INTEREST RATES AND VENTURE CAPITAL INVESTMENTS

Early evidence of the heterogeneous effects of rising interest rates across funding stages

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Master Thesis

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ABSTRACT: This thesis examines the impact of rising central bank interest rates on European venture capital investment activity between 2016 and the first quarter of 2023. Using a comprehensive dataset of 32,832 funding rounds across different funding stages, we run a set of regressions to study the relationship between interest rates and VC investments measured by total invested amounts, number of rounds, and average round size. While we find no evidence for an effect of interest rates on overall VC investment activity, our findings reveal that rising interest rates have heterogenous effects on VC investments across different funding stages. We observe that higher interest rates lead to increased total invested amounts for seed-stage rounds and a decrease for early- and late-stage rounds. Additionally, higher interest rates correspond to a decline in the number of early-stage rounds, while no significant effect is found for seed- or late-stage rounds. Higher interest rates are also associated with increased average round sizes for seed-stage rounds, a marginal increase for early-stage rounds, and a decrease for late-stage rounds. Finally, higher interest rates negatively affect the odds of a round being early- or late-stage, as opposed to seed-stage.

Keywords: Venture Capital Investments, VC, Monetary Policy, Interest Rates

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1. Introduction

The year 2022 was a turbulent one for the financial markets. Post-covid 19 recovery was halted by Russia's invasion of Ukraine which sent ripples across the economy. Financial markets left a decade of low-interest rates and monetary stimulus in exchange for high inflation, tighter monetary policies, and, consequently, a higher cost of capital. The effects on the public markets became immediately evident, with falling asset prices and a worsened economic outlook and investor sentiment (Adrian, 2022). However, the effects on the private markets, and more specifically, the Venture Capital (VC) industry, are still less known to this day. The decline in public markets led to speculation that the private markets would not only face lower valuations but also become more restrictive with capital to invest, leading to a global reduction in overall VC activity (The Economist, 2022; Teare, 2023). Additionally, a recent survey by the European Investment Bank showed deteriorating investor sentiment for European VCs, listing rising interest rates and inflation as key challenges (Kraemer-Eis et al., 2022). Although these initial observations are interesting, they remain largely speculative as they have yet to be rigorously analyzed through an academic lens.

Previous studies have shown that VC activity is affected by various macroeconomic factors such as stock market performance, GDP growth, and labor market development (Gompers & Lerner, 2000). One often overlooked factor in these studies is the effect of monetary policy and particularly central bank interest rates, despite its potential impact on VC investments through factors like cost of capital and private and public valuations (e.g., Shane,1996; Gilchrist & Leahy, 2002), money allocated to entrepreneurship (King & Levine, 1993), and investor sentiment (Bellavitis et al., 2024). Existing studies on the topic predominantly focus on the impact of interest rates on VCs' fundraising activities (e.g., Gompers & Lerner,1998; Bellavitis et al., 2024), but there is a lack of empirical evidence on how interest rates directly affect VC investments. Furthermore, the limited literature exploring this relationship does not consider the heterogeneity between different stages of funding rounds (e.g., Bellavitis & Matanova, 2017; Van Pottelsberghe & Romain, 2004).

The primary focus of this thesis is to explore how the recent changes in central bank interest rates in Europe have affected the VC industry and its investment activities. We aim to investigate if a significant relationship exists between central bank interest rates and VC investment activity, measured by the number of funding rounds, total invested amounts, and average round size. Furthermore, as VC investments are differentiated by funding stages, each with unique funding needs, risks, and return profiles (Gompers & Lerner, 2000), we also aim to study if this relationship differs across funding

stages, classified as seed, early, and late. In doing so, we seek to address the following research question:

To what extent has the VC investment activity in the studied European markets been affected by changes in central bank interest rates?

We study a sample of 32,832 funding rounds, each representing a collection of VC investments, from 26 European countries, spanning January 1st, 2016, to March 31st, 2023. We hypothesize that increased interest rates, which raise the cost of capital and lower asset prices, will negatively impact overall VC investments regardless of funding stage. Moreover, we theorize that this effect will vary across funding stages due to their differing characteristics, with seed-stage investments being relatively less affected due to their smaller size, higher risks, and longer investment horizons.

