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The impact of interest rates on growth stock returns

European stock market analysis

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ABSTRACT:

Interest rates are among the most fundamental concepts and financial instruments in the financial world. The effect of interest rates and monetary policies exercised by central banks on the stock market is a widely studied field in finance. Interest rates are found to be one of the main factors that explain the movements of the stock market. Conventional wisdom states that the relationship between stock market returns is negative as interest rates increase, stock prices decrease, and vice versa. However, the relationship and the sensitivity have been found to differ for different stocks and stock portfolios.

Growth companies are often associated with high innovation, job creation, and economic development and they are considered to contribute well to every economy. While growth investing tends to underperform compared to value investing, it is still one of the most common investing strategies, where investors invest in growth companies that carry high expectations for future growth and -profits. "Momentum" and diversification may be among the main factors that drive the popularity of growth investing, but still, all professional investors seek to optimize their risk management to their preference within the chosen investment strategy.

Recent rate hikes by the European Central Bank in 2022 have ended the lower-bound interest rate period, which started soon after the financial crisis of 2008. Now, as the interest rate levels in Europe and globally may shift back to the long-term average after a decade of lower bound rates, it is reasonable to inspect the academic literature on the impact and significance of interest rates on growth stock returns.

This study implements an empirical analysis of the European stock market and examines the effect of interest rate fluctuations specifically for the market price of growth stocks. The analysis shows time variation within the results, indicating that sensitivity between interest rate fluctuations and growth stock returns varies for different periods due to economic cycles, monetary policies, and other economic factors. Careful interpretation of the results indicates that during lower bound interest rates, growth stock returns and interest rate fluctuations have a positive relationship, and they may have a co-movement behaviour to positive or negative economic news and events. The results of this study are assumed to be interesting to professional investors from the perspective of interest rate risk management and asset allocation strategy.

Keywords: Growth stocks, growth investing, interest rates, interest rate risk, European stock market

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TIIVISTELMÄ:

Korot kuuluvat fundamentaalisesti tärkeimpien talouden konseptien ja instrumenttien joukkoon. Korkojen sekä keskuspankin harjoittaman rahapolitiikan vaikutukset osakemarkkinoihin, on laaja tieteellisen tutkimuksen ala rahoituksessa. Korkojen nähdään olevan yksi tärkeimpiä tekijöitä selittämässä osakemarkkinoiden liikkeitä. Yleisesti hyväksytyn olettaman mukaan, osakemarkkinoiden ja korkojen välillä on negatiivinen suhde, joten kun korot nousevat, osakkeiden arvo laskee ja toisinpäin. Tämän suhteen ja suhteen herkkyyden on kuitenkin huomattu olevan erilainen eri osakkeiden sekä osakeportfolioiden välillä.

Kasvuyritykset usein yhdistetään korkeaan innovointiin, työpaikkojen luontiin ja talouden terveelliseen kehitykseen, sekä niiden usein nähdään olevan yleisesti hyväksi jokaiselle taloudelle. Vaikka kasvusijoittamisella on taipumus osoittaa arvosijoittamista heikompaa suorituskykyä, kasvusijoittaminen on silti yksi suosituimmista sijoitusstrategioista. Kasvusijoittamisessa sijoittajat investoivat kasvuyrityksiin, jotka kantavat korkeita odotuksia tulevaisuuden kasvusta ja suorituskyvystä. Vaikka ”momentum” ja hajautus saattavat olla tekijöitä, jotka ajavat kasvusijoittamisen suosiota, niin silti kaikki ammattimaiset sijoittajat pyrkivät optimoimaan sijoittamisen riskienhallintaa omien preferenssiensä mukaan sijoitusstrategiassaan.

Euroopan keskuspankin viimeaikaiset koronnostot vuonna 2022 toivat matalan koron ja löysän rahapolitiikan aikakauden päätökseensä, jonka voidaan nähdä alkaneen nopeasti vuoden 2008 finanssikriisin jälkeen. Nyt, kun Euroopassa, ja muualla maailmaa, korot näyttävät palaavan lähemmäs pidemmän ajan keskiarvoa matalien korkojen vuosikymmenen jälkeen, on järkevää katsastaa tieteellisen tutkimuksen alaa koskien korkojen vaikutusta ja merkitystä kasvuosakkeiden tuottoihin.

Tämä tutkielma implementoi empiirillisen analyysin Euroopan osakemarkkinoista ja tutkii korkojen muutoksen vaikutusta erityisesti kasvuosakkeiden markkina-arvoon. Analyysi näyttää aikavariaatiota tuloksissa, indikoiden, että herkkyys korkojen muutosten ja kasvuosakkeiden tuotoissa vaihtelee eri ajanjaksojen välillä johtuen talouden sykleistä, harjoitetusta rahapolitiikasta sekä muista taloudellisista tekijöistä. Tuloksien varovainen tulkinta osoittaa, että matalan korkojen ajanjakson aikana korkomuutosten ja kasvuosakkeiden tuottojen välinen suhde on positiivinen, ja ne käyttäytyvät yhteisliikkeellä talouden positiiviseen ja negatiivisiin uutisiin sekä tapatumiin. Tutkimuksen tulokset ovat oletettavasti kiinnostavia ammattimaisille sijoittajille korkoriskin sekä omaisuuden allokoinnin strategian näkökulmasta.

Avainsanat: Kasvuosakkeet, kasvusijoittaminen, korot, korkoriski, Euroopan osakemarkkinat

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Abbreviations

APR	annual percentage rate
APY	annual percentage yield
BET	break even time
BTM	book to market ratio
BVPS	book value per share
CAPM	capital asset pricing model
CML	capital market line
DCF	discounted cash flow model
EB	Euribor
ECB	European central bank
EMH	efficient market hypothesis
EPS	earnings per share
EU	European union
FED	federal reserve system
FX	foreign exchange
GDP	gross domestic product
MRO	main refinancing rate
M&A	mergers and acquisitions
OLS	ordinary least squares
OTC	over the counter
PB	price to book ratio
PCF	price to cash flow ratio
PE	price to earnings ratio
PS	price to share ratio
QR	quantile regression
US	United states
USD	United states dollar
VAR	vector autoregression
WACC	weighted average cost of capital

1 Introduction

Asset prices are understood to reflect and be sensitive to economic cycles and news. In academic research, a key focus has been directed to identifying different events and variables and their relation to asset prices, in order to construct asset pricing models that identify the systematic risk of the asset in hand. The range of variables studied is extensive in academic research and in real-world practice. Among the central variables considered is the interest rate factor, as interest rates reflect the state of the economy. Interest rates and their expectations are undertaking a substantial role when professional investors are valuing and investing in different asset classes.

There are various investment strategies that professional investors use in their attempt to beat the market. Across these different strategies, it is clear that value and growth investing are among the most popular strategies used. These two strategies can sometimes even be seen as rivals to each other's, as they are both based on the same ideology to use different financial ratios like book-to-market (also known as BTM) and earnings-to-price (also known as PE), but they take different views on these ratios.

In growth investing, investors seek to find companies that show future growth potential that will reflect high stock returns. Growth investing relies on the efficient market hypothesis that assumes that all available information is already priced into the current stock price. In contrast, value investors seek to find companies that have strong financial fundamentals but are undervalued by their current share price. In general, value investors expect that this valuation error will be corrected by the market in the future, making the stock a good investment now.

Macroeconomic factors play an important role in the behaviour of stock markets and the development of financial markets (Faria & Verona, 2020). In order to anticipate market reactions, it is viable to understand monetary policy and interest rates (Kurov and Raluca, 2018). In real-world practice, investors can use their knowledge in the input on their stock- and portfolio selection process, and risk management and to allocate their investments accordingly. In this study, we try to disclose relevant information on the relationship between interest rate changes and growth stock portfolios which can provide useful insight from interest rate risk management's perspective and for investors' determination process of asset allocation decisions.

1.1 Motivation for the study

It is not easy to make a general statement about whether financial markets in Europe are less developed than in the US, as the level of development varies between countries and financial sectors across Europe. However, Europe's financial markets are often seen as less developed compared to the financial markets of the US. This also corresponds to the academic literature regarding financial markets in Europe, as the traditional financial research in the US has a long history and many of the prestigious financial journals are based in the US. Also, there are notable differences between Europe's and US financial markets, institutions, regulations, and bank integration, among other factors. Thus, this study adds to the financial research made from the stock price sensitivity to interest rate changes specifically for European markets that for example Jareño, Ferrer & Miroslavova (2016) propose in their study of the US stock market sensitivity on interest rates.

We acknowledge that the recent shifts in 2022 in monetary policies globally and in Europe make different traditional financial research fields less or more relevant once again, especially as the zero- and lower-bound interest rates rate period has come to its end, at least for now. This motivates us to update the fields of financial research that may have been in a lesser focus for the past decade. Also, as the zero- and lower-bound interest rate period has come to its now after 2022, it is useful to examine the period for future interest if more loose monetary policy periods would repeat in the future.

1.2 Hypotheses and the research question of the study

The theory and literature review of this study can be derived to have three assumptions about the effect that interest rates have on stock prices. First, an increase in interest rates leads to reduced cash flows for companies and lower discounted cash flows for investors. Second, an increase in interest rates leads to increased equity premiums which will make investors rebalance their investments. Third, bonds and other fixed-income financial instruments' attractiveness has a positive relationship with tightening monetary policy.

These three assumptions suggest an inverse relationship between interest rate changes and stock performance. Also, following the first assumption and the literature, the sensitivity and the negative relationship should be stronger for value companies than growth companies. It is notable, that while the relationship between interest rates and stock performance is widely studied, literature and European evidence still trails the US. Also, the recent interest rate hikes that started in Europe in 2022 motivates to update the literature and study the relationship between interest rates and stock performance. Consequently, the research question of this study emerges. The research question and the three hypotheses which allows us to answer it can be written as follows,

Is the stock price's sensitivity for interest rate changes different for growth companies that are not, in general, expected to rely on strong free cash flows or to pay out dividends for shareholders in the near future?

H_1: *The change in the interest rate can explain the returns of the European growth stocks.*

H_2: *Interest rate changes have a negative relationship to growth stocks' monthly stock returns.*

H_3: *Growth stocks are less negatively sensitive to interest rate changes than value portfolios.*

1.3 Structure of the thesis

This study is structured as follows: Chapter 2 covers the basic concepts and the relevant theories regarding interest rates. We will also cover a short overview of the historic development of relevant interest rates in the context of this study. In Chapter 3 we describe growth companies and the characteristics that separate these companies from the rest. In order to understand more deeply the investors' aspects, we will also cover the fundamentals and the theorem of growth stocks and growth investing. In Chapter 4 we set up the ground for our academic approach as we introduce the modern asset pricing theories and models and reflect them to the context of specific investment strategies used in growth or value investing. In Chapter 5 we cover the earlier academic literature from three aspects: the performance of growth stocks, interest rates and monetary policies' effect on the stock market, and interest rate's sensitivity to growth companies and their firm-level and stock performance. In Chapter 6 we explain and execute our empirical research in order to answer our research question and hypothesis'. In Chapter 7 we highlight the results of our empirical research and interpret the empirical findings. Finally, Chapter 8 shortly summarises the study, findings, interpretations, and suggested future research considerations.

2 Interest rates

Central banks, such as the Federal Reserve of the United States (also known as FED and the US) and the European Central Bank (also known as ECB) are set to control and maintain stability in the economies. Central banks have different direct and indirect tools to accelerate or slow down economic activities, such as spending and lending. One of the most important and influential economic tools that the central banks govern are the interest rates that the central banks set which banks use to lend to each other, and the interest rates which banks can borrow money from the central bank itself. However, interest rates and the context can be referring to government- and corporate bonds, mortgages, or other financial instruments.

In the simplest of terms, interest rates can be defined in two ways. Firstly, interest rate is the amount that a lender charges from a borrower in exchange when lending money. For the borrower, the cost of borrowing is noted as an annual percentage rate (APR). Secondly, interest rates can be yielding, for example from a savings account on deposed funds or if the investor has purchased a government bond. Therefore, interest rates can express also the annual percentage yield (APY). The main purpose of interest rates is that it encourages lending out capital, and in doing so, the capital flows from a surplus sector to the deficit sector where the capital is needed. Interest rates can also be referred to as the price or time value of money. (Schmidt, 2017)

As stated, interest rates refer to the cost of borrowing money and the return of lending money. As interest rates are one of the most fundamental aspects of financial theories and in real-world practice, the research background and the theory of interest rates is a multifarious and multidisciplinary field that relies on economics, mathematics, and finance. In this chapter, we will discuss the key theories for interest rates and their interpretation. This helps us to go forward as we study the effects of interest rate changes on stock returns in the context of this study.

2.1 Nominal interest rate and real interest rate

Fisher's (1930) book Theory of Interest is considered one of the building blocks of the modern theory of interest rates. In his book, Fisher (1930) divides the interest rate between the nominal interest rate and the real interest rate. The nominal interest rate is the rate that is quoted by banks and other financial institutions without any extra treatment. The real interest rate, in turn, is inflation adjusted inflation rate. The real interest rate determines the factual purchasing power of money. Fisher (1930) introduces the Fisher equation that states that the nominal interest rate is the sum of the inflation rate and the real interest rate. The Fisher equation can and is also being applied in other fields of finance, for example for finding the inflation-adjusted return for a portfolio's return. Therefore, while Fisher's equation originally derives from interest rate theory, it haves many use cases. Fisher equation is noted as follows,

$$(1 + i) = (1 + r) \times (1 + \pi) \tag{1}$$

where,

i = the nominal interest rate
r = the real interest rate
π = the inflation rate
(Fisher, 1930).

