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The Impact of Interest Rates on German Companies' Financing Decisions Between Public Debt and Public Equity: An Analysis of the Implications on the Debt-to-Equity Ratio in the DAX

SARAH KATHARINA MOEHRLEIN

Work project carried out under the supervision of:

Ekaterina Gavrilova

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Abstract

This thesis analyzes the effects of interest rates and credit risk on German companies' public financing decision-making from 2002 to 2022, controlling for macroeconomic indicators. The results show that a 0.1% absolute increase in the 10-year-mid-swap rate leads to a 7.451% decrease in weekly bond issuances in the observed dataset. In contrast to debt issuances, equity issuances prove to be less affected by interest rates, and more impacted by credit risk in the market. When analyzing the exposure of the DAX' debt-to-equity ratio to interest rates and credit risk, the results show a positive correlation between the 3-month-Euribor and the debt-to-equity ratio.

Keywords: Public debt issuance, public equity issuance, interest rates, macroeconomic risk

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Group Part

1. Introduction

How do financing decisions regarding public equity and debt adapt to changing risk and interest rate environments, where monetary policy changes are an important determinant? This research examines the impact of anticipated or effective changes in monetary policy by the European Central Bank (ECB) on interest rates and present market risk and therefore on the changes in financing decisions of German corporates. Since 2009, European economies have experienced a low-interest rate environment, primarily driven by the aftermath of the banking crisis in 2008. To prevent deflation and foster economic growth, the ECB has implemented expansionary monetary policies, resulting in the stimulation of investment and growth of businesses and the private sector. During these times of cheap borrowing and relatively high company valuations, overall, after COVID-19, executives had a variety of options to choose from to get access to new money for refinancing or investment purposes. The aftermath of COVID-19 is a time when uncertainty in the market is high and central banks are hesitant regarding new monetary policy decisions and how to behave in an environment of high inflation, which was unheard of in the decades before (Haddad, Moreira, and Muir, 2021). Interest rate hikes of 75 basis points, which are levels not observed since 1999, can cause significant changes in the cost of debt for corporates and therefore limit their access to fresh capital. Additionally, not only the basis for financing costs rises in environments of tighter monetary policy but also spreads widen amid rising uncertainty and volatility in the market (Baum and Chi, 2010). While firm-specific return volatility can explain about one-third of the variation in credit spreads (Campbell and Taksler, 2003), macroeconomic uncertainty represents another driver of credit spreads. This is indicated through evidence by Baum, Chakraborty, and Liu in 2010 who stress the importance of macroeconomic uncertainty in determining both the level and changes of a company's leverage.

This increasing uncertainty is partially driven by rising borrowing costs because it will have a significant impact on economic growth, companies' financing costs, margins, net income, and consequently firms' default risk. Furthermore, there is evidence that corporate bond yields are highly impacted by liquidity factors and tax effects, indicating that base interest rates are one driver of bond yields (Elton, Gruber, Agrawal and Mann, 2004). Additional factors add pressure to the decision-making metrics of the ECB, in comparison to the Federal Reserve (Fed). For instance, the fragmentation of the Eurozone due to the members' different economic strengths. Nevertheless, interest rates in the Eurozone rise at a fast pace in 2022 (Rakic, 2022), illustrated by noticeable changes and high volatility in the financial market. Debt yields are rising, and equity prices are falling, as discount rates are increasing and expected future cash flows are deteriorating.

At the same time, macroeconomic factors further intensify the feeling of uncertainty and therefore also risk sentiment in the market. This analysis is facing one important challenge: The unpredictability of markets. The COVID-19 aftermath together with the Russia-Ukraine war illustrates this perfectly. Germany is facing an energy crisis, so even with tighter monetary policy and rising interest rates, many discounts in the equity market must be explained by also considering the market sentiment. Often, restrictive monetary policies follow impactful macroeconomic events (Friedman, 1968). In that case, interest rates rise simultaneously with increasing macroeconomic risk in the market. Financing decisions often mirror a company's risk appetite in funding decisions: While financing through debt is generally cheaper than through equity, it increases the risk of the company to default. In contrast, equity is more expensive as it does not provide a tax benefit to companies. However, it does not add pressure to the company's risk and probability of financial distress.

There are different theories that examine the practice of capital structures. Some of the most shaping theories were published by Modigliani and Miller (MM). In 1958, they publish

their first theory and conclude that capital structure cannot create value in companies. This would make the importance of the right financing decisions negligible. However, when taxes are added to the equation, as in MM's next theorem, more debt can increase the tax shield and therefore adds value. However, the decision on how to finance a company is significantly more complex than just considering a tax shield. Overall, factors related to uncertainty are major drivers in financing decisions. Consequently, apart from the cost of financing, the risk of financing needs to be considered. This is indicated by the trade-off theory, first introduced by Kraus and Litzenberger in 1979, which examines the state of optimal capital structure. The theory states that decisions about capital structure are mainly dependent on taxes and distress costs of the company. With a rising debt-to-equity ratio, the probability and therefore, cost of bankruptcy increases. Hence, at a particular ratio, the benefit generated through the interest tax shield is offset by the increase in harm coming from potential bankruptcy (Kraus and Litzenberger, 1979).

This thesis aims to answer the research question of whether more restrictive monetary policy, expressed in rising interest rates, has an impact on financing decisions of German corporates. The thesis follows the subsequent structure: In the first part, we discuss the existing literature on the matter, first focusing on general capital structure decisions. In the latter, we go more into detail on debt and equity financing and lastly, we justify decision making by taking capital market theories into account. After this review follows the explanation of the hypotheses for the statistical analysis part. The results are discussed based on the reviewed literature and then tested against the previously stated expectations, both from a theoretical and interpretational point of view. The main goal is to find explanations and elaborate on conflicting results when comparing them to the initial expectations and textbook theories.

2. Literature Review on Applicable Economic Theories

2.1 Overview

Companies generate additional capital in several ways to invest in new projects and grow. The three most widely known processes to raise funds are through equity and debt financing in the public market and reinvesting the company's retained earnings. There are numerous benefits for companies to enter the public market, including an improvement of their capital base, facilitating potential acquisitions, diversifying the ownership of the company, or enhancing prestige. Nevertheless, managers must consider potential disadvantages of the public market. In the last decade, the European economy was shaped by policy rates close to zero or even to below zero percent to stimulate the economy after the downturn and increase consumer spending. However, the changing macroeconomic as well as the interest rate environment of the most recent months poses the question of how companies react to a changing risk and cost environment of corporate financing.

2.2 Corporate Financing Decision Making: Why Debt over Equity?

The decision on whether debt issuances are favored over equity issuances goes further than considering the advantages and disadvantages of the source of capital. The individual situation of a company is equally important. However, certain impacts are equally measurable across all corporates in the public market, which Modigliani and Miller researched in 1985. For their propositions I and II, capital markets are assumed to be perfect. When one relaxes these assumptions, capital structure and therefore, financing decision-making remains one of the most integral tasks of a company's manager. This is driven by the existence of taxes and the fact that interest payments are tax-deductible, decreasing the taxable income of a company and creating an incentive to issue debt. This creates an interest tax shield, the gain a company generates from deducting the number of interest payments from its taxable income. Hence, a levered company's value is higher than an unlevered company's value solely impacted by the present

value of tax savings through debt financing (Berk and DeMarzo, 2019). However, since the level of interest payments in the future varies, calculating the exact benefits or disadvantages of debt financing is generally challenging. Interest payments are impacted by several factors, including changes in the debt issuance of companies, transaction costs, fluctuating target interest rates in the market, and varying interest rates the company must pay based on its default risk. Hence, it is relevant to examine the significance of the impact of changing macroeconomic factors and more specifically base interest rates in the market. One can state that tax benefits play a relevant role for investors in capital structure decision making. However, the management's decision making in this context is also significantly driven by macroeconomic factors and particularly the monetary policy environment of central banks. In Modigliani and Miller's theory, the impact of interest rates is an integral component as it influences the cost of debt and cost of equity significantly.

2.3 Debt Financing

In this research, the focus is on publicly traded debt, and we do not consider private debtors. Although building investors' confidence, which is necessary to issue public debt, is costly (Bradley, Jarrell, and Kim, 1984). Especially large companies still use the public debt market next to private financing to raise funds. According to Bradley, Jarrell, and Kim (1984), there are four considerations when choosing between private and public debt: Flotation costs, leverage-related costs, the value of liquidity, and the resolution of information problems. Flotation costs are mostly associated with fees for the United States Securities and Exchange Commission (SEC) registration, listing, trustees, investment bankers, and printing. Leverage-related costs are related to bankruptcy and agency costs. In contrast to public debt, private debt avoids or reduces most of these floating costs. However, public issuances are particularly beneficial for companies with large issuances as they can spread the fixed component of the associated costs over a larger volume. In general, public offerings are also more liquid than

private offerings because the bonds can be resold in the secondary market. Additionally, Amihud and Mendelson (1988) found evidence that yields on private debt are generally higher than yields on public debt, mainly caused by the credit quality, duration of debt, and its tax treatment. Secondary market liquidity and the associated savings should be linked to the issuance size. This indicates that the higher the issuance size, the higher the liquidity in the secondary market, which creates further benefits for companies with larger amounts of debt outstanding. The higher liquidity will then lead to lower yields, providing further cost reductions for larger firms. Considering the value of liquidity, public markets offer more liquidity due to the buying and selling activity in secondary markets. In contrast, smaller public issuances may lead to less liquidity in the market and would therefore not represent a significant reduction in yields (Easterwood and Kadapakkam, 1991). The cost of debt is not only driven by issuance costs but also by costs that compensate the investor for the potential risk that the company may default. While there is no such security that is risk-free, government securities are usually considered a good estimate as they have a low probability of default. The ECB is the only issuer of banknotes and bank reserves in the Eurozone, and it influences the conditions in the money market and can control short-term interest rates. Hence, through its control of the money supply, it can influence economic development. Their main objective is price stability. By making use of the monetary policy transmission mechanism, it impacts economic variables such as outputs or prices (European Central Bank, 2011). Since the ECB can change the quantity of money in circulation, it can impact price stability as well. One of the ECB's main tools to achieve price stability is its procedure of setting key interest rates including the rates for the main refinancing operations, marginal lending facility, and deposit facility. Bonds are priced against a benchmark rate, which is heavily influenced by the ECB base rates, and a corporate spread, which represents the credit default risk of a company. Potentially, a new issue premium and additional factors play a role. However, they have a comparably minor influence

on the bond's price in the end (Özdemir-Dilidüzgün, Altıok-Yılmaz, and Akben-Selçuk, 2022). The interest rate environment, which is influenced by monetary policy, is therefore not only important for the stock market, as discount rates of corporates are impacted but also primarily for the bond market.

2.4 Equity Financing

Public Equity is usually issued through Initial Public Offerings and secondary share issuances. According to research from Pagano, Panetta, and Zingales (1998), the motives for going public vary widely. However, gaining access to an alternative source of financing is most likely the main reason. Particularly for firms in need of large investments in the present and future with high leverage and expected high growth, the opportunity of going public might seem appealing. Hence, these factors are expected to have a positive correlation with the probability of an IPO. Through the decision to go public, the liquidity of the company's stock in combination with the potential diversification by the initial holders of the company will increase (Pagano, 1993). Further, investor recognition might be another reason for a company to follow the path of going public. While investors often ignore that certain companies exist, listing a company on a major exchange would increase the likelihood of getting more attention from investors. This can be concluded as there is a positive correlation between the number of investors that are aware of a company's security and the stock price (Merton, 1987). As indicated by Ritter (1991), when other industry competitors are overvalued, companies have the incentive to go public as they could take advantage of the overvaluation and sell equity at high prices. There is a positive correlation between the median industry market-to-book ratio and corresponding companies going public (Ritter, 1991). A standard deviation rise of one in the market-to-book ratio increases the odds of a company going public by 25% relative to the industry. However, this relationship is also explained by the need for more funds in sectors with high growth opportunities, leading to high market-to-book ratios. High valuations would then indicate that

investors expect high future growth opportunities in the industry. According to research, share issuance activities are cyclical as they are expected to rise during economic booms and drop during recessions (Lowry, 2003). Marchisio and Ravasi (2001) and Burton et al. (2006) state that the pecking order theory is one reason for companies to decide on an IPO. As they already exhausted other sources available for financing, they choose to issue shares as a last resort. Examining the cost of issuing public equity, it is crucial to differentiate between what theories suggest and what is observable in real-life scenarios. One example is the positive correlation between the cost of equity and the expected future return on the company's common stock in the market. The cost of equity is considered the compensation for shareholders to provide capital and take on equity risk. Hence, it implies the opportunity cost of investing in the equity instead of other companies with a similar risk profile (Ross, et.al., 2005). It consists of the risk-free rate and the equity risk premium. All factors being equal, a rise in the cost of equity increases the expected future return of the common stock of the company. With a rise in the cost of equity, which might be driven by the risk-free rate or the risk premium, equity valuations typically decrease. This would lead to companies having to issue new equity at discounted prices. On the other hand, they could acquire back the shares for lower prices. A higher expected future return would potentially encourage some companies to consider postponing share issuances. Generally, it is crucial to consider how future and expected changes in interest rates impact managerial decision-making.

3. Research Design

The following section describes the research approach used in the context of this thesis. It includes the presentation of the research question and hypothesis, an explanation of the variables derived from the dataset and an overview of the expected as well as observed outcomes.

3.1 Research Question and Hypothesis

This research intends to characterize the influence of monetary policy, for instance, a rise in interest rates and a change in risk in the market, on the financing decisions of companies. However, the determinants of these financing decisions are numerous and often non-quantifiable. For instance, in the current macroeconomic environment, uncertainty from the Russia-Ukraine war and the resulting energy crisis in Europe are determinants that are likely to play a huge role in company decision-making. Consequently, the regressions cannot capture the complete causal effect of the independent variables but are a meaningful indicator of how the interest rate environment influences financing decision-making. Each regression focuses on one of two main independent variables: the cost and risk of issuing debt and equity in the market. Cost in the models is represented by estimates of the risk-free benchmark rate. In our regressions, we use the 10-year-mid-swap (EURMS) or 3-month-Euribor (EURIBOR) rate, which are both important references in the bond pricing industry. They reflect the impact of changes in monetary policy from the ECB. We chose to contrast the benchmarks, as they reflect different maturities. The 3-month-Euribor represents the average interest rate that banks charge to each other for short-term uncollateralized borrowing in the Euro area. It is not totally risk-free but can still serve as a good estimate for risk-free rates. This is because under normal market conditions the probability that an AA-rated financial institution will default during a short period, for instance, 3 months), is small (Hull, 2012).

Changes in monetary policy, such as interest rate hikes by the ECB, lead to increases in the risk-free rate and make borrowing more expensive. Subsequently, this impacts the use of the two main financing tools that companies use in the public market. These two main financing tools are equity, including share issuances and IPOs, and debt in the form of public bond issuances. In general, if inflation is demand-driven and surpasses the target medium-term inflation rate of 2 percent, central banks react by tightening monetary policy often in the form of hiking interest rates. All things being equal, this causes a drop in consumers' willingness to spend money, leading to a decrease in GDP. Consequently, corporates' need for capital and their ability to raise capital decreases, not only because it becomes more expensive but also because with less consumer spending power, a new product instruction is tied to more risk. This decreases revenues again and lowers the company's bottom line (Skousen, 2010). Furthermore, financing decisions are the result of a complex mix of monetary, individual, and psychological influences. The optimal capital structure ratio is a puzzle that is highly dependent on the financing decisions between debt and equity, which are further influenced by challenges like risk-shifting problems. The pecking order hypothesis moves away from the big picture of optimal capital structure and looks solely at the advantages and disadvantages a certain type of financing has for the company. The pecking order predicts that adverse selection costs lead to the optimal order of choice of financing (Frank, 2011). It is assumed that firms prefer retained earnings, then choose debt and equity as the last resort. Equity, overall, when it is not overvalued, is very expensive for the company. Therefore, it is only issued when there is no other choice. Many times, information asymmetries play a relevant role because of market sentiment and investors' confidence. Additionally, from a market perspective, market timing comes into play: Lucky companies with high share prices issue more equity. Taking this one step further, in times of economic downturn, net earnings might decrease, which then leads to a decrease in retained earnings. In the case that monetary resources are needed rapidly, retained

earnings as the preferred source might not be liquid enough. According to Bessler, Drobetz, and Grüninger (2011), testing the pecking order theory is a question of ongoing interest.

