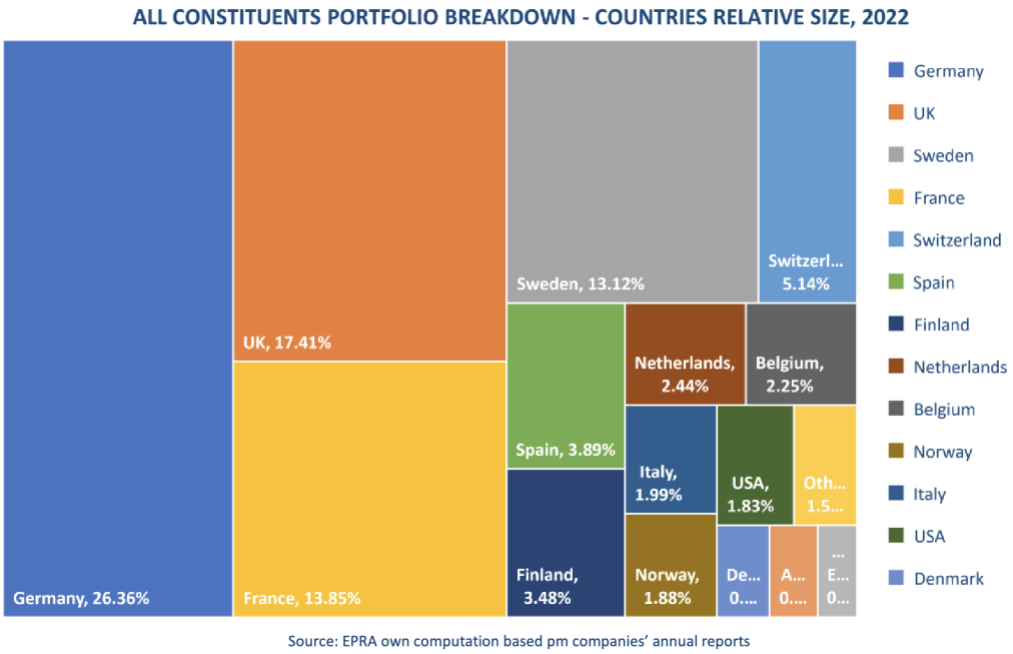


Figure 7 - EU-REIT Market Share by Country

As indicated in the study Beckmann, Huerta-Sanchez, & Ngo (2019), when compared to the United States, REITs demonstrate a similar trend in Europe. Like in Europe, they predominantly invest in residential real estate, as illustrated in the figure below (Beckmann, Huerta-Sanchez, & Ngo, REIT industry liquidity, valuation, and ownership reactions to ETF inceptions, 2019).

Investment Focus	Frequency	Percent
Unclassified	32	8.70
Diversified	33	8.97
Health care	21	5.71
Industrial/Office	60	16.3
Lodging/Resorts	32	8.70
Mortgage	74	20.11
Mortgage Backed Securities	9	2.45
Residential	38	10.33
Retails	62	16.85
Self-Storage	7	1.90

Figure 8 - Investments focus of US-REITs (sample 368)

1.3.4 Belgian REITs

Several key players dominate the Belgian REIT market, engaging in strong competition. Though all classified as "Sociétés Immobilières Réglementées" (SIRs), these entities have diverse

missions and invest in a wide range of real estate sectors, including residential, industrial, and other real estate activities.

REITs are set up as corporations or trusts and are not subject to tax at the corporate level if they distribute at least 90% (in the form of dividends) of their net annual earnings to shareholders and meet certain other requirements (Commission, 2023). Among the top 20 companies listed on the Euronext Brussels stock exchange in Belgium, three belong to the category of REITs: Aedifica, WDP, and Cofinimmo.

Observing the figure below, among the array of REITs in Belgium (Yahoo Finance, 2024), notable ones include Aedifica, Ascencio, Care Property Invest, Cofinimmo, Home Invest Belgium, Immo Moury, Intervest Offices & Warehouses, Montea, Qrf, Retail Estates, Vastned Belgium, Warehouses De Pauw, Warehouses Estates, Wereldhave Belgium, and Xior Student Housing.

Analysis indicates that historically, Cofinimmo has held the position of market leader (Finance, 2024) in terms of stock price (as showcased by the dark blue line “COF.BR”). However, the graph also illustrates significant declines during the 2008 financial crisis and the COVID-19 crisis in 2020. Concerningly, the situation in 2024 seems more alarming, with the stock price hitting an all-time low since its public listing.

Figure 9 - Belgium REITs

Several factors, likely contributing to this record low in 2024, could include the ongoing war in Ukraine, the Israeli-Palestinian conflict in Gaza, and the global energy crisis. These combined events have likely created significant economic uncertainty, impacting investor confidence and potentially leading to the decline in Cofinimmo's stock price.

2 Part II - Literature review

In this second part of the Thesis, the study will explore a selection of academic papers that have delved into the factors influencing the stock price of Real Estate Investment Trusts (REITs). The Literature review is divided in five Chapters.

2.1 Interest rates

In this first chapter, the thesis will examine the effects of interest rates on real estate investment trusts (REITs) using research and academic papers. A first study, (Joyce, 2020) focused on the relationship between Real Estate Investment Trusts (REITs) returns and various economic factors. By analysing historical data spanning several decades and employing regression analysis techniques, the research described the primary drivers of a REIT's performance with a particular focus on market influences, interest rates, and inflation.

One of the central findings of the study (Joyce, 2020) is the substantial impact of market dynamics, as indicated by the market index, on REIT returns. The analysis demonstrated that approximately one-third of the movement in REITs can be attributed to fluctuations in the broader market. This suggests a strong correlation between REIT performance and the overall sentiment and performance of the financial markets.

Furthermore, the study highlights the significant role played by inflation, as captured by the consumer price index (CPI), in influencing REIT returns. The results indicate that changes in inflation levels have a considerable impact on REIT performance, with inflation explaining around 25% of the movement in REITs. This underscores the importance of macroeconomic factors in driving investor behavior and, consequently, REIT returns. In addition to market

dynamics and inflation, the study also examined the influence of interest rates on REIT performance. While interest rates are identified as a significant factor, their impact on REIT returns is comparatively lesser than that of market indices and inflation. The analysis suggests that interest rate fluctuations contributed to only around 1% of the movement in REITs, highlighting a more nuanced relationship between interest rates and REIT performance.

Another paper by Alam & Md. Gazi Salah (Alam & Md. Gazi Salah, 2009) delves into this connection across fifteen developed and developing countries. It underscores the significance of understanding the relationship between Interest rates and REITs performance. By analyzing monthly data from January 1988 to March 2003, the study reveals that none of the examined stock markets adhere to the random walk model. Through regressions, the paper uncovers a negative correlation between interest rates and stock prices across all countries studied. Moreover, changes in interest rates exhibit a significant negative relationship with changes in share prices in six countries. The paper concludes by suggesting that controlling interest rates could enhance these countries' stock exchanges by attracting more investors and promoting greater company investment.

Moreover, a study by Takayasu (Takayasu, 2013) focuses on the impact of stock prices and interest rates on the Real Estate Investment Trust (REIT) market in Japan. It analyses data from two distinct periods, pre- and post- 2008 crisis, examining variables such as stock prices, interest rates, and REIT market trends. The study reveals that during periods of financial stress, particularly after the 2008 crisis, stock prices exert a more significant positive influence on the REIT market, whereas higher interest rates have a more pronounced negative effect. The paper suggests that during crises, monitoring specific interest rates is crucial for stabilizing the REIT market and the broader financial system.

2.2 Oil commodity

In this second chapter, the thesis will examine the effects of Crude Oil as a commodity relative to Real estate investment trusts (REITs) using various academic papers. The first one being a study (Nazlioglu, Gupta, Gormus, & Soytas, 2019) that demonstrates the interconnectedness

between oil markets and Real Estate Investment Trusts (REITs), considering their growing importance in investment portfolios. As commodity markets, including oil, became more and more important for our western economies, studying their interactions with assets like REITs became almost essential. And this study focused on evaluating that across nineteen international markets, using econometric techniques. Results indicated price uncertainty in oil markets market affects price uncertainty in the REITs market and vice versa. However, the more mature was the market the weaker was the transmission.