The real interest rate is the true indicator of the return on lending and the cost of borrowing. The real interest rate accounts for the fact that over time money will be worthless in the future due to inflation. When we rearrange equation (1), we can calculate and find the real interest rate as follows,

$$r = \frac{(1+i)}{(1+\pi)} - 1 \tag{2}$$

2.2 Risk-free interest rate

Often in financial theories, -models, -literature, and -practice, the risk-free rate is used to determine that what is the risk-free return that investors can pursue instead of a riskier asset. The risk-free return may be compared to for asset's or portfolio's return in order to discover the risk premium that the investment bears over the risk-free rate. This is an important concept because it guides understanding the risk premium, meaning the excess risk over the risk-free rate that the investor is exposed to by holding a riskier asset than a risk-free asset. In general, government bonds are referred to as risk-free assets. Governments, like the US, are considered to be financially stable enough, with an excellent credit rating, that there is no risk of default for their long-term debt issues, hence their bonds are risk-free assets for investors.

While in practice, the risk-free rate is compared to government bonds, the true risk-free rate can be determined to be theoretical, because, in order to have a truly risk-free rate, it would have to represent a rate of return with absolutely zero risk in a certain investment duration. In reality, even governments, like the US, or the most stable economies in Europe, Germany for instance, have a theoretical chance of default. But because governments with strong economies are highly unlikely to default on their bonds, the risk-free rate in practice is reflected from the government debt issues.

The risk-free rate is not constant over time as it is affected by inflation expectations. In times of increased inflation expectations, risk-free rates increase and vice versa. Brealey, Myers, and Franklin (2020) describe the relationship of risk-free rate and inflation from a point of view of the time value of money. They explain, that as inflation expectations increase, investors demand a higher nominal rate of return for their investments in order to achieve the expected real return. In addition, the risk-free rate varies depending on duration, or in other words, on the investment period. For instance, government bonds and their APYs vary depending on the bond duration. Hence, when academics or professional investors are using the risk-free rate, for instance in asset pricing models, the risk-free rate is to be chosen correspondently, to match the duration.

By additional definition, the risk-free interest rate reflects a systematic risk that is the smallest possible risk in the market at a specific time for a declared duration. Systematic risk and the risk-free rate are indispensable concepts in many financial models and theories on economic activity and asset pricing. For instance, the capital asset pricing model (see Chapter 4.3.3.) relies entirely on the concepts of a risk-free rate of return and systematic risk (Pratt, Grabowski & Brealey, 2014).

2.3 Interest rates and monetary policies

Central banks, like FED and ECB, use interest rates to influence the economy by adjusting the rates and affecting the cost of borrowing and the return on lending. Interest rates are not the only tools that central banks govern as they have other fiscal policy tools in their mandate as well. The central banks affect economies in pursuit to maintain steady inflation in order to keep the economy stabilized and support sustainable economic growth. In general, periods of high-interest rates are considered to be a consequence of tight monetary policies where inflation expectations are high. In contrast, when monetary policies are considered to be loose, interest rates show periods of lower bound rates as inflation expectations are low (Lioui & Maio, 2014). From the interest rate literature, two main theories regarding monetary policies emerge, the monetary policy transmission mechanism and the Taylor rule.

The monetary policy transmission mechanism theory states that central banks use interest rates to stimulate or slow down economic activity. Following this theory, economies may need stimulation when in a downturn, but to maintain long-term sustainable economic activity, when the economy is overheating the central banks can slow down the short-term economic activity. Lowering interest rates will make borrowing cheaper, which stimulates the economy through higher levels of spending and investments, and in turn, raises inflation. Increasing interest rates will make borrowing more expensive, which reduces economic activity through decreasing levels of spending and investments and decreases inflation. (Bernanke & Gertler, 1995.)

The Taylor rule introduced by Taylor (1993) instead, is a guideline that represents how central banks should determine their nominal interest rate in contrast to the inflation and GDP data changes. The key idea is that interest rates should be settled so that they maintain stability in the economy through stable inflation and GDP at its potential level. In general, the inflation target of central banks try to maintain is often determined as 2%. The Taylor rule formula is as follows,

$$i = 2 + \pi + \frac{1}{2}(\pi - 2) + \frac{1}{2}(q - q^*) \qquad (3)$$

where,

i = Central bank's target interest rate
π = Inflation
q = Current level of GDP
q^* = Natural or potential level of GDP
(Orphanides, 2003)

Both, the monetary policy transmission mechanism theory, and the Taylor rule are widely studied theories in academic research, as well as in real-world practices. As both theories are quite simplified, a lot of different views and criticism against them have also emerged. For instance, the Monetary Policy Report by FED (2022) notes that simple policy rules, such as the Taylor rule, can be limited in usual economic circumstances as they do not consider the other tools than interest rate changes, that the central banks possess, such as asset purchases, etc. In addition, they note that Taylor's rule does not account for the lower bound interest rates that have dominated after the aftermath of the financial crisis of 2008. (Federal Reserve System, 2022)

Other studies also show that the Taylor rule should not be mechanically followed as a one-size-fits-all solution across different economies. This is because it can be seen as a simple monetary policy that is not robust enough to model uncertainty about the natural rate of interest. Also, using Taylor's rule may lead to needless policy volatility (Orphanides & Williams, 2003). As other studies conclude, also Taylor (2007) points out that the Taylor rule is not a right fit for all policies and should be considered as a useful tool rather than a mechanical guide, as it does not account for every factor that can affect different economies.

Also, similar comments are to be made towards monetary policy transmission mechanism theory as it has been shown by other studies, that the true theoretical mechanical monetary policy guide depends on the country, the type of monetary policy, and the tools that central banks have available within their policy (Janus, 2016). However, these two theories set up the groundwork for the central bank's behaviour in their mission to keep economies stabilized and support growth.

2.4 Term structure of interest rates

As we try to understand economies and economic cycles, it is reasonable to cover the term structure of interest rates, also known as the yield curve. The yield curve theory explains the relationship between bond yields to maturity. In a normal market environment, the yield curve is upward trending so that bond yield and the maturity of bonds are positively correlated. This means that if the maturity increases the yield also increases, and contrariwise. Thus, the yield curve illustrates the behaviour of interest rates with different maturities.

In turn, the expectations theory, segmented markets theory, and liquidity premium theory try to describe how this behaviour is explained from the aspect of three key behavioural characteristics of interest rates. The three key behavioural characteristics are:

1. *Interest rates for different maturities tend to move together.*

2. *Short-term interest rates deviate more.*

3. *Short-term interest rate tends to be smaller than the long-term interest rate.*

The expectations theory of the yield curve states that long-term interest rates are determined by the market expectations of short-term interest rates. The theory assumes that investors do not prefer short- or long interest rates over another and that there is no inflation risk or interest rate risk. Thus, investors will hold a bond that offers the best return, regardless of the maturity of the bond. The expectations theory can be summed up with an example that an investor has two options. The first option is to buy a 100€ bond that matures in one year, and after one year, the investor buys another one-year bond. Option two is to buy a 100€ bond that matures in 2 years. In expectations theory, option one and option two are equal and do not offer superior returns over the other. This bond selection example can be written as follows,

$$100€ \times (1 + i_t) \times 100€ \times (1 + i_{t+1}) = (1 + i_{2t})^2 \tag{4}$$

where,

i_t = interest rate for one year for the one-year bond
i_{t+1} = interest rate after one year for the one-year bond at the time $t + 1$
i_{2t} = interest rate for the two-year bond at the time t
(Cox, Ingersoll, and Ross, 2007.)

While expectations theory and the equation that it generates is a useful tool for predicting short-term interest rates, it is still a theoretical model and does not fully reflect the relation of short- and long-term interest rates. In other words, the expectations theory tries to explain how to predict the changes in the yield curve (Campbell, 1991). However, the expectations theory does not explain why bonds with longer maturity typically offer higher yields, in other words, the upward slope in the yield curve. The segmented markets theory attempts to explain that.

The segmented markets theory considers the long and short interest rates to be entirely distinct asset classes from each other. This is seen in the assumption that only long bonds and long interest rates carry inflation risks, unlike in expectations theory. This is because, in the real world, time brings uncertainty. In the context of different bond maturities, shorter bonds are less connected to the risks that longer bonds carry. Thus, the segmented markets theory explains the upward slope in the yield curve. In contrast, the liquidity premium theory utilizes the assumptions of expectations theory but considers the bonds with different maturities as substitutes, not as perfect substitutes. According to the liquidity premium theory, investors expect a liquidity premium on bonds with longer maturity. (Cox et al., 2007.)

Typically in an upward-trending market cycle, the yield curve is upward-sloping, which means that short-term interests have lower yields than long-term interests. In general, when the yield curve is inverted, where the short-term interest rates offer a higher yield than long-term interest rates, the yield curve is indicating a positive sign of an upcoming recession. A study by Faria and Verona (2020) shows that the yield curve is one of the most promising macroeconomic variables when trying to predict equity market behaviour in terms of a stable economy, economic growth, or economic recession. They point out that the yield curve hands out important information about the state of the economic cycle, which in turn explains the time variation in stock market returns.

2.5 Interest rate risk

Interest rate risk is one of the external risks that all investors, companies, banks, Insurance companies, homeowners, etc. face, but can be managed (Yasuoka 2018). Companies face two types of risks, internal risks, and external risks. These internal risks, in general, are risks that are related to the operations of the company which the company can affect through its operations. External risks instead are risks that are generated by external factors to which the company has an exposure, but which cannot be managed straight through the operations of the company. External risks can be related to geopolitical-, currency- or macroeconomic factors just to name a few. Interest rate risk is an external risk for all companies bearing debt, that affects externally but directly, for example to the cost of capital.

Companies that bear debt can, and should to some extent, manage the interest rate risk through their decision-making process and with hedge tools available to minimize the non-wanted external risks. As mentioned, changes in interest rates affect the capital structure and to the cost of capital. But the changes in interest rate can also affect the cash flow and earnings. For example, higher interest rates make borrowing more expensive and add to the financing costs of the debt. According to Brealey et. al. (2020), interest rate risk is one of the most common external risks that companies manage actively as 83% of their sample companies managed interest rate risk to some extent through derivatives.

Interest rate risk varies between different companies as the exposure to the interest rate risk depends on the capital structure of the company. A study by Bretscher, Schmid, and Vedolin (2018) states that companies that are smaller in size are more exposed to the interest rate risk, ceteris paribus. In contrast, companies that are holding no debt, where the capital structure consists only of equity, have no interest rate risk or the interest rate risk is almost non-existent. However, the literature on interest rate risk management also concludes, that both positive and negative relations are found and hypothesised on interest rate risk exposure to company size and debt usage of companies. Hence, interest rate risk, in general, applies to every company to hedge against. The most common tools and hedges are interest rate swaps, forward rate agreements, and OTC options (Hakkarainen, Kasanen & Puttonen, 1997).

Past evidence seems to point out that the interest rate risk is more widely managed among US companies than in Europe. For instance, Bartram, Brown, and Fehle (2009) show that prior to the financial crisis of 2008, foreign exchange (also known as FX) hedging has been more common in Europe than in the US, but interest rate hedging by interest rate derivatives has been significantly more common in the US than in Europe. Only

32,4% of companies had reported interest rate hedging in Europe, while the corresponding measure in the US was 40,4%.

Thus, in Europe, it has been more typical to hedge on FX, but companies based in the US are managing interest rate risk at a wider scale than in Europe. The FX hedge might be explained as European companies can have more exposure to foreign currencies as not all countries inside Europe have adapted to Euro. But the interest rate hedging should be essentially equal between Europe and US. Thus, we can make the assumption, that the interest rate hedging in Europe is trailing the US due to the more immature corporate debt markets in Europe.

From the investors' perspective, there is another approach to the interest rate risk than to just evaluate the interest rate risk effects on the capital structure and future cash flows from a firm-specific level. Investors also evaluate, in part of their risk management, the interest rate risk as the asset's market price sensitivity to the interest rate changes. In the context of stock investing, different stocks can carry a different amount of interest rate risk than others through the firm-level effect, but also because of the market-level of effect. For instance, investors may be willing to pay more, in other words, willing to pay a premium for individual stocks that are expected to perform better either in higher or lower interest rate conditions. This means, that as stock prices are sensitive to interest rate changes, the sensitivity can vary between different assets, stocks, or stock portfolios also through the market's perspective. (Lioui & Maio, 2014.)

2.6 Overview of interest rates in Europe

The ECB, which was established in 1998 governs the key interest rates in the euro area. The key interest rates that the ECB governs are the main refinancing rate, also known as MRO, marginal lending rate, and deposit interest rate. In general, the MRO is referenced when discussing the ECB key interest rate without further specifications. The MRO rate is the interest rate that ECB uses when providing liquidity to the euro area through its refinancing operations. It is also considered to be the main tool that the ECB affects the economy of Europe in achieving its monetary policy objectives. The historical MRO rate notation is shown in Figure 1.

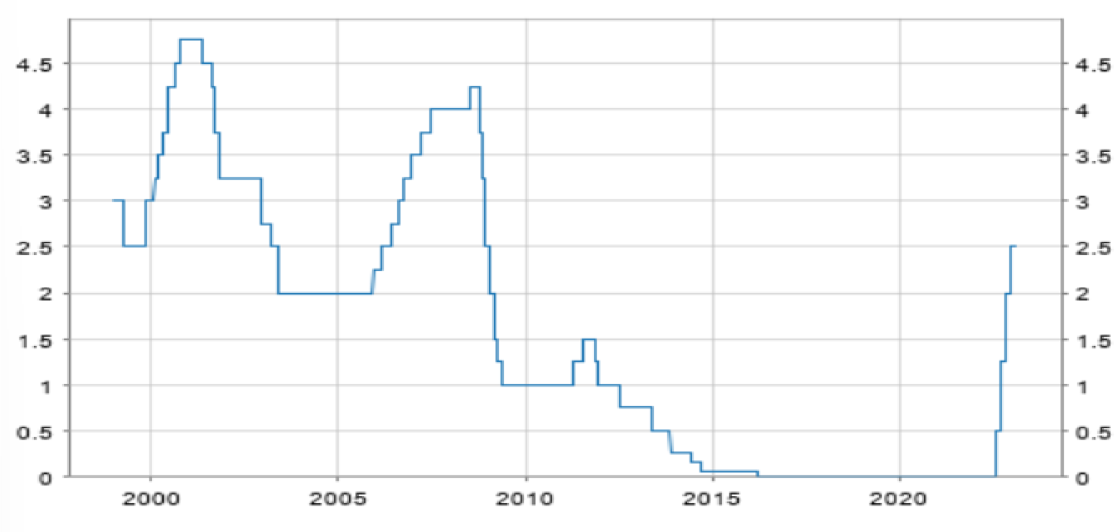

Figure 1. ECB Key interest rate, main refinancing operations, 1.1.1999 - 3.2.2023 (European Central Bank, 2023).