The analysis is furthermore based on the assumption that cost of debt and cost of equity are important influences in the financing decisions of corporates. We are assuming that CAPM holds:

$$Cost\ of\ Equity = rf + ß * (rf + MRP)$$

The risk-free rate (rf) in this case is the benchmark rate for cost of debt, not including the spread paid by corporates at issuance. All else equal, an increase in the risk-free rate, meaning the cost of debt, would mean an increase in the cost of equity. However, there are two other factors to consider: the change of investors' variance covariance matrix (Buser, 1977) and the market risk premium (MRP), which is normally based on average historical returns, and decreases as the economy is slowing down and returns are diminishing as well. Consequently, it is hard to estimate the consequence for the cost of equity in the market. That depends not only on the monetary policy cycles but also on other factors like risk in the market, and how far into tightening and decreasing valuations the cycle of decreasing GDP is.

The chronology of these events can be mapped as the following:

1) An important macroeconomic event happens that impacts the market's prices in a significant way. Such an event could, for instance, be the disruption of supply chains during COVID-19. The shock to economies all over the world had to be offset by expansionary monetary policy by the ECB and cash support by official governments (Rakic, 2021).
2) There is high liquidity in the market and money is cheap. Consequently, individuals increase spending. In this example, prices increase simultaneously because supply cannot cover demand anymore (DW, 2021).
3) Following this event, inflation continuously increases (Koranyi, 2022).

4) To prevent further intensification of this development and avoid stagflation, which is a term for the combination of inflation with no GDP growth, the ECB becomes hawkish (Rakic, 2022).
5) The tightening cycle starts with tapering and interest rate hikes. This has two important implications: 1) There is less money supply and therefore, liquidity in the market and 2) the cost of new money increases because the risk-free rate, or base rate, increases.
6) The market reacts consequently. Equity valuations fall because of the increase in discount rate. Debt issuances become more expensive. As a result, many investors decide to stay side-lined and avoid participating in equity and debt markets. Managers are aware that investors now expect to be rewarded with a larger premium due to the rising risk in the market. They are also forced to reward investors with higher yields when issuing debt securities than it used to be the case in the last 13 years in which the market was shaped by low interest rates and looser central bank decision making policies (Rakic, 2022). Equity issuances pose an alternative but face two important problems: the market is illiquid, and valuations are comparably low.

Accordingly, equity issuances depend on more than monetary policy. For instance, they depend on how optimistic experts are about the market and the specific industry. Decisive is not only the corporate's willingness to issue but also their ability to issue and if there is demand in the market for equity. Equity market timing is the practice of issuing shares at high prices and repurchasing at low prices exploit temporary fluctuations in cost of equity relative to cost of other forms of capital (Baker, 2002).

3.2 Data

This part of the Research Design Chapter is devoted to the dataset used for the analysis. The primary data sources for dependent and independent variables are weekly data points related to debt and equity issuances in the German public market. If the data is not available on a weekly

basis, the last data point available is used for the subsequent periods until a new data point becomes available. The starting point is calendar week 1 of 2002 because it represents the initial changeover at which euro banknotes and coins were introduced in 12 countries in the European Union and the start of the ECB implementing monetary policy in Eurozone countries.

3.3 Dependent and Independent Variables

In this section, the most important independent and dependent variables used in the regression analysis are presented. The goal of the analysis is to test for the impact of changing base rates in the context of monetary policy from the ECB, on bond and equity issuances of corporates in Germany. All data was derived from Bloomberg and Refinitiv. An overview including all applicable variables and important additional information is depicted in Table 4.3. in the Appendix.

Dependent Variables

The dependent variables consequently are derived from the sum and count of all bond and equity issuances in a week between 2002 and 2022. Dependent variables include the (1) total corporate debt issuance volume (in EUR million (mn)), (2) total corporate equity issuance volume (in EUR mn), (3) count of corporate debt issuances, (4) count of corporate equity issuances, (5) average debt issuance volume per deal, (6) average equity issuance volume per deal, and (7) ratio of total debt issuance volume to the sum of equity and debt issuance volume. All dependent variables are based on data from Germany. The total equity and debt issuance volume in Germany serves as estimates of the capital issuance of German public companies. Both variables indicate how much companies are willing to issue in the public financial market at a certain point in time. This research examines whether and how significantly a company's total financing volume is impacted by the underlying macroeconomic environment and monetary policy decision-making. The number of corporate debt and corporate equity issuances in Germany is used in a similar context. They represent the simple decision of whether a

company decided to issue debt or equity in general, not considering the issuance size. The average debt and equity issuance volume per deal in Germany gives information about how macroeconomic events might impact the average volume per deal. In times of expansionary monetary policy and economic growth, we expect higher average issuance sizes. The ratio of total debt issuance volume to the sum of equity and debt issuance volume in Germany provides information about how companies' strategies change in terms of whether they prefer equity over debt financing or vice versa and the exposure to economic factors.

Independent Variables

Changes in monetary policy, macroeconomic risk, and the health of the financial market are driving factors in companies' financial decision-making. Therefore, we use different variables to reflect the impact of the risk-free rate, macroeconomic risk, and financial health in the market. The three-month Euro Interbank Offered Rate (EURIBOR/3-month-Euribor), which is released every day, represents the average interest rate at which European banks lend money to each other for short-term uncollateralized loans with different maturities. This research uses the 90 days Euribor, which represents a fixed rate that banks will pay after three months to borrow money from other banks, for several reasons. First, the rate represents the lending among European banks denominated in Euro, which represents the market and currency that is analyzed. It incorporates a snapshot of the forward expectations for the 3-month-Euribor and provides insights into market liquidity. Additionally, supply and demand dynamics are reflected, which may support investors' outlook expectations. However, it does not incorporate significant credit quality premiums of banks due to the short maturity of the benchmark loan and high credit ratings of banks. A potential counterargument against the use of the short-term rate may be that corporate bonds are usually priced with information that is based on the mid-swap rates of the same maturity as the bond itself. Hence, the 10-year-mid-swap rates is

included in the regression analysis as the average maturity of investment grade corporate bond is 12 years (Çelik, Demirtaş, and Isaksson, 2020).

To assess the investor's market risk, we use Markit iTraxx Europe index (ITRAXX) to represent market risk. It comprises 125 equally weighted credit default swaps on investment grade European corporate entities. Generally, the index allows credit investors to get an understanding of whether the market follows a bullish or bearish sentiment on credit securities. Hence, a relatively high measure indicates investors are bearish towards the market, and demand for corporate bonds in the primary and secondary markets is rather low. It also indicates that investors are willing to spend more to hedge themselves against potential defaults of corporate bonds and that the demand for credit default swaps is rising. The iBoxx Euro Corporates Overall Total Return Index (IBOXX) is a measure of the Euro-denominated corporate, investment, and investment grade bond market and comprises corporate bonds with a maturity of at least one year. It represents and thus can also be used as a proxy for the performance of the most liquid corporate bonds. Additionally, it acts as a yield estimate for potential debt issuances. Hence, the higher the index, the higher the likelihood of comparable bond prices to being high as well. This index is often either driven by the monetary decision-making of central banks, e.g., when central banks hike benchmark rates the index is expected to be lower.

Generally, all independent variables in the regressions are lagged by four weeks. This is necessary to reflect the time the market needs to absorb new information transmitted by the independent variables before reacting to it.

Control Variables

The goal of this research is to estimate the causal effect of interest rate changes and risk in the market on corporate debt and equity issuances. To account for general economic sentiment, and gross domestic product (GDP) development, control variables are added to the regression models. The GDP is generally used as a measure of the monetary value of final goods and

services produced in a particular country over a certain period (Sullivan and Sheffrin, 1996). Hence, the GDP can stand as a measure of economic health in a certain country. A rising GDP illustrates a growing economy while a drop in GDP levels indicates a deteriorating economy. It is important to be aware that an increasing growth rate in GDP is the key to rising income, profits, public capital raising, and standard of living of the population. The DAX Index is an index illustrating the performance of the 40 largest companies listed on the Frankfurter Stock Exchange. The companies need to fulfill certain minimum quality and profitability requirements. The ZEW German Indicator of Economic Sentiment analyses the assessment and forecasts about the economy of up to 300 experts from banks, insurance companies and financial departments form selected corporations. Participating experts comment on their six months expectations concerning the economy on a monthly base. The rationale behind using this indicator was to see a correlation between a positive outlook of the economy and companies issuing more capital in the public market. Further, it represents a forward-looking measure. Thereupon, if decision-makers expect a rather positive future, they may try to prepare for times in which they need more financing to respond to investor demand.

3.4 Baseline Regression Models

We test the relationship between interest rates and equity and debt issuances in Germany by performing Ordinary-Least Square regressions. The standard model for this kind of analysis is the following (Nokeri, 2021):

$$y = \beta_0 + \beta_1 X_1 + \ldots + \beta_n X_n + \varepsilon_i$$

As explained, metrics of equity and debt issuances serve as the dependent variables, while X_1-X_n denote the explanatory variables with their respective coefficients β_1- β_n. The goal is to test whether a variation in interest rates and credit risk can explain a variation in equity and debt issuances in Germany. To perform this test, the following models are used:

Baseline Models

$$y = \beta_0 + \beta_1 EURMS10Ylag + \varepsilon_i$$

$$y = \beta_0 + \beta_1 EURMS10Ylag + i.Year + \varepsilon_i$$

This research's basic relationships examine the impact of interest rates on the main dependent variables (see Table 6 in the Appendix). These regressions are tested with robust standard errors and year fixed effects, to illustrate how the fixed effects per year, independently of the independent variable, impact the regression result. This can provide an indicator of how a coefficient might change from year to year.

H1: Corporations reduce the usage of public debt and equity financing when interest rates are higher and when risk in the market increases.

This basis regression shows the effect of interest rates as well as credit risk in the market on financing liquidity in the German market, expressed through debt and equity issuances in Germany.

$$logTotalFin = \beta_0 + \beta_1 EURIBORlag + \varepsilon_i$$

$$logTotalFin = \beta_0 + \beta_1 EURMS10Ylag + \varepsilon_i$$

$$logTotalFin = \beta_0 + \beta_1 ITRAXXlag + \varepsilon_i$$

The dependent variable y for this hypothesis is logTotalFin, the sum of the EUR amounts of equity and debt issuances in Germany, in logarithmic form.

H2: Corporate public debt issuances decrease both in total volume and count when interest rates are higher, while public equity issuances are less affected by the interest rate environment (cost tradeoff hypothesis).

H2 follows the rationale that the cost of debt issuances increases when interest rates in the markets rise. This hypothesis examines the impact of changes in monetary policy through interest rates on corporate bonds and equity issuances in Germany. Assuming this hypothesis is true, with tighter monetary policy, the cost of debt increases, and therefore, the attractiveness

of debt decreases. For this scenario, we expect a decrease in volume and a stable or small decrease in the count of debt issuances. The same applies to equity issuances, although for this dependent variable, we expect to observe less significant results and more causality coming from additional economic indicators, like ZEW scores. We also expect a decrease in the volume and a stable or small decrease in the count of equity issuances because when the economic situation worsens, less equity is issued on average. However, the results will likely show low R^2 and a high p-value so that an omitted variable bias cannot be excluded. Equity decisions are often independent of monetary policy incentives. For equity issuances, the R^2 results are expected to be less significant than for regressions involving debt issuance metrics (see Appendix Graphs 1.2 and 2.2 for the distribution of absolute equity and bond issuances as well as average deal size over time). There is significantly more variation and deviation in the equity data, which makes the interpretation of this proportionality more difficult. A tighter monetary policy slows down economic growth. Consequently, two things can happen, which influence the importance of equity financing: 1) for corporates, equity issuances do not increase the risk of bankruptcy because of financial distress. Therefore, they might favor equity issuances when debt becomes more expensive, or 2) investors require higher returns because of risk in the market increases. This will make investors very selective in investments. Corporates know that and do not want to take the risk of issuing when the market is less liquid, as a failed issuance would have further implications on signaling effects. It depends on which overweighs, and consequently, equity issuances increase or decrease. To test this basic relationship, data points for economic confidence and performance are added. This limits the effect of omitted variables, and to account for determinants that go beyond the risk-free rate.

$$y = \beta_0 + \beta_1 rf + \beta_2 GRZEWI + \beta_3 GRZCURR + \beta_4 logGDP + \beta_5 DAX + \varepsilon_i$$

The dependent variable y takes on different values: sum of debt issuances, sum of equity issuances, count of debt issuances, and count of equity issuances in Germany. This model's

independent variable representing the risk-free rate (rf) takes on the 10-year-mid-swap and 3-month-Euribor to discuss possible differences in results. We expect negative coefficients for all scenarios. However, we also expect less significance in the independent variables when estimating the dependent variables related to equity, due to the economic intuition explained above. This indicates that equity issuances are exposed to more diverse macroeconomic influences than debt issuances.

H3: Corporates issue debt and equity in smaller average issuance sizes when interest rates are higher.

H3 builds on the concept that with tighter monetary policy, risk and uncertainty in the market is higher, and liquidity is lower. With lower issuance sizes, companies can contain their exposure to interest rates as well as equity over- and under-valuations.

$$AVGE = \beta_0 + \beta_1 rf + \beta_2 GRZEWI + \beta_3 GRZCURR + \beta_4 logGDP + \beta_5 DAX + \varepsilon_i$$

$$AVGD = \beta_0 + \beta_1 rf + \beta_2 GRZEWI + \beta_3 GRZCURR + \beta_4 logGDP + \beta_5 DAX + \varepsilon_i$$

The dependent variable y is the average equity deal issuance volume and the average debt deal issuance volume. The main independent variable representing the risk-free rate is modelled with both the 10-year-mid-swap and the 3-month-Euribor to discuss a possible explanation of differences in results.

H4: Public debt financing in proportion to the sum of debt and equity financing decreases when interest rates rise (significance of debt issuances theory).

$$DTotalFin = \beta_0 + \beta_1 rf + \beta_2 GRZEWI + \beta_3 GRZCURR + \beta_4 logGDP + \beta_5 DAX + \varepsilon_i$$

The dependent variable in this model is DTotalFin, meaning the proportion of debt issuances in comparison to the sum of equity and debt issuances (ratio of debt to total issuance volume). The main independent variable representing the risk-free rate is tested with both MS10Y and the 3-month-Euribor to discuss a possible explanation of differences in results. The rationale for H4 is similar to H3's but examines a different angle. H4 is examining the relative, not

absolute, development of debt issuances in comparison to whole financing efforts. We expect a slightly negative correlation. However, as equity issuances develop more independently, we do not expect the impact to be significant for interpretation.