We test this by running panel regressions with aggregated data for each quarter, country, and funding stage, as well as a binomial logistic regression on a funding round level. We begin by analyzing the effect of rising interest rates on overall VC investment activity regardless of funding stage and find no support for a significant relationship. Next, we analyze the same effect but consider the heterogeneity of different funding stages. We find a positive relationship between interest rates and total invested amounts in seed-stage rounds and a negative relationship for both early- and late-stage rounds. We also find that interest rates have a negative effect on the number of early-stage rounds but find no significant effect for seed- or late-stage rounds. Higher interest rates are also associated with increased average round sizes for seed-stage rounds, a marginal increase in early-stage rounds, and a decrease in late-stage rounds. Additionally, our results indicate that rising interest rates are associated with lower odds of a funding round being non-seed (early- or late-stage) compared to seed. Finally, we performed several robustness tests to further validate our results. These were generally more robust for seed- and early-stage rounds across our model specifications.

1.1. Contribution

This thesis contributes to the existing but limited research on the relationship between interest rates and VC activity, an area that, as mentioned above, we argue is understudied but important to explore further for several reasons.

First, interest rates affect the cost and availability of capital for both investors and entrepreneurs (King & Levine, 1993; Shane, 1996), and exploring this relationship can provide valuable insights into how the VC industry responds to changes in monetary policies. Second, the VC industry plays a crucial role in funding entrepreneurial companies (startups), which have been shown to contribute to economic prosperity (Gompers & Lerner, 2001). A decrease in VC funding due to interest rate hikes may thus lead to a funding gap, negatively impacting economic development and growth. Third, the heterogeneity of the different funding stages is important to understand, as startups in different stages have different funding needs, risks, and return profiles (Gompers & Lerner, 2000). By exploring how interest rates may affect these stages differently, our research offers valuable insights into the nuances of the VC market and highlights the varying effects of monetary policy on investments in startups at different stages of their lifecycle.

Furthermore, our research is conducted during a time of macroeconomic transition, as many European economies move away from a long-prevailing near-zero interest rate regime. The initial effects of this transition on the VC industry have yet to be thoroughly examined in an academic setting. Although we acknowledge the limitations of conducting this study in close proximity to the start of the interest hikes, we argue that it is valuable to explore these early effects, as has been done by previous research in other times of macroeconomic uncertainty (Block & Sandner, 2009; Bellavitis et al., 2021).

Finally, although the VC industry today is considered well-established in the developed world, the bulk of the activity and subsequent research focus has historically been centered in the United States (Metrick & Yasuda, 2011). Hence, the European market is particularly interesting as it, in recent years, has seen significant growth in the number of funding rounds and amounts invested by VCs, thus having a more significant role in the financial landscape (Demertzis & Guetta-Jeanrenaud, 2022).

We believe the results of this study can benefit several actors. Academically, the identified research gap alone justifies further investigation. Professionally, our findings can offer insights into the macroeconomic factors affecting VC investments, helping professionals recognize potential market patterns, risks, and opportunities. For policymakers, we contribute to understanding how the broader economic landscape impacts this industry and, more specifically, the impact of monetary policies across startups in different funding stages. By conducting this study, we hope to provide insights into how to support the growth and development of the region's startups, which can drive innovation, job creation, and overall economic growth.

2. Previous literature

This section provides an overview of the existing literature on the relevant topics of this study. A general background on VC is presented in section 2.1. Section 2.2 outlines the previous research on how VC activity is affected by macroeconomic factors. Finally, section 2.3 presents previous research focusing specifically on interest rates.

2.1. Background on venture capital

Da Rin et al. (2013) define VC as an asset management activity that invests funds raised from institutional investors or wealthy individuals into promising new companies with a high growth potential. A VC fund is structured as a limited partnership, with the VC as the general partner (GP) and the investors acting as limited partners (LP). VC is considered a subset of Private Equity (PE) since it invests in private companies, as opposed to public companies whose securities are listed on public exchanges such as NASDAQ and NYSE. The VC firms serve their portfolio companies by funding growth and providing oversight and support, with the goal of maximizing financial returns through a sale or initial public offering of the investment (Metrick & Yasuda, 2011).

VCs typically invest in companies through so-called rounds, a structured fundraising event where multiple investors contribute capital in exchange for equity in the target company. It is worth noting that several VCs can invest in the same investment round, and the funds raised in each round are thus a sum of all the VC investments. The categorization of a funding round depends on factors such as the startup's maturity, commercialization, and exit opportunities (Metrick & Yasuda, 2011), which subsequently lead to different risk and return profiles (Gompers & Lerner, 2000). Although the exact classifications of rounds can vary slightly, Crunchbase categorizes VC investments into three categories, so-called stages, with several sub-categories, depending on the maturity and size of the investment: seed, early, and late stages. The first stage, seed, encompasses pre-seed- and seed investments, often a company's first fundraising round, with round sizes typically ranging between $10K to $2M. The second stage, early, includes series A and B rounds and typically range between $1M to $30M. The final stage, late, encompasses investments in series C and later, typically exceeding $10M and often much larger (Crunchbase, 2021). VCs typically invest in specific stages, industries, and geographies, although some may change their focus over time (Metrick & Yasuda, 2011). Figure 1 below shows a simplified illustration of the stages of a startup according to its earnings and with corresponding different sources of funding over time (Cardullo, 1999).