Government bond yields reflect how expensive in a given time it is for the government to borrow money. These bonds are determined and influenced by many factors, such as inflation expectations, economic growth statistics and forecasts, and the overall market demands for bonds. In Europe, governments issue these bonds with varying maturities. In general, the German bond yield is often used as a benchmark for European bond yields, for the overall status quo of the European fixed-income market. However, the ECB also provides data and statistics on the overall European government bond market and yields. When we compare Europe to the US, the nominal Euro-area 10-year bond, including all European issuers with triple-A credit rating reported by ECB can be used as an equivalent to the US government 10 years treasury bond. The Euro-area 10-year bond reported by ECB is illustrated in Figure 2.

Figure 2. Euro-area 10-year government bond, nominal, all issuers with AAA rating (European Central Bank, 2023).

The Euro interbank offered rate, often referred as to Euribor, is a commonly used reference rate in the eurozone for floating rate loans, derivatives, corporate loans, mortgages, etc. At its core, Euribor is used as a reference rate for euro-denominated lending between banks in the European interbank market. Euribor rates were first introduced in 1999 and were quickly adapted in the euro-zone, as other domestic reference rates like Frankfurt's Fibor and Helsinki's Helibor merged into Euribor.

Figure 3. Historical Euribor 12 months (Euribor-rates.eu, 2023).

From the end 1990s to the present time in 2023, all three interest rates, ECB key interest rates, government bonds, and Euribor rate, have experienced various trends and changes due to several economic cycles and factors. Most radical peaks at the ECB key rates have been seen after the dot-com crisis, during the financial crisis of 2008, and the most recent rate hike happening in 2022 and 2023. A similar trend is also noticeable in Euribor rates, logically. However, during the period between the financial crisis of 2008 and 2022 rate hikes, ECB and Euribor rates experienced unprecedented low bound levels, and even negative values, due to the loose monetary policy. However, due to many economic factors, in 2022 ECB has tightened the monetary policy measurably to set the Euro-area inflation under control back to the two percent target level.

As seen, Euro-area government bonds are also following the same trends as the ECB key interest rates and Euribor rates. Government bonds peaked during the financial crisis of 2008 due to the economic slowdown and increasing risk aversion. After the crisis government bonds remained low due to the ECB's loose monetary policy and the economic recovery from the financial crisis of 2008 and the Euro crisis. However, similarly than other rates, government bonds have been increasing rapidly since the beginning of 2022 due to ECB interest rates hikes, inflation rates, economic expectations, and political events, among other factors.

3 Growth companies

For the context of this study, it is of key importance to understand growth, growth companies, growth stocks, and growth investing. In this chapter, we will cover these concepts in order to understand what separates growth companies and growth investing strategies from the rest. Also, understanding growth is important as it is one of the key building blocks of economic prosperity and job creation among different economies.

3.1 Understanding growth companies

In academic literature, growth companies are businesses that are experiencing exceptional growth in terms of revenue, market share, and other performance-related metrics. Understanding growth factors and growth companies is important as they contribute well to our economy and are often associated with high innovation, job creation, and economic development. Understanding growth is important also because growth is found to explain the success and survival of companies in the long term. For example, companies that's revenue growth is slower than GDP are found to be significantly more likely to fall, usually via acquisition, than a company that matched or exceeds the growth rate of the overall economy's GDP (Birch, 1979; Smith, Thompson & Viguerie, 2005.)

Growth companies can be defined in different ways, but usually, they are defined in the terms of the number of employees and terms of revenue. For instance, the Eurostat-OECD manual on Business Demography Statistics (2007) defines growth companies as enterprises with average annualised growth greater than 20% per annum over a three-year period either in employee count growth or growth in revenue. Growth companies can be either young or old in their business maturity. In some literature growth companies, that are also relatively young by their age, are referred to as Gazelles. When measuring growth by revenue- or employee growth, some thresholds are in order, because a very small company can double its employee count if a two-person company hires two persons more. (Henreksen & Johansson, 2010.)

Before covering company valuations, it is reasonable to cover the ways that companies grow and some of the main drivers of value creation behind growth. One of the ways of understanding growth and how revenue growth is generated is to divide the revenue growth into three subcategories:

1. *Portfolio momentum, meaning the organic revenue growth that the company is experiencing, is due to the overall growth in the market segment where the company is operating.*

2. *Market share performance, meaning the revenue growth by acquiring a larger market share from its competitors in the overall market segment from its operations.*

3. *Mergers and Acquisitions (M&A), which is also known as inorganic growth generated when a company grows by buying revenue through acquisition or divestments.*

(Koller, Goedhart, Wessels & 2020.)

These three categories in their input are well studied in the literature related to business growth. For instance, Baghai, Sven, and Viguerie (2007) study the portfolio momentum, market share performance, and M&A from the perspective of large companies and how they explain growth. In their global sample size of 200 companies, they find that portfolio momentum and M&A is the main driver of growth as it explains 80% of the growth differences among companies. Their findings can be interpreted so that management cannot solely focus on competition and gaining market share but should also focus on areas where it wants to compete. However, observations from Goedhart's and Koller's (2017) study of organic growth show, that in the US and in Europe, more value has been generated by companies that have been demonstrating organic growth compared to companies growing more heavily through acquisitions.

Over the long term, sustaining growth comes challenging. The natural life cycle of products and services demands companies to constantly seek new possibilities and forces them to keep innovating. Companies should be trying to replace every product or service that matures and suffers from a decline in revenue, in order to find new products or services to sell to maintain the growth phase. Also, companies are constantly competing for market share, as stated in subcategory 2, and therefore innovation and finding new revenue streams in the long term are crucial. It can also be, that the whole market where the company operates suffers from a decrease in revenue so much so that organic growth comes more difficult (Koller, Goedhart, Wessels, 2020).

Economic cycles, among other factors, determine the ability of companies to show growth. These factors also affect the overall survival rate of companies. For example, the financial crisis of 2008 and its effects on the growth rate of different companies are broadly studied. It is found that the downturn market cycle had a negative effect, especially on growth companies in general. However, the effects and their magnitude vary on different variables, such as company size in terms of revenue or human capital, the company's access to finance, etc. For instance, a study by Peric and Viteze (2015) demonstrates, that a company's revenue size is positively associated with a higher growth rate during 2008-2013.

In contrast, a study by Cowling, Liu, Ledger, and Zhang (2015) shows that small and medium-sized companies with relatively better access to financing managed to maintain revenue growth better, than their counterparts with limited access to financing. Overall, the effects of the financial crisis of 2008 are seen in Figure 4 which demonstrates the revenue growth -% distribution of companies generating over 1 billion USD revenue annually.

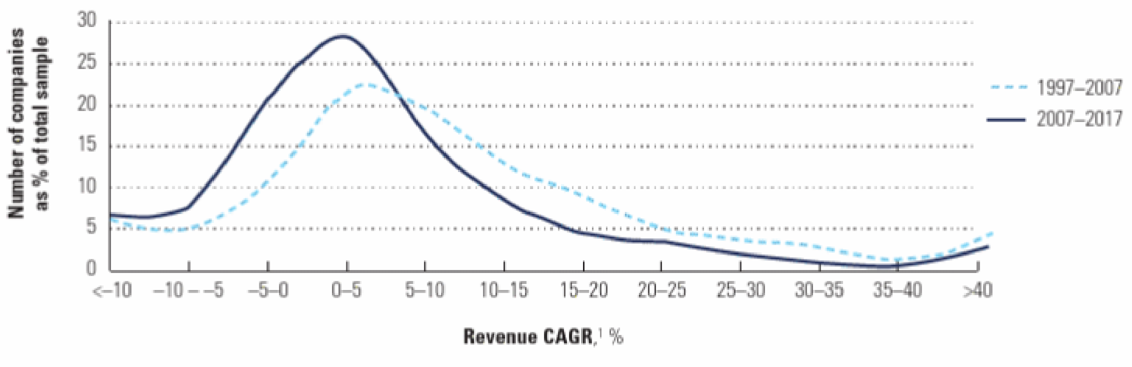

Figure 4. Distribution of growth rates of large companies (Koller, Goedhart & Wessels, 2020).

3.1.1 Capital Structure

When assessing growth and the factors that are influencing it, it is reasonable to discuss the capital structure, its main components, and the academic research behind it. The capital structure contains the mix of debt and equity that companies are using to finance their operations. Debt, in general, covers bonds and loans, whilst equity covers retained earnings, stock capital, and capital loans. The structure can be built on different instruments that are not listed above, but in general, bonds, loans, retained earnings, stock capital, and capital loans are the main components that form the financing sources for all companies. In the context of this study, capital structure is of key attention, because the interest rate changes effect directly to the cost of capital as the cost of debt is affected. To understand how companies try to optimise the capital structure, we will cover the most relevant theories for approaching capital structure and for measuring the cost of each capital component and the total capital structure.

The capital structure of companies is a widely studied subject in corporate finance. Theories that have received immense academic attention and have led to numerous follow-up studies are the Trade-off theory by Modigliani and Miller (1958) and the pecking order theory introduced by Myers (1984). The Trade-off theory states that when the cost of debt is balanced against the cost of equity the company reaches the optimal capital structure. Pecking Order theory is thought to be an alternative to Trade-off theory, where internal funds ought to be the most preferred source of funds to finance operations over debt and equity. The most not desired way of financing is considered to be issuing new equity as it is stated to be the costliest.

The most generalised way to measure the overall cost of the capital of companies is the weighted average cost of capital (also known as WACC) theory by Modigliani and Miller (1958). The WACC can be calculated by dividing the company's market values of equity and debt by the company's total market value and multiplying them separately by their costs before summing them together. In addition, the corporate tax rate is being considered to the cost of debt as it decreases the cost of debt. In other words, WACC weights the cost of capital components in their relative importance giving a precise result of the cost of the capital structure. The WACC formula is as follows,

$$WACC = \left(\frac{E}{V} \times Re\right) + \left(\frac{D}{V} \times Rd \times (1 - Tc)\right) \tag{5}$$

where,

$WACC$ = Weighted average cost of capital
E = Market value of the company's equity
D = Market value of the company's debt
V = Total market value of the company
Re = Cost of equity
Rd = Cost of debt
Tc = Corporate tax rate
(Modigliani & Miller, 1958.)

Academic research is not yet, best of our knowledge fully covered the comparative leverage between value and growth stocks. However, there is some evidence that growth companies tend to be more leveraged than value companies (Andoseh, 2010). Because it is plausible that the interest rate changes affect more to the companies that are on average more leveraged, in the context of this study, the relative amount of leverage of growth companies versus value companies is an interesting factor to consider. We will cover more on this subject in Chapter 5.2.

3.2 Understanding growth investing

While it is well documented that value investing tends to overperform growth investing (see Chapter 5.1.), growth investing is still one of the most common investing strategies exercised by professional investors. Growth investors invest in companies that show future growth potential which will generate high stock returns, relying on the efficient market hypothesis which states that all available information is already priced in the current stock price. It could be expected that growth investing would have lost its attractiveness due to the better performance of value portfolios, but this has not happened for several reasons. For instance, diversification of investors' investment portfolios and momentum trading are also considered to be driving factors for growth investing.

By one definition, the growth stock term is used on companies that have increased their earnings per share (also known as EPS) in the past more than the common companies in general and are forecasted to do so in the future as well. Contrast for growth stocks are value stocks, that are not linked with high expectations for the future, and their value is, in general, derived from the balance sheet, not from the profit and loss statement as does the growth stocks. (Schießl, 2013.)

Characteristics for growth stocks are high ratios in their price-to-book (also known as PB)-, book-to-market (also known as BTM), price-to-earnings (also known as PE)-, price-to-cashflow (also known as PCF)- and price-to-share (also known as PS) ratios. These ratios are higher than the average common stock due that growth stocks carry a lot of expectations of future growth on their shoulders. Investors value growth stocks by their future metrics, not by the profitability of today. Also, for growth stocks, it is uncommon to hand out dividends, as growth companies invest their earnings usually back into their operations to generate growth over dividends. (Schießl 2013.)

4 Valuation and asset pricing

In order to understand the stock prices of common stocks, or more specifically, growth stocks, it is reasonable to discuss the share price valuation and cover the most common valuation methods. This helps us to understand how investors see these assets and how the market behaves as a whole. We begin by introducing the most important concepts and theories which modern asset pricing- and valuation methods derive originally from. Key concepts are the portfolio theory by Markowitz (1952), the efficient market hypothesis by Samuelson (1965), and Fama (1970) which set the framework for the valuation approaches and methods discussed later in Chapter 4.3.

4.1 Portfolio theory

Markowitz (1952) presents the modern portfolio theory in a search for an optimal approach for investing in portfolios using mean-variance analysis contrary to investing in singular securities. In short, the modern portfolio theory is a mathematical framework for building optimal portfolios for maximum expected return while the risk is at its minimum. In other words, the portfolio theory presents the optimal risk-return ratio for given investments. Portfolio's expected return is its components' weighted returns and can be written as follows,

$$E\left(R_p\right) = \sum_{i=1}^{n} w_i r_i \tag{6}$$

where,

$E\left(R_p\right)$ = Expected return for portfolio p
w = weight of each security i in portfolio p
$\sum_{i=1}^{n} w_i = 1$

Now as we can calculate the expected portfolio return, in order to maximise the risk-return ratio, we need to be able to calculate the risk. The portfolio risk is considered to be generated by the standard deviations of the individual securities. Hence, the portfolio risk, the portfolio variance, for two securities a and b can be written as follows,

$$\sigma_p^2 = w_a^2\sigma_a^2 + w_b^2\sigma_b^2 + 2w_a w_b \sigma_a \sigma_b p_{ab} \tag{7}$$

where,

σ = standard deviation for securities
p_{ab} = correlation coefficient between a and b, which is interpreted as $|\mathrm{p}| \leq 1$
(Markowitz, 1952.)