H5: Credit risk in the market increases when interest rates rise and expectations of economic performance decrease.

$$ITRAXXlag = \beta_0 + \beta_1 rf + \beta_2 GRZEWI + \varepsilon_i$$

The dependent variable in this model is ITRAXX. IBOXX includes non-investment grade bonds and the risk-free rate and is a proxy for bond prices. ITRAXX reflects the credit default swaps market and therefore only the corporate spread. For ITRAXX the expected outcome is a positive correlation with interest rates. Risk originates in two sources in this scenario, repayment risk and the ability to serve interest payments. We expect a high significance of results while at the same time the omittance of many factors, overall related to uncertainty and credit risk, that cannot be reflected by monetary policy. An example is a disproportionate increase in uncertainty in the market due to the Russia-Ukraine war, which is not entirely linked to monetary policy tightening per se. We run this regression in preparation to find a viable connection between interest rates and credit risk in the market. From the results, we want to draw conclusions about the impact of changes in monetary policy (effective or anticipated) on uncertainty and credit risk in the market.

H6: Debt risk appetite and therefore, public debt issuances decrease as credit risk in the market increases together with higher interest rates.

$$y = \beta_0 + \beta_1 EURIBORlag + \beta_2 ITRAXXlag + \beta_3 GRZEWI + \beta_4 GRZCURR + \beta_5 logGDP + \beta_6 DAX + \varepsilon_i$$

$$y = \beta_0 + \beta_1 IBOXXlag + \beta_2 GRZEWI + \beta_3 GRZCURR + \beta_4 logGDP + \beta_5 DAX + \varepsilon_i$$

The resulting hypothesis is based on the credit risk view examined previously. ITRAXX, not including the risk-free rate, together with the 3-month-Euribor serve as the main independent

variables in this regression. Expression of uncertainty are often of macroeconomic nature but can also change according to how the ECB reacts to certain events. IBOXX already incorporates the risk-free rate, while ITRAXX does not, as it tracks credit default swaps, which represent the corporate credit spread. Therefore, the design for the IBOXX regression does not include the risk-free variable as part of the explanatory variables. For H6 to be true, we expect a decrease in the count of debt issuances, sum of debt issuances, and average debt deal issuance volume if credit risk in the market increases. For the equity side, we expect a decrease in volume and stable or small decrease in count of share issuances but a possible increase in the significance of equity financing (expressed in DTotalFin as a percentage of debt issuances in relation to whole financing amount).

H7: Public debt financing in proportion to the sum of debt and equity financing decreases when interest rates rise and credit risk in the market increases.

$$DTotalFin = \beta_0 + \beta_1 EURIBORlag + \beta_2 ITRAXXlag + \beta_3 GRZEWI + \beta_4 GRZCURR + \beta_5 logGDP + \beta_6 DAX + \varepsilon_i$$

$$DTotalFin = \beta_0 + \beta_1 IBOXXlag + \beta_2 GRZEWI + \beta_3 GRZCURR + \beta_4 logGDP + \beta_5 DAX + \varepsilon_i$$

The dependent variable in this model is DTotalFin, the ratio of debt to total issuance volume. The main independent variables representing credit risk in the market are IBOXX and a combination of ITRAXX and the 3-month-Euribor to discuss possible differences in results. The goal is to examine the impact of changes in risk in the market on the significance of equity and debt financing. We expect a decrease in the significance of debt financing when ITRAXX increases and therefore, credit spreads increase. This would indicate an increase in the significance of equity financing, because of how the variable is structured: DTotalFin = Debt / (Debt + Equity). This is not related to how the total sum of financing develops, but how it is distributed across debt and equity. We expect a positive correlation between IBOXX and the ratio of debt to total issuance volume (DTotalFin) because yields on corporates decrease when

IBOXX increases, which is favorable for issuers. Graph 2.3 in the Appendix shows that equity issuances are distributed relatively unevenly, not following a clear pattern apart from fewer equity issuances in times of economic turmoil.

4. Regression Analysis

The estimated regression models are tested using STATA, a statistics software. After running the baseline regressions, White's test for heteroskedasticity is performed, concluding that heteroskedasticity might be an issue for all models. The p-values are below the 5%-level for which the hypothesis of homoskedasticity can be rejected on a 95% confidence level. Consequently, robust standard errors are used. It is common practice in the academic finance literature to perform additional regressions which implement controls for the year fixed effects. These are effects not observable or measurable but need to be estimated since leaving them out leads to a sub-optimally trained regression model (Gormley and Matsa, 2014).

4.1 Discussion of Results

We interpret all regressions involving the sum of equity issuances and sum of debt issuances from a log – level standpoint, as the dependent variable is in logarithmic form, and the independent variables are winsorized, but in normal form. To give context to the interpretation of results, an economic calendar highlighting the most important developments and events of the time analyzed by the regression models follows. In the time between 2002 and 2022, both the number of public debt issuances and public equity issuances rise noticeably. While the number of equity issuances is historically volatile, the number of debt financing rises exponentially with no outliers. Particularly between 2020 and 2022, the number of public debt financing rises at high rates. In 2021, the number of corporate debt issuances is more than 20 times the issuance in 2009 and more than 330 times the number in 2002. Over the same period, the number of equity issuances varies a lot. While it shows an upside trend in times of economic

growth, it also falls when economic uncertainty rises. Between 2002 and 2004, issuances cross equity and debt is historically low. The years are characterized by declining global economic activity, because of the burst of the Dot.com (Technology) bubble, the 9/11 terrorist attack in 2001, and the resulting stock-market crash in 2002. As the main refinancing rate of the ECB rose to as high as 4.75%, discount rates rose, and equity valuations dropped. In the weeks following the terrorist attack on September 11th, the world equity markets lose an estimated USD 2 trillion and 20 of the world's major stock market indexes dipped by more than 10%. In addition, 32 national indices fell at least by 8%. Travel, trade, and communication sectors are impacted negatively as costs rise. In consequence, this threatens the functioning and efficiency of global production chains. Additionally, business and consumer confidence take a noticeable hit (Noshab, 2002). Companies' equity prices decline, which most likely discourages companies to issue equity in the public market. With the rising probability of companies defaulting, the cost for companies to issue debt also rises. On the other hand, central banks decrease interest rates to weather economic difficulties. After 2004 and prior to the financial crisis, the number of equity issuances follows an upside trend, in line with higher economic output, reflected by a rise in GDP growth. Graph 3.2. in the Appendix visualizes the development of equity and debt issuances over the years.

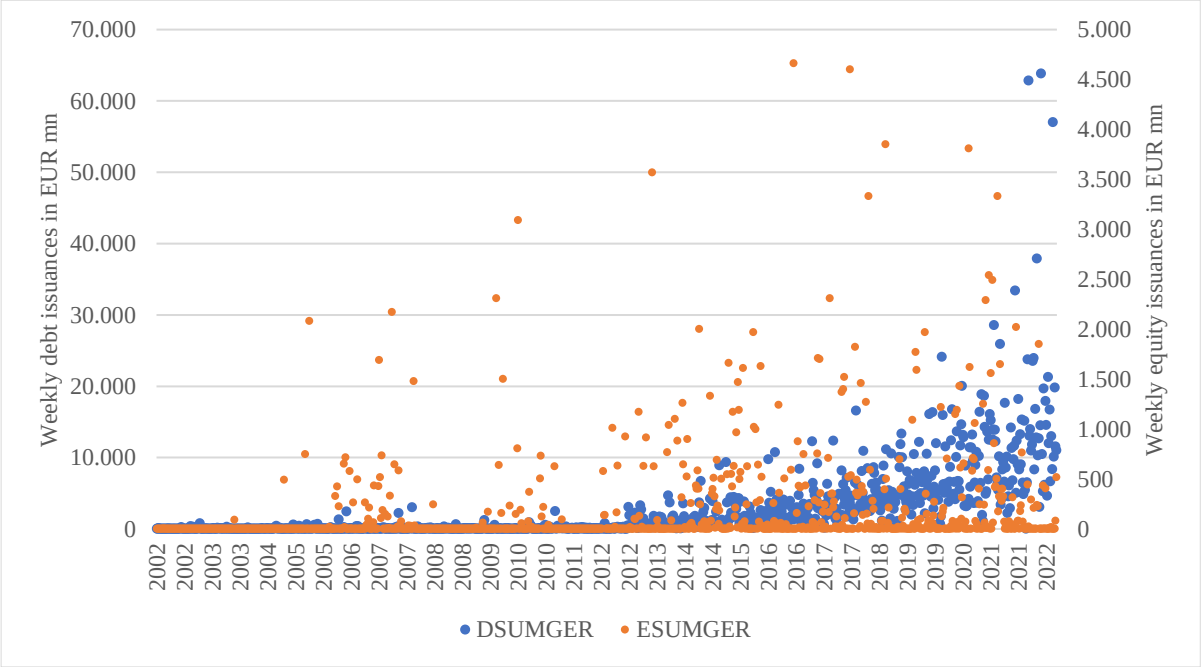
However, the financial crisis in 2007, which is shaped by the sub-prime mortgage crisis and corporate fraud, caused the global economy to fall into the deepest recession since the great depression. The ECB consequently rises interest rates again to levels as high as 4%. This causes the number of equity issuances to drop significantly from 2007 to 2008 as it leads to significant consequences for the economic health and fiscal position of EU member states, including Germany. The European Union reacts with drastic measures such as the bailout of several banks and support for stressed sovereigns. In 2009, companies in Germany increase their activity in equity financing again as the German economy recovers from the crisis. In the subsequent year,

the number of equity issuances drops. Between 2011 and 2015, the number of public equity financing rises gradually despite modest growth in GDP in Germany, before it drops in 2016, impacted by the Greek Debt Crisis, which had a significant influence on other countries in Europe and the world. As Greece is not able to pay back its sovereign debt, the European Union provides loans to Greece to fulfill its debt payments and avoid a sovereign default. However, this creates symmetric risks within Europe as other EU members are at risk of default as well (Szczepanski, 2019). Fears over slowing economic growth in Europe most likely impact the drop in corporate bond issuances between 2018 and 2019, despite the loose monetary policy approach of the European Central Bank. In 2020 and prior to the COVID-19 pandemic, however, companies are increasingly looking for public capital. While the European Central Bank follows an expansionary monetary policy approach through Asset Purchase Programs, which already started in 2014, and cheap borrowing costs, companies decide to issue more debt and equity in the public market. In Q3 2019, outstanding debt relative to the size of the US economy in the nonfinancial business sector, including corporates, reaches a new peak (Buckley, et al., 2021). This trend of rising numbers in public equity issuances reversed as the COVID-19 pandemic affected the global economy. In contrast, public debt financing continued its upside path. However, according to Acharya and Steffen (2020), companies with credit ratings AAA-A increase their bond issuance activities during COVID-19 while firms with BBB ratings (the lowest investment grade rating) do not. One reason for the debt pile-up is that the default risk of companies remained relatively contained (Valla and Miguet, 2022).

Considering the changing macroeconomic environment, we expect the results of our regressions to be significant. However, we must consider the following factors: the distribution of equity issuances is very volatile in the observed years and the importance of external debt financing. Therefore, debt issuances rise significantly on average since 2002. Additionally, as Myers indicates in his work from 1984, the “modified pecking order” can be an explanation to

understand financing decisions. The balance of borrowing just enough to keep the debt safe through restraints, but close enough to default risk, changes when the macroeconomic environment changes (Myers, 1984).

Figure 1 – Distribution of weekly equity (ESUMGER) and debt issuances (DSUMGER) in Germany



Source: Bloomberg (2022)

Throughout our interpretation, we hold all variables constant when interpreting the effect of one. Additionally, it is presumed that all Gauss Markov assumptions hold. For most of the interpretation, we do not interpret constants, as it is economically not possible to set all independents to 0 and a negative coefficient would not be logical in the real world.

Baseline: When estimating the impact of the 10-year-mid-swap on y, in the models where the dependent variable takes on the sum of equity issuances, sum of debt issuances, count of debt issuances, count of equity issuances, average debt deal issuance volume and average equity deal issuance volume, it is evident that the β_1 coefficient becomes less significant, or even insignificant. This can also be due to a general trend of interest rate cuts in the dataset up until recently, which creates fixed effects over the years. It is statistically hard to conclude causality here. However, an observation is interesting for this research. The year-fixed effects

are only statistically significant for debt issuances, which show an increasing trend in the dataset across time. This again supports the observation that debt issuances in general have been increasing (see Graph 3.2. and 1.2).

H1: Estimating the effect of the 3-month-Euribor, 10-year-mid-swap, and ITRAXX on the total weekly usage of corporate financing tools, we observe a negative correlation between interest rates (expressed both in the 3-month-Euribor and the 10-year-mid-swap) and the sum of debt and equity financing. The 0-hypothesis of zero effect of all regressed main independents is rejected on a 99% confidence level. This means, with a 1 unit increase in ITRAXX, we expect a 3.96% decrease in the sum of debt and equity issuances. With a 0.1% absolute increase in the 3-month-Euribor and the 10-year-mid-swap, the results show an expected 11.4% and a 12.3% decrease in the sum of total financing, respectively. The goodness of fit, R^2, is highest for the 10-year-mid-swap, meaning it is the model that can explain the most variation in the dependent variable. This is intuitive, as corporate bond issuances are often priced against the 10-year-mid-swap rate. Debt issuances are generally more frequent and higher in total volume than equity issuances, meaning the impact of interest rates on debt issuances has more weight even in this analysis (compare all coefficients of H1 to Table 7.1 in the Appendix).

H2: The regression output for H2 - H4 is derived from Table 7.2 and 7.3 in the Appendix. We observe a negative correlation between the 3-month-Euribor and the 10-year-mid-swap, and the sum and count of corporate bond issuances when estimating the effect of interest rates on total weekly corporate bond issuances in Germany. We measure the impact of interest rates both with 3-month Euribor and 10-year EUR mid-swap rate as they are the main independent variables representing interest rates in the market. To account for other factors that influence the decision-making process of firms regarding public debt financing, measures of economic expectations, GDP and DAX data are added for all models. We reject the hypothesis of zero effect of the 3-month-Euribor and the 10-year-mid-swap on the weekly sum and count

of equity and debt issuances on a 99% confidence level. We expect a 7.451% decrease in the volume of weekly bond issuances with a 0.1% absolute increase in the 10-year-mid-swap. For public equity issuances, the decrease is lower, at 5.996%. In contrast, we can observe the count of bond issuances increasing when interest rates rising. This can also be due to the year fixed effect from the baseline regression (see Graph 3.2). The count of equity issuances, however, is negatively correlated with interest rates. We expect a 1.8 unit decrease in count of equity issuances with a 1% absolute increase in 3-month-Euribor. In general, standard errors are very high across all models in this hypothesis, indicating a wide distribution of results and therefore also a higher independence of the dependent variables than the model can measure. R^2 indicates that the models estimating public debt data can explain the most variance in the respective dependent variable. The goodness of fit is throughout significantly lower for equity issuances, as expected. Interesting to note is that DAX and GDP metrics have high statistical significance in almost all regressions, however, might be practically insignificant because of their low coefficients. Regressions with the 10-year-mid-swap rate as the main independent variable generally produce more extreme coefficients, but always with the same sign when comparing it to the models with the 3-month-Euribor rate. The hypothesis can be partially accepted, as we can confirm the negative relationship between the sum of debt issuances and the main independent variables representing risk free rate. However, the count of debt issuances shows a positive correlation, against expectations.

H3: Estimating the effect of interest rates on the average deal size of equity and debt issuances, we observe a negative correlation, in line with expectations. The results are statistically significant for average debt and equity deal size on a 99% confidence level. Both results support the hypothesis, that when corporates decide to issue in higher interest rate environments, they do so in smaller sizes to be less exposed to higher costs of financing. With a 1% increase in the 10-year-mid-swap, we expect a 1.76 million decrease in average debt

issuance deal size, and a 3.73 million decrease in equity issuance size. However, R^2 indicates that the model can only explain a relatively limited portion of variance in the dependent variables. Indicators of economic performance and health seem to not have a statistically significant effect on the average deal sizes. Overall, regarding equity deal sizes, we expected this result and low goodness of fit, as equity deal issuance sizes have very high standard deviations across the data set (see Graph 1.3).