Another study (Hanif, Andraz, Gubareva, & Teplova, 2024) showed the link between oil and REIT performance across fourteen global indices. Spanning from January 2016 to August 2022, including periods of the COVID-19 pandemic and the Russia-Ukraine conflict, the research applies methodologies consistent with previous works. Findings indicate that, except for Japan during COVID-19 and the Netherlands during the Russia-Ukraine conflict, REITs generally cannot reduce portfolio risk, by acting as a hedge, for oil, meaning that REITs and Oil are not completely decorrelated.

The study underscores the importance of understanding country-specific REIT exposures for effective portfolio management, suggesting continuous rebalancing given the evolving market conditions. Additionally, increasing oil market volatility, possibly influenced by increasing environmental consciousness (ESG) and regulatory changes must be analysed closely when allocating a portfolio (Hanif, Andraz, Gubareva, & Teplova, 2024).

2.3 Earnings Per Share (EPS) and Debt to Equity Ratio (DER)

Here, a paper conducted by Novita & Osesoga (Novita & Osesoga, 2021) delves into the factors affecting stock prices, specifically focusing on Earnings Per Share (EPS), Current Ratio, Return On Asset (ROA), and Debt to Equity Ratio (DER) within property, real estate, and building construction companies listed on the Indonesia Stock Exchange between 2017 and 2019.

The results indicated a positive and significant correlation between EPS and stock prices, while ROA and DER exhibit negative and significant correlations. However, the Current Ratio does not show a significant impact on stock prices. The study emphasizes the importance of investor attention to EPS and DER, while management should prioritize strategies to enhance net income and favour equity financing over debt to boost stock prices.

2.4 Interest rates and Financial leverage

Additionally, a paper conducted (Allen, Madura, & Springer, 2000) examined the nuanced sensitivity of Real Estate Investment Trusts (REITs) to fluctuations in both stock market returns and interest rates. The findings revealed a positive association between changes in stock market returns and REIT returns, contrasting with a significant negative relationship observed in both equity and REIT portfolios concerning interest rate changes. The analysis employed ordinary least squares regression (OLS) to analyse the REITs sensitivity to market returns and interest rate fluctuations, considering factors such as asset structure, financial leverage, management strategy, and specialization level within REIT portfolios.

Results highlighted the profound influence of financial leverage and management strategy on REITs' market risk, with higher leverage increasing market risk and self-managed REITs (without third-party property management) demonstrating diminished market sensitivity.

Moreover, the study discovered the impact of financial leverage and management strategy on REITs' susceptibility to interest rate fluctuations, indicating increased interest rate risk with increased leverage and reduced sensitivity in self-managed REITs (Allen, Madura, & Springer, 2000).

2.5 Diversification

Moreover, a research paper authored by Picou (Picou, 2022) underscores the advantages of diversification achieved through the incorporation of Real Estate Investment Trusts (REITs) into investment portfolios spanning various asset classes. Despite a decline in these advantages

over time, integrating a 5% allocation of REITs notably diminishes portfolio variance and reduces risk per unit of return.

REITs consistently outperform the majority asset classes, except for specific large-cap equities. Remarkably, they either match or exceed the performance of widely acknowledged indexes such as the Russell 3000 and value portfolios. Contrary to previous assumptions, portfolio management stands to gain from including REITs at the 5% threshold. However, the extent of their benefits varies by country, with more pronounced advantages observed in international and emerging markets. Although small-cap stocks also derive benefits from REIT inclusion, substantial risk reduction necessitates a significant allocation due to their high volatility. In summary, the combination of REITs with large-cap or growth stocks yields substantial diversification benefits and enhances risk-adjusted returns.

Another study by Poudel, Rogers, and Jain (Poudel, Rogers, & Jain, 2020) highlights the examination of the effects of modifications in the S&P 500 Index on Real Estate Investment Trusts (REITs). The study employs return computations and regression analysis to evaluate market responses. Moreover, it investigates differences in returns when utilizing different market proxies, and the findings revealed variations in risk between REITs included in the S&P 500 Index and those excluded, with the REITs that were excluded from the S&P 500 demonstrating higher risk profiles.

The literature underscores the multitude of factors influencing the stock prices of Belgian REITs, categorized into explicit and implicit determinants. Explicit factors, backed by historical data, include elements like interest rates, which consistently show a negative impact on real estate market companies' stock prices. Economic indicators such as GDP growth, unemployment rates, and inflation also play crucial roles in shaping stock prices. While implicit determinants are namely taxation policies, international geopolitical events, national political developments, and climate change contribute to the complex nature of factors influencing REITs' stock prices.

3 Part III - Empirical Analysis

The third section of the thesis consist of the Empirical Analysis, which is divided into three chapters: the first is “Introduction to the Analysis,” followed by “Quantitative Model,” where this thesis describes the model it will will be using, and finally “Data Analysis,” where the thesis will be the show how the analysis was performed and its results.

3.1 Introduction to the Analysis

In this Empirical Analysis, the focus shifts to examining the factors influencing REITs. The analysis will predominantly rely on macroeconomic data to investigate the correlation between real estate prices and the underlying causal factors, following a similar approach employed by Novita & Osesoga (2021) in their multivariate linear regression analysis.

The Belgian REIT chosen for this analysis is Cofinimmo SA, a prominent Real Estate Investment Trust (REIT) based in Belgium. Through the application of statistical methods, specifically regression analysis, the study aims to study the relationships and dependencies among various variables, thereby discovering the determinants influencing Cofinimmo SA's stock performance.

3.1.1 Cofinimmo

Cofinimmo SA (Cofinimmo, 2024), trading as « COFB » on Euronext Brussels is a one of the 20 largest listed companies in Belgium (BEL20) that specializes in rental properties and was established in 1983. Over the years, it has invested in a Real Estate portfolio with amounts exceeding 4€ billion covering nearly 2,000,000m2 across Belgium, The Netherlands, France, Germany, and Spain. Notably, Cofinimmo is a leading figure in commercial real estate investments in Belgium and operates under a specific tax regime, obliging it to distribute a significant portion of its net income (80%) annually as a "Société immobilière règlementée" under Belgian law.

In the backdrop of its 2023 annual report (Cofinimmo, 2024), Cofinimmo has shown of financial stability, and a particular interest in sustainable practices. Cofinimmo, under CEO Jean-Pierre Hanin (*Cofinimmo SA (COFB) Stock Price & News*, n.d.) and despite market fluctuations, realized a market capitalization of €2.45 billion.

Over the past year, its stock price has demonstrated considerable variability (*Cofinimmo SA (COFB) Stock Price & News*, n.d.), with a low of under 60€ and a high of more than 150€ as seen on the graph below (Figure 10). Despite these fluctuations, Cofinimmo continues to offer an attractive dividend yield of 6.50%, appealing to income-oriented investors seeking regular income streams from their investments.

Figure 11 - Cofinimmo Stock Price in EUR (Y axes) and Time (X axes)

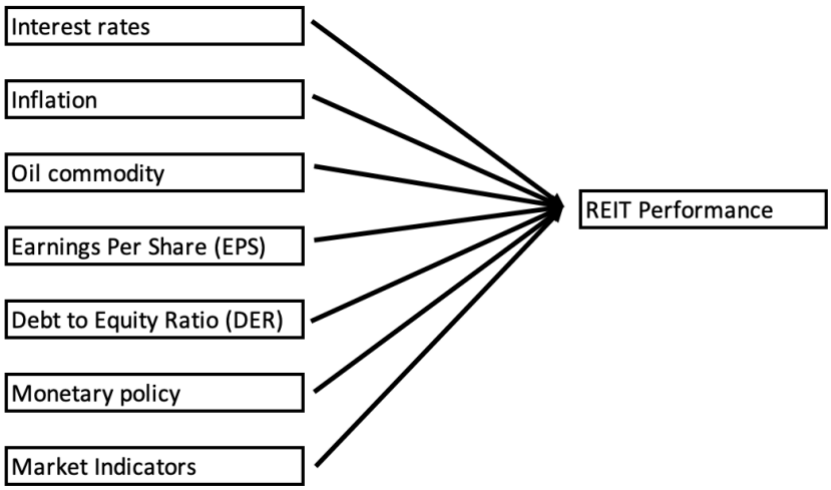
Furthermore, the company, with a workforce of 155 employees, is known for its extensive holdings in health real estate and office spaces. It has also been awarded a climate rating of B by the CDP[6], underscoring its commitment to environmental sustainability and responsible business practices.