Figure 1. Illustration of a startup's financing cycle

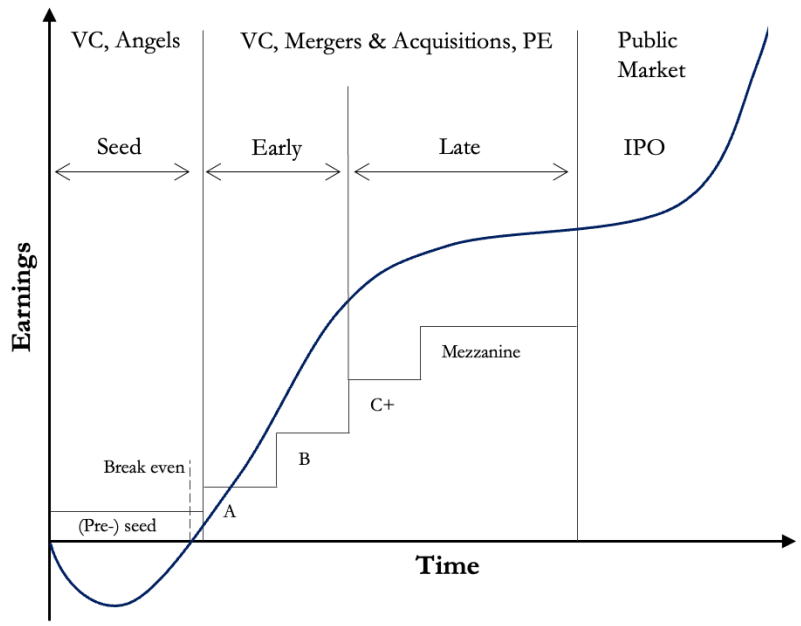

Figure 1 below shows a simplified illustration of the stages of a startup according to its earnings and different sources of funding. The bold curved line shows the relationship between the startup's earnings, plotted on the Y axis, over time, plotted on the X axis. The graph is divided into different sections, corresponding to a startup's funding stage, seed, early, late, and IPO, as well as sources of funding, venture capital (VC), angel investors (Angels), Mergers & Acquisitions, private equity (PE), and the public market. The graph also includes points for the break-even point, and typical funding rounds: Pre-seed, peed, A, B, C+, and mezzanine financing. Note: The labels have been slightly modified to correspond to the ones used in this thesis and to align better with the current VC landscape, as the illustration is dated to 1999. Source: Cardullo (1999).

VCs are often considered one of the few financing alternatives for the high-risk and high-reward projects that are startups. By funding these entrepreneurial companies, VCs have been shown to contribute to economic prosperity. Since the inception of the first true venture capital firm, American Research and Development (ARD), in 1946, VC has grown to become a key factor in the success of many of the most important and innovative companies of the past several decades, including Apple, Microsoft, and Starbucks (Gompers & Lerner, 2001). In recent years, the global VC markets have grown significantly, with the total value of funding rounds growing by a factor of three in the EU and US between 2019 and 2021. This growth is partially explained by favorable financial market conditions, supportive monetary policies, and a large number of successful exits, which have contributed to an increased supply of capital and, consequently, increased VC investments (Demertzis & Guetta-Jeanrenaud, 2022).

2.2. Venture capital and macroeconomic factors

VC is often considered an alternative investment class distinct from traditional asset classes such as bonds or stocks (Metrick & Yasuda, 2011). Yet, previous studies have shown that VC, like other asset classes, still is affected by macroeconomic factors such as stock market performance, GDP growth, and labor market development (Gompers & Lerner, 2000). Macroeconomic factors have been shown to affect VC investment decisions, particularly during economic uncertainty related to financial crises. However, the empirical results of these uncertainties' relative effects on different VC funding stages are inconclusive. For example, Howell et al. (2020) found that recessions are associated with a decline in invested amounts, number of investments, and average round sizes. This pattern was particularly noticeable in early-stage investments, which encompasses both early- and seed-stage rounds according to their definition. Similarly, Bellativitis et al. (2021) and Brown et al. (2020), who examined the initial effects of Covid-19 on VC investments, found a significant decline in investment volume. The decline was especially present in seed-stage investments, attributed to investors moving away from riskier investments in response to the increased macroeconomic uncertainty that Covid-19 created.