H4: The impact of interest rates on the significance of debt and equity financing, meaning the distribution of the dollar amounts of public financing across debt and equity tools, is not statistically relevant. We observe some statistical relevance in GDP and expectations of economic situation in Germany. However, the coefficients are very low, overall, in relation to the modelled constants. We can therefore reject hypothesis 4 as there is no observable impact of interest rates on the distribution of public financing across debt and equity tools. It is important to mention that debt issuances generally make up most of the public financing, which impacts the results and makes changes less observable. The results with the 3-month-Euribor rate as the representative of interest rates only look marginally different. This shows that both independent variables are good indicators for the rates that are directed by monetary policy expansion or contraction and which influence liquidity and interest rates in the market.

H5: This hypothesis estimates the effect of interest rates on credit risk in the market. We observe a positive correlation between interest rate rises and ITRAXX, along with initial expectations. With a 0.1% absolute increase in the 10-year-mid-swap rate, we expect a 2.68-point increase in ITRAXX. This result is statistically significant on a 99% significance level and is consistent with the economic intuition explained above. Even though IBOXX is also an index representative of credit risk in the market, there is a significant difference: IBOXX includes the risk-free rate while ITRAXX only represents the corporate credit spread. As it only captures the additional effect of credit risk on corporate financing, the latter is of more

importance. When testing the same relationships with the 3-month-Euribor rate instead of the 10-year-mid-swap rate we observe similar results overall in the coefficients' signs. The 3-month-Euribor seems to have a more significant impact on ITRAXX as the coefficient is more than double compared to the 10-year-mid-swap coefficient, keeping everything else constant. With the 3-month-Euribor rate increasing 0.1%, we expect ITRAXX to increase by 5.5 points. All regression results are displayed in Table 7.4 in the Appendix.

H6: This hypothesis has a similar intuition as the cost hypothesis. However, instead of solely estimating the impact of interest rates on the public financing decisions of companies, we estimate the impact of credit risk in the market on the same dependent variables. When denoting ITRAXX and the 3-month-Euribor rate as independent variables for this regression, we observe a negative correlation between the volume of debt issuances and credit risk in the market. When ITRAXX increases by 1 unit, we expect the volume of debt issuances to decrease by 0.997%. The same counts for equity issuances, with a decrease of 2.95%. However, as observed in H2, the goodness of fit for the equity metrics indicates that the independent variables can explain 65% of the variation in the sum of debt issuances but just about 10% in the variation of the sum of equity issuances. When we estimate the count of equity and debt issuances, the coefficient of ITRAXX is positive, meaning there is a positive correlation between credit risk in the market and debt issuances. However, the constant is extremely negative, possibly making this result practically insignificant. The coefficient of the count of debt issuances of 0.843 is significantly different than for the count of equity issuances, meaning a change in credit risk has a less instant and intense impact on the count of equity issuances than it does on debt issuances. For both, the result is statistically significant on a 99% confidence level. Again, we observe that the data surrounding debt issuances are better explained by changes in ITRAXX and the 3-month-Euribor than the data surrounding equity issuances, with a goodness of fit under 10%. Finally, there is a negative correlation between

credit risk and the average debt and equity deal volume. With ITRAXX increasing by 1 unit, we expect average debt deal volume and average equity deal volume to decrease by 0.501 million and 1.496 million respectively, both with high statistical significance. Additionally, and in contrast to equity issuance data, the additional economic indicators show statistically significant impact on debt issuance data. A possible explanation is that the credit risk in the market captures some of the influences that macroeconomic indicators like GDP and economic surveys have on public financing decision-making. By adding ITRAXX to the model and comparing the 3-month-Euribor's coefficients, we observe that the impact, in whichever direction, is overestimated by the models excluding ITRAXX. Some magnitude of causal effect is therefore corrected when including ITRAXX. Interesting to observe is again that the count and sum of equity issuances is statistical independence to the variables related to ZEW scores in this case. This indicates that credit risk in the market impacts the use of equity financing, possibly because it includes general macroeconomic risk, while variations in the count of debt and equity issuances and the sum of debt issuances can be explained by changes in ITRAXX and the 3-month-Euribor at a 99% confidence level. We observe the same pattern with average deal issuance sizes. There is a negative correlation between ITRAXX and the average debt deal issuance volume and the average equity deal issuance volume. This relationship shows high statistical significance. However, the average debt deal issuance volume is also highly dependent on the 3-month-Euriborrate. We can reject the hypothesis of zero impact of the 3-month-Euribor on the average equity deal issuance volume at any conventional confidence level.

H7: When ITRAXX increases by 1 unit, the Debt to Total Financing ratio decreases by 0.000635, which confirms the hypothesis that when interest rates rise, debt becomes less attractive as a financing tool. However, with an R^2 of only 8.5%, only a small part of the variation in the ratio of debt to total issuance volume (DTotalFin) can be explained by the 3-

month-Euribor. This goes in line with the positive correlation between ITRAXX and the sum and count of equity issuances. It also confirms the result showing a higher coefficient of ITRAXX estimating the sum of equity issuances than when estimating the sum of debt issuances. Further, when credit risk increases, the sum of equity issuances decrease more than the sum of debt issuances does. However, this hypothesis can still not be accepted as the coefficient is too low to have a practically significant impact.

4.2 Limitations and Suggestions for Further Research

This research focuses on interest rates as a market influence, which are impacted by monetary policy decisions from the ECB. However, tapering and the bond purchase programs by the ECB are additional crucial influences on liquidity and are an interesting factor influencing the bond and equity market. Moreover, new monetary regulation tools like Central Bank Digital Currencies (CBDC) will play a role in the future and will have an impact on how companies finance themselves, for instance by introducing new models of public and external financing. Furthermore, the development of interest rates and monetary policy, a key component of this research is currently in the most interesting transition. Interest rates are rising at paces the market has not experienced in decades, after years of low, and even negative financing costs. It would be interesting to run this analysis in 10 years again. The future sample would reflect a larger variation in the sample of interest rates, and accounts for the time after COVID-19, with high inflation and large interest rate hikes. Furthermore, one can challenge the decisions regarding proxies for interest rates and credit risk in the market. ITRAXX was only introduced in 2012, limiting the data to a smaller sample size. The 10-year-mid-swap rate and the 3-month-Euribor rate both do not exactly represent the base rates published by the ECB; however, they reflect important benchmarks of the bond pricing market, which is the risk-free rate that the models of this research are aiming for.

5. Conclusion

The goal of this research is to analyze the impact of interest rates, influenced by monetary policy decisions of the ECB, on financing decisions between debt and equity issuances of German corporates. The statistical results show that the timing and average size of public debt issuances is impacted by ECB monetary policy decision making, while equity issuances occur more independently. Also, we observe that interest rates have a negative impact on the average deal size of equity and debt. In contrast, the impact of interest rates on the distribution of the EUR amounts of public financing are not statistically significant. Important to notice is that global credit markets are noticeably larger than equity markets, with debt deals happening more quickly than on the equity side. Moreover, the models overestimate the impact and significance of interest rates when not considering credit risk in the relationship between interest rates and issuances. Consequently, credit risk in the market is also negatively correlated with issuances. This is intuitive because higher credit spreads cause higher costs for debt issuances. However, especially the regression between the independent variable ITRAXX and the dependent variables sum of equity and sum of debt issuances, imply that macroeconomic risk factors explain the variation in the sum of debt issuances much better than the variation in the sum of equity issuances. There are many macroeconomic and personal factors that one needs to consider when predicting trends in corporate financing decisions. It is likely that equity issuances are generally more independent of the macroeconomic environment than debt issuances. Decisions related to equity are made by executives on special occasions, independent of monetary policy or macroeconomic drivers. Additionally, the year-fixed effects provide evidence for the dependency of financing decisions on the year-specific economic environment. Generally, the takeaway from this research is that debt and equity are not only different in their structure and advantages and disadvantages at issuance but also in the influences impacting their issuance timing and motivation. Equity is more exposed to idiosyncratic risks, while debt

issuances are more linked to macroeconomic factors such as interest rate changes and credit risk in the market. To draw conclusions with more certainty, we need to repeat this analysis at a later point, including the 8–10-year period after the COVID-19 pandemic, during an environment where interest rates experience sharp increases.

6. An Analysis of the Implications on the Debt-to-Equity Ratio in the DAX

6.1 Background

In a major part of this research, the focus is on which factors are most determinant in the financing decision between debt and equity. The capital structure puzzle is given less importance because the goal is to find the external, and mostly macroeconomic factors that lead to the decision of whether to issue debt or equity. In this part of the research, the internal factors, more specifically the target D/E ratio of German corporates is the focus. How does the general capital structure, a product of financing decisions, change in different interest rate environments? This is a part of the optimal capital structure puzzle, which has been a challenge for economists in the past centuries. Like Myers states in his paper in 1984, there are theories investigating the reason for certain target ratios. However, the result of such ratio can still depend on different point of views and preferences. Two possible approaches to explain capital structure are the static tradeoff theory, in which the firm is setting a target D/E ratio for themselves, which is the focus of this part of the research, and the pecking order framework, which focuses on the advantages and disadvantages of the available types of financing (Myers, 1984).

For this part of the further research, I assume that a company, when making a certain financing decision, is having the change in debt-to-equity ratio in mind after that decision is implemented. Target debt-to-equity ratios differ across industries. However, it is interesting to observe the trend of distribution of capital between debt and equity across industries and different interest rate environments. In general, it is observable that debt-to-equity ratios across high growth companies, characterized by volatile cash flows, low tangibles in the balance sheet, and high human capital, are lower than for low growth companies. The latter are characterized by a high fraction of tangibles in the balance sheet, steady cash flows, and a mature business

model. This is intuitive, as low growth is associated with more reliability, while high growth is associated with more risk (Berk, 2019). Apart from the industry and maturity of a company, its debt-to-equity ratio is influenced by other determinants. These determinants are worked with in capital structure theories. One example is the tradeoff theory, focusing on the tradeoff and balance between financial distress costs and the tax shield created by debt (Kraus and Litzenberger, 1979). Another determinant are risk-shifting problems, which describe the conflict of heterogeneous investment opportunities. Companies and their managers also show differences in how flexible they are to take on risks and opaque investments (Berk, 2019). Non-monetary related theories play a role as well. For instance, the signaling effect assumes that when a company takes on debt it is confident about the future and repayment. In contrast, when it issues equity, it could signal that the equity is overvalued, which might not necessarily be true. However, capital markets tend to interpret and react to these decisions. Furthermore, the credibility principle claims that one's self-interest is only credible if it is supported by actions that would be costly to take if the claims enter. Moreover, there is the management entrenchment theory, which states that managers choose a certain capital structure primarily to avoid the discipline of debt and maintain their own entrenchment (Berk, 2019). In addition, managers might seek to minimize leverage to prevent their job loss that would accompany financial distress, which is increasingly more important in times of economic turmoil or when debt becomes more expensive. In the end, decision-makers continuously face agency problems. They tend to choose a capital structure that minimizes agency problems as covenants are in place now. Finally, personal circumstances of managers and their risk aversion play a role and impact the relevance of the previously discussed theories. Risk aversion of individual managers is a variable that is very hard to measure and often omitted when analyzing executive decision making (Coleman, 2007, p. 17).

Finding the optimal level of debt for a firm depends on different scenarios. Whether or not it is favorable to issue debt and therefore increase the debt-to-equity ratio depends on the present value of financial distress costs and the probability of financial distress in contrast to the present value of interest tax shields created by the interest paid on debt until maturity. An important equation to consider when deciding whether or whether not to issue debt is the following:

*PV (interest tax shield) – PV (financial distress cost) * probability !< PV (interest tax shield)*

This equation supports the previously discussed tradeoff theory, which eventually leads to the optimal capital structure which is primarily determined by the financing decisions that executives take (Kraus and Litzenberger, 1979).

$$VL = VU + PV(TS) - PV(\text{fin distress})$$

As discussed, there are different influences that determine capital structure, and they are of psychological nature, strategic nature, monetary and risk aversion nature, or macroeconomic nature. Other theories support stockholder interest and how it can differ from managerial interest. These can be examined, but the scope of their empirical analysis exceeds the limits of this research. Many of the above-mentioned influences have an origin which can be linked to own control, risk aversion, or personal preference. However, the macroeconomic and monetary policy influences, as focused on through the impact of interest rates in this case, are out-of-control influences. In the following, I assess the impact of monetary policy expansion or tightening expressed through interest rate levels on the relative distribution of debt and equity of German corporates in the DAX. The DAX comprises and measures the performance of the 40 largest German publicly companies in terms of order book volume and market capitalization on the Frankfurt Stock Exchange (Deutsche Börse). Comparable indices are the FTSE100 in the UK and the Dow Jones Industrial Average in the US. Do interest rates influence the distribution of debt and equity across the largest corporates in the German stock market?

6.2 Hypothesis

H1: Interest rates influence the average capital structure across DAX corporates.

The expected outcome is to observe a statistically significant impact of interest rates on the debt-to-equity ratio across German DAX corporates. The direction of this relationship is hard to estimate, overall, because of the previously assessed influences. However, there is a trend of decreasing debt-to-equity ratios in the dataset, which could impact the results of this regression. The relationship is tested with the first two baseline regressions. When interest rates are higher, equity valuations decrease because of higher discounts rates. This would cause debt-to-equity ratios to increase, and a positive correlation would be observed.

H2: The capital structure distribution across the DAX is influenced by both interest rate environment and credit risk environment.

I expect the impact of the interest rate representative to decrease when ITRAXX is added to the model, as ITRAXX captures some of that impact on the debt-to-equity ratio of the DAX. Nevertheless, the coefficient of the 3-month-Euribor rate and ITRAXX is expected to have the same sign.

$$DAXDE = \beta_0 + \beta_1 EURIBORlag + \beta_2 ITRAXX + \beta_3 logGDP + \beta_4 GRZEWI + \varepsilon_i$$

H3: Increasing bond prices (increasing IBOXX and therefore decreasing yields) tend to increase the debt-to-equity ratio of corporates in the DAX.

With increasing corporate yields, prices of bonds decrease and consequently, debt issuances are more expensive for corporates, which could lead to a decrease in the debt-to-equity ratio of corporates. However, at the same time this is linked to macroeconomic factors that also concern equity valuations. When in turn equity valuations decrease with higher discount factors, the total ratio will increase, as equity is in the denominator. This relationship is tested with the baseline regressions.

For all hypotheses, the crucial challenge is the average trend in the data set towards a generally lower debt-to-equity ratio in the DAX. This could bias results. Interest rates or risk in the market might fail to explain this trend, as it originates mainly from year-fixed effects or general changes in strategy across the economy.