[6] CDP (formerly known as the Carbon Disclosure Project) is utilized by companies, investors, and governments to assess their environmental impact. The score, ranging from A to D (D being the lowest)

One of the achievements highlighted in the report (Cofinimmo, 2024) is that the company has attained a debt-to-assets ratio (standing at 43.8%), while on the side having investments totaling 338 million EUR towards healthcare real estate projects. Cofinimmo's operational performance showed a increase in gross rental revenues by 8.5% and an impressive occupancy rate of 98.5%.

3.1.2 Methodology

In my methodological approach, I start by identifying variables that could potentially impact Cofinimmo's stock price and other macroeconomic factors, which I derived in the Litterature review. The following macroeconomic factors were identified:



The subsequent step involves data collection, employing tools such as Excel and R, and applying natural log (LN) difference transformations to ensure the dataset's stationarity. Employing descriptive statistics and visualization, including metrics such as minimum, maximum, mean, variance, which in all provides a comprehensive overview of the data. Additionally, I identify and eliminate outliers by examining the maximum and minimum values within each column using Excel.

Following this, a rigorous Linear relationship analysis and Multivariate Regression analysis is conducted on Cofinimmo's stock price against an array of macroeconomic variables. This

regression equation uses coefficients (β) associated with variables like the CPI Index, Unemployment rate, 10-year Interest Rate, Oil prices, CAC40, DAX40, and NASDAQ indices, along with the error term (e). Subsequent hypothesis testing evaluates the statistical significance of these variables on the dependent variable, Cofinimmo's stock price, and assesses the most effective model, considering the potential need for log or square root transformations.

The methodology also uses Linear Model Assumption Testing, involving assessments for Normality, Multicollinearity, Heteroscedasticity, and Autocorrelation. These tests are important in ensuring the robustness and reliability of the regression models. Hypothesis testing, formulated around the null hypothesis (H0) and alternative hypothesis (H1), scrutinizes the variables impacts on Cofinimmo's stock price. This analysis aims to discover the implications for individual Belgian investors.

3.2 Multivariate Linear Regression

In this chapter, this thesis will present the model utilized to examine the relationship between Cofinimmo's stock price and explanatory variables. Our analysis is based on a dataset characterized by an independent and identically distributed sample. This refers to a collection of observations (Yi, Xi), where each observation is unrelated to the others and originates from the same probability distribution. Within the framework of regression analysis, this implies that the errors (ε) associated with each observation are mutually independent and adhere to a consistent probability distribution with identical mean and variance.

The "Conditional Expectancy" model employed for studying stock prices is described by Van Bellegem (Van Bellegem, 2022) as follows:

$$\mathbb{E}(Y|X_1, X_2, \dots, X_K) = \beta_1 X_1 + \dots + \beta_K X_K$$

Including the error term:

$$Y = \beta_1 X_1 + \dots + \beta_K X_K + \varepsilon$$

The iid. sample (Yi, Xi), i = 1,...,n follows a multiple linear regression model if the following conditions are satisfied for all i:

1. There exist K real coefficients $\beta_1, \ldots \beta_K$ such that Y = **X**β + ε, where the vector "Y" represents the dependent variable (stock price), the matrix "**X**" represents the independent variables (factors influencing stock price), the vector "β" represents the vector of coefficients, and ε represents the vector of the error terms capturing unexplained variation.

2. The variables ε are such that E(ε|**X**) = 0, indicating that the error term has a conditional mean of zero given the values of the independent variables. This assumption ensures that there is no systematic bias in the model predictions.

3. The rank of the matrix **X** is K with probability equal to 1. This condition ensures that the independent variables are linearly independent and there are no perfect multicollinearity issues, allowing for the estimation of unique coefficients for each independent variable.

4. This model is homoscedastic under conditional variance if there exists a strictly positive real number σ such that Var(ε|**X**) = $\sigma^2 \mathbf{I_n}$, where Var(ε|**X**) represents the conditional variance of the error term given the independent variables **X**, σ^2 represents the constant variance, and $\mathbf{I_n}$ represents the identity matrix. Homoscedasticity implies that the variance of the error term is constant across all levels of the independent variables, ensuring that the model's predictions are equally precise for all observations.

5. This model is homoscedastic under conditional variance if there exists a strictly positive real number σ such that Var(ε|**X**) = $\sigma^2\mathbf{I_n}$, where Var(ε|**X**) represents the conditional variance of the error term given the independent variables **X**, σ^2 represents the constant variance, and $\mathbf{I_n}$ represents the identity matrix. Homoscedasticity implies that the variance of the error term is constant across all

levels of the independent variables, ensuring that the model's predictions are equally precise for all observations.

3.3 Data Analysis

In this chapter, the thesis explains how data collection is performed, conducts descriptive statistics on the data, performs data transformations, and finally conducts the analysis using the model developed in the previous chapter.

3.3.1 Data collection

For the analysis, I'll be utilizing a comprehensive dataset that includes monthly data that covers the timeframe from January 2, 2000 (Incl.) to January 11, 2023 (incl.), providing a substantial span for the study.

Within this dataset, several key variables are included. The first one being “COFB.BR”, representing the adjusted closing stock price (in EURO) of Cofinimmo SA (COFB.BR) (*Cofinimmo SA - Yahoo Finance*, 2024). This variable serves as the dependent variable for the study, forming the basis for analysis.

Additionally, the dataset incorporates the Consumer Price Index (CPI) for All Items in Belgium, offering insights into inflation trends over the period under consideration. This index is presented on a monthly basis and does not incorporate seasonal adjustments (Organization for Economic Co-operation and Development, 1955).

Moreover, the dataset includes information on unemployment rates in Belgium, providing a crucial indicator of economic health (Organization for Economic Co-operation and Development, 1983). These rates are harmonized and presented monthly as a percentage, with adjustments made for seasonal variations.

Another significant variable is the interest rate 10 yo, sourced from the Chicago Board Options Exchange (CBOE) Interest Rate 10 Year Treasury Note. This interest rate is represented by the adjusted closing price, offering insights into long-term borrowing costs (Yahoo Finance, 2024).

The dataset also encompasses data on oil prices, specifically Crude Oil Prices for Brent in Europe in USD per Barrel. These prices are denoted in Dollars per Barrel and are provided on a monthly basis without seasonal adjustments (U.S. Energy Information Administration, 1987).

Furthermore, the adjusted closing prices of key stock market indices are included: the CAC40 index traded in EUR (Yahoo Finance ^FCHI, 2024), the DAX40 index also traded in EUR (Yahoo Finance ^GDAXI, 2024) which are market capitalization-weighted floating index that reflects the performance of the 40 most important (in terms of market capitalization) and actively traded stocks listed on Euronext Paris and Frankfort respectively.

Next, there is the NASDAQ Composite index traded in USD (Yahoo Finance ^IXIC, 2019), The Nasdaq Composite is a stock market index that encompasses nearly all the stocks listed on the Nasdaq exchange. Together, these variables will provide a comprehensive framework for analyzing various aspects of economic and financial dynamics over the specified timeframe.

In summary, this thesis has centralized in an Excel file all the important information, containing a table with 9 columns and 287 rows. These columns, for nomenclature purposes, are labeled as follows:

- “Dates” representing monthly dates from 01/02/2000 to 01/11/2023.
- “COFB.BR” representing Cofinimmo SA monthly adjusted closing stock price (in EUR).
- “CPI” representing the Consumer Price Index (CPI) for All Items in Belgium.
- “Unemployment rate” representing the Unemployment rates in Belgium.
- “Interest Rate” representing the CBOE Interest Rate 10 Year Treasury Note.
- “Oil” representing the Crude Oil Prices for Brent in Europe in USD per Barrel.
- “CAC40” representing the CAC40 stock market index traded in EUR.

- "DAX40" representing the DAX40 stock market index traded in EUR.
- "NASDAQ" representing the NASDAQ stock market index traded in USD.