In contrast, Block & Sandner (2009) found that during the then-current financial crisis, the average late-stage round, defined as all rounds after seed stage, decreased by 20%, while seed-stage rounds were unaffected. They attributed this to newly founded firms being able to postpone their funding and expansion plans while later-stage firms were in more urgent need of capital and thus unable to postpone fundraising. In addition, they argued that increased economic certainty made late-stage investments less attractive as they involve larger investments required by VCs compared to earlier-stage rounds. Similarly, Cumming et al. (2005) found that in illiquid exit markets, typically occurring during recessions, VC investors invest proportionally more in earlier-stage companies with longer investment horizons. Despite examining different periods and macroeconomic conditions, the aforementioned studies consistently point to varying effects of macroeconomic factors on different funding stages, warranting further analysis.

2.3. Venture capital and interest rates

Monetary policy, particularly central bank interest rates, is a macroeconomic factor that can significantly impact a country's economic activity (e.g., Bernanke & Alan, 1992). By lowering these rates, the goal is usually to boost demand in the real economy as it lowers the cost of borrowing for banks and their customers (Molyneux et al., 2019). Conversely, when central banks increase interest

rates, it tends to dampen demand in the economy since they increase the cost of borrowing for banks and their customers, leading to reduced spending and economic activity (e.g., Cecchetti, 2000). This is often done as a measure to control inflation and stabilize the economy. For example, research has found how the central bank interest rate affects asset prices (Gilchrist & Leahy, 2002), economic growth, as well as capital allocated entrepreneurship (King & Levine, 1993), as it affects the cost of capital (Shane, 1996). However, this factor is often overlooked in the context of entrepreneurial finance.

The limited previous studies exploring how VC activity is affected by interest rates primarily focus on VC fundraising from LPs, offering only a theoretical viewpoint of a corresponding effect on VC investment activity that lacks empirical testing. Gompers & Lerner (1998) suggest that investors' commitment to VC depends on the expected rate of return compared to other investments. If interest rates increase, investing in VC funds may become less attractive since safer asset classes, such as bonds, becomes more appealing, leading to a decreased willingness for investors to supply funds to VCs. On the other hand, decreasing interest rates have been shown to increase LPs' willingness to commit capital to VCs as they may not be able to earn high returns from other asset classes (Bellavitis & Matanova, 2017; Bellavitis et al., 2024). Even though these studies indirectly link together VC investment activity and interest rates through VC fundraising activities, it should be noted that the explicit relationship between monetary policy, as measured by interest rates, and VC investment activity remains largely unexplored.

Although a research gap exists, some studies have explored the topic in more detail. Bellavitis & Matanova (2017) studied the supply and demand dynamics of VC activity and found that higher lending interest rates made VC a relatively cheaper source of financing for entrepreneurs compared to, for example, bank loans. Additionally, they found that higher interest rates increase VC investments in markets with more VC supply than demand; however, the effects are minimal in markets with high demand but low supply. Furthermore, a study by Van Pottelsberghe & Romain (2004) evaluated the impact of macroeconomic factors, including GDP and interest rates, on the demand and supply of VC across 16 OECD countries between 1990 and 2000. They found a positive relationship between interest rates and VC investments, but that the investment activity was also affected by GDP growth and labor market factors.

While the existing literature provides insight into the relationship between interest rates and VC investments, the studies generally take an extended retrospective approach. Our study aims to contribute by focusing on a more recent period, which we in section 4.1 argue differs in distinct ways.

3. Hypotheses

This section presents the hypotheses constructed to answer the research question stated in section 1. Section 3.1 presents the hypotheses focusing on how overall VC investment activity is affected by interest rates, while section 3.2 outlines the hypotheses on how specific funding stages may be affected differently.