6.3 Baseline Regressions and Discussion of Results

Baseline Regressions (applicable to H1 and H3)

$$DAXDE = \beta_0 + \beta_1 EURIBORlag + \beta_2 logGDP + \beta_3 GRZEWI + \varepsilon_i$$

$$DAXDE = \beta_0 + \beta_1 EURMS10Ylag + \beta_2 logGDP + \beta_3 GRZEWI + \varepsilon_i$$

$$DAXDE = \beta_0 + \beta_1 IBOXXlag + \beta_2 logGDP + \beta_3 GRZEWI + \varepsilon_i$$

The dependent variable is modelled as DAXDE. It represents the total sum of short-term and long-term debt divided by the total equity in the DAX. The main independent variable for the risk-free rate is tested with both 10-year-mid-swap and the 3-month-Euribor, to allow for a comparison of both results. IBOXX, as the other independent variable, represents credit risk in the market. Furthermore, GRZEWI, the Germany Expectations of economic growth indicator, is added to the model as an independent control variable to control for the economic situation in Germany. A higher value in that variable stands for more survey participants voting for a positive expectation of economic growth. The sentiment about economic growth or stability is expected to be a determinant in whether a company decides to alter their leverage and, consequently, increase the debt-to-equity ratio or not. There is, if any, limited literature analyzing the relationship of interest in this part of the research. However, from an economic perspective, it can be stated that in times of economic optimism, an executive might be willing to take on more risk, for instance increase leverage, because the risk of not being able to serve the debt decreases. Additionally, when the debt is cheap, the present value of financial distress decreases simultaneously. When interest rate environments change, the market reacts according to changing discount rates. This influences the balance sheet structure of corporates and

therefore, debt-to-equity ratios change even without actions from the executive side. For instance, there are debt covenants for which at certain market capitalization the loan either gets restructured or interest rates altered, which then lead to liability changes. Furthermore, market value depreciation may be considered as a determinant of goodwill impairment and convertible bonds with warrants get effected by stock market movements because they influence convertibility which impact equity and asset balance (Spiteri, 2020). Lastly, the asset side is impacted by the macroeconomic environment. For instance, revenues decrease, and expenses increase, as observed in recent months during the crisis of soaring energy prices. There is much literature on how a change in debt-to-equity ratios affect stock returns or dividend payout ratios. For instance, Bhandari empirically analyzed debt-to-equity ratios and expected common stock returns. He finds positive correlation between the two variables concluding that the premium which is associated with the debt-to-equity ratio is likely to be more than a risk premium (Bhandari, 1988). However, there is limited literature regarding what the reasons for a change in debt-to-equity ratio are and why companies target a specific debt-to-equity ratio in different environments and industries. Within industries, target debt-to-equity ratios are often defined according to the average peers' ratios, to be comparable within the industry. The reason for that is that corporates within one industry often share certain attributes like default risk, cash flow volatility, and exposure to certain macroeconomic drivers. On the one hand, it would be intuitive to say that debt-to-equity ratios stay the same in times of higher interest rates. Corporates in these times issue less debt because the debt is more expensive and therefore riskier for them from a credit risk point of view. On the other hand, if all stays equal, equity is impacted negatively by the changing macroeconomic environment and market pricing. For instance, convertible bonds would convert to equity because of a decreasing market capitalization of the company. Another example is when retained earnings decrease following economic contraction which would impact the numbers on the income statement. This increases

debt-to-equity ratios. A positive coefficient is expected for the credit risk variable IBOXX, as when IBOXX increases, the credit risk in the market decreases and the level of debt-to-equity ratios can be higher without increasing default risk.

6.4 Discussion of Results

The estimated regression models are tested using STATA, a statistics software. After running the baseline regressions, White's test for heteroskedasticity is performed, concluding that heteroskedasticity might be an issue for all models. As the p-values are below the 5%-level, the hypothesis of homoskedasticity can be rejected on a 95% confidence level. Consequently, robust standard errors are used for all regressions. It is common practice in the academic finance literature to perform additional regressions which implement controls for the year-fixed effects. These are non-observable or measurable effects that need to be estimated since leaving them out leads to a sub-optimally trained regression model (Gormley and Matsa, 2014). For comparability purposes, this was done for the baseline regressions, testing the impact of the 3-month-Euribor and 10-year-mid-swap rate as the main independents.

H1: When estimating the effect of interest rates on the distribution of debt and equity across the DAX, the results show a positive correlation between the interest rate representatives and the debt-to-equity ratio in the DAX (DAXDE). To account for other factors that influence the capital structure goals of corporates, the model includes measures of economic expectations like GDP and DAX data. The 0-hypothesis of zero effect of the 3-month-Euribor and 10-year-midswap on the average debt-to-equity ratio in the DAX (DAXDE), the regressed dependent variable, can be rejected on a 99% confidence level. For H1, this means, a 0.1% absolute increase in the 3-month-Euribor leads to a 2.825 point increase in debt-to-equity ratio of the DAX in the observed dataset. According to the results for the goodness of fit, R^2, the model explains over 80% of variation in the dependent variable. As observed in the previous regressions, the 10-year-mid-swap rate had a more extreme impact on the dependent variable,

however with the same coefficient's sign. A 0.1% increase in the 10-year-mid-swap rate is expected to lead to a 3.365 point increase in the debt-to-equity ratio, with a goodness of fit of 0.86, similar to R^2 of the 3-month-Euribor. When accounting for year-fixed effects, the output shows statistical significance for each year's effect and GDP data. Nevertheless, this could be due to the general trend of debt-to-equity ratios in the DAX over the years (compare Table 8.4 with year-fixed effects and 8.5 without year-fixed effects). Interesting to observe is that the year-fixed effects are less extreme for the 3-month-Euribor than for the 10-year-mid-swap rate. The coefficient of the 10-year-mid-swap rate decreases significantly, to only a small fraction of the coefficient when not accounting for year-fixed effects. The coefficient of the 3-month-Euribor decreases to about half. The coefficient of the 3-month-Euribor decreases, but still has statistical significance on a 99% confidence level, while the 10-year-mid-swap rate coefficient shows no statistical significance. The results show, that in this type of research it is important to account for effects that are unique to each year and characterize these. Reasons for that could be impactful macroeconomic events or other significant influences in the market which do not follow a pattern attributable to independent variables. After accounting for year-fixed effects, the coefficient of the 10-year-mid-swap is only a fraction of the one in the model without year-fixed effects.

H2: In the model including the 3-month-Euribor and ITRAXX, I test the influence of both interest rates and credit risk on the debt-to-equity ratio in the DAX. The results show a decrease in the coefficient of the 3-month-Euribor when adding ITRAXX to the model. Therefore, the model is overestimating the impact of interest rates on the debt-to-equity ratio of companies in the DAX when not accounting for the impact of credit risk in the market. Including ITRAXX in the model results in a coefficient of 1.482 for the 3-month-Euribor, translating into a 1.482-point increase in the debt-to-equity ratio of the DAX for each 0.1% absolute increase in the 3-month-Euribor. For each point increase in ITRAXX, the expectation

is a 0.146-point increase in the debt-to-equity ratio. Looking at indicators of economic expectation in Germany, the results show that with more positive economic expectations, the debt-to-equity ratio increases. Nevertheless, the coefficient is low and hence not practically relevant for this research. GDP across all tested models has a slightly negative relationship with the debt-to-equity ratio. The results indicate, that with higher GDP, the debt-to-equity ratio in the DAX decreases. This, however, is highly influenced by the general trend of increasing GDP and decreasing debt-to-equity ratio over the years (see Graph 8.3). ITRAXX, as also depicted in Figure 2 below, moved relatively independent to the debt-to-equity ratio.

Table 2: Regression results for hypothesis 2

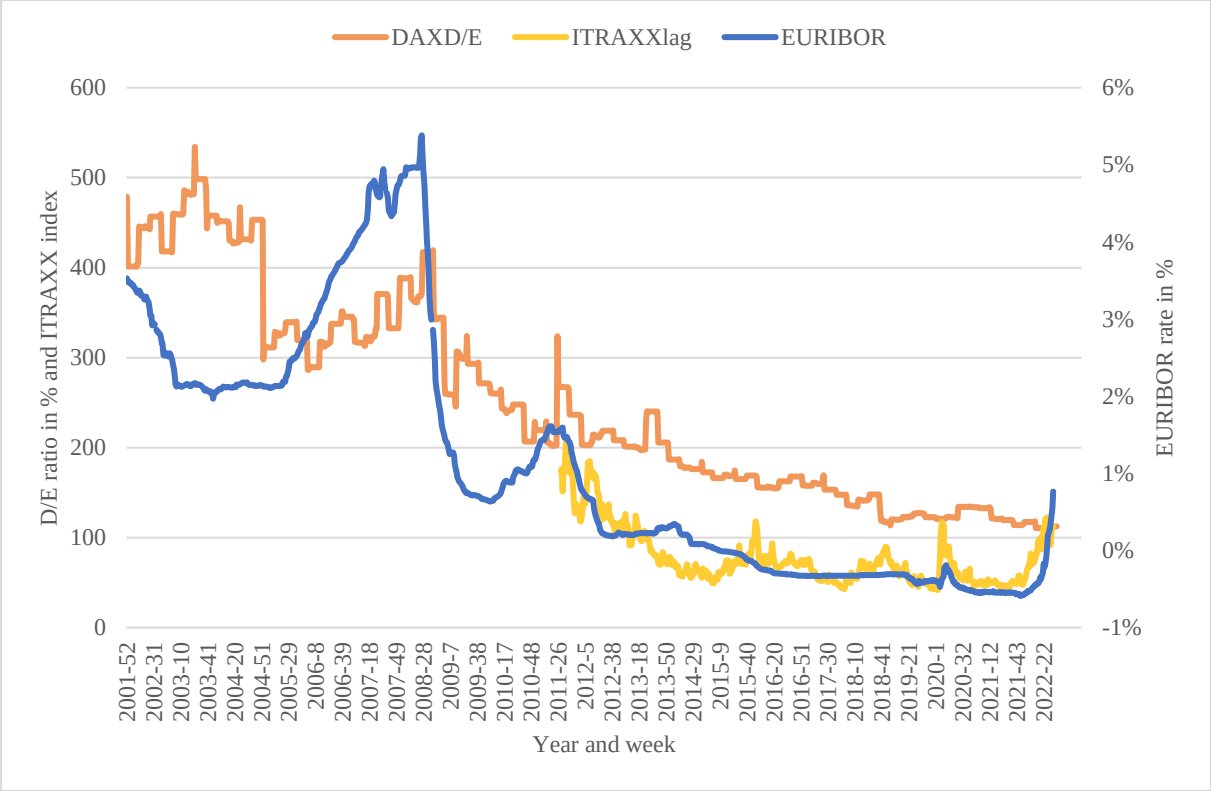
	(1)	(2)
VARIABLES	DAXDE	DAXDE
EURIBORlag	1,482***	778.6***
	(250.2)	(289.7)
ITRAXXlag		0.146***
		(0.0259)
logGDP	-269.6***	-263.9***
	(8.075)	(7.422)
GRZEWI	0.0484**	0.0827***
	(0.0194)	(0.0192)
Constant	3,821***	3,731***
	(109.9)	(100.5)
Observations	545	543
R-squared	0.853	0.858

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

H3: Equally relevant to point out are the differences in the third baseline regression, with IBOXX as the main independent. When adjusting for year-fixed effects, the coefficient of IBOXX stays statistically significant, but its sign changes as well as the magnitude of impact to predict the debt-to-equity ratio of the DAX. The impact in this case is extreme: When not adjusting for year-fixed effects, with a 1-point increase in IBOXX, a 2.86-point decrease in the debt-to-equity ratio of the DAX is expected, against what the hypothesis states. The 0-

hypothesis of no impact of IBOXX on the debt-to-equity ratio across DAX corporates can be rejected on a 99% confidence level, both with and without year-fixed effects.

Figure 2: Historical development of the debt-to-equity ratio of the DAX to ITRAXX and EURIBOR



6.5 Conclusion

To conclude, H1 is accepted as the impact of the independent variable, the risk-free rate, on the debt-to-equity ratio of the DAX is statistically and practically significant on every conventional confidence level. Important to note is the difference in results between the 3-month-Euribor and the 10-year-mid-swap rate. The coefficient of the 10-year-mid-swap rate is significantly more exposed to year-fixed effects than the 3-month-Euribor rate's coefficient. H2 is accepted as well, because adding ITRAXX as a metric of credit risk decreased the expected impact of the 3-month-Euribor rate on the average debt-to-equity ratio of the DAX. H3 cannot be accepted, as the coefficient of IBOXX on the debt-to-equity ratio is not statistically significant on any

conventional confidence level when adjusting for year-fixed effects. In further research, it would be interesting to include additional factors like management's risk aversion or industry of the corporate, to include more idiosyncratic risks factors in the model.

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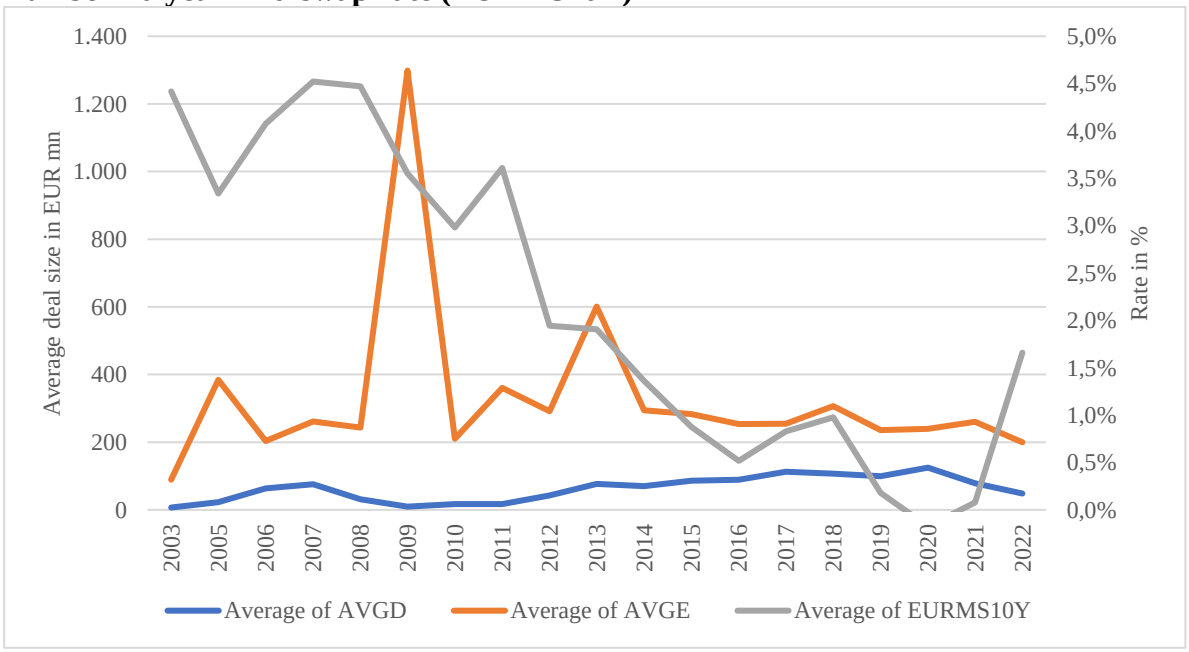
8. Appendix