3.3.2 Descriptive Statistics

In this section, the thesis delves into descriptive statistics to understand the broader picture of the data before doing the linear relationship analysis, multivariate linear modeling, and hypothesis testing. When examining the graph below, notable events in the past became apparent, including the 2008 subprime crisis, where a discernible downturn in the share price can be seen. Another noteworthy observation is the substantial impact of the COVID-19 pandemic in 2021, which led to a dramatic decline in share price, resulting in an approximate 50% loss of its value.

Despite these notable fluctuations, a prevailing trend emerged from the data. Over time, there has been a consistent upward trajectory, with the share price showing a tendency to increase by approximately 1% per year. This trend, encapsulated by the equation y = 0.0092x - 319.77, underscores the resilience and long-term growth potential of the investment despite short-term disruptions and market volatility.

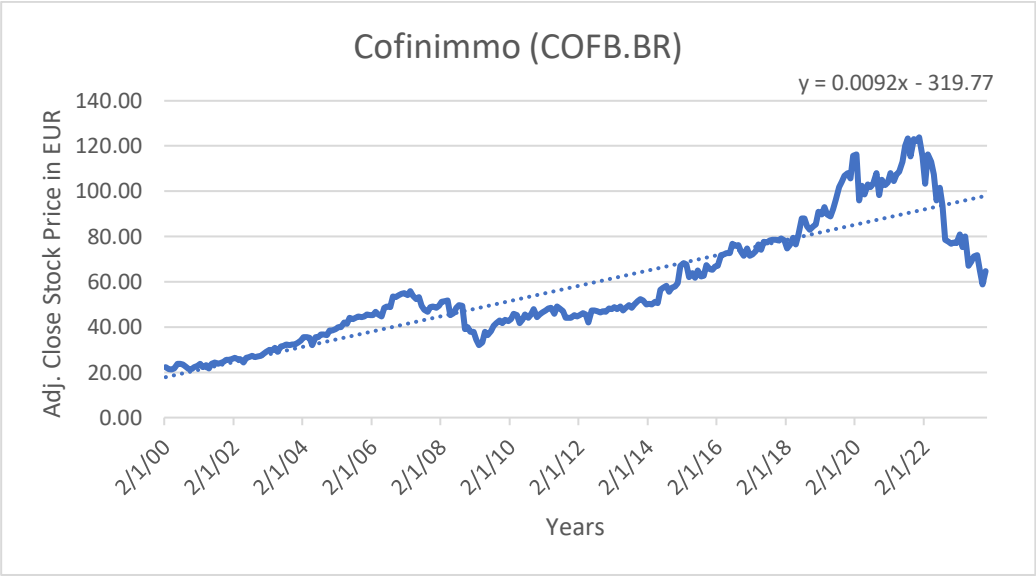


Figure 12 - Cofinimmo Adj. Close Price in EUR

As seen on the Figure below, this study shows multiple side-by-side plots of the DAX, CAC40, and Nasdaq to compare them with Cofinimmo's graph. This analysis revealed several similarities, including downturns in 2008 and during the COVID epidemic, as well as an overall upward trend.

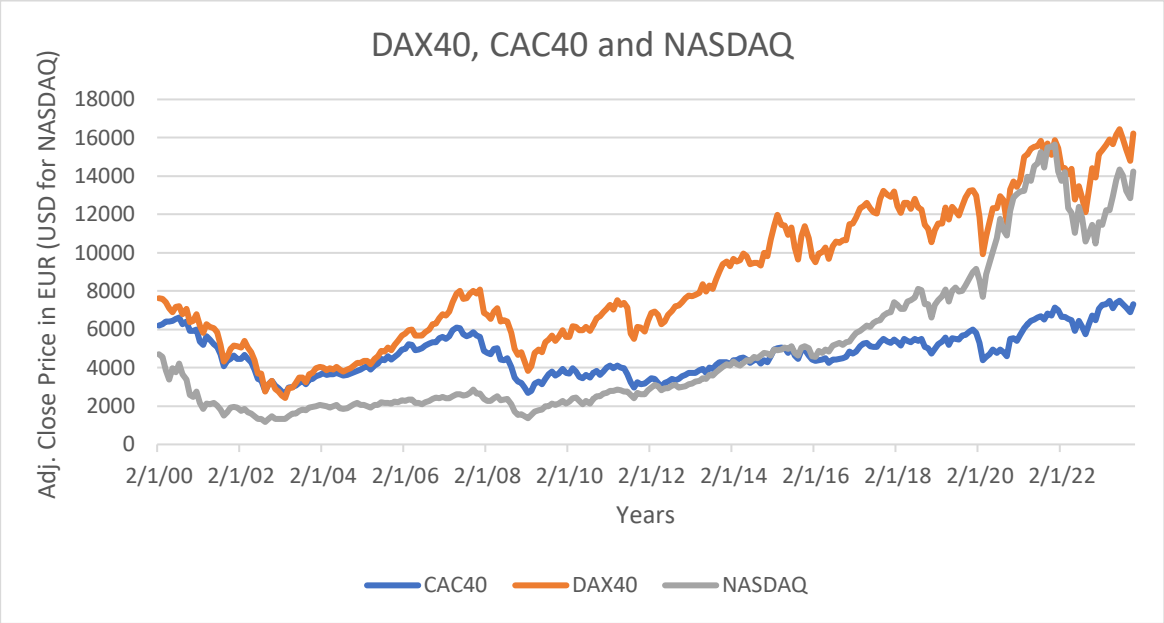


Figure 13 - DAX40, CAC40 and Nasdaq

Additionally, if Crude oil price is included in the comparison analysis (as seen on the graph below), a higher level of variability compared to the market indices DAX40, CAC40, and Nasdaq. Despite this variability, crude oil prices are also susceptible to crises, as demonstrated by the downturns in 2008 and 2021 during the COVID pandemic.

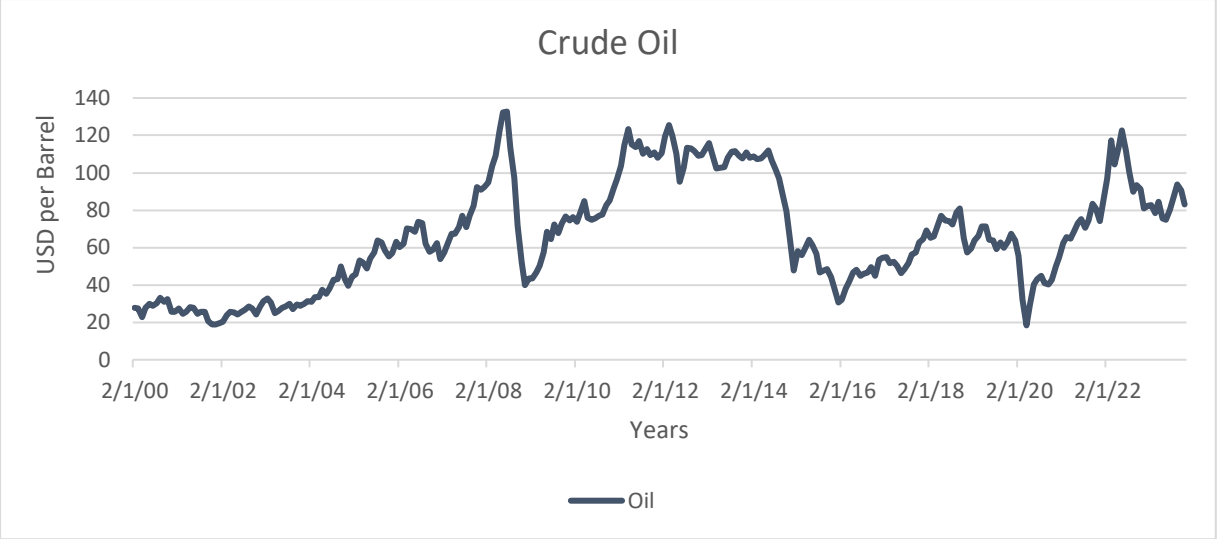


Figure 14 - Crude OIl Price

3.3.3 Data Transformations

The initial step involved retrieving data, where an Excel file was utilized to centralize information. Subsequently, a natural logarithm (LN) difference transformation was applied to ensure the creation of stationary variables, leaving aside the Unemployment rate Interest Rate that had already gone through stationarity transformations.