3.1. Interest rates and overall VC investment activity

As outlined in Section 2.3, central bank interest rates are an important factor affecting the cost and availability of capital for entrepreneurs and investors. Still, its effect on VC investments is somewhat ambiguous. Previous studies have demonstrated that increased interest rates increase the cost of capital, leading to reduced economic activity, reduced asset prices, and less money allocated to entrepreneurship, indirectly implying reduced VC activity (e.g., Gilchrist & Leahy, 2002; King & Levine, 1993). However, studies on how VC investments are directly affected by interest rates are limited. As previously mentioned, both Bellavitis & Matanova (2017) and Van Pottelsberghe & Romain (2004) found a positive relationship between interest rates and VC investments, however, moderated by supply- and demand dynamics. It should be noted that their sample periods end in 2015 and 2000, respectively, whereas our sample begins in 2016, and we argue that the environment has undergone profound changes during our sample period, which will be further discussed in section 4.1.

With these somewhat inconclusive views above, we formulate our hypothesis based on fundamental financial reasoning as follows: As interest rates increase, the cost of capital increases, leading to lower asset prices across public and private markets. This would lead to less money invested in each funding round through the valuation lever alone, all else equal. Furthermore, with the uncertainty that gradually increasing interest rates may bring, VC investors may become more hesitant to make investments due to fear of changing valuations. This would lead to fewer investments being made, all else equal. These factors should together lead to a reduced number of rounds, reduced average round sizes, and less total amount invested. Therefore, we expect to see a negative relationship between interest rates and overall VC investments, i.e., regardless of the funding stage. Hence, we hypothesize that:

H1:	Increased interest rates decrease the total amount invested by VCs.
H2:	Increased interest rates decrease the number of rounds invested in by VCs.
H3:	Increased interest rates decrease the average amount invested in each round by VCs.

By examining these hypotheses simultaneously, we can obtain a nuanced view of the various effects interest rates might have on different aspects of VC investments.

3.2. Interest rates and VC investment activity across funding stages

In addition to the previous hypotheses on how overall VC investment activity has been affected by the rising interest rates, we also believe it is important to consider the heterogeneity of VC investments in different funding stages. This allows us to better understand the varying impacts of interest rates on seed-, early-, and late-stage investments, as several factors such as risk and return profiles, investment horizons, and the maturity of the company can vary significantly between the stages (Gompers & Lerner, 2000). This approach also aligns with methodologies used in previous literature studying VC investments across different stages (e.g., Bellatvitis et al., 2021; Block & Sandner, 2009; Howell et al., 2020). Still, to our knowledge, no other study has specifically examined how interest rates might affect different funding stages in different ways.

The studies mentioned above that incorporates a stage-level analysis mainly focus on times of crisis and shocks that may abruptly affect investments. In contrast, our study examines a period of gradually increasing interest rates, which, as mentioned in section 3.1, we believe may cause uncertainty regarding capital costs and valuations, but not to the same extent as during a shock. However, we theorize that there will be an effect that varies across funding stages. Specifically, we theorize that increased interest rates will make VCs more likely to invest in seed-stage companies compared to early- and late-stage ones. We reason that the amount invested in seed-stage companies is not only smaller, but these investments are also already associated with relatively higher risks and expected returns. Therefore, these investments should be relatively less affected by increased capital costs in absolute terms, i.e., euro amounts. Furthermore, as seed-stage funding rounds often are made early on in a

startup's life, factors such as the startup's potential for growth and innovation matter more than the precise valuation. This could make seed-stage rounds relatively less affected by capital cost fluctuations compared to later-stage rounds, which rely more on accurate valuations and financial performance to determine investment decisions. Finally, due to seed-stage investments' relatively longer investment horizons, they may be less affected by the effects of interest rates on near-term private and public valuations. Expanding on the hypotheses presented in the previous section, we hypothesize that:

H4a:	Increased interest rates decrease the amount invested by VCs in **early-stage** rounds more than in **seed-stage** rounds.
H4b:	Increased interest rates decrease the amount invested by VCs in **late-stage** rounds more than in **seed-stage** rounds.
H5a:	Increased interest rates decrease the number of **early-stage** rounds invested in by VCs more than **seed-stage** rounds.
H5b:	Increased interest rates decrease the number of **late-stage** rounds invested in by VCs more than **seed-stage** rounds.
H6a:	Increased interest rates decrease the average amount invested by VCs in **early-stage** rounds more than in **seed-stage** rounds.
H6b:	Increased interest rates decrease the average amount invested by VCs in **late-stage** rounds more than in **seed-stage** rounds.
H7:	Increased interest rates decrease the odds of VCs investing in **early- or late-stage** rounds, as compared to **seed-stage** investments.

By examining these hypotheses in addition to the ones presented in the previous section, we can obtain a nuanced view of the stage-specific effects that interest rates might have on VC investments.