1. Average equity (AVGE) and debt deal issuance volume (AVGD)

Table 1.1. – Average Debt and Equity Issuances

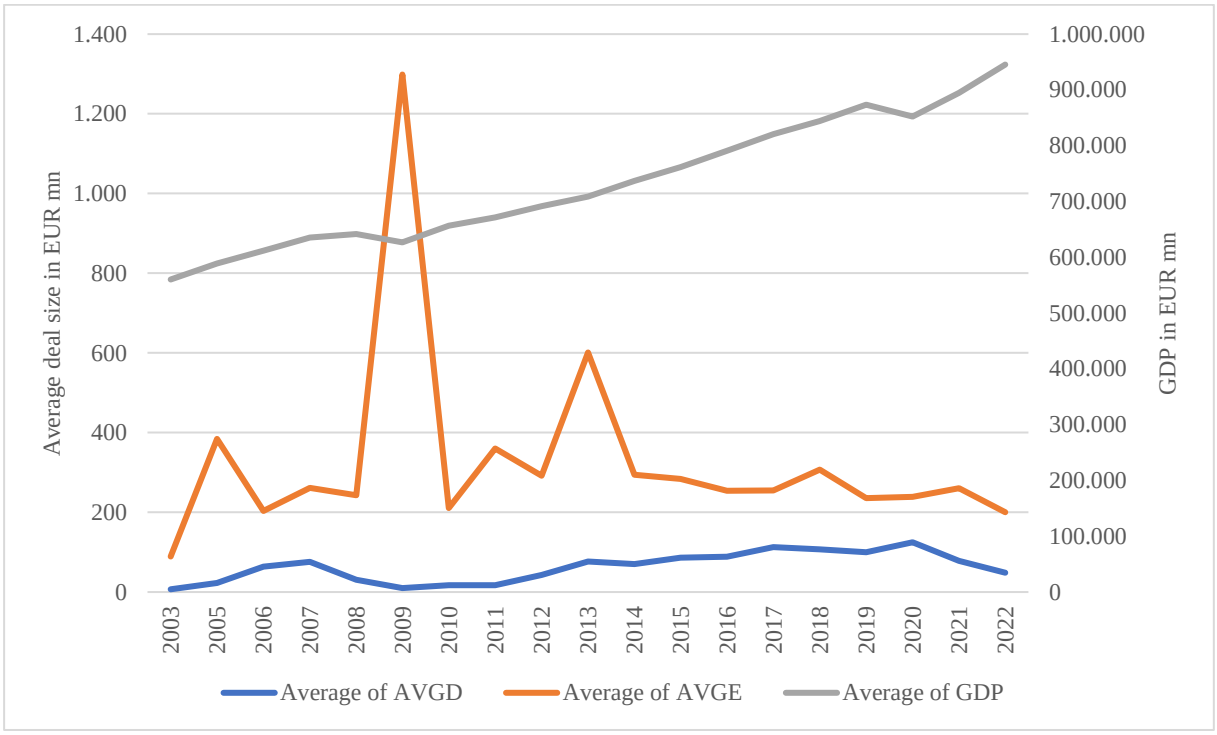
Year	Average of AVGD	Average of AVGE
2003	6,83	89,16
2005	22,42	384,40
2006	63,31	203,30
2007	75,89	261,61
2008	31,00	242,98
2009	9,68	1298,57
2010	17,43	210,42
2011	17,03	360,50
2012	42,69	291,84
2013	76,54	601,34
2014	69,75	294,47
2015	86,22	283,48
2016	88,81	253,79
2017	112,61	254,54
2018	107,16	307,00
2019	99,46	235,97
2020	124,79	239,07
2021	78,15	260,39
2022	48,67	200,06

Graph 1.2. – Average equity (AVGE) and debt (AVGD) deal issuance volume with Euribor 10-year-mid-swap rate (EURMS10Y)



Source: Bloomberg (2022)

Graph 1.3. – Average equity (AVGE) and debt deal issuance volume (AVGD) and German GDP



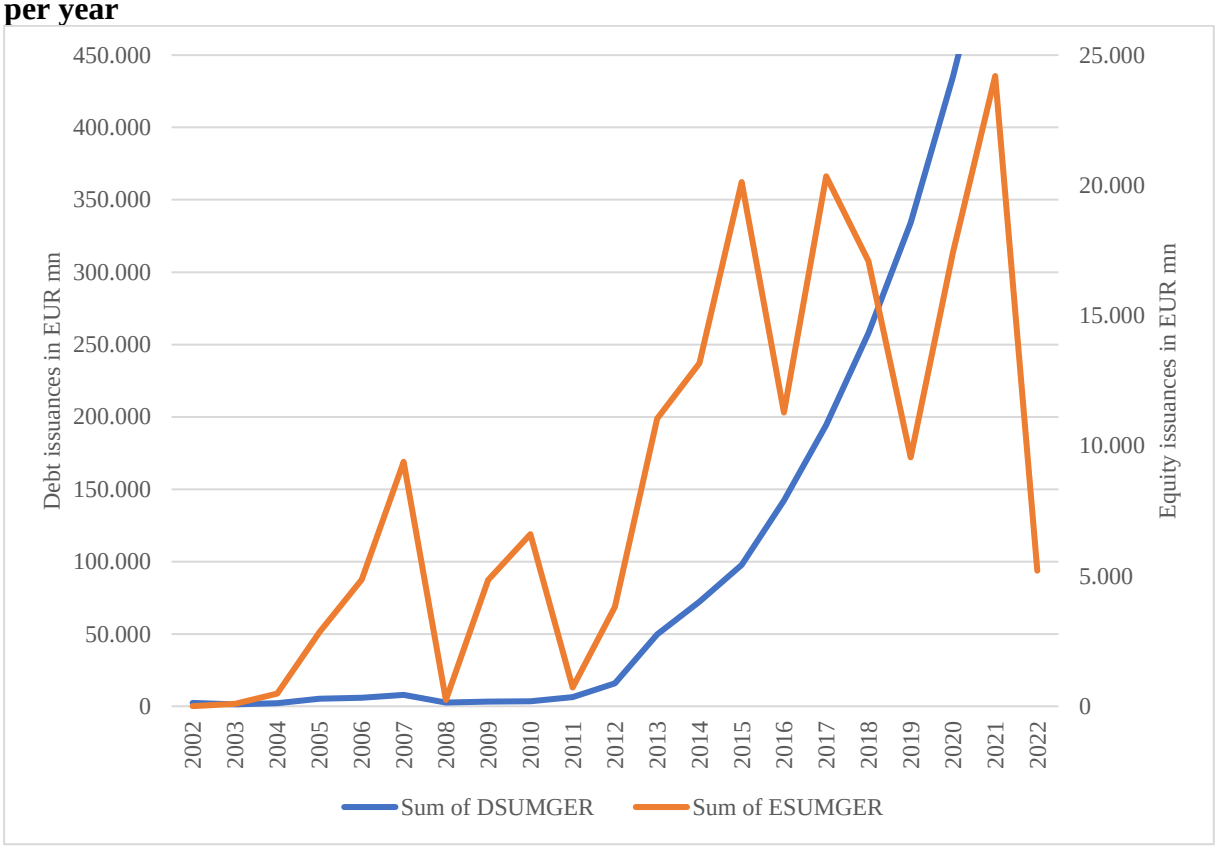
Source: Bloomberg (2022)

2. Sum of equity (ESUMGER) and debt (DSUMGER) issuances in Germany per year

Table 2.1. – Sum of equity (ESUMGER) and debt Issuances (DSUMGER) per year

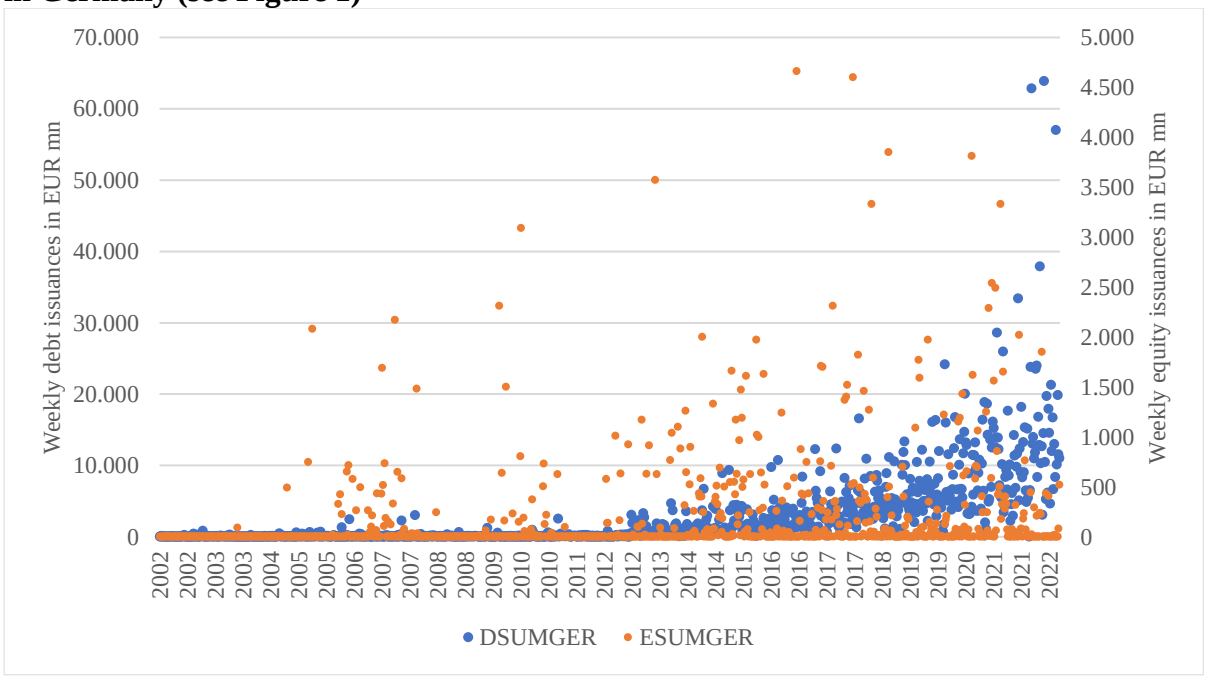
Year	Total DSUMGER	Total ESUMGER
2002	2.223,18	4,02
2003	1.305,22	89,16
2004	2.002,90	490,86
2005	5.173,53	2.848,80
2006	5.821,07	4.855,90
2007	7.805,77	9.379,48
2008	2.501,80	242,98
2009	3.245,45	4.851,38
2010	3.423,65	6.602,36
2011	6.380,50	720,99
2012	15.907,36	3.817,91
2013	49.770,15	11.038,44
2014	72.298,21	13.165,13
2015	97.663,26	20.130,72
2016	142.127,08	11.275,55
2017	194.367,49	20.342,87
2018	257.758,23	17.095,24
2019	334.071,70	9.551,74
2020	435.040,59	17.424,66
2021	550.663,55	24.196,94
2022	649.334,34	5.203,76

Graph 2.2. – Sum of equity (ESUMGER) and debt issuances (DSUMGER) in Germany per year



Source: Bloomberg (2022)

Graph 2.3. – Distribution of weekly equity (ESUMGER) and debt issuances (DSUMGER) in Germany (see Figure 1)



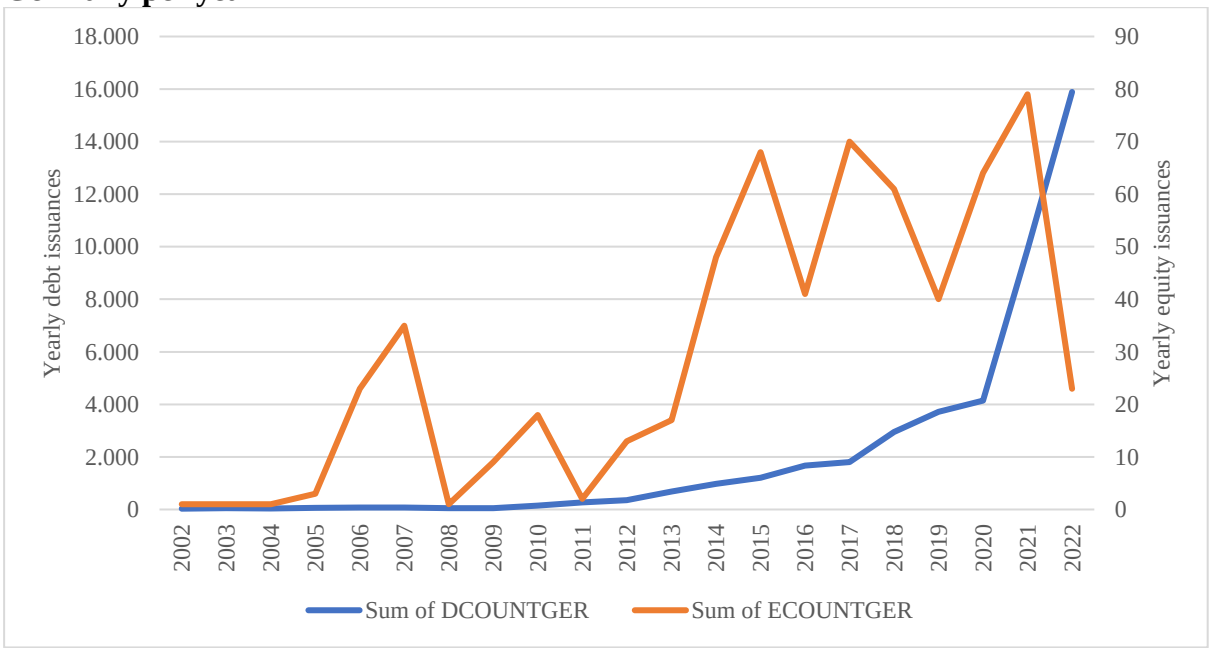
Source: Bloomberg (2022)

3. The count of equity and debt issuances in Germany

Table 3.1. – Count of equity (ECOUNTGER) and debt issuances (DCOUNTGER) in Germany per year

Year	Total DCOUNTGER	Total ECOUNTGER
2002	30	1
2003	48	1
2004	38	1
2005	68	3
2006	70	23
2007	80	35
2008	52	1
2009	47	9
2010	153	18
2011	271	2
2012	359	13
2013	689	17
2014	977	48
2015	1212	68
2016	1672	41
2017	1808	70
2018	2952	61
2019	3714	40
2020	4139	64
2021	9900	79
2022	15890	23

Graph 3.2. – Count of equity (ECOUNTGER) and debt issuances (DCOUNTGER) in Germany per year



Source: Bloomberg (2022)

4. Variables

Table 4.1. – Dependent variables

Variable name	Expected sign	Description	Calculation
logDSUMGER	(-)	Total corporate debt issuance volume in Germany in EUR mn	
logESUMGER		Total equity issuance volume in Germany in EUR mn	
DCOUNTGER	(-)	Count of corporate debt issuances in Germany	
ECOUNTGER		Count of equity issuances in Germany	
AVGD	(-)	Average debt issuance volume per deal in Germany in EUR mn	DSUMGER/DCOUNTGER
AVGE		Average equity issuance volume per deal in Germany in EUR mn.	ESUMGER/ECOUNTGER
DTotalFin	(-)	Ratio of total debt issuance volume to the sum of equity and debt issuance volume in Germany.	DSUMGER / (DSUMGER + ESUMGER)
ETotalFin		Ratio of total equity issuance volume to the sum of equity and debt issuance volume in Germany.	ESUMGER / (DSUMGER + ESUMGER)