If the correlation coefficient is equal to one, the securities have a perfect positive correlation, and they evolve in the same direction. In contrast, if the correlation is minus one, they move perfectly in opposite directions. The correlation of the two securities directly influences the portfolio variance, and therefore an investor can by security selection influence the portfolio risk.

Markowitz's (1952) theory suggests that investors can reduce the amount of risk in their portfolio investment strategy by diversifying their investment well enough. As a result, well-diversified portfolio bears decreased amount of risk than a non-diversified portfolio, ceteris paribus. The model also suggests that by taking more risk, investors can expect a higher return. But at the same time, investors face a greater chance of negative returns as the expected risk increases, thus the risk-return trade-off. Therefore, a better perspective is to consider the risk tolerance level of the investor and find the optimal portfolio using Markowitz's method.

As stated, optimal portfolios can be constructed with different expected return preferences. Markowitz (1952) theorises about optimal portfolios that exist on the efficient frontier. This is pictured in Graph 5 where the most desired relationship of the risk-return ratio is illustrated on the illustrated curve between points *E* and *F*. The efficient frontier line represents the portfolios that maximise the expected rate of return on a certain level of risk, hence the name efficient portfolios. The curvature shown in the efficient frontier follows the covariance effect, which states that moving to higher values of expected return progressively forces to decrease in the number of individual securities held in the portfolio. The efficient frontier determines the risk-return trade-off and plots the efficient portfolios. (Francis & Dongcheol, 2013.)

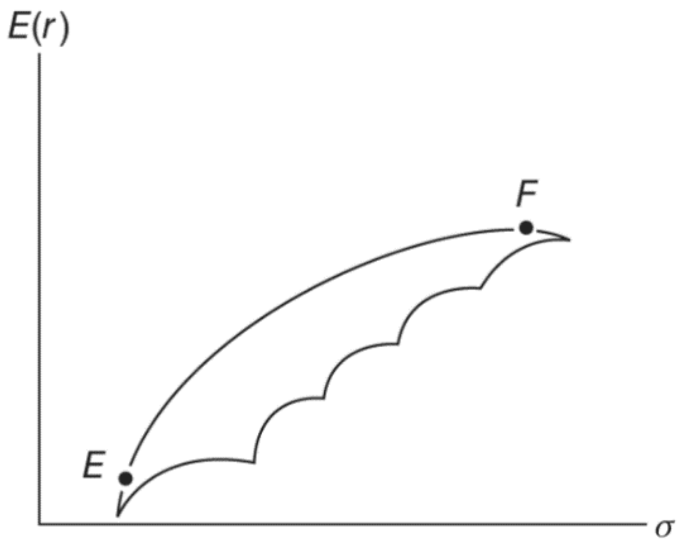

Figure 5. Efficient frontier and investment opportunities (Francis & Dongcheol, 2013).

Markowitz's (1952) portfolio theory thus implies that optimal portfolios are diversified across different asset classes. Toby (1958) complements Markowitz's theory adding that it is rational to hold interest-bearing assets and adds the risk-free rate into the analysis. When r_f is added to the model, it opens a new possible scenario noted by the capital market line (also known as CML), by lending and borrowing using the risk-free rate. The optimal portfolio M, that optimises the risk-return ratio can be leveraged or unleveraged when borrowing or lending is possible with a risk-free rate. This allows the investor to hold a portfolio within CML according to the risk preference. This is illustrated in Figure 6. (Francis & Dongcheol, 2013.)

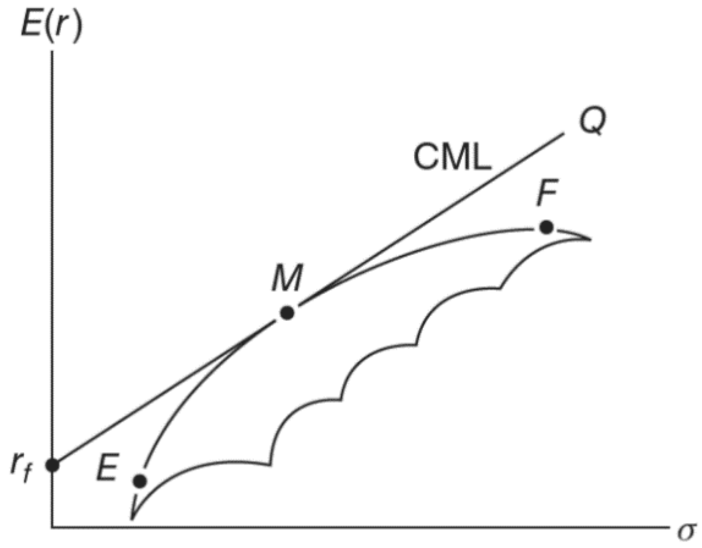

Figure 6. Efficient frontier, risk-free rate, and the CML (Francis & Dongcheol, 2013).

4.2 Efficient markets

Similarly to portfolio theory, the efficient market hypothesis, also known as EMH, is one of the building blocks of modern financial concepts and has been at the centre of interest of scholars, researchers, and real-world practitioners since it was first introduced. The market behaviour, often seen as herd behaviour, on the stock market seems to behave irrational and random as Kendal (1953) concludes in the early literature. The literature evolved rather soon during the next decades, for instance, Samuelson (1965) states that returns evolve randomly, but stock prices are reflecting all available information at a certain time. Samuelson (1965) continues to add that competition amongst investors in the market explains the unpredictability and randomness of stock price variation.

Fama (1970) continued the research of stock market behaviour and introduced the efficient market hypothesis, EMH, which states that in efficient markets stock prices reflect all available information, transactions are zero-costs, and all market participants behave rationally. This means, that in order for the market to be perfectly efficient, all investors have to have access to the same information. When they do, an individual or group of investors cannot systematically outperform the market, as stock prices reflect all publicly available information. Hence, when the market is perfectly efficient, the current stock prices reflect the true value of its asset, and that new information is quickly altering the true value as investors react to the information presented. This implies, that arbitrage opportunities and profits do not exist in a perfectly efficient market.

EMH is considered to be categorised into three forms, that reflect the amount of information that is available for market participants. First, the weak form is considered to be the dominant form, where the past prices, returns, volume, etc., reflect the stock prices, and therefore the future prices cannot be accurately predicted. The semi-strong form is reached when in addition to the historical data past prices, etc., all publicly available information is accounted for the current stock price. Lastly, the strong form is reached when all information relevant to the company, insider information included, is reflected in the stock price and therefore already “priced in”. Thus, in the presence of a strong efficient market form, future stock prices are completely unpredictable, because the stock price changes reflect only new information, immediately. (Fama 1970).

In the framework of EMH, the deviations from the predictions that EMH gives are called market anomalies, assuming that these mispricings are persistent and systematic patterns that are unexplainable with known asset pricing models or multifactor models. In fact, asset pricing models like the multifactor models by Fama and French (1993; 2015) try to capture anomaly variables in their models through their factors that would explain the expected return of the asset. However, these can be burdensome as anomalies disappear quickly and usually cannot be repeated. (Hou, Xue & Chang, 2020.)

Despite EMH being at its core a theoretical assumption that only grips a real-world practice of finance, it is still a key concept for generating investment strategies, capturing anomalies, and distributing as a framework for asset pricing models. EMH and portfolio theories deliver a major perspective for market behaviour, which is of key importance, as we try to understand the approaches for valuation and asset pricing models.

4.3 Stock valuation

In this chapter, we cover the valuation methods to value publicly traded common stocks. The theoretical value of the company and its stock may, and usually does, differ from the market valuation as the market valuation is driven also by behavioural finance theories and other factors. A valuation can be based on only the company's current status, but valuation can also take into consideration future revenue, cash flow, and profit expectations. When future expectations are taken into consideration, the models describe the company's and the share price's actual real value. Hence, growth stocks have also their own valuation aspects and methods that are being covered in this chapter.

4.3.1 Multiples valuation

One of the most common ways to evaluate share price and the company's real value is to use market multiples, such as BTM, PB, PE, PCF, and PS ratios. Multiples valuation is closely related to the relative valuation model, where the underlying company is compared to its peers using multiple valuation methods and ratios. Comparing multiples amongst peer companies can be an effective and a quick way to map the market valuation of the underlying company or to spot over- or undervalued companies among the peers. This valuation method used to compare multiples amongst similar companies is called valuation by comparables. (Kallunki & Niemelä, 2012; Brealey, Myers & Allen, 2020.)

In general, the PE ratio is the most common ratio for multiples valuation estimates. PE ratio is calculated by dividing a company's market value of a share by the earnings per share. PE can be expressed as follows,

$$PE = \frac{Market\ value\ per\ share}{Earnings\ per\ share} \tag{8}$$

PE multiple is to be handled always within the comparable group. As a standalone ratio, it gives a good insight against for example the market median, but the ratio can be misleading when wrongly interpret. Differences within the PE ratio can be explained by differences in the company's growth expectations, differences in stages of maturity, differences in debt levels, or differences in company and market risks. If the analysed stock has more growth expectations with a low level of risk, it has to have a higher PE ratio than stocks with lesser growth expectations or higher risks in general. (Kallunki & Niemelä, 2012.)

In the case of PE, it is also useful to discuss the break-even time, also known as BET. The PE multiple is representing the BET, as it tells how many years would take for the company's earnings to match the current share price. But because this representation is perfect only then when earnings never change and interest rates are zero, which is an unrealistic scenario, a more sophisticated formula for BET is needed. A more realistic BET can be calculated by adding an estimate of growth in earnings and a discounting process. The accurate way to approximate BET is as follows,

$$BET = \frac{\ln(1+r\times PE)}{\ln(1+r)} \tag{9}$$

where,

BET = break-even time

$r = \frac{1+estimated\ growth\ of\ earnings}{1+discounting\ rate} - 1$

By estimating BET, investors get some sense of the basis for value comparison between different assets with differing growth expectations. BET seeks to interpret the PE ratio in relation to the growth rate, in other words, it tells how much would the PE ratio be for different levels of growth. Figure (8) presents the trade-off between the PE and growth rate for given levels of BET. As shown, increases in the growth rate are leading to larger increases for PE, as valuations get higher. (Estep, 2019)

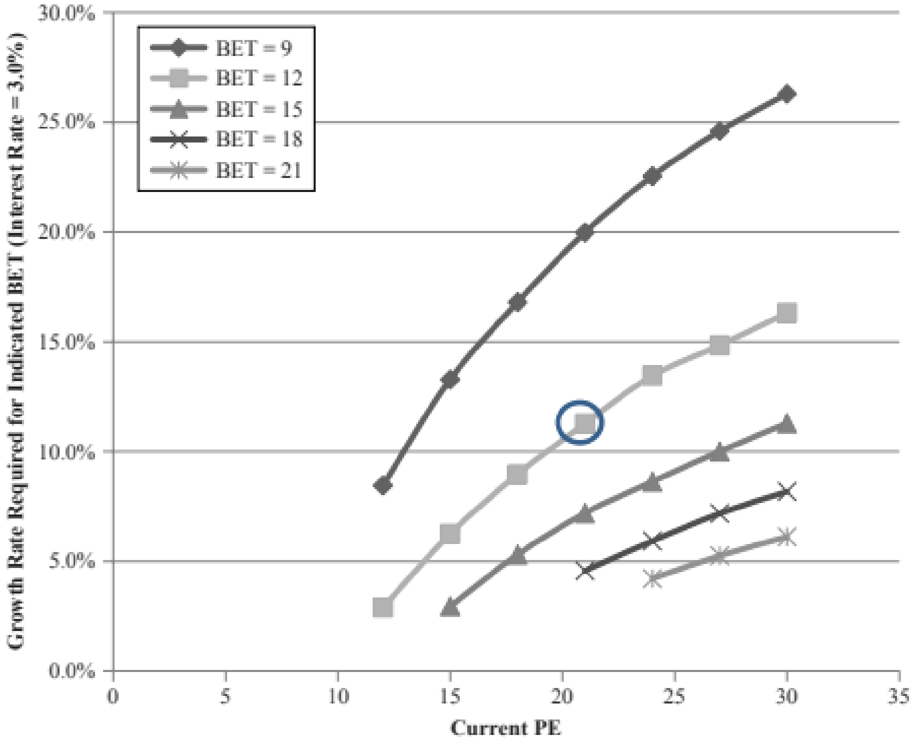

Figure 7. Growth/PE trade-off for given BET (Estep, 2019).

Book value represents the value of a company as an accounting measure, where the book value represents the net difference between the company's total assets and total liabilities. Hence, it represents the shareholder's equity in the company. From a valuation perspective, the book value is often seen as the bare minimum value of the company, as it represents the net value of assets in a liquidation scenario. However, book value does not account for the value of intangible assets or the goodwill, so it does not always reflect the company's true value. The book value of a company is a good indicator of the company's overall health and performance. Book value per share (also known as BVPS), is one of the common metrics used to assess the share price to its underlying assets. (Brealey et al., 2020.)

Another, one of the most fundamental multiples valuation methods is the book-to-market ratio, also known as BTM. The ratio helps identify companies and stocks with either a high or low book value of equity in relation to its market value of equity. Companies that have a high BTM ratio are referred to as growth companies, as their current high stock price relative to the common equity indicates that investors are willing to pay a premium for future growth expectations and opportunities. Controversially, companies with low BTM ratios are referred to as value companies as their current stock price is low in relation to the common equity that the company carries. BTM can be calculated as follows,

$$BTM = \frac{Common\ Shareholders'\ Equity}{Market\ Cap} \tag{10}$$

Like PE, also the BTM ratio is widely used in the academic literature on asset pricing models among other fields. Fama and French (1992) state that BTM is a useful tool to identify value and growth stocks, and a good factor for explaining stock returns. In Chapter 5, we will discuss and compare the performance between growth and value stocks and portfolios. In this study and in our empirical research, we will follow the ideology of BTM as a dividing factor between value and growth stocks (see Chapters 5.1. and 6.2.).