4. Data and methodology

This section presents an overview of the various data sources used in the study. Section 4.1 provides a general overview of the sample and delimitations of the study. A detailed description of the variables used in the analysis and their data sources is presented in section 4.2. Finally, section 4.3 presents the methodology used to test our hypotheses.

4.1. Overview of sample and delimitations

The sample consists of 33,832 funding rounds across 26 European countries between January 1st, 2016, and March 31st, 2023. While the sample consists of funding rounds, it is worth noting that each round could encompass investments from several VCs. We chose to focus our study on funding rounds where the target company is based in Europe. This allows us to study several national markets that, to varying degrees, are interlinked through trade agreements, currency unions, and labor mobility. Thus, they may also be affected by similar macroeconomic and geopolitical factors. Ideally, we would also want to restrict our sample to funding rounds made by European investors to truly isolate the effect of interest rates on VC investments, but unfortunately, data on investor location was only available for approximately 50% of our observations. However, approximately 70% of these had the lead investors located in Europe, a proportion consistent with previous research (e.g., Bradley et al., 2019; Demertzis & Guetta-Jeanrenaud, 2022). Therefore, we argue that limiting the sample to only rounds with confirmed European investors (35% of the total sample) would not compensate for the loss of empirical data and statistical power. Nevertheless, as part of our robustness tests in section 5.3, we re-run our regressions with the reduced sample to test the sensitivity of our main results.

We chose the period between January 1st, 2016, and Match 31st, 2023, as we argue it is distinct from previously studied periods in multiple ways. First, the only similar study, to our knowledge, ended its sample period in 2015 (Bellavitis & Matanova, 2017). Though they differ in scope and focus, our study could be viewed as somewhat of an extension. Second, the period is also associated with increased European VC investment activity. Figures 2 and 3 show the total number of rounds and total raised amount per quarter, and the year 2016 seems to be associated with an upward trend, especially for the total raised amount. Lastly, the period includes a general shift from a low-interest rate environment to a more rapid increase towards its conclusion, allowing us to study the initial effects of increasing interest rates on VC investment activity.

Figure 2: Number of funding rounds per stage and quarter

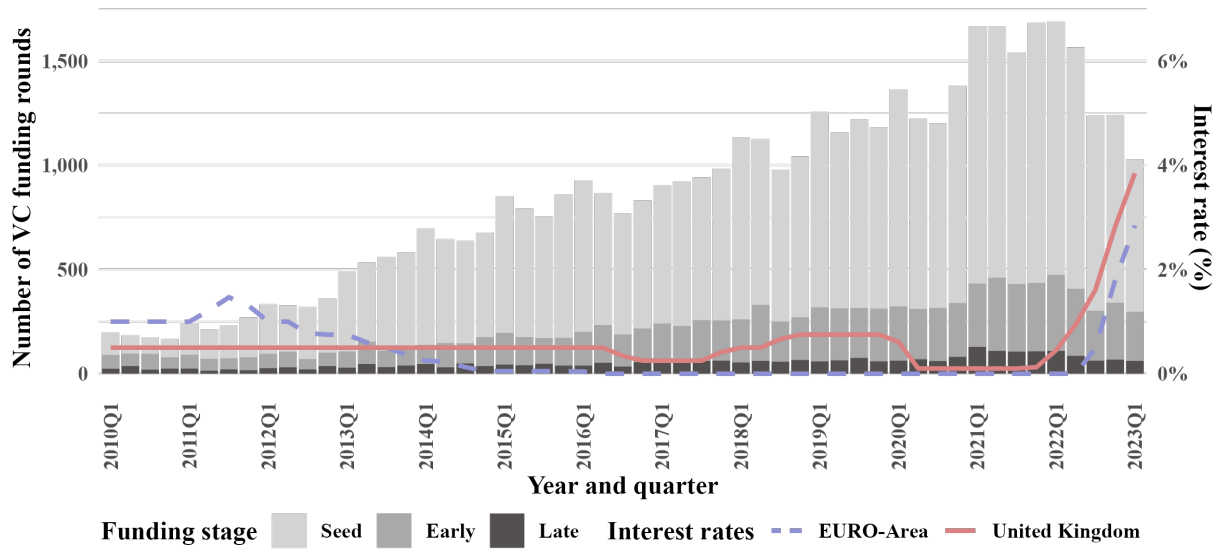

Figure 2 shows a combination chart displaying the number of funding rounds per stage and quarter alongside selected policy rates for the Euro-area and the United Kingdom. The first component is a stacked bar chart representing the number of Funding rounds for each funding stage, seed, early, and late, plotted on the left axis. The second component is a line chart displaying the central bank interest rates for the Euro-area and the United Kingdom, plotted on the right axis. The x-axis represents the time period on a quarterly basis, spanning from Q1 2010 to Q1 2023.