The following transformations were applied to obtain "Returns," or in other words, "Growth Rates."

$$g_{\text{COFB.BR}} = LN(\text{COFB. BR}_t/\text{COFB. BR}_{t-1})$$

$$g_{CPI} = LN(CPI_t/CPI_{t-1})$$

$$g_{Oil} = LN(Oil_t/Oil_{t-1})$$

$$g_{CAC40} = LN(CAC40_t/CAC40_{t-1})$$

$$g_{DAX40} = LN(DAX40_t/DAX40_{t-1})$$

$$g_{NASDAQ} = LN(NASDAQ_t/NASDAQ_{t-1})$$

The second step focused on Outliers Detection and Removal. Techniques, as it can be seen on the figure below, including visualizations such as histograms, boxplots, and Q-Q plots, were employed for all the variables. After calculating the mean and standard deviation, it became apparent that outlier removal was necessary.

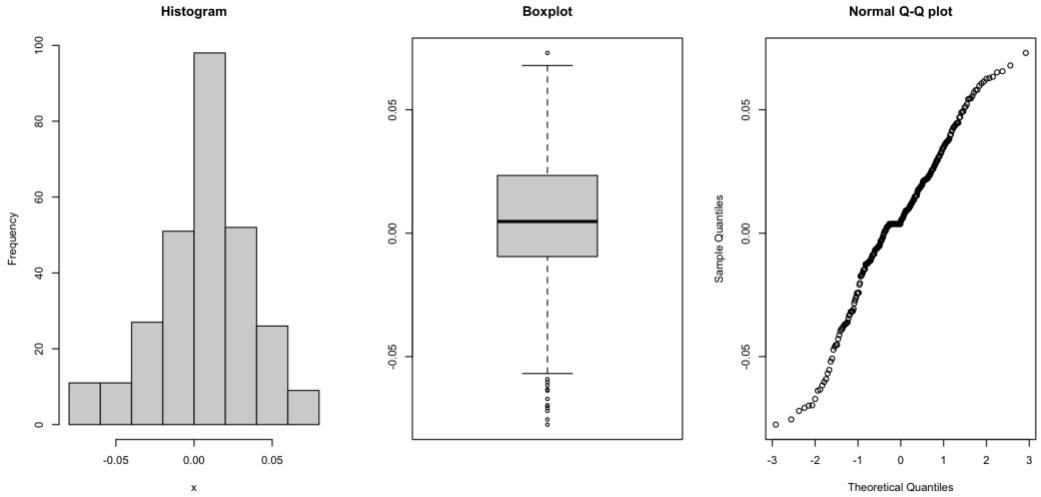


Figure 15 – Cofinimmo Histograms, boxplots, and Q-Q plots

To mitigate the loss of significant information, this study opted to replace both the maximum and minimum values of each variable. This replacement was done by substituting them with the mean value of their respective columns, these values are shown on the figure below.

	COFB.BR	CPI Index	Unemployment	Interest Rate	Oil	CAC40	DAX40	NASDAQ
Maximum	7.8%	0.8%	5.1%	17.0%	13.2%	7.2%	8.6%	10.3%
Average (Arithmetic)	0.4%	0.2%	-0.1%	-0.1%	0.4%	0.1%	0.3%	0.4%
Minimum	-8.1%	-0.3%	-4.7%	-15.1%	-16.5%	-8.8%	-9.9%	-11.0%

Figure 16 - Max, Min, Mean Analysis

3.3.4 Linear Relationship Analysis

In this section, this study will conduct univariate Linear Regression using both Excel and R, utilizing the stationary and outlier-free data obtained from the preceding section's.

Upon performing the initial three linear regressions, denoted as M_1, M_2, and M_3, with $g_{\text{COFB.BR}}$ as the dependent variable and g_{CPI}, the $Unemployment\ rate$, and $Interest\ rate$ as independent variables. This study observed a consistent negative relationship across all models, but for the M_4 with g_{Oil} which demonstrated a positive linear relationship. However, it's noteworthy that all beta coefficients (except for the intercept) were found to be not significantly different than zero (at 5%). The models are presented below.

$$M_1 := g_{\text{COFB.BR}} = \underbrace{0.005970}_{p=0.0097**} - \underbrace{0.242838}_{\text{p=0.7656}} * g_{CPI} + \varepsilon$$

$$M_2 := g_{\text{COFB.BR}} = \underbrace{0.005267}_{p=0.0097**} - \underbrace{0.169120}_{\text{p=0.0775}} * Unemployment\ rate + \varepsilon$$

$$M_3 := g_{\text{COFB.BR}} = \underbrace{0.005535}_{p=0.00213\ **} - \underbrace{0.011857}_{\text{p=0.68008}} * Interest\ rate + \varepsilon$$

$$M_4 := g_{\text{COFB.BR}} = \underbrace{0.005469}_{p=0.00263\ **} + \underbrace{0.008472}_{\text{p=0.76301}} * g_{Oil} + \varepsilon$$

Conversely, when conducting three additional models, this time incorporating all three market indices, namely g_{CAC40}, g_{DAX40}, and g_{NASDAQ}, the thesis observed contrasting outcomes. The analysis revealed a positive linear relationship, with all coefficients found to be statistically significant at the 1% level. The equations representing these findings are provided below.

$$M_5 := g_{\text{COFB.BR}} = \underbrace{0.005059}_{p=0.00355\ **} + \underbrace{0.233669}_{\text{p=2.54e-06}\ ***} * g_{CAC40} + \varepsilon$$

$$M_6 := g_{\text{COFB.BR}} = \underbrace{0.004930}_{p=0.00593\ **} + \underbrace{0.123987}_{\text{p=0.00741}\ **} * g_{DAX40} + \varepsilon$$

$$M_7 := g_{\text{COFB.BR}} = \underbrace{0.004862}_{p=0.00668\ **} + \underbrace{0.112166}_{\text{p=0.00586}\ **} * g_{NASDAQ} + \varepsilon$$

To visualize the presence of the linear relationships between the variables, the study conducted a scatter plot illustrating the association between the market indexes and COF.BR, as depicted by the M_4 equation provided below for the case of g_{CAC40}. The coefficients yielded from the regression analysis are found to be significantly different from zero. However, the dispersion of data points across the plot indicates a lack of strong linear relationship. The equation presented below summarizes this observation:

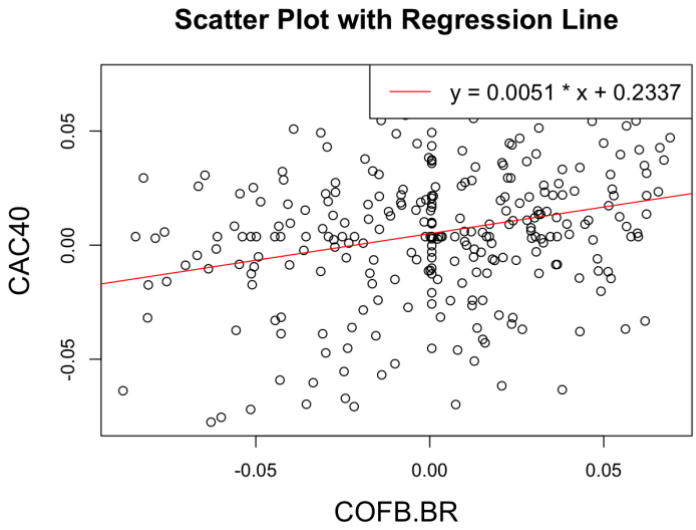


Figure 17 - Scatter Plot with g_COFB.BR and g_CAC40

3.3.5 Multivariate Linear Regression and Assumption testing

In this section, the thesis will perform a multivariate model in order to study the relationship between the dependent variable 'COFB.BR' and independent variables.