Multiples valuation methods are partially criticized amongst the theoretical literature because the single multiples valuation method can give an oversimplified valuation of the underlying company without taking into consideration other sufficient and necessary variables to obtain a reliable valuation. Thus, multiples valuation ratios are held to give a good supporting insight into the market valuation and the real valuation for other, more comprehensive valuation and asset pricing models. (Kallunki & Niemelä, 2012.)

4.3.2 Dividend model

The dividend-based model of valuation states that the share price today is a reflection of the future dividends that the shareowner receives for owning the asset. Following the discounted cash flow model, also known as DCF, the market value, meaning the present value of an asset, is the sum of its future cash flows discounted with a discount rate such as the expected rate of return. The discount rate, therefore, is for example the expected rate of return of other similar risk-level assets. Hence, the discount rate is the expected return of the risk class. The dividend discount model equation is as follows,

$$P_0 = \sum_{t=1}^{H} \frac{DIV_t}{(1+r)^t} \quad (11)$$

where,

P_0 = Share value today
DIV = Dividends at time t
r = Expected return, the discount rate
(Brealey, Myers & Allen, 2020.)

Commonly, the expected return is guided by the risk premium and a risk-free rate. Therefore, according to the model, changes in the risk-free rate affect directly the valuation of an asset and influence pricing. In other words, changes in risk-free interest rates are commonly agreed to directly affect asset pricing, at least when using a dividend discount model. Also, in the real-world economy, there are various variables that can influence the expected cash flows, i.e., dividends, interest rates, inflation, and other real and nominal forces. Thus, the dividend discount model links asset pricing to systematic risk, through macroeconomy (Chen, Roll & Ross, 1986.)

The dividend-based valuation model fits companies that are in their mature stage and are expected to pay dividends. But for younger companies that focus on growing their revenue, the more suitable option in most cases is not to pay a dividend to the shareholder from their profit but to reinvest into the company itself, to invest in growth. Divided-based model is still an appropriate model to valuate growth companies, but it is difficult to use because the cash flows of future dividends are usually so far away in time for growth companies. Hence, in academic research and in real-life practice, valuation for growth companies is mostly done by comparables and earning-base formulas. (Brealey et. al., 2020.)

4.3.3 Capital asset pricing model

When trying to perceive the stock market and its behaviour, it is useful to discuss the capital asset pricing model, also known as CAPM, developed by Sharpe (1964). CAPM is one of the cornerstones in asset pricing theory and it is recognised widely in financial research and in practice. It gives a good insight into stock, and portfolio valuations and prices, as we are approaching discovering the expected returns for common stocks and growth stocks. CAPM is a broadly used model in finance that illustrates the relation of the expected return on risk of an asset. The model is used in both, examining single stocks, or constructed portfolios or indices. The model describes that higher expected returns are being achieved by increasing assets or portfolio risk. In other words, the higher the risk, the higher the expected return that investors demand. (Sharpe, 1964.)

The model follows Markowitz's (1952) portfolio theory and Tobin's (1958) research on portfolio tangency. Hence, the model follows several assumptions: investors can borrow and lend at a risk-free rate, investors have similar expectations and have the same information available, markets are in equilibrium, investors have the same investment options and alternatives available, and lastly, investors' investment durations are same for their investments. The CAPM states that the sum of a risk-free rate and the risk premium is equal to the expected return of an asset. The Risk premium is constructed using the asset's beta, which measures the relativeness of the asset's movement to the movements in overall markets, in other words, the asset's risk sensitivity to the market risk. Therefore, beta is the asset's volatility measure related to market volatility. The market risk premium is the excess return of the market return over a risk-free rate, such as the government bond. The CAPM formula can be written as follows,

$$E(R_i) = R_f + \beta[E(R_m) - R_f] \tag{12}$$

where,

$E(R_i)$ = expected return on stock i

R_f = risk free rate

β_f = beta of the stock

$E(R_m)$ = expected return of the market portfolio

(Sharpe, 1964.)

CAPM is a so-called single factor model as it uses the asset's exposure using the beta, to a market factor, and therefore beta being the single explanatory factor for the expected return. Thus, in CAPM, beta is the exposure to the systematic risk of the market portfolio. Beta can be noted as,

$$\beta = \frac{COV(R_i R_m)}{\sigma^2(R_m)} \tag{13}$$

where,

R_i = Asset return

R_m = Market portfolio return

$\sigma^2(R_m)$ = Variance of the return of the market portfolio

$COV(R_i R_m)$ = Covariance between market portfolio return and asset return

Although CAPM is a widely recognised model in finance, it has been criticised also for some of its weaknesses. For instance, Fama and French (1993) explain that one of the major CAPM's disadvantages is its weakness to explain market returns and the timeline. As a consequence of CAPM weaknesses, other models have been merged and developed and the focus has shifted from a single-factor model to multifactor models, for instance, the three-factor model by Fama and French (1993) and the five-factor model by Fama and French (2015). This is natural, as Sharpe (1964) himself discusses and describes the problems of CAPM already when he first introduced it, such as strict and unrealistic assumptions.

4.3.4 Multifactor models

As it has been empirically found, that CAPM is not fully capable to explain cross-section stock returns and leaves anomaly variables unexplained, multifactor models have been theorised and developed to explore the other variables that explain asset prices besides market sensitivity. One of the key models presented as a continuance for CAPM is the three-factor model by Fama and French (1993), which accounts for the company size and value sensitivity in addition to market sensitivity, the beta. The size and value factors are accounted for because according to Fama and French (1992), they have a strong explanatory power for average stock returns when compared to other variables, such as leverage and earnings yield. The explanatory power is presented to remain strong for value and size factors even when other variables lose their explanatory power, or they are simply just dominating other factors and being more effective. The size factor is presented as SMB (small minus big) and the value factor is measured from the book-to-market multiple and presented as HML (high minus low). The Fama and French three-factor model can be written as follows,

$$R_{it} - R_{ft} = \alpha_i + \beta_i\left(R_{mt} - R_{ft}\right) + s_i SMB_t + h_i HML_t + \epsilon_{it} \tag{14}$$

where,

R_{it} = return of the asset or portfolio i for period t
R_{ft} = return of the risk-free rate f for period t
α_i = intercept of the asset or portfolio i
R_{mt} = return of value-weight market portfolio m for period t
SMB_t = return on a well-diversified portfolio of small stocks minus the return on a well-diversified portfolio of big stocks for period t
HML_t = return on well-diversified portfolio of high book-to-market stocks minus return on well-diversified portfolio of low book-to-market stocks for period i
β_i, s_i and h_i = factor exposures, in other words, factor coefficients
ϵ_{it} = zero-mean residual, in other words, the error term

(Fama and French, 1993.)

To interpret the model, the zero-mean residual, meaning the error term is created when the independent variables do not fully explain the dependent variable in the regression model. This means that the relationship between the independent and dependent variables is incomplete, and the regression equation may deviate according to the error term during empirical regression analysis. The intercept is zero when all the variation of returns for all assets in portfolio i is captured by coefficients β_i, s_i and h_i, otherwise the intercept is over zero. The three-factor model has performed well as an explanatory equation for asset returns, as for example, Fama and French (1993) are able to bring the intercepts close to zero in their study as they demonstrate the overperformance of the three-factor model over CAPM. But, while not zero, it then still leaves room to study what other variables are there that may strengthen the explanatory power of the model.

As a result of the development of valuation theory and research of strong cash flow being linked with higher returns, Fama and French (2006) study the expected profitability and expected investment variables. Through their empirical findings, they support the hypotheses that higher expected profitability generates higher expected returns and that higher growth in book equity generates lower expected returns. Aharoni, Grundy, and Zeng (2013) explore the Fama and French (2006) approach, but they shift the focus from the per-share level measures of expected investment and expected profitability to a more comprehensive company-level analysis. They conclude findings supporting the profitability and investment factors as explanatory variables on asset's or portfolio's return. This ultimately led Fama and French (2015) to publish a paper where a five-factor model is introduced. The Fama and French (2015) five-factor model captures size, value, profitability, and investment variables for explaining average stock returns. The model is as follows,

$$R_{it} - R_{ft} = \alpha_i + \beta_i(R_{mt} - R_{ft}) + s_i SMB_t + h_i HML_t + r_i RMW_t + c_i CMA_t + \epsilon_{it} \quad (15)$$

where,

RMW_t = return on well-diversified portfolio with robust profitability minus return of well-diversified portfolio with weak profitability
CMA_t = return on well-diversified portfolio with low conservative (low) investment minus return of well-diversified portfolio with aggressive (high) investment companies.
β_i, s_i, h_i, r_i and c_i = factor exposures, in other words, factor coefficients
(Fama and French, 2015.)

5 Literature review

The relationship between interest rates and the stock markets has been studied vastly in earlier literature. The earlier literature tries to understand how the stock market responds, reacts, and behaves in relation to interest rate changes, and how the interest rate movements and expectations predict the stock market. In the present interest rate environment, where both ECB and FED have increased their key interest rate substantially during 2022 and the interest rate expectations and bond market volatility are increased, it is once again useful to update the literature on the stock market response to the interest rate changes.

In this chapter, we will discuss the academic literature on the relationship between interest rates and the stock market and more specifically, for the purpose of this study, examine the literature on interest rates' relationship to growth stocks. We will also framework the earlier literature on growth stock performance, in order to understand the growth stock portfolios better when we compare them to the overall market and other portfolios.

5.1 Performance of growth stocks

The performance of growth stock portfolios versus value stock portfolios and market portfolios is a widely studied field in finance. The key literature points out that in the long run, value portfolios capture better performance than growth portfolios (Fama & French, 1992; Fama & French, 1998). The performance of these different strategies on portfolio performance is studied through a return basis and on a risk-adjusted basis. For instance, Bauman and Miller (1997) show that EPS estimates are systematically overestimated among growth stocks when compared to value stock EPS forecasts.

Bauman, Conover, and Miller (1998) find that the performance of stock portfolios varies on a singular annual basis between growth and value portfolios, but on those years that value portfolios outperformed growth portfolios, they did so with a high margin. Whilst contrariwise, growth portfolios did so with a small margin. This, in a 10-year period results in more favourable returns for value portfolios. Also, a study by Chongsoo, Cheh, and Kim (2017) presents similar results by stating that value stock portfolios tend to perform better even with different holding periods than growth stock portfolios. Interestingly, Andoseh (2010) finds that growth stocks tend to outperform value stocks during a loose monetary policy when interest rates are declining.

It is also noticed that are differences between differently constructed value and growth portfolios. In general, it is found that the results for portfolio returns vary depending on construction determinants, in other words, on the multiple that determines the portfolio as a value or a growth portfolio. For instance, Athanassakos (2009) captures in his study of value and growth stocks' value premium, that portfolios constructed using a PE multiple as an identification and separation method of a value or a growth portfolio over PB multiple, resulted in a higher value premium for value portfolio. However, as Fama and French (1998) show in their study that constructing a portfolio using a PB multiple criteria generates a higher value premium than when constructing with by other multiples. Despite the different views of the multiples, the literature is unanimous that value portfolios tend to overperform growth portfolios.

5.2 Relation between interest rates and the stock market

It is commonly known that asset prices reflect and react to economical news and events through different forces. It has been well documented that central banks, through their fund's rates such as ECB's key rates, influence the expected short- and long rates like government bonds, significantly. In turn, this has supported having a direct impact on the equity markets as discount rates reflect the expectations of the monetary policies. The general consensus is that interest rates have an inverse relation to stock prices (Chen, Roll & Ross, 1986; Cook & Hahn, 1988; Jensen, Johnson, & Bauman, 1997; Jareño, Ferrer, & Miroslavova, 2016.)

Interest rate changes are found to have an effect on stock price movements as the interest rates influence the investment and financing options, decisions, and resolutions. Low interest rates make borrowing relatively cheaper, which can make the expansion investment decision more attractive and increase the growth targets, expectations, and prospects. This alone can alter the company's valuation and therefore influence the share price. In contrast, high interest rates may tighten the sources of financing, as the cost of debt increases, and therefore limit the potential investment prospect that the company may have. Therefore, higher interest rates should have a negative effect on stock prices, and countervailing, lower interest rates should increase the stock price. (Fama, 1965; Campbell & Shiller, 1988.)

Interest rates affect stock prices also through investors' investment and portfolio decisions. This means, that changes in interest rates pivot the investors to reassess the attractiveness of their investments in reflection of other opportunity investments. For instance, expectations theory, also known as unbiased expectations theory, introduced by Muth (1961) states that investors will reallocate their funds as the interest changes as the attractiveness of different investment options alters.

According to Muth (1961), if interest rates increase, bonds may become a more attractive investment option as a source of fixed income as they offer higher interest on the invested capital than before. This shift in the investors' allocation of investments in their portfolio modifies the rate of demand for stocks. If we follow this thought, when interest rates rise, the stock prices should decrease as the demand for stocks falls because bonds and other fixed-income, interest-rate-based investment options raise their attractiveness. (Campbell & Shiller, 1991; Campbell & Shiller, 1998.)

Different individual stocks can also have different sensitivities to different interest maturities. In other words, some stocks might be more sensitive to short-term interest rate changes than others, and some to long-term interest rate changes. According to Chen, Roll, and Ross (1986), assets that are more inversely sensitive to long-term interest rate changes, are more valuable than others. This indicates that investors are expecting these assets to be relatively more valuable and offer better real returns than other assets would when interest rates decrease. Thus, individual stocks that are more negatively correlated with long-term interest rate changes, are carrying negative risk premium, ceteris paribus. Different sectors and industries are also showing a different levels of sensitivity to interest rate changes. For instance, Jareño et al. (2016) study the sensitivity of interest rate changes in different industries in the US. They conclude that their results do not support homogeneity at the industry level as the sensitivity to interest rate change has major differences from industry to industry.