Figure 3: Total raised amount (MEUR) by stage and quarter

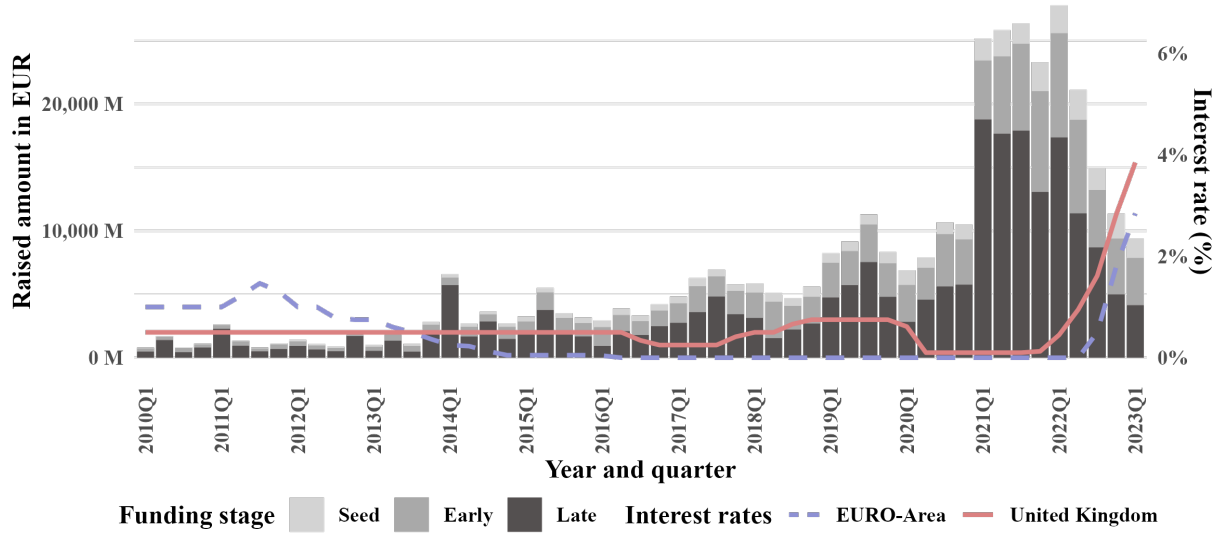

Figure 3 shows a combination chart displaying the total raised amount in VC funding rounds per stage and quarter alongside selected policy rates for the Euro-area and the United Kingdom. The first component is a stacked bar chart representing the total raised amount in VC funding for each stage, seed, early, and late, plotted on the left axis. The second component is a line chart displaying the central bank interest rates for the Euro-area and the United Kingdom, plotted on the right axis. The x-axis represents the time period on a quarterly basis, spanning from Q1 2010 to Q1 2023.

While there may be various macroeconomic and geopolitical factors affecting VC investments during the studied period, we chose to focus on the effect of interest rates as it is one of the key instruments central banks have at their disposal to respond to fluctuations in the economy. This argument is further explored in section 4.2.

Regarding the classification of funding stages, we largely follow Crunchbase's categorization (Crunchbase, 2021), as has been done in previous research (Bellavitis et al., 2021; Block et al., 2019). We classify pre-seed and seed investment rounds as seed stage, Series A and B rounds as early stage, and all subsequent investments after Series B as late-stage rounds. We include PE investments into startups as late-stage VC investments in accordance with Crunchbase's categorization. This is also supported by the similar nature of late-stage VC- and PE firms concerning fund structures and investors (Pitchbook, 2023). However, we re-run our regressions excluding PE investments as part of our robustness tests in section 5.3. Furthermore, we exclude investments made by angel investors due to their fundamental differences from VC funds (Hellmann and Thiele, 2015; Da Rin et al.,2013).

Lastly, we limit our analysis to investments made by VCs into startups, excluding VC fundraising activities from institutional investors. There are three main reasons for this decision. First, VC fundraising is likely associated with longer lead times compared to VC investments, and hence the observable effects of the recent increases in interest rates on fundraising may be delayed. Second, the record-breaking fundraising prior to the interest rate hikes makes them less likely to raise additional funds in the near future, delaying the impact even further (Shi, 2023). Finally, we also desire to maintain a focused scope of analysis throughout this study, and adding this perspective would potentially dilute the analysis and add complexity.