Table 4.2 – Independent variables

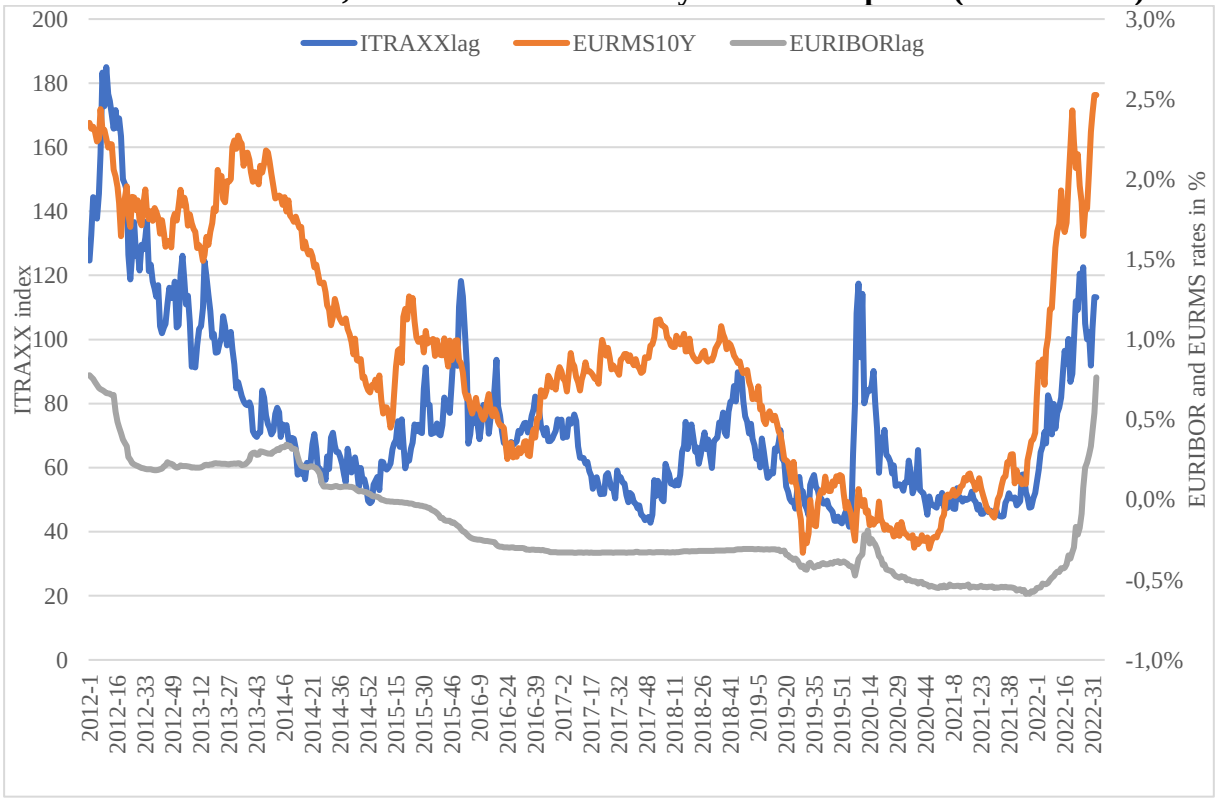
Variable name	Description	Note
IBOXXlag	IBOXX Euro Corporates Overall Total Return Index measures the Euro denominated, corporate, investment and investment grade bond market. The index includes bonds with minimum 1 years to maturity. Bond type includes fixed and zero coupon, step-ups, event-driven bonds, dated and undated callable subordinated corporate bonds, soft bullets.	
ITRAXXlag	The Markit ITRAXX Europe index comprises 125 equally weighted credit	ITRAXX became available only in the beginning of

	default swaps on investment grade European corporate entities, distributed among 4 sub-indices: Financials (Senior & Subordinated), Non-Financials and HiVol. The composition of each Markit ITRAXX index is determined by the Index Rules. Markit ITRAXX indices roll every 6 months in March & September.	2012, which is why regressions with ITRAXX only include the years 2012 – 2022.
EURMSlag	Vanilla Interest Rate Swap (10 Years)	Benchmark for corporate debt spread pricing
EURIBORlag	The 3-month Euribor (Euro Interbank Offered Rate) is the benchmark rate of the large euro money market. It is sponsored by the European Money Markets Institute, which represents 2,800 banks in the fifteen Member States of the European Union and the EMU division of ACI, the Financial Markets Association	The 3-months rate used as it is used for bond yield forecast on Bloomberg and used for mid-swap rate and hence bond valuations
GRZECURR	Germany Assessment of current situation	
GRZEWI	Germany Expectations of economic growth	
GDP	Nominal Gross Domestic Product for Germany, Quarterly, Not Seasonally Adjusted	

Table 4.3. – Summary Statistics

	(1)	(2)	(3)	(4)	(5)	(7)	(8)	(10)	(15)	(16)	(18)
VARIABLES	N	mean	sd	min	max	Var	skewness	sum	p50	p75	p95
DCOUNTGER	1,077	36.78	79.41	0	500	6,306	3.963	39,613	6	37	154
ECOUNTGER	1,077	0.579	0.959	0	4	0.921	1.776	624	0	1	3
EURMS10Ylag	1,060	0.0239	0.0169	-0.00255	0.0537	0.000285	0.0188	25.32	0.0225	0.0399	0.0481
DAX	1,077	8,380	3,549	2,403	16,160	1.259e+07	0.320	9.025e+06	7,507	11,587	14,413
DAXDE	1,077	247.9	113.4	110.7	498.3	12,853	0.613	267,008	208.1	332.5	456.9
DAX_STLT_D	1,077	12,274	1,372	9,119	15,153	1.882e+06	-0.367	1.322e+07	12,620	13,165	14,334
EURIBORlag	1,058	0.0116	0.0161	-0.00553	0.0496	0.000260	0.812	12.23	0.00654	0.0215	0.0459
ITRAXXlag	556	77.52	31.26	43.44	178.8	977.4	1.537	43,100	69.01	86.13	148.5
GRZCURR	1,073	2.417	61.26	-95.80	91.50	3,752	-0.187	2,593	11.10	56.60	87.90
GRZEWI	1,073	17.39	33.90	-55.50	77.40	1,149	-0.294	18,661	17.80	45.30	69.90
GDP	1,077	706,706	119,679	531,010	953,710	1.432e+10	0.378	7.611e+08	682,360	803,730	915,990
IBOXXlag	1,059	181.0	42.17	109.7	244.4	1,779	-0.0224	191,662	178.8	222.9	242.0
DTotalFin	907	0.886	0.259	0	1	0.0671	-2.515	804.0	1	1	1
TotalFin	1,077	2,843	5,515	0	63,842	3.042e+07	4.817	3.062e+06	397.6	3,611	13,006
logTotalFin	907	6.295	2.539	-0.693	11.06	6.445	-0.532	5,709	6.904	8.439	9.521
AVGD	1,080	55.91	70.80	0	408.9	5,013	2.335	60,379	35.00	77.07	193.9
AVGE	1,080	91.09	227.9	0	1,480	51,944	3.694	98,373	0	43.09	543.7
logDSUMGER	1,077	5.061	3.315	0	11.06	10.99	-0.268	5,451	5.488	8.120	9.431
logESUMGER	1,077	1.767	2.641	0	8.447	6.976	1.030	1,904	0	4.100	6.967
logGDP	1,077	13.45	0.167	13.18	13.77	0.0280	0.179	14,490	13.43	13.60	13.73

5. 3-month Euribor, ITRAXX index and 10-year-mid-swap rate (EURMS10Y)



Source: Bloomberg (2022)

6. Baseline Regressions with and without fixed effects

Table 6 – Baseline Regressions

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
VARIABLES	logTotalFin	logDSUMGER	logESUMGER	DCOUNTGER	ECOUNTGER	AVGD	AVGE	logTotalFin	logDSUMGER	logESUMGER	DCOUNTGER	ECOUNTGER	AVGD	AVGE
EURMS10Ylag	-34.48*	-33.34*	-30.26	64.84	-4.057	200.1	-2,926	-123.1***	-163.9***	-65.72***	-2,058***	-24.64***	-1,613***	-3,013***
	(17.70)	(18.99)	(25.11)	(714.9)	(7.831)	(668.9)	(2,135)	(3.158)	(3.000)	(4.294)	(120.2)	(1.674)	(114.1)	(380.0)
2003.Year	-0.775	0.619	-0.180	0.997	-0.0317	0.244	-21.19							
	(0.496)	(0.402)	(0.222)	(5.588)	(0.0668)	(8.776)	(16.87)							
2004.Year	-0.349	0.306	-0.167	0.788	-0.0345	14.08	-15.27							
	(0.555)	(0.426)	(0.231)	(6.021)	(0.0692)	(13.40)	(19.33)							
2005.Year	0.319	1.191**	-0.156	1.876	-0.0229	40.08**	-0.809							
	(0.554)	(0.534)	(0.421)	(10.95)	(0.124)	(16.90)	(40.99)							
2006.Year	0.182	1.010**	1.379***	1.537	0.392***	17.47	43.42							
	(0.539)	(0.461)	(0.432)	(7.002)	(0.133)	(14.16)	(28.08)							
2007.Year	0.253	1.535***	1.891***	1.261	0.649***	27.83*	94.99**							
	(0.535)	(0.414)	(0.391)	(3.101)	(0.146)	(14.64)	(37.56)							
2008.Year	0.0132	0.928**	-0.0734	0.909	-0.0201	14.03	-9.779							
	(0.499)	(0.416)	(0.173)	(3.541)	(0.0473)	(11.61)	(11.88)							
2009.Year	0.0147	0.874*	0.283	1.430	0.0980	22.68	28.02							
	(0.538)	(0.498)	(0.456)	(10.37)	(0.134)	(15.89)	(46.42)							
2010.Year	-0.591	0.438	0.805	3.789	0.247	7.787	21.38							
	(0.635)	(0.554)	(0.604)	(14.12)	(0.176)	(16.25)	(56.69)							
2011.Year	-0.607	2.088***	-0.401	6.058	-0.0589	9.406	-42.56							
	(0.577)	(0.516)	(0.537)	(13.83)	(0.157)	(18.97)	(44.91)							
2012.Year	-0.275	2.220***	0.179	8.791	0.111	21.97	-21.08							
	(0.744)	(0.720)	(0.826)	(21.91)	(0.247)	(22.66)	(70.14)							
2013.Year	1.919***	4.417***	0.748	14.80	0.247	67.43**	69.79							
	(0.699)	(0.691)	(0.855)	(22.06)	(0.259)	(26.71)	(76.47)							
2014.Year	2.139***	4.600***	2.422**	21.01	0.796**	62.50**	81.43							
	(0.761)	(0.776)	(0.992)	(25.66)	(0.315)	(26.85)	(89.93)							
2015.Year	2.389***	4.874***	2.394**	25.87	1.146***	70.65**	62.94							
	(0.839)	(0.865)	(1.119)	(29.50)	(0.374)	(29.70)	(94.17)							
2016.Year	2.537***	5.175***	0.905	34.63	0.587	78.74**	-25.77							
	(0.900)	(0.934)	(1.176)	(32.12)	(0.371)	(32.64)	(96.81)							
2017.Year	3.011***	5.620***	2.144*	37.51	1.164***	106.8***	36.56							
	(0.849)	(0.875)	(1.127)	(29.92)	(0.368)	(31.79)	(97.07)							
2018.Year	3.366***	6.012***	1.954*	59.84**	1.032***	88.69***	22.14							
	(0.826)	(0.849)	(1.097)	(29.38)	(0.361)	(29.53)	(98.45)							
2019.Year	3.373***	6.059***	1.162	75.72**	0.591	93.03***	-17.04							
	(0.940)	(0.981)	(1.253)	(34.14)	(0.397)	(34.28)	(99.92)							
2020.Year	3.428***	6.100***	1.618	83.64**	1.065**	103.8***	-14.59							
	(1.003)	(1.054)	(1.360)	(37.16)	(0.448)	(36.73)	(114.0)							
2021.Year	3.781***	6.441***	2.443*	192.2***	1.261***	66.81*	50.75							
	(0.963)	(1.009)	(1.302)	(41.14)	(0.429)	(34.39)	(111.8)							
2022.Year	4.700***	7.397***	0.633	305.3***	0.430	43.03*	-42.88							
	(0.741)	(0.744)	(0.939)	(39.63)	(0.309)	(24.36)	(76.97)							
Constant	5.401***	2.678***	1.546	-2.813	0.223	5.936	146.5	8.803***	8.955***	3.348***	85.40***	1.173***	94.72***	163.8***
	(0.972)	(1.019)	(1.256)	(35.77)	(0.391)	(34.62)	(106.8)	(0.0592)	(0.0629)	(0.148)	(4.801)	(0.0593)	(3.227)	(13.50)
Observations	890	1,058	1,058	1,058	1,058	1,058	1,058	890	1,058	1,058	1,058	1,058	1,060	1,060
R-squared	0.739	0.783	0.256	0.688	0.278	0.203	0.079	0.602	0.695	0.175	0.192	0.185	0.147	0.049

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

7. Regression Models for H1 – H7

Table 7.1. – Regression output for hypothesis 1

	(1)	(2)	(3)
VARIABLES	logTotalFin	logTotalFin	logTotalFin
EURIBORlag	-114.4***		
	(4.554)		
EURMSlag		-123.1***	
		(3.158)	
ITRAXXlag			-0.0396***
			(0.00242)
Constant	7.284***	8.803***	10.76***
	(0.0594)	(0.0592)	(0.165)
Observations	889	890	556
R-squared	0.476	0.602	0.470

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 7.2. – Regression output for hypothesis 2 - 4 with 3-month-Euribor

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
VARIABLES	logDSUMGER	logESUMGER	DCOUNTGER	ECOUNTGER	AVGD	AVGE	DTotalFin
EURIBORlag	-50.24***	-35.02***	1,488***	-9.703***	-939.1***	-2,403***	-0.948
	(7.424)	(8.141)	(219.7)	(2.779)	(296.3)	(782.6)	(1.214)
GRZEWI	-0.00383	0.000948	-0.000871	0.000118	-0.0904	0.210	-0.000744*
	(0.00249)	(0.00320)	(0.0964)	(0.00115)	(0.0905)	(0.283)	(0.000386)
GRZCURR	-0.000638	0.00320**	-0.520***	0.000590	0.0204	0.203	-0.000564***
	(0.000959)	(0.00145)	(0.0509)	(0.000569)	(0.0388)	(0.130)	(0.000152)
logGDP	5.125***	-10.38***	338.3***	-3.373***	-140.2**	-600.9***	0.696***
	(1.700)	(2.155)	(66.03)	(0.802)	(69.47)	(196.6)	(0.242)
DAX	0.000391***	0.000660***	0.00706***	0.000244***	0.0104***	0.0319***	-2.02e-05**
	(6.56e-05)	(8.48e-05)	(0.00250)	(3.25e-05)	(0.00264)	(0.00775)	(9.75e-06)
Constant	-66.53***	136.2***	-4,590***	44.04***	1,869**	7,933***	-8.297***
	(22.45)	(28.45)	(873.1)	(10.58)	(917.6)	(2,596)	(3.198)
Observations	1,053	1,053	1,053	1,053	1,053	1,053	888
R-squared	0.744	0.230	0.514	0.243	0.144	0.069	0.066

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 7.3. – Regression output for hypothesis 2 – 4 with 10-year-mid-swap rate

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
VARIABLES	logDSUMGER	logESUMGER	DCOUNTGER	ECOUNTGER	AVGD	AVGE	DTotalFin
EURMSlag	-74.51***	-59.96***	3,374***	-18.47***	-1,762***	-3,729***	-1.389
	(7.477)	(10.22)	(418.4)	(3.641)	(287.6)	(924.9)	(1.090)
GRZEWI	-0.00104	0.00212	0.0368	0.000249	-0.0764	0.332	-0.000703*
	(0.00220)	(0.00271)	(0.0650)	(0.000930)	(0.0747)	(0.259)	(0.000378)
GRZCURR	-0.000622	0.00318**	-0.515***	0.000581	0.0192	0.203	-0.000554***
	(0.000950)	(0.00142)	(0.0438)	(0.000558)	(0.0375)	(0.130)	(0.000148)
logGDP	4.542***	-11.86***	509.5***	-4.024***	-199.5***	-653.7***	0.689***
	(1.555)	(2.032)	(73.16)	(0.748)	(58.28)	(184.7)	(0.243)
DAX	0.000277***	0.000596***	0.00822***	0.000229***	0.00889***	0.0269***	-2.24e-05**
	(5.87e-05)	(7.80e-05)	(0.00219)	(2.95e-05)	(0.00227)	(0.00725)	(1.02e-05)
Constant	-56.57***	157.8***	-6,967***	53.25***	2,709***	8,745***	-8.158**
	(20.62)	(26.97)	(980.5)	(9.926)	(772.3)	(2,450)	(3.212)
Observations	1,054	1,054	1,054	1,054	1,054	1,054	889
R-squared	0.753	0.240	0.577	0.252	0.159	0.073	0.067

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 7.4. – Regression outputs for hypothesis 5 & 6

	(1)	(2)
VARIABLES	ITRAXXlag	ITRAXXlag
EURMSlag	2,680***	
	(133.4)	
GRZEWI	-0.218***	-0.192***
	(0.0259)	(0.0231)
EURIBORlag		5,500***
		(210.6)
Constant	55.76***	86.24***
	(1.333)	(0.899)
Observations	555	556
R-squared	0.565	0.672

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 7.5. – Regression output for hypothesis 6 with ITRAXX index and 3-month-Euribor