In order to understand and anticipate how the market reacts to different economic events and news, it is important to understand monetary policies' relations to interest rates. At its core, positive economic and financial news should reflect positively on the stock market and individual stocks. However, positive news and good economic development should also increase the likelihood of tightening monetary policies and increasing interest rates. If interest rates and practiced monetary policies are affected due to positive news, it should lead to a tightening equity risk premium. Kurov and Raluca (2018) discuss the monetary policy that has been practiced after the financial crisis of 2008. According to them, the post-era of 2008 can be considered as a condition of high monetary uncertainty, where policy expectations are more sensitive to economic news, which in turn leads to the medium- and long-term interest rates being more sensitive to financial news.

Academic research before the financial crisis of 2008 has extensively documented a positive reaction to monetary policy surprises on stock prices, where the positive reaction is even stronger during a time of financial distress or bad development of the economy. However, different results have been documented from times of financial distress. Kontonikas, MacDonald, and Saggu (2013) demonstrate evidence that during the financial crisis of 2008, it was not well-known what the stock market's response to rate cuts would be. They show that short-term stock market returns had even negative effects on rate cuts during the crisis. In contrast, they point out that during the period outside the positive effect is very visible, supporting the consensus.

Based on the monetary transmission mechanism, it could be reasoned that changes in monetary policies and in interest rates should lead to different effects on stocks and companies that have different characteristics. For instance, Maio (2013) finds that the impact of FEDs fund rate changes on monthly returns is greater for small and value stocks than for large and growth stocks, as the impact is stronger for future expected cash flows than for a future equity premium. As growth companies have smaller cash flows and are expected to have smaller dividends, according to Maio (2013), their monthly stock returns are reacting less to interest rate changes.

While the focus of earlier literature has been in the US, interest rate sensitivity and the effect of interest rate changes on stock markets are also widely studied in the European market. As the Euro was introduced in 1999, European bond markets and corporate borrowing took a leap forward from traditional bank borrowing toward public debt markets (Korkeamäki, 2011). Hence, it is safe to assume that after the introduction and adaptation of the Euro, the Euro-area's financial markets have also substantially integrated, overall. Korkeamäki (2011) studies the interest rate sensitivity prior to the introduction of the Euro and the post-era of it. Interestingly, he finds that in Europe a negative relationship between interest rates and the stock market is present prior to 1999, but not after the Euro has been introduced. This indicates that the general consensus is only supported prior Euro.

5.3 Relation between interest rates and growth stocks

Earlier literature shows that the relationship between stock returns and interest rate changes can be different for individual stocks and different portfolios, and differ between industries (Jensen et al., 1997; Maio, 2013; Jareño et al., 2016). Also, academic research has developed a bridge between the interest rate literature to the stock portfolio comparison between value and growth stocks. In the existing academic context, the trend is usually, at least partially, to compare the sensitivity between value and growth portfolios, where a multiple valuation ratio is used to divide and construct these portfolios. This naturally leads to a competition-like comparison between value and growth stock portfolios.

One of the key studies bridging the literature between monetary policy and multiple valuation ratio portfolios is the study by Lioui and Maio (2014), where they examine the cross-section of stock returns to interest rate sensitivity. They find that interest rate risk is a key factor in explaining the value premium. They also find that value stocks, determined by the BTM ratio, tend to be more sensitive to interest rate risk than growth stocks. They rationalise this by stating that companies that are low valued, can be seen as “cash cows”, without opportunistic growth opportunities, making them behave more like bonds and other fixed-income financial instruments.

In contrast, evidence has also been found that supports the idea, that growth companies are more leveraged than value companies, and therefore more sensitive to interest rate risk. Andoseh (2010) shows that large-cap growth stocks are more sensitive to interest rates than small-cap value stocks. His study follows the assumption that large-cap growth companies are more leveraged by debt, than small-cap value companies, and is one of the corresponding reasons for the higher interest rate sensitivity among large-cap growth stocks

Interest rates’ relation to stocks, where the PE multiple acts as a dividing factor for determining a growth portfolio, has also been widely studied. For instance, Estep (2019) studies the SP500 growth and value indexes and how well the monthly unit change of the 10-year US treasury rate explains the earnings growth expectations against the future quarterly total return. Their results point out that their regression gives different results for different time periods. By dividing their sample into subperiods of a period before the financial crisis of 2008 and a period after, and by excluding the mid-2008 to the end of 2009 period from their sample, they were able to show more accurate results with hypothesized coefficient signs. However, their results still remain non-significant, and they conclude the relationship between long interest rate change and earnings to appear statistically random.

6 Data and methodology

In this chapter, we build the foundation of our empirical analysis for the study. We begin by describing the type of data that is been used, and how the data has been treated. We explain the approach to building our portfolios and the methodology on how to analyse the impact of interest rate changes on European growth stocks. The purpose of this chapter is to make the empirical analysis of this study more transparent and reproducible.

6.1 Sample description

In our empirical study, we use the stock and accounting data from the Thomson Reuters database for the stocks within STOXX Europe 600 index from January 1999 to December 2022. To be more precise, we collected the individual stock data of the companies, that were included in the index on the last day of December 2022. Hence, our dataset does not include individual stock data of companies that were excluded from the STOXX Europe 600 index between January 1999 and December 2022. This means that our data is biased as it only includes the companies that have been added to the STOXX Europe 600 index from 1999 to 2023, or companies that have remained in the index during the period.

Our snapshot of the STOXX Europe 600 index and its 600 companies from December of 2022 includes 354 companies that have been in the index since January 1999 and 246 companies that have been added to the index after January 1999. Thus, our empirical study sets challenges for real-world practice as it excludes companies that have reduced in size, for example, due to poor performance, enough to be dropped from the index during our sample period. Simplified, our dataset does not include “losers”. Finally, as we only try to understand growth companies, we exclude companies that are classified to operate in banking, insurance, or in other financial industries, leaving 470 companies in the population.

For the interest rate data, we use two different datasets, short-term interest data, and long-term interest rate data. For short interest rates, we use Euribor one-month interest rate quoted on a monthly basis from 1.1.1999 to 1.1.2023. The Euribor data is collected from the Thomson Reuters database. For long interest rates, we use the Euro area 10-year government benchmark bond yield quoted on a monthly basis from 1.1.1999 to 1.1.2023. The Euro area benchmark bond yield data is collected from European Central Banks' statistical data warehouse. Figure 8 shows the interest rate levels for both, the Euribor data and the Euro area benchmark data.

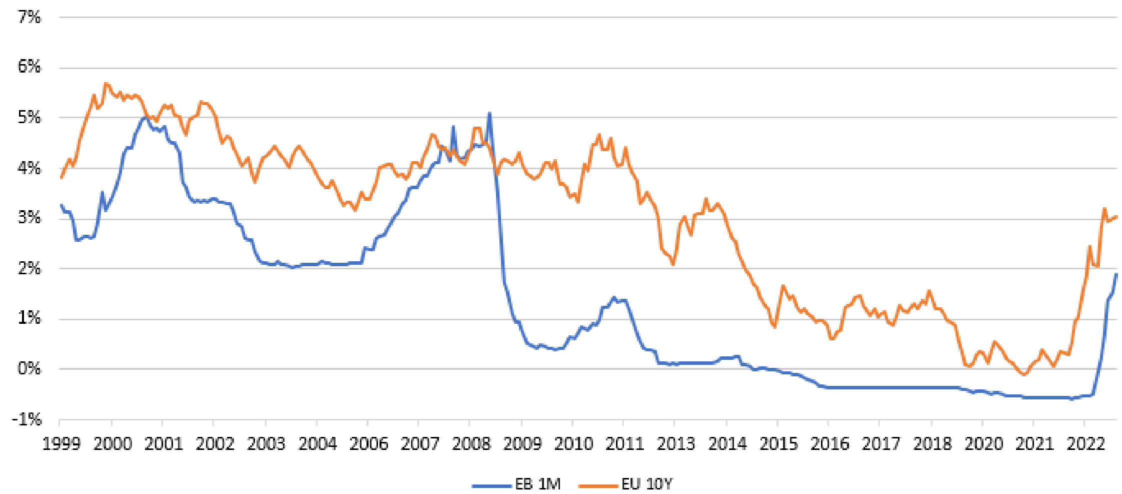

Figure 8. Euribor 1 month and Euro area benchmark bond yield rates, 1999 – 2022 (Thomson Reuters 2023; ECB 2023).

For our empirical analysis, we calculate and use the monthly unit change for both interest rates. We determine to use the monthly unit change instead of calculating the monthly percent change Because in our study period, both interest rates, short and long interest rates, also have data points where interests are near and even below zero as shown in Figure 8. Thus, unit change is the more preferable method for displaying monthly interest rate change because the percentage change would distort the results when the interest rates are near zero. Using this method, we are limiting the noise that the change in percent would create in the analysis. In contrast, we are losing the effect of relative change in interest rate as we only analyse the interest rate changes at the unit level.

As our stock data sample period is from 1.1.1999 to 31.12.2022, it includes the dot-com crisis, the financial crisis of 2008, the Euro crisis that followed the financial crisis of 2008, covid-19 pandemic, and the rate hikes seen in 2022. This means that our sample has periods, where the stock market returns, and the fluctuations of interest rates are more volatile than in the healthy economic cycle. Also following Estep's (2019) rationalisation, these crises can generate extreme values that can have an effect on the empirical analysis.

Thus, as the period is long enough, we divide our sample into subsamples and study different periods separately alongside the full period sample. We are determined to take this approach; hence we also divide our sample period into two subperiods. The first subperiod is from 1.1.1999 to 31.12.2007 that is corresponding to the period before the financial crisis of 2008. The second subperiod is from 1.1.2009 to 31.12.2022 which is corresponding to the period after the financial crisis of 2008. We determine to leave the year 2008 fully absent from each subsample as we can assume that the stock price fluctuations in that year could give outliers to the population giving misrepresenting results.

6.2 Portfolio construction

Using the accounting data, we form three portfolios according to the book-to-market ratio: low BTM-, medium BTM, and high BTM portfolios. Portfolios are rebalanced yearly in January according to the BTM ratio. Whilst making the study more hypothetical, we determine to divide the stocks into portfolios by the upcoming yearend BTM, not by the yearend BTM of the previous year. We take this approach out of the interest to match the monthly stock returns of the year with the outcome accounting data of the end of the year. This causes limitations to the real-world practice, as the portfolios in question can only be constructed with these definitions for subsequent analysis, but not in real time.

In January of each year, we include the new add-on companies that have been added to the STOXX Europe 600 index. Following Fama and French's (2015) approach, we then exclude yearly the companies having negative BTM ratios in our sample. In those years, when the individual stock count is divisible by three, the portfolios are evenly divided, but if not, the surplus is allocated to the high BTM portfolio or high BTM portfolio and medium BTM portfolio. In addition to the three portfolios, we also obtain a fourth portfolio, an adjusted market portfolio, that includes the low-, medium- and high portfolios. We will later use this portfolio as one of our independent variables in our regression test. Portfolio statistics are presented in Table 1.

Table 1. Portfolio statistics

Variable	*Low*	*Medium*	*High*	*Market*
Mean BTM	0,1848	0,4084	0,9197	0,5051
Median BTM	0,1938	0,4027	0,8101	0,4035
Mean count	121	122	122	368
Median count	127	128	128	383
Minimum count	46	46	47	139
Maximum count	151	151	151	453

Sample period 1.1.1999 - 31.12.2022

As shown in Table 1, the mean BTM ratio for the whole population is 0,505, and the median is 0,403. As the distributions of BTM ratios are skewed to right, it shows that our population includes individual stocks that may have very high BTM ratios that pull up the median compared to the average. Whilst our yearly data grows from 1999 having a population count of 265 to the year 2021 where the population count is 453, the minimum count of the individual stock count is from the year 2022. This is because, at the time of this study, all of the companies have yet to publish their accounting data for the year 2022. However, the population of 139 in 2022 leads to a minimum of 46 individual stock count for the portfolios, making the population still large enough for our empirical testing with reliable results.

Finally, we calculate the monthly portfolio stock returns for each portfolio for the period 1.1.1999 – 31.12.2022 with the following formula,

$$R_t = \frac{P_t}{P_{t-1}} - 1 \qquad (16)$$

where,

R_t = Return of a stock at time t

P = Price of a stock at time t

Monthly portfolio returns show that more favourable returns are obtained with the low BTM portfolio, which is in line with the results of previous studies in academic research as it has been shown that value stocks, where BTM is the decisive factor, generate a higher return than growth stocks. The sums of monthly returns for each portfolio are presented in Figure 9.

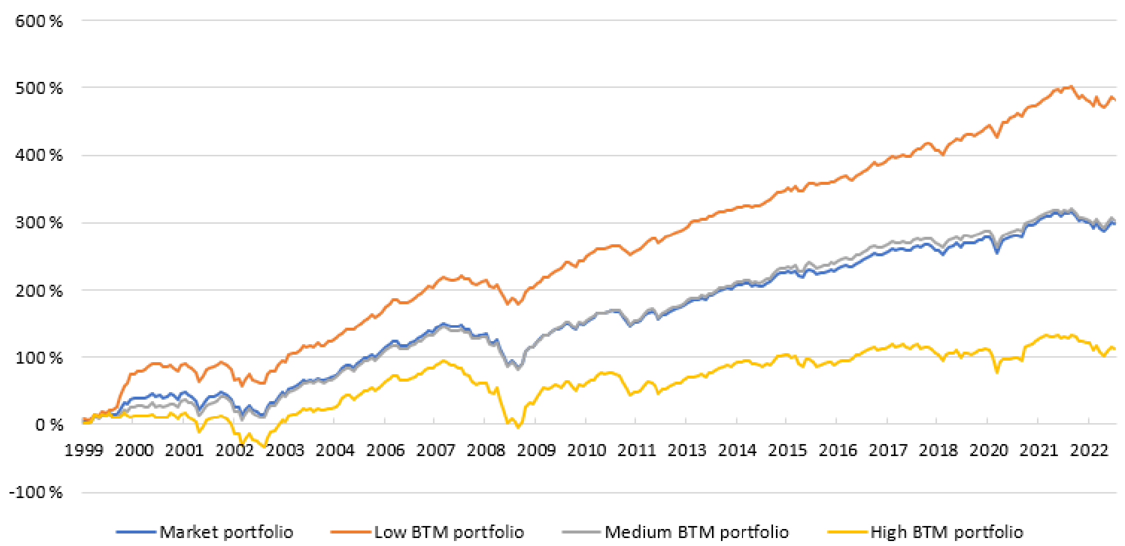

Figure 9. Sum of returns for constructed portfolios, 1999 – 2022 (Thomson Reuters, 2023).