4.2. Variables and data sources

This section presents a detailed description of the variables used in the analysis. A complete list of all variables and their data sources can be found in Appendix 1.

4.2.1. Dependent variables

The primary data source for this study is Crunchbase, a comprehensive online database providing information about startups as well as their investors and funding rounds. We were granted research access to the database and used it to collect all the information related to our main unit of analysis, funding rounds, and subsequently VC investments. The database is regarded as a leading source of

funding rounds for startups and is used both by practitioners and academics due to the quantity and quality of the data (Ferrati & Muffatto, 2020). Crunchbase collects data from a global network of investment firms, community contributors including investors and entrepreneurs, data analysts, and technologies such as artificial intelligence and machine learning (Crunchbase, 2022). It should be noted that since the database partly relies on crowdsourcing, it may lack some observations and, at times, certain data points for some funding rounds. Most notable in our analysis was the lack of data on investors and investor location. Although that somewhat limits the possibility of nuance in our analysis, it does not undermine the robustness or validity of the study's findings.

Apart from the size of the funding rounds, we used Crunchbase to collect data on the target company's name and location, investment date, funding stage, location of investments, the lead investors, and the lead investors' location. We designed four dependent variables based on the Crunchbase data, where the first three are used in our panel regression models, and the fourth is used in our binomial logistic regression model. These variables will be explained in the sections below.

4.2.1.1. Raised amount

Our first dependent variable captures the total raised amount by startups and subsequently invested by VCs in the corresponding rounds. Hence this variable captures the round size (the amount invested by all VCs) and not the ticket size (the amount invested by each VC). To facilitate comparison, we aggregate this variable in our panel data per quarter, country, and funding stage, with the amounts converted to EUR. The variable is implicitly a one-period forward measure capturing the total amounts raised during the quarter, allocated to the start of the quarter. Conversely, our independent variables and controls are not forward-looking, taking on the value at the start of the quarter. Thus, the independent variables can be said to predict the next three months' fundraising, which mitigates concerns about reverse causality. The variable has been log-transformed to help account for nonlinearity.

4.2.1.2. Number of rounds

Our second dependent variable captures the number of funding rounds per quarter, country, and funding stage. The variable follows the same logic as raised amount as it is implicitly a one-period forward measure capturing the total amounts raised during the quarter and allocating it to the start of the quarter. The variable has been log-transformed to help account for nonlinearity.

4.2.1.3. Average round size

Our third dependent variable captures the average amount invested per funding round, by dividing the total raised amount by the number of rounds. The variable subsequently follows the same logic as the previous two dependent variables and captures the average round size per quarter, country, and funding stage. Note that this is not the average invested amount per VC but rather the average amount invested by all VCs per round. Furthermore, the average round size does not necessarily correspond to valuations, as the same company could raise varying amounts at the same valuations by giving up different amounts of equity. However, since data on private valuation are generally unavailable, we cannot explore the effect of interest rates on VC valuations empirically in this thesis. The variable has been log-transformed to help account for nonlinearity.

4.2.1.4. Funding stage

Our final dependent variable is a category variable that classifies if a funding round is considered a seed-, early- or late-stage investment, in accordance with what was described in section 4.2.1. This variable does not aggregate the VC investments in any way. Instead, it is done on a round-to-round basis. The variable is used in our binomial regression, as later described in section 4.3.3. However, due to the binary classification required by the model, the variable has been modified to be categorized as seed or non-seed investments. The funding stage variable is also used to construct dummy variables for each funding stage and is used as independent variables and fixed effects in our panel data regressions.

4.2.2. Independent variables

4.2.2.1. Central bank interest rates

Our main independent variable in this study is the central bank interest rate in the respective country of each investment. We chose this as the main variable representing monetary policy for multiple reasons. Most importantly, interest rates influence the economy in several ways, including through a direct link to the cost of capital for investors, as it affects the cost of borrowing (e.g., Gilchrist & Leahy, 2002; Shane, 1996). Furthermore, similar to Bellavitis et al. (2024), we argue that central bank interest rates are widely known and well-covered in the media, which can also affect investor sentiment. Central bank interest rates also have the benefits of being standardized and available in a

consistent manner across many countries. It should be noted that using central bank interest rates means focusing solely on short-term rates. However, as they influence long-term interest rates and capture the direct and immediate effects of monetary policies (Bernanke & Alan, 1992), we argue that they represent the optimal choice given the