The initial multivariate model M_8, involving all seven transformed variables, faced several issues. Notably, g_{CPI}, $Unem.$, g_{Oil}, g_{DAX40}, and g_{NASDAQ} were found to be not significant different than 0 as it can be seen on the figure below, prompting thus their removal from the model.

$$M_8 :=$$

```
Coefficients:
                      Estimate Std. Error t value Pr(>|t|)
(Intercept)           0.004793   0.002289   2.094  0.03717 *
data$`CPI Index`     -0.001302   0.853985  -0.002  0.99878
data$Unemployment    -0.163858   0.093327  -1.756  0.08024 .
data$`Interest Rate` -0.036894   0.028170  -1.310  0.19139
data$Oil              0.003562   0.029125   0.122  0.90276
data$CAC40            0.279758   0.073390   3.812  0.00017 ***
data$DAX40           -0.069009   0.070446  -0.980  0.32814
data$NASDAQ           0.033156   0.048178   0.688  0.49190
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

The analysis encountered difficulties in confirming the underlying assumptions, especially the normality assumption of the residuals, required for a valid multivariate linear regression model. These assumptions were checked using various methods in R software (See Appendix for more details).

Here's a breakdown of the assumptions that were tested (See Appendix for more details):

1. Normality Assumption: Ensuring residuals adhered to Gaussian distribution characteristics through Q-Q plots, Shapiro-Wilk tests, and the Jarque-Bera test.
2. Multicollinearity: Assessing potential collinearities among independent variables via Variance Inflation Factors (VIF) and a thorough examination of the correlation matrix.
3. Heteroscedasticity: Testing for heteroscedasticity using the Goldfeld-Quandt and Breusch-Pagan tests, providing insights into the variance structure of residuals.
4. Autocorrelation: Examining autocorrelation in residuals through the Durbin-Watson and Breusch-Godfrey LM tests, crucial for evaluating potential temporal dependencies.

To address the difficulties in confirming the underlying assumptions, the variable 'Interest' underwent a square root transformation, resulting in the modified model, M_9. Post the square root transformation, the derived model (M_9) exhibited significant (at 10%) coefficients while adhering to the primary assumption of linear regression. The final model, which the results can be seen on the Table Below, reflects a more robust representation of the relationship

between the growth rate of COFB.BR, the square root of 'Interest,' and the growth rate of 'CAC40.'

$$M_9 := g_{\text{COFB.BR}} = \underbrace{0.01405}_{p=0.028403\,*} - \underbrace{0.05175}_{\text{p=0.067096}} * \sqrt{Interest} + \underbrace{0.075669}_{\text{p=0.000204}\,***} * g_{CAC40} + \varepsilon$$

Model M_9 confirms the assumptions necessary for conducting inference in a multivariate regression model. One of these assumptions is the normality assumption, which was assessed using a QQ plot, depicted in the figure below. The results of the Shapiro-Wilk normality test for the residuals of model M_9 indicate a test statistic (W) of 0.99169 with a corresponding p-value of 0.6421. Similarly, the Jarque-Bera normality test yields a test statistic (X-squared) of 0.0819 with an asymptotic p-value of 0.9599. In both tests, the p-values exceed the common significance level of 0.05. Consequently, the model fails to reject the null hypothesis in both instances, indicating that the residuals adhere to a normal distribution.

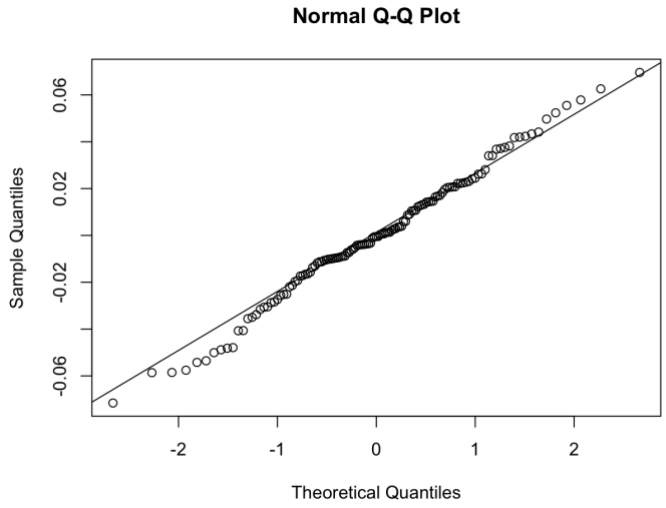


Figure 18 - M9 Normality QQ-Plot

Additionally, multicollinearity does not appear to be a significant issue in model M9. The Variance Inflation Factor (VIF) values for both the square root of the Interest Rate and the CAC40 index are approximately 1.02, which is well below the commonly accepted threshold of 10 for identifying multicollinearity. Additionally, the correlation matrix (as seen on the

figure below) does not indicate any extremely high correlations (close to 1 or -1) between independent variables, further suggesting that multicollinearity is not a major concern. Moreover, the Goldfeld-Quandt test suggests that there is no evidence of heteroscedasticity, as the p-value (0.2545) exceeds the significance level of 0.05.

	COFB.BR	CPI Index	Unemployment	Interest Rate	Oil	CAC40	DAX40	NASDAQ
COFB.BR	1.00000000	-1.773343e-02	-0.104757400	-2.452964e-02	0.01793845	0.27450664	0.15832670	0.1628386497
CPI Index	-0.01773343	1.000000e+00	0.038960115	-7.567444e-05	0.33288993	-0.09146575	-0.15675243	0.0009742728
Unemployment	-0.10475740	3.896011e-02	1.000000000	-9.336959e-03	0.01847082	0.01519660	0.09694951	-0.0115981806
Interest Rate	-0.02452964	-7.567444e-05	-0.009336959	1.000000e+00	0.10440996	0.17594633	0.14243067	0.0994121972
Oil	0.01793845	3.328899e-01	0.018470821	1.044100e-01	1.00000000	0.08095098	0.09371356	0.0400201445
CAC40	0.27450664	-9.146575e-02	0.015196596	1.759463e-01	0.08095098	1.00000000	0.73152927	0.5125437467
DAX40	0.15832670	-1.567524e-01	0.096949506	1.424307e-01	0.09371356	0.73152927	1.00000000	0.5405669730
NASDAQ	0.16283865	9.742728e-04	-0.011598181	9.941220e-02	0.04002014	0.51254375	0.54056697	1.0000000000

Figure 19 - Correlation Matrix

3.3.6 Findings

Firsthand findings from the linear relationship analysis demonstrate a notable, significantly different than 0, positive linear relationship with market indices, represented by the variables g_{CAC40}, g_{DAX40}, and g_{NASDAQ}.

And secondhand findings show that, after many different models that had insufficient significance or had issues validating certain assumptions, a final model emerged and studied the relationship between the growth rate of Cofinimmo SA's Stock price and pivotal factors such as the square root of 'Interest Rate' and the growth rate of 'CAC40 Index'. The M_9 model suggests that, when all factors are set to zero (square root of 'Interest Rate' and 'CAC40' growth rate are both zero), the expected growth rate of COFB.BR stands at 0.014050 meaning that it increases over time.

Examining individual coefficients, the square root of 'Interest Rate' reveals a negative association with COFB.BR's growth rate (which is in line with my intuition and the literature). A one-unit increase in the square root of 'Interest Rate' corresponds to a decrease of approximately 0.051750 units in COFB.BR's growth rate. Conversely, the growth rate of

'CAC40' demonstrates a positive influence. A unit increase in 'CAC40' growth rate is associated with an uptick of around 0.289457 units in COFB.BR's growth rate.

For the Belgian investor considering an investment in COFB.BR, the statistical significance of the 'CAC40' coefficient in the regression model (p-value < 0.05) highlights its important role in explaining COFB.BR's growth. This insight can be valuable for portfolio allocation, revealing how changes in interest rates and the CAC40 index can influence COFB.BR's growth rate. Using this knowledge, investors can try to mitigate as much as possible their risks, adjusting the proportion of REITs in their portfolio’s allocation.

However, the Belgian investor must not forget that this model does not take into account external factors (as mentionned previously) such as taxation, geopolitical events, and climate change also exert influence on COFB.BR's performance. Therefore, a comprehensive investment strategy should integrate these broader influences alongside the regression model insights.

4 Part IV - Conclusion

In conclusion, this thesis has studied the dynamics of Real Estate Investment Trusts (REITs), with a specific focus on understanding the determinants of stock prices within the Belgian market, exemplified by the case of Cofinimmo SA. The research question searched to uncover the factors influencing the stock price of a Belgian real estate company, providing valuable insights for investors.

Through a comprehensive literature review and empirical analysis spanning from February 1st, 2000, to November 1st, 2023, this study used Linear relationship Analysis, Multivariate linear regression models and Hypothesis testing to analyze the relationships between various macroeconomic variables on Cofinimmo SA's stock price.

The findings revealed that there is indeed a, significantly different than 0, positive linear relationship with market Indices such as DAX40, CAC40 and NASDAQ (representing a basket of large listed companies). Additionally, the Multivariate linear regression underlined, significantly different than 0, negative linear relationship of interest rates and the postive one concerning the CAC40 market index on Cofinimmo SA.

These empirical insights modestly contribute to the progression of educational understanding of real estate investment, particularly concerning the determinants influencing REITs' stock prices, and more specifically within the Belgian setting. And looking ahead, future research should continue exploring the impact of additional macroeconomic factors on REIT performance and delve deeper into the qualitative aspects of what drives the Stock Price of a REIT such as the quality and engagement of their managment.

Investing in REITs offers significant potential for returns, particularly due to their specific dividend policies, which typically involve distributing at least 80% of their net income annually. However, in today's investment landscape, considering Environmental, Social, and Governance (ESG) factors has become crucial. Integrating ESG considerations into investment decisions will play a vital role in realizing the full potential of the REIT market, contributing to both economic prosperity and social value creation.

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6 Appendix

6.1 Results in R