6.3 Methodology

In this study, we use an ordinary least squares, also known as OLS, regression model for our empirical analysis in order to discover if short- or long-term interest rates have had an impact on stock portfolios that are formed based on the book-to-market ratio. The OLS regression model allows us to answer our research hypothesises as we can assume that the relationship of our model is linear. In our model, the explanatory variables are the monthly returns of the adjusted market portfolio and the interest rate monthly unit change of the corresponding month for the given regression. For analysing the impact of changes in the short interest rates on constructed portfolio's stock returns the regression formulas are as follows,

$$Growth_L = \beta_0 + \beta_1 MKT + \beta_2 EB_{1-month} + \varepsilon \tag{17}$$

$$Growth_M = \beta_0 + \beta_1 MKT + \beta_2 EB_{1-month} + \varepsilon \tag{18}$$

$$Growth_H = \beta_0 + \beta_1 MKT + \beta_2 EB_{1-month} + \varepsilon \tag{19}$$

where,

$Growth_L$ = Low BTM portfolio return

$Growth_M$ = Medium BTM portfolio return

$Growth_H$ = High BTM portfolio return

$EB_{1-month}$ = Change in the Euribor one-month interest rate

MKT = Market factor (adjusted market portfolio of STOXX Europe 600)

β_0 = Constant

β_1 and β_2 = Coefficients

ε = Error term

In addition, to test separately the impact of long interest rates on constructed portfolios' stock returns, we build the following regression models using the Euro-area 10-year benchmark government bond as an explanatory variable instead of the Euribor one-month interest rate. For analysing the impact of changes in the long interest rates on constructed portfolio’s stock returns the regression formulas are as follows,

$$Growth_L = \beta_0 + \beta_1 MKT + \beta_2 EU_{10-year} + \varepsilon \tag{20}$$

$$Growth_M = \beta_0 + \beta_1 MKT + \beta_2 EU_{10-year} + \varepsilon \tag{21}$$

$$Growth_H = \beta_0 + \beta_1 MKT + \beta_2 EU_{10-year} + \varepsilon \tag{22}$$

where,

$EU_{10-year}$ = Change in the Euro are 10-year benchmark rate

6.4 Descriptive Statistics

Now, as we know how the portfolios have been constructed, we will cover the statistics and features of the variables used in the empirical analysis. Descriptive statistics are presented in Table 2. The first three variables, which are low, medium, and high, represent the three portfolios formed based on the BTM ratio from low to high. These three variables are studied as our dependent variables. The next variables, market, EB 1 M, and EU 10 Y represent our independent variables, where the market is the adjusted market portfolio, EB 1 M is our short interest rate, and EU 10 Y is the long interest rate. As shown, in total the number of observations is 288, which represents the 288 months of observations on portfolio returns or interest rate fluctuations.

Table 2. Descriptive statistics, full sample period

Variable	*Low*	*Medium*	*High*	*Market*	*EB 1 M*	*EU 10 Y*
Mean	0,0167	0,0105	0,0039	0,0103	-0,0048	-0,0027
Median	0,0214	0,0159	0,0064	0,0148	0,0101	0,0113
Standard Error	0,0028	0,0028	0,0033	0,0028	-0,0010	-0,0346
Standard Deviation	0,0478	0,0473	0,0567	0,0483	0,1717	0,1917
Sample Variance	0,0023	0,0022	0,0032	0,0023	0,0295	0,0368
Skewness	-0,4160	-0,5289	-0,5171	-0,5909	-1,0034	0,5487
Minimum	-0,1474	-0,1753	-0,2348	-0,1748	-0,9200	-0,5916
Maximum	0,1721	0,1964	0,2059	0,1728	0,7020	0,7555
No. of observations	288	288	288	288	288	288
Sample period 1.1.1999 - 31.12.2022						

As seen from Table 2, corresponding to the reasoning from Figure 9, the differences in returns are noticeable. The mean monthly return for a low BTM portfolio is 1,67% while the high BTM portfolio was able to show a mean monthly return of 0,39%. The low BTM portfolio did outperform the adjusted market portfolio by 0,64% and the high BTM portfolio by 1,28%. Out of the 288 months, the low BTM portfolio outperformed the high BTM portfolio for 209 months. All of the portfolio variables are skewed to the left, meaning that there is a higher frequency of negative returns and fewer observations where portfolios would have large positive returns. Also, the monthly return values have the widest range amongst high BTM portfolio as the largest negative return was -23,48% and the largest positive return was 20,59% in our sample.

In turn, the interest rate variables have a negative mean but a positive median. The unit change for short interest rates' mean is -0,48% and median of 1,01%, and the unit change for long interest rate mean is -0,27% and median of 1,13%. While the distribution is negatively skewed for short interest rates at -1,00, surprisingly the skewness is positive for long interest rates, having a skewness of 0,55, despite the negative mean and positive median.

During our sample period, the highest fluctuations for short interest are seen during the dot-com bubble, the financial crisis of 2008, and during the interest rate hikes in 2022.

Out of our study period from January 1999 to December 2022, the count of months where fluctuations were higher than |0,25%| is 25 months for Euribor one-month. In contrast, the Euro area 10-year benchmark government bond experienced 47 months over 288 months a fluctuation of over |0,25%|. This corresponds with that the standard deviation of long interest rate changes is higher than for short interest rates. The plausible explanation is the Euro crisis period. Euro area government bonds can be seen fluctuating during the dot-com crisis, the financial crisis of 2008, and during rate hikes in 2022, it is notable that between 2009 and 2016, during the euro crisis, government bonds have been fluctuating more than the short interest rate of Euribor one-month.

It is also insightful to cover the descriptive statistics from the subsample periods. The first subsample period from January 1999 to December 2007 is presented in Table 3. The second subsample period from January 2009 to December 2022 is presented in Table 4. The subsamples are not equal by their number of observations as the sample before the financial crisis covers observations in total from 108 months. In turn, the subsample after the financial crisis of 2008 covers observations in total from 168 months. While the second subsample is longer than the first, both subsamples still include enough observations for statistical analysis.

As seen in Table 3, the sample before the financial crisis of 2008 shows higher mean and medium monthly returns for every portfolio than the full period, except for the median return for the market portfolio. Similar to the full sample, the low BTM value portfolio offers higher monthly returns than other portfolios and the high BTM offers the lowest returns. Interestingly, low and high BTM portfolios' standard deviation is exactly the same, indicating the same level of risk. Also, as the standard error is higher for each portfolio, the portfolio returns are more volatile in the first subsample than in the full sample, indicating higher risk than in the full sample.

In turn, the mean changes for both, short and long interest rates, are positive. For both interest rates, the median is smaller than the mean, which is in line with the positive skew that both interest rate changes have. In the first subsample, the fluctuations of interest rate changes, are smaller than in the full sample. Out of the 108-month observation period, the short interest rate fluctuated more than |0,25%| in 12 observations and the long interest rate in 13 observations.

Table 3. Descriptive statistics, first subsample period

Variable	*Low*	*Medium*	*High*	*Market*	*EB 1 M*	*EU 10 Y*
Mean	0,0201	0,0126	0,0068	0,0130	0,0096	0,0038
Median	0,0217	0,0160	0,0050	0,0137	0,0010	-0,0173
Standard Error	0,0050	0,0044	0,0050	0,0045	0,0168	0,0154
Standard Deviation	0,0525	0,0459	0,0517	0,0464	0,1751	0,1602
Sample Variance	0,0028	0,0021	0,0027	0,0022	0,0307	0,0256
Skewness	-0,2776	-0,7470	-0,5391	-0,6785	0,2237	0,2694
Minimum	-0,1474	-0,1342	-0,1755	-0,1348	-0,5870	-0,3102
Maximum	0,1721	0,1197	0,1401	0,1153	0,6840	0,3941
No. of observations	108	108	108	108	108	108

Sample period 1.1.1999 - 31.12.2007

In turn, as seen in Table 4, the second subsample also shows the higher mean and median returns than the full sample. This is reasonable because the stock market in general did not perform strongly in 2008 when the financial crisis was unfolding. Nevertheless, the same trend is noticeable from the second subsample, that the low BTM portfolio outperforms the medium, high, and market portfolios. This indicates that in our sample there is a strong correlation between lower-than-average BTM and higher monthly returns.

Table 4. Descriptive statistics, second subsample period

Variable	*Low*	*Medium*	*High*	*Market*	*EB 1 M*	*EU 10 Y*
Mean	0,0175	0,0125	0,0062	0,0121	-0,0043	-0,0063
Median	0,0215	0,0167	0,0089	0,0163	-0,0020	-0,0441
Standard Error	0,0032	0,0035	0,0042	0,0035	0,0098	0,0161
Standard Deviation	0,0421	0,0449	0,0540	0,0454	0,1273	0,2087
Sample Variance	0,0018	0,0020	0,0029	0,0021	0,0162	0,0436
Skewness	-0,4991	-0,2067	-0,0932	-0,2848	-0,4616	0,6674
Minimum	-0,1137	-0,1753	-0,2348	-0,1748	-0,8680	-0,5916
Maximum	0,1260	0,1964	0,2059	0,1728	0,7020	0,7555
No. of observations	168	168	168	168	168	168

Sample period 1.1.2009 - 31.12.2022

The loose monetary policies exercised in the post-era of the 2008 financial crisis can be seen in Table 4, as the mean and median unit changes are negative for both rates. Also, while the standard error for the long interest rate is at a similar level for both subsamples, the standard error for the short interest rate is substantially lower in the second subsample. As we expected, the long interest rates have more sample variance in the second subsample than in the first, which may be explained by the Euro crisis and the uncertainty among European governments in the 2010s. In the second subsample there are 31 observations where the fluctuations of long interest rate are higher than |0,25%|, while the corresponding count for short interest rate is only 9.

7 Empirical regression results

In this chapter, we present the results of our empirical analysis. We will cover the OLS regression results as we present the factor intercepts, factor exposures, t-statistics, and R^2, from all regression models. Our results are presented first from the full sample and then from the first and second subsamples. We will also interpret the regression results and determine the statistical significance of the results. Before discussing the results of each regression separately, it is useful to acknowledge and present the common features that can be derived from the results in general.

First, the R^2 is nearly identical when comparing regression results between short- and long-term interest rate factors' regression results with the matching periods. The range of difference in R^2 in matching sample periods between short- and long-interest rate factors varies between -0,4% and 0,5%. Hence, it can be stated that the choice to use either short- or long-term interest as an interest rate factor, does not affect the R^2 that much. However, when comparing different sample periods, larger fluctuations are shown, which will discuss later on in this chapter.

Second, the growth stock portfolios do not generate alpha in our full sample period or in our subsample periods, as the intercept coefficients are negative in every regression regarding growth portfolios. This correlates with the discussion made in earlier chapters regarding Figure 9 and Tables 2, 3, and 4, where we recognise that growth stock portfolio performance is weaker compared to the adjusted market portfolio. Thus, our results support the consensus of value portfolios outperform growth portfolios, in general.

Third, it is clear that our market factor, the adjusted market portfolio, explains the returns of every constructed portfolio extremely well. In all of the regression results the market factor explains the monthly returns with a 1% significance level as the t-values are excessively high. Also, a common feature is found regarding the BTM ratio's ability to affect the coefficients of market factor, or in other words, the relationship between the portfolio's BTM ratio and beta. When examining the beta for growth portfolios, the beta is high, as it is more than one for every regression. In contrast, the value portfolio has the lowest beta, as the beta is less than one in all other results but the regressions of the first subsample. This means that a high BTM portfolio carries more variance and more risk than markets in general.

Next, we discuss the regression results separately beginning with the regressions where the short-term interest rate factor is used in the full sample, continuing to interpret the results also for the two subsamples. We then move to discuss the regression results where the long-interest rate factor is used for the full sample, and for the two subsamples. The full sample results focusing on short interest rates are presented in Table 5.

Table 5. Regressions, full sample period & short-term interest rate factor

Regression analysis of the impact of short interest rate changes on stock portfolios in EU stock markets

Sample period 1.1.1999 - 31.12.2022

	Low	*Medium*	*High*
Intercept	0,007	0,001	-0,008
	(7,427)***	(1,150)	(-8,773)***
Market	0,932	0,970	1,134
	(48,056)***	(108,475)***	(62,588)***
EB 1 M	0,008	-0,004	-0,004
	(1,390)	(-1,412)	(-0,822)
Sample Size	288	288	288
R Square	0,891	0,976	0,932
Adj. R Square	0,890	0,976	0,932

*** Significant at the 0,01 level
** Significant at the 0,05 level
* Significant at the 0,10 level

As seen from Table 5, our model generates a good R^2 for each regression because the market factor is explaining the behaviour of each portfolio's monthly returns with high accuracy. The model explains the monthly returns of the growth portfolio (R^2 = 0,932) slightly better than the value portfolio (R^2 = 0,891). Also, we obtain a negative relationship between the growth stock portfolio's returns and the short interest rate change indicating that over the full period growth stocks are inversely sensitive to changes in the short interest rate. Interestingly value portfolio has a positive coefficient on short interest rate changes indicating a positive relationship and sensitivity. However, these results regarding either growth- or value portfolios are not statistically significant even for a 10% significance level. The next regression results, regarding the first subsample period and short-term interest rate factor are presented in Table 6.