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
VARIABLES	logDSUMGER	logESUMGER	DCOUNTGER	ECOUNTGER	AVGD	AVGE	DTotalFin	logDSUMGER	logESUMGER	DCOUNTGER	ECOUNTGER	AVGD	AVGE	DTotalFin
ITRAXXlag	-0.00997***	-0.0295***	0.843***	-0.00902***	-0.501***	-1.496**	0.000635							
	(0.00279)	(0.00660)	(0.164)	(0.00220)	(0.143)	(0.633)	(0.000531)							
EURIBORlag	-163.9***	-82.54	10,265***	-50.48**	-7,156***	-3,122	-8.257*	-206.2***	-209.2***	13,904***	-89.27***	-9,279***	-9,517**	-5.623
	(40.19)	(56.22)	(2,027)	(19.81)	(1,480)	(4,970)	(4.675)	(38.21)	(50.21)	(2,146)	(17.91)	(1,286)	(4,448)	(4.209)
GRZEWI	-0.000681	0.00574	0.547***	0.00212	-0.220**	0.641	-0.000568**	0.00224	0.0141***	0.312**	0.00466***	-0.0739	1.069***	-0.000764***
	(0.00182)	(0.00440)	(0.140)	(0.00162)	(0.0960)	(0.422)	(0.000279)	(0.00177)	(0.00418)	(0.129)	(0.00152)	(0.0911)	(0.385)	(0.000269)
GRZCURR	-0.00302***	-0.00109	-0.204***	0.000219	-0.0483	-0.184	-0.000175	-0.00168*	0.00276	-0.313***	0.00139	0.0188	0.0121	-0.000264*
	(0.000981)	(0.00288)	(0.0683)	(0.00127)	(0.0641)	(0.265)	(0.000147)	(0.000943)	(0.00281)	(0.0654)	(0.00122)	(0.0616)	(0.262)	(0.000141)
logGDP	6.142***	-4.824**	1,064***	-1.007	-236.1***	-439.3***	0.275**	6.888***	-2.753	1,007***	-0.383	-198.7***	-332.5**	0.223*
	(1.247)	(1.963)	(96.77)	(0.755)	(48.95)	(169.6)	(0.120)	(1.290)	(1.956)	(92.60)	(0.744)	(50.32)	(165.2)	(0.120)
Constant	-75.19***	70.43***	-14,443***	15.23	3,324***	6,214***	-2.871*	-86.23***	39.62	-13,591***	5.934	2,771***	4,627**	-2.102
	(16.91)	(26.84)	(1,319)	(10.33)	(667.3)	(2,323)	(1.632)	(17.51)	(26.60)	(1,254)	(10.11)	(684.4)	(2,250)	(1.631)
Observations	543	543	543	543	543	543	543	545	545	545	545	545	545	545
R-squared	0.655	0.097	0.532	0.103	0.108	0.038	0.081	0.647	0.068	0.511	0.086	0.091	0.029	0.076
Robust standard errors in parentheses														
*** p<0.01, ** p<0.05, * p<0.1														

Table 7.6. – Regression output for hypothesis 6 with IBOXX

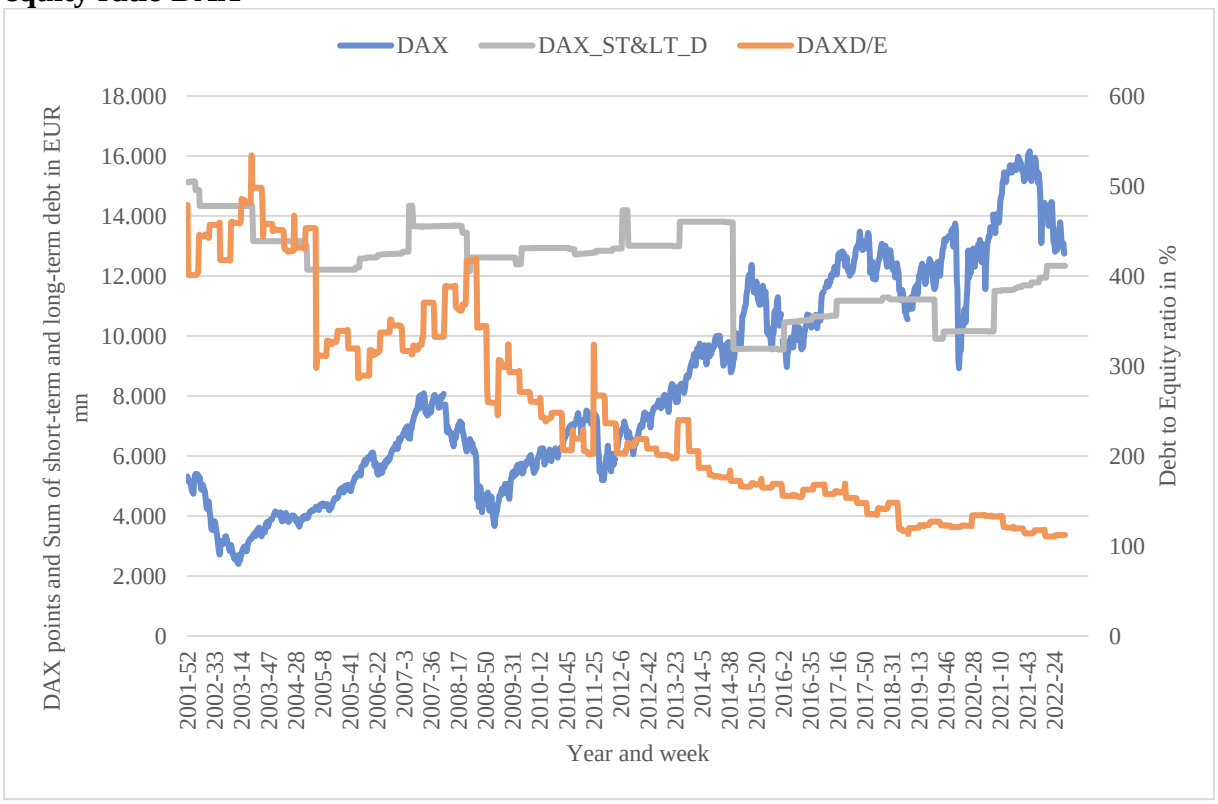
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
VARIABLES	logDSUMGER	logESUMGER	DCOUNTGER	ECOUNTGER	AVGD	AVGE	DTotalFin
IBOXXlag	0.0460***	0.0789***	-4.208***	0.0295***	2.325***	3.496***	0.000324
	(0.00638)	(0.0143)	(0.582)	(0.00517)	(0.281)	(1.229)	(0.000842)
GRZEWI	0.00139	0.00894**	0.518***	0.00300*	-0.146	0.846**	-0.000663**
	(0.00172)	(0.00421)	(0.124)	(0.00155)	(0.0918)	(0.403)	(0.000265)
GRZCURR	-0.000161	0.00415	-0.410***	0.00200*	0.0861	0.0760	-0.000218
	(0.000923)	(0.00270)	(0.0660)	(0.00118)	(0.0598)	(0.253)	(0.000136)
logGDP	5.609***	-9.394***	1,276***	-2.527**	-298.8***	-619.3***	0.342***
	(1.060)	(2.670)	(123.3)	(1.021)	(48.38)	(205.7)	(0.112)
Constant	-78.62***	113.0***	-16,360***	28.78**	3,636***	7,778***	-3.787***
	(13.29)	(33.58)	(1,551)	(12.89)	(609.3)	(2,581)	(1.392)
Observations	545	545	545	545	545	545	545
R-squared	0.639	0.094	0.550	0.106	0.096	0.035	0.073

Robust standard errors in parentheses

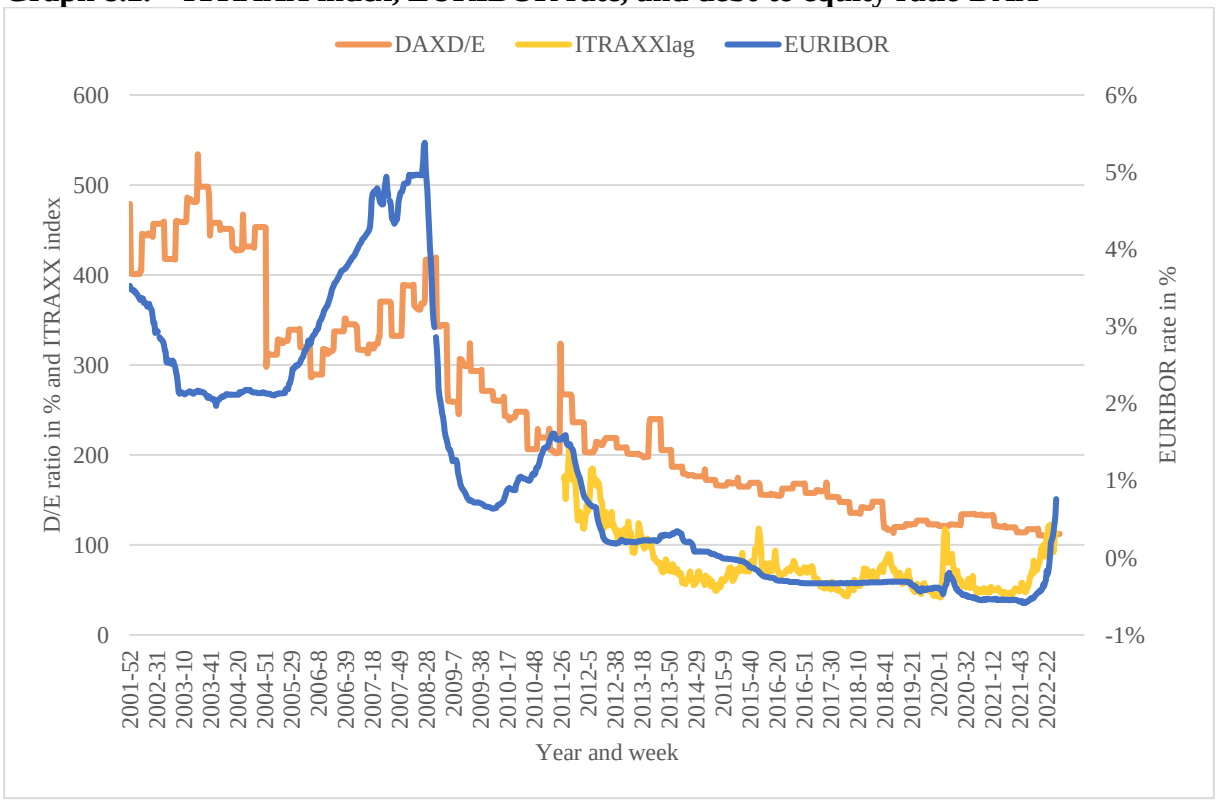
*** p<0.01, ** p<0.05, * p<0.1

8. Debt-to-equity ratio in the DAX

Graph 8.1. – DAX index, sum of short-term and long-term debt in the DAX, debt-to-equity ratio DAX



Graph 8.2. – ITRAXX index, EURIBOR rate, and debt-to equity ratio DAX



Graph 8.3. – GDP numbers and debt-to-equity ratio of the DAX

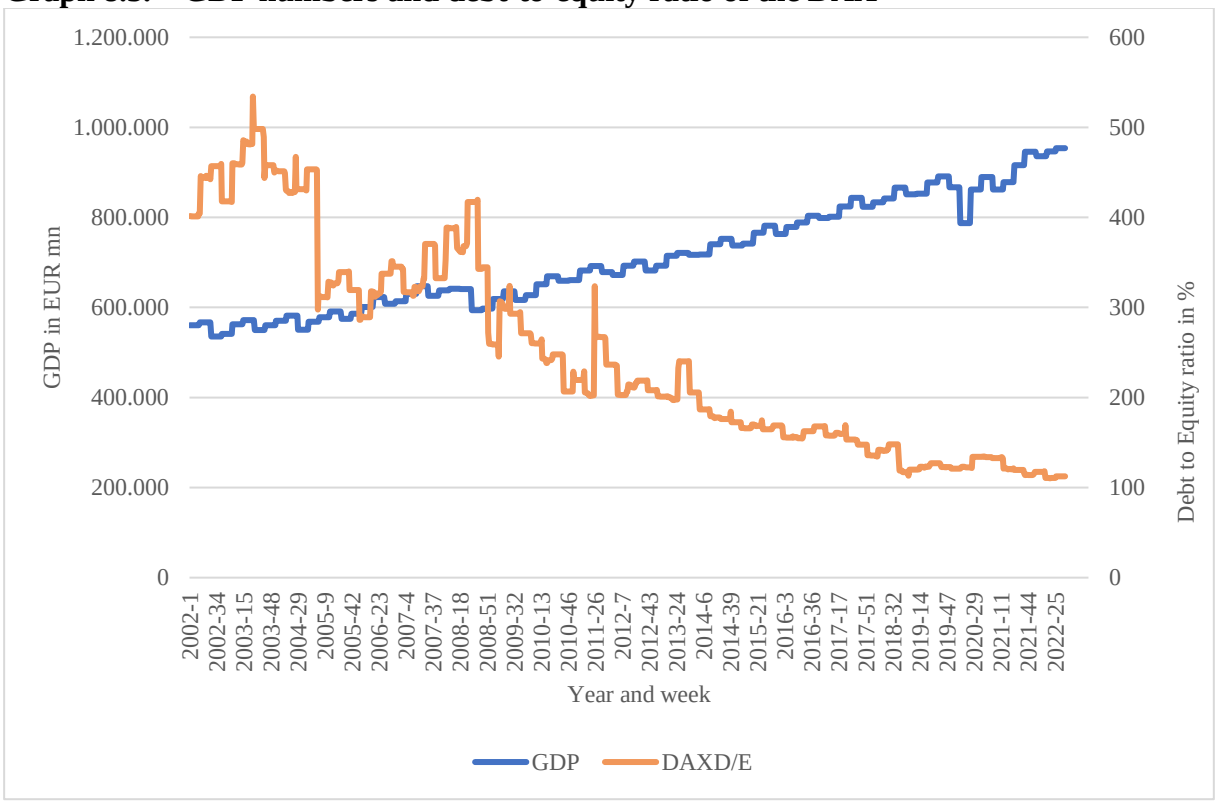


Table 8.4. and 8.5. – Regression output for hypothesis 1

With year-fixed effects				Without year-fixed effects			
	(1)	(2)	(3)		(1)	(2)	(3)
VARIABLES	DAXDE	DAXDE	DAXDE	VARIABLES	DAXDE	DAXDE	DAXDE
EURMS10Ylag	142.8			EURIBORlag	2,825***		
	(230.7)				(123.6)		
logGDP	67.62***	80.95***	24.70	logGDP	-394.7***	-306.7***	91.18***
	(18.99)	(19.42)	(22.44)		(14.01)	(17.13)	(26.54)
GRZEWI	0.0356*	0.119***	0.00685	GRZEWI	0.272***	0.130***	0.299***
	(0.0215)	(0.0249)	(0.0231)		(0.0385)	(0.0400)	(0.0397)
EURIBORlag		1,890***		EURMS10Ylag		3,365***	
		(352.4)				(153.0)	
IBOXXlag			0.457***	IBOXXlag			-2.867***
			(0.135)				(0.100)
Constant	-469.8*	-705.4***	54.81	Constant	5,520***	4,292***	-464.4
	(254.3)	(259.5)	(288.7)		(190.5)	(234.2)	(340.0)
Observations	1,054	1,053	1,053	Observations	1,053	1,054	1,053
R-squared	0.982	0.983	0.982	R-squared	0.871	0.863	0.885
Robust standard errors in parentheses				Robust standard errors in parentheses			
*** p<0.01, ** p<0.05, * p<0.1				*** p<0.01, ** p<0.05, * p<0.1			