```
> print(descriptive_stats)
                  Minimum     Maximum          Mean     Variance
COFB.BR       -0.077561822 0.073047399  0.0055408582 9.061478e-04
CPI Index     -0.002642591 0.007618788  0.0017660704 4.832256e-06
Unemployment  -0.045809536 0.051293294 -0.0016204777 3.476803e-04
Interest Rate -0.145986146 0.166889059 -0.0004595565 3.877961e-03
Oil           -0.158732186 0.128497748  0.0085022526 4.062338e-03
CAC40         -0.088152050 0.069067276  0.0020602951 1.250558e-03
DAX40         -0.097397802 0.084931413  0.0049238990 1.477602e-03
NASDAQ        -0.106727486 0.101646399  0.0060503629 1.909806e-03
```

Figure 20 - Minimum Maximum Mean Variance

```
> summary(M1)

Call:
lm(formula = data$COFB.BR ~ data$`CPI Index`)

Residuals:
      Min        1Q    Median        3Q       Max
-0.083605 -0.014780 -0.000701  0.017684  0.067916

Coefficients:
                  Estimate Std. Error t value Pr(>|t|)
(Intercept)       0.005970   0.002293   2.604   0.0097 **
data$`CPI Index` -0.242838   0.813885  -0.298   0.7656
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.03015 on 283 degrees of freedom
Multiple R-squared:  0.0003145, Adjusted R-squared:  -0.003218
F-statistic: 0.08902 on 1 and 283 DF,  p-value: 0.7656
```

Figure 21 - M1 Model

```
> summary(M2)

Call:
lm(formula = data$COFB.BR ~ data$Unemployment)

Residuals:
      Min        1Q    Median        3Q       Max
-0.084954 -0.015290  0.000368  0.017924  0.067640

Coefficients:
                   Estimate Std. Error t value Pr(>|t|)
(Intercept)         0.005267   0.001783   2.954   0.0034 **
data$Unemployment -0.169120   0.095438  -1.772   0.0775 .
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.02999 on 283 degrees of freedom
Multiple R-squared:  0.01097,   Adjusted R-squared:  0.007479
F-statistic:  3.14 on 1 and 283 DF,  p-value: 0.07746
```

Figure 22 - M2 Model

```
> summary(M3)

Call:
lm(formula = data$COFB.BR ~ data$`Interest Rate`)

Residuals:
      Min        1Q    Median        3Q       Max
-0.083113 -0.014788 -0.000486  0.018635  0.068025

Coefficients:
                     Estimate Std. Error t value Pr(>|t|)
(Intercept)           0.005535   0.001786   3.100  0.00213 **
data$`Interest Rate` -0.011857   0.028726  -0.413  0.68008
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.03015 on 283 degrees of freedom
Multiple R-squared:  0.0006017, Adjusted R-squared:  -0.00293
F-statistic: 0.1704 on 1 and 283 DF,  p-value: 0.6801
```

Figure 23 - M3 Model

```
> summary(M4)

Call:
lm(formula = data$COFB.BR ~ data$Oil)

Residuals:
      Min        1Q    Median        3Q       Max
-0.082337 -0.014847 -0.000657  0.018263  0.067436

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept) 0.005469   0.001802   3.035  0.00263 **
data$Oil    0.008472   0.028070   0.302  0.76301
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.03015 on 283 degrees of freedom
Multiple R-squared:  0.0003218, Adjusted R-squared:  -0.003211
F-statistic: 0.0911 on 1 and 283 DF,  p-value: 0.763
```

Figure 24 - M4 Model

```
> summary(M5)

Call:
lm(formula = data$COFB.BR ~ data$CAC40)

Residuals:
      Min        1Q    Median        3Q       Max
-0.077324 -0.015270  0.000468  0.018656  0.067852

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept) 0.005059   0.001721   2.941  0.00355 **
data$CAC40  0.233669   0.048657   4.802 2.54e-06 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.029 on 283 degrees of freedom
Multiple R-squared:  0.07535,   Adjusted R-squared:  0.07209
F-statistic: 23.06 on 1 and 283 DF,  p-value: 2.545e-06
```

Figure 25 - M5 Model

```
> summary(M6)

Call:
lm(formula = data$COFB.BR ~ data$DAX40)

Residuals:
      Min        1Q    Median        3Q       Max
-0.082015 -0.015850  0.000872  0.018523  0.067790

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept) 0.004930   0.001778   2.773  0.00593 **
data$DAX40  0.123987   0.045964   2.697  0.00741 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.02978 on 283 degrees of freedom
Multiple R-squared:  0.02507,   Adjusted R-squared:  0.02162
F-statistic: 7.276 on 1 and 283 DF,  p-value: 0.007406
```

Figure 26 - M6 Model

```
> summary(M7)

Call:
lm(formula = data$COFB.BR ~ data$NASDAQ)

Residuals:
      Min        1Q    Median        3Q       Max
-0.081977 -0.015730  0.001473  0.017816  0.062803

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept) 0.004862   0.001779   2.733  0.00668 **
data$NASDAQ 0.112166   0.040400   2.776  0.00586 **
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.02975 on 283 degrees of freedom
Multiple R-squared:  0.02652,   Adjusted R-squared:  0.02308
F-statistic: 7.709 on 1 and 283 DF,  p-value: 0.005863
```

Figure 27 - M7 Model

```
> summary(M8) # Print the summary of the regression model

Call:
lm(formula = data$COFB.BR ~ data$`CPI Index` + data$Unemployment +
    data$`Interest Rate` + data$Oil + data$CAC40 + data$DAX40 +
    data$NASDAQ)

Residuals:
      Min        1Q    Median        3Q       Max
-0.081721 -0.014574  0.000872  0.019412  0.069646

Coefficients:
                     Estimate Std. Error t value Pr(>|t|)
(Intercept)           0.004793   0.002289   2.094  0.03717 *
data$`CPI Index`     -0.001302   0.853985  -0.002  0.99878
data$Unemployment    -0.163858   0.093327  -1.756  0.08024 .
data$`Interest Rate` -0.036894   0.028170  -1.310  0.19139
data$Oil              0.003562   0.029125   0.122  0.90276
data$CAC40            0.279758   0.073390   3.812  0.00017 ***
data$DAX40           -0.069009   0.070446  -0.980  0.32814
data$NASDAQ           0.033156   0.048178   0.688  0.49190
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.02897 on 277 degrees of freedom
Multiple R-squared:  0.09674,   Adjusted R-squared:  0.07392
F-statistic: 4.238 on 7 and 277 DF,  p-value: 0.0001832
```

Figure 28 - M8 Model

```
> summary(M9) # Print the summary of the regression model

Call:
lm(formula = data$COFB.BR ~ +sqrt(data$`Interest Rate`) + data$CAC40)