Table 6. Regressions, first subsample period & short-term interest rate factor

Regression analysis of the impact of short interest rate changes on stock portfolios in EU stock markets

Sample period 1.1.1999 - 31.12.2007			
	Low	*Medium*	*High*
Intercept	0,006	0,000	-0,007
	(3,675)***	(-0,0278)	(-4,653)***
Market	1,070	0,973	1,070
	(31,643)***	(54,195)***	(34.509)***
EB 1 M	0,022	-0,002	-0,020
	(2,421)**	(-0,434)	(-2,485)**
Sample Size	108	108	108
R Square	0,906	0,966	0,919
Adj. R Square	0,905	0,965	0,917

*** Significant at the 0,01 level
** Significant at the 0,05 level
* Significant at the 0,10 level

From Table 6 we observe similar results for R^2, but the difference in the model's capability to show the explanatory power between growth and value portfolios is smaller. As expected, the relationship between growth portfolio returns and change in the short interest rate is negative. The coefficient on the interest rate factor for the growth portfolio is -0,020, at the 5% significance level. As for the value stock comparison, we notice that the relationship between the interest rate factor and the value portfolio is also statistically significant at a 5% level, but the relationship is positive with a 0,022 coefficient, showing an opposite relationship than the growth portfolio. It is also useful to note, that the medium BTM portfolio captures a small negative relationship with the short-term interest rate, but with no statistical significance. Next, the results from the second subsample and the short interest rate factor are presented in Table 7.

Table 7. Regressions, second subsample period & short-term interest rate factor

Regression analysis of the impact of short interest rate changes on stock portfolios in EU stock markets			
Sample period 1.1.2009 - 31.12.2022			
	Low	*Medium*	*High*
Intercept	0,007	0,001	-0,008
	(5,999)***	(1,426)	(-6,684)***
Market	0,869	0,979	1,146
	(35,058)***	(94,022)***	(46,806)***
EB 1 M	0,003	-0,001	-0,002
	(0,320)	(-0,318)	(-0,181)
Sample Size	168	168	168
R Square	0,882	0,982	0,930
Adj. R Square	0,880	0,981	0,929

*** Significant at the 0,01 level
** Significant at the 0,05 level
* Significant at the 0,10 level

As we interpret the result from Table 7, we notice that the regression model explains the monthly returns for growth portfolios better than value portfolios, especially in the second subsample. In the second subsample, the model explains the dependent variable 4,8% better for the growth portfolio than for the value portfolio (growth portfolio R^2 minus value portfolio R^2). The coefficients are showing the same relationship direction in both of the two subsamples, as we are presented with a negative sign for the growth portfolio and a positive sign for the value portfolio. But, in the second subsample, the short-term interest rate factor is not economically affecting portfolio returns that much, and the sensitivity is weaker in both portfolios than in the first subsample. However, we are not presented statistically significant results, as the t-values are extremely low, and do not hold even for a 10% significance level.

Table 8. Regressions, full sample period & long-term interest rate factor

Regression analysis of the impact of long interest rate changes on stock portfolios in EU stock markets			
Sample period 1.1.1999 - 31.12.2022			
	Low	*Medium*	*High*
Intercept	0,007	0,001	-0,008
	(7,348)***	(1,169)	(2,213)**
Market	0,934	0,969	1,132
	(48,143)***	(108,927)***	(63,000)***
EU 10 Y	-0,006	-0,004	0,010
	(-1,134)	(-1,995)*	(2,213)**
Sample Size	288	288	288
R Square	0,891	0,977	0,933
Adj. R Square	0,890	0,976	0,933

*** Significant at the 0,01 level
** Significant at the 0,05 level
* Significant at the 0,10 level

The full sample regression results where the long-term interest rate factor is used instead of the short-term interest rate factor, are presented in Table 8. First what we notice is that the regression for each portfolio has nearly identical results for R^2 than with a regression of a short interest rate factor. Interestingly, the impact direction of long-term interest rate on portfolio returns seems to be reversed for the growth- and value portfolio compared to the impact direction of short-term interest rate. For the growth portfolio, the long-term interest rate factor coefficient is 0,010 with a 5% statistical significance, indicating a positive sensitivity between growth stock price and change in the long-term interest rate. For the medium BTM and value portfolio, the sensitivity seems to be negative. However, the medium BTM portfolio's long-term interest rate factor coefficient is

-0,004, and the value portfolio's -0,006 indicating a relatively weak sensitivity. Also, out of medium BTM- and value portfolios, only medium the BTM portfolio's regression result is statistically significant and only for a 10% significance level.

Table 9. Regressions, first subsample period & long-term interest rate factor

Regression analysis of the impact of long interest rate changes on stock portfolios in EU stock markets

Sample period 1.1.1999 - 31.12.2007

	Low	*Medium*	*High*
Intercept	0,006	0,000	-0,007
	(3,751)***	(-0,092)	(4,681)***
Market	1,065	0,979	1,073
	(30,525)***	(54,455)***	(33,362)***
EU 10 Y	0,015	-0,009	-0,011
	(-1,533)	(-1,792)*	(1,208)
Sample Size	108	108	108
R Square	0,903	0,967	0,915
Adj. R Square	0,902	0,966	0,914

*** Significant at the 0,01 level
** Significant at the 0,05 level
* Significant at the 0,10 level

Table 9 presents the result from the first subsample period and for the long-term interest rate factor. While we do not obtain statistically significant results for growth or value portfolios, the medium BTM portfolio's returns are negatively sensitive to long-term interest rates as the coefficient is -0,009 at a 10% significance level. Although the results for growth stocks are non-significant, it is still notable that the relationship between long-term interest rate changes and stock prices for growth portfolios is inversely sensitive and would support the general consensus for the negative relationship between interest rates and growth stock prices. In contrast, the value portfolio is behaving not as expected as the relationship is presented with a positive coefficient. Also, when comparing the results between short- and long-term interest rate factors, we notice that the sensitivity is stronger for short-term interest rates in the growth and in the value portfolio, as the absolute value is higher for both. However, results in Table 9 show non-significant results for growth and value portfolios.

Table 10. Regressions, second subsample period & long-term interest rate factor

Regression analysis of the impact of long interest rate changes on stock portfolios in EU stock markets

Sample period 1.1.2009 - 31.12.2022

	Low	*Medium*	*High*
Intercept	0,007	0,001	-0,008
	(6,175)***	(1,442)	(-6,959)**
Market	0,860	0,978	1,157
	(35,476)***	(93,573)***	(48,834)***
EU 10 Y	-0,017	-0,003	0,019
	(-3,177)***	(-1,109)	(3,720)***
Sample Size	168	168	168
R Square	0,888	0,982	0,935
Adj. R Square	0,887	0,982	0,935

*** Significant at the 0,01 level
** Significant at the 0,05 level
* Significant at the 0,10 level

Finally, the regression results for the second subsample period where the interest rate factor is the long-term interest rate are presented in Table 10. Here, the coefficient for the long-term interest rate factors for the growth portfolio is 0,019, and for the value portfolio -0,017. Both results are statistically significant at a 1% significance level. As we can see, the growth portfolio sensitivity for the long-term interest rate factor does not support the general consensus of the negative relationship between interest rates and stock prices. It is also interesting to consider that while these results do not support the H_2 hypothesis, because the growth stock portfolio is positively sensitive to interest rate changes, we may not reject the H_3 based on the results from Table 10 because the growth stock portfolio is indeed less negatively sensitive as it is positively sensitive.

Altogether, our regression results are able to capture statistically significant sensitivity between the growth portfolio's monthly returns and short-term interest rates only in the first subsample period (Table 6). In contrast, statistically significant results are obtained between growth portfolios and long-term interest rates in the full sample (table 8) and in the second subsample period (table 10). This means, that short-term interest rates have had a direct negative sensitivity effect on growth portfolios before the financial crisis, but the relationship appears to be statistically random in the post-2008 financial crisis era. In contrast, long-term interest rates are affecting the growth stock portfolio's monthly returns significantly with a positive sensitivity in the post-2008 financial crisis era, and the effect is strong enough to make the full sample period still significant, although in the pre-2008 financial crisis era the relationship is statistically random.

While the obtained results differ between short- and long-term interest rates and can give mixed signals at first, there is still room to make logical conclusions after reflecting on the earlier academic literature. First of all, value portfolios capture better performance and higher alpha than growth portfolios following Fama and French (1992; 1998). Second, our results support the observations of Korkeamäki (2011), that the consensus for the negative relationship between interest rate change and stock markets in Europe is not obtained fully in the post-Euro era. But, as our study does not consider the era before the introduction of the Euro, our results are not fully comparable. However, the randomness of the results is visible for both interest rate factors as interest rate factor coefficients show surprising signs and statistical significance is not present in all of the results. Third, our results coincide with the research by Estep (2019), that the relationship between interest rates and stock performance among growth stocks seems to be random and is not fully explainable with the consensus assumptions. While Estep (2019) concludes this regarding the stock and company analysis from the US, we can complement the same observation to be visible in Europe.

Our results indicate that the duration of the interest rate affects the rate's factor sensitivity to explain stock market returns. While our results are not fully identical to Etsep's

(2019), still some similar characteristics concerning the randomness of the results are present. Most of the assumptions derived from earlier literature covered in Chapter 6 are notwithstanding the results of this study. Still, we are able to capture statistical significance in some of the results, indicating that a better understanding of the event, and time variation is needed. Also, deepening the level of analysis on the events, cycles, and other economic factors in order to understand the period and time variation of the results, will give insightful frames to asset allocation strategies in portfolio management. We will continue the discussion of our obtained results and the interpretations in Chapter 8.

8 Conclusions and discussion

In this chapter, we briefly summarise the study and our empirical findings. We compare the results with previous studies and earlier literature. Also, we consider the key observations and their relevance from the real-world practice's perspective. In addition, we cover the importance of the study and briefly discuss future considerations to strengthen the financial literacy field in interest rate sensitivity on asset prices.

The main purpose of this study is to create a further understanding of the interest rate sensitivity to growth stock portfolio short-term returns in Europe. Our research is motivated by the differences in the pre- and post-financial crisis of 2008 periods on general interest rate levels and monetary policies in Europe. This study targets to find whether the general consensus of the effect of interest rates on growth stock returns is supported during the unprecedented low-bound interest rates and loose monetary policies that have been dominating the post-2008 financial crisis era. From the academic perspective, the topic in question is interesting as it adds to the literature on asset allocation, and how interest rates drive investors to rebalance their portfolios (Muth, 1961). Also, from the practical perspective of investors, an important aspect of interest rate risk management is the ability to interpret and anticipate market reactions and the short-term market movements' relation to interest rate fluctuations.

We present an empirical analysis of the relationship between interest rate fluctuations on growth stock portfolio returns, where the book-to-market ratio is used as a determinant to identify and construct the growth stock portfolio. In general, factor regression models are a popular method to measure and evaluate variables that can be assumed to explain portfolio performance. Therefore, this study implements an OLS regression model with two explanatory factors for measuring the relationship between interest rates and market returns to growth portfolio returns. We also obtain empirical results for value and neutral portfolios, in order to compare the economic differences between portfolios with different characteristics.

The analysis and the empirical results show, for the periods tested, some evidence of interest rate sensitivity. But the key observation is that the analysis results do not fully agree with the general conventional wisdom of the academic financial literature as the relationship is not explained in every period. We observe time variation among the results, indicating that economic cycles, monetary policies, and other economic factors affect the market behaviour on the direct sensitivity of interest rate changes on growth stock returns. In addition, as described in Chapter 5.2., economic positive signals affect positively interest rates, and positively stock returns, ceteris paribus. Hence, a careful interpretation from the results could be made, that during the period of lower bound interest rates, growth stocks, and interest rates have a positive relationship as they are reacting together to positive and negative economic news and signals, and the relationship can be seen as “co-movement”.

The results show, cautiously, that extremely loose monetary policy when interest rates are kept a lower bound levels year after year, can turn the relationship between interest rates and growth stock returns to be positive, which is the opposite of the conventional consensus advocates. This is insightful from an investors’ perspective, as the interest rate sensitivity factor of stocks is meaningful for the asset allocation strategy and the interest rate risk tolerance in portfolio management. We suggest that investors might drift away from the conventional consensus during the loose monetary policy, as according to our results, investors should expect a positive relationship between growth stock returns and interest rates during years of extremely loose monetary policy and lower bound interest rates.

However, our results do not show statistically significant evidence for all individual regressions, and the interpretation is derived from individual regressions without considering the effect of interest rate duration. Hence, a deepened analysis is needed to further understand the relationship between growth stocks and interest rates across different interest rate durations. Also, the characteristics of the stock portfolios constructed for the empirical analysis might factor into whether the results obtained produce statistically significant results. Our portfolios are theoretical as they essentially only include “winner” stocks excluding stocks that have been dropped from the STOXX Europe 600 index during the sample period (see chapter 6.1). While selecting “winners” can undoubtedly be the main goal for any given investor, except for short sellers, the assumption that an investor will succeed perfectly in the selection process to construct a highly diversified portfolio with no “loser” stocks is not realistic. Thus, a complementary study that includes stocks and companies from across the performance distribution is recommended.

As the descriptive statistics Tables 4, 5, and 6 indicate, there is a strong correlation with lower than sample average BTM with higher monthly returns. This is also seen from the regression results as growth portfolios create negative alpha and value portfolios positive alpha in every sample period. Also, while our sample excludes the outlier companies, that will have a negative BTM ratio at the end of the ongoing year, we do not exclude any outliers which might have extremely high BTM. Thus, a complementary study is recommended where four or five portfolios would be constructed using the BTM. For example, using a quantile approach, a more comprehensive analysis is possible from the performance and sensitivity analysis perspective.

We also acknowledge that an alternative methodology to the OLS regression, such as the quantile regression model (also known as the QR model) and the vector autoregression model (also known as the VAR model) should also be applied to a similar study. For instance, the QR regression would allow us to identify and interpret the results within conditional quantiles inside the growth stock portfolios. This would give a more precise picture of the distribution of stock returns within constructed portfolios and could be especially relevant from the risk management and asset allocation point of view. In turn, the VAR model would present an opportunity to study the lagged effects, meaning the short- and long-term effects of interest changes on the constructed portfolios.

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