Residuals:
      Min        1Q    Median        3Q       Max
-0.071564 -0.015700 -0.000466  0.018309  0.069588

Coefficients:
                            Estimate Std. Error t value Pr(>|t|)
(Intercept)                 0.014050   0.006337   2.217 0.028403 *
sqrt(data$`Interest Rate`) -0.051750   0.028018  -1.847 0.067096 .
data$CAC40                  0.289457   0.075669   3.825 0.000204 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.02798 on 126 degrees of freedom
  (156 observations deleted due to missingness)
Multiple R-squared:  0.1144,    Adjusted R-squared:  0.1003
F-statistic: 8.138 on 2 and 126 DF,  p-value: 0.0004742
```

Figure 29 – M9 Model

```
> qqnorm(M9$residuals) #Q-Q plot of residuals
> print(qqline(M9$residuals)) #--> OK, it's Normal
NULL
>
> shapiro.test(M9$residuals) # Shapiro-Wilk test for normality of residuals

        Shapiro-Wilk normality test

data:  M9$residuals
W = 0.99169, p-value = 0.6421

>
> fBasics::jarqueberaTest(M9$residuals)

Title:
 Jarque - Bera Normalality Test

Test Results:
  STATISTIC:
    X-squared: 0.0819
  P VALUE:
    Asymptotic p Value: 0.9599
```

Figure 30 - M9 Normality Assumption

```
> ######## 2) Multicolinearity ########
>
> library(car)
> print(vif(M9))
sqrt(data$`Interest Rate`)                data$CAC40
                  1.023516                  1.023516
>
> independent_variables <- data[, -1] # Exclude the first column ('Dates')
> correlation_matrix <- cor(independent_variables) # Calculate the correlation matrix
> print(correlation_matrix) # Print the correlation matrix
                  COFB.BR     CPI Index Unemployment Interest Rate        Oil       CAC40       DAX40        NASDAQ
COFB.BR        1.00000000 -1.773343e-02 -0.104757400 -2.452964e-02 0.01793845  0.27450664  0.15832670  0.1628386497
CPI Index     -0.01773343  1.000000e+00  0.038960115 -7.567444e-05 0.33288993 -0.09146575 -0.15675243  0.0009742728
Unemployment  -0.10475740  3.896011e-02  1.000000000 -9.336959e-03 0.01847082  0.01519660  0.09694951 -0.0115981806
Interest Rate -0.02452964 -7.567444e-05 -0.009336959  1.000000e+00 0.10440996  0.17594633  0.14243067  0.0994121972
Oil            0.01793845  3.328899e-01  0.018470821  1.044100e-01 1.00000000  0.08095098  0.09371356  0.0400201445
CAC40          0.27450664 -9.146575e-02  0.015196596  1.759463e-01 0.08095098  1.00000000  0.73152927  0.5125437467
DAX40          0.15832670 -1.567524e-01  0.096949506  1.424307e-01 0.09371356  0.73152927  1.00000000  0.5405669730
NASDAQ         0.16283865  9.742728e-04 -0.011598181  9.941220e-02 0.04002014  0.51254375  0.54056697  1.0000000000
```

Figure 31 - M9 Multicollinearity

```
> ######## 3)Heteroscedasticity ########
>
> lmtest::gqtest(M9)

        Goldfeld-Quandt test

data:  M9
GQ = 1.1846, df1 = 62, df2 = 61, p-value = 0.2545
alternative hypothesis: variance increases from segment 1 to 2
```

Figure 32 - M9 Heteroscedasticity

6.2 R Code

######### Read the Excel file into a data frame

library(readxl)

data <- Master_Thesis_Lochlan_Reeves_18022024 <- read_excel("Thesis/R/Master_Thesis_Lochlan_Reeves_18022024.xlsx", range = "J5:R290")

View(Master_Thesis_Lochlan_Reeves_18022024)

Extract numeric data excluding 'Dates' column

numeric_data <- data[, -1]

PART I: Data Transformations ##

```
# Convert 'Dates' column to date type if it is not already
data$Dates <- as.Date(data$Dates)

# Calculate descriptive statistics
min_values <- apply(numeric_data, 2, min, na.rm = TRUE)
max_values <- apply(numeric_data, 2, max, na.rm = TRUE)
mean_values <- apply(numeric_data, 2, mean, na.rm = TRUE)
var_values <- apply(numeric_data, 2, var, na.rm = TRUE)

descriptive_stats <- data.frame(
  Minimum = min_values,
  Maximum = max_values,
  Mean = mean_values,
  Variance = var_values)

print(descriptive_stats)
```

Outliers detection

```
#library(gridExtra)
x = data$COFB.BR
#histogram, Q-Q plot, and boxplot
par(mfrow = c(1, 3))
hist(x, main = "Histogram")
boxplot(x, main = "Boxplot")
qqnorm(x, main = "Normal Q-Q plot")
```

```
# get mean and Standard deviation
#mean = mean(x)
#std = sd(x)


PART II : Univariate regressions ########################################


### Linear relationships - Univariate regressions

M1 <- lm(data$COFB.BR        # Fit a linear regression model
         ~ data$`CPI Index`)
summary(M1)

M2 <- lm(data$COFB.BR        # Fit a linear regression model
         ~ data$Unemployment)
summary(M2)


M3 <- lm(data$COFB.BR        # Fit a linear regression model
      ~ data$`Interest Rate`)
summary(M3)

M4 <- lm(data$COFB.BR        # Fit a linear regression model
      ~ data$Oil)
summary(M4)

M5 <- lm(data$COFB.BR        # Fit a linear regression model
      ~ data$CAC40)
summary(M5)

M6 <- lm(data$COFB.BR        # Fit a linear regression model
      ~ data$DAX40)
summary(M6)
```

```
M7 <- lm(data$COFB.BR        # Fit a linear regression model
      ~ data$NASDAQ)
summary(M7)

##### Scatter plots

y <- data$COFB.BR
x <- data$CAC40
# Set graphical parameters to display plot alone and increase size
par(mfrow=c(1,1), mar=c(5, 5, 4, 2) + 0.1, oma=c(0, 0, 0, 0))

# Create scatter plot
plot(x, y, main="Scatter Plot with Regression Line", xlab="COFB.BR", ylab="CAC40", cex.main=1.5, cex.lab=1.5)

# Fit linear regression model
fit <- lm(y ~ x)

# Add regression line to plot
abline(fit, col="red")

# Add equation of the regression line to the plot
eq <- paste("y =", round(coef(fit)[1], 4), "* x +", round(coef(fit)[2], 4))
legend("topright", legend=eq, col="red", lty=1, cex=1.2)



PART III : Multivariate Linear Regression ########################################



M8 <- lm(data$COFB.BR        # Fit a linear regression model
      ~ data$`CPI Index`
```

```
    + data$Unemployment
    + data$`Interest Rate`
    + data$Oil
    + data$CAC40
    + data$DAX40
    + data$NASDAQ)


summary(M8) # Print the summary of the regression model



M9 <- lm(data$COFB.BR        # Fit a linear regression model
         ~ #data$`CPI Index`
         #+ data$Unemployment
         + sqrt(data$`Interest Rate`)
         #+ data$Oil
         + data$CAC40)
         #+ data$DAX40)
         #+ data$NASDAQ)
summary(M9) # Print the summary of the regression model




# PART III : Assumption Testing ##########################################

######## 1) Normality assumption: #########

library(lmtest)

qqnorm(M9$residuals) #Q-Q plot of residuals
print(qqline(M9$residuals)) #--> OK, it's Normal
```

```
shapiro.test(M9$residuals) # Shapiro-Wilk test for normality of residuals

fBasics::jarqueberaTest(M9$residuals)


######## 2) Multicolinearity ########

library(car)
print(vif(M9))

independent_variables <- data[, -1] # Exclude the first column ('Dates')
correlation_matrix <- cor(independent_variables) # Calculate the correlation matrix
print(correlation_matrix) # Print the correlation matrix

######## 3)Heteroscedasticity ########

lmtest::gqtest(M9)



######## 3)Auto-Correlation ########

library(car) # Load the required library

durbinWatsonTest(M9) # Perform the Durbin-Watson test

bgtest(M9) # Perform the Breusch-Godfrey LM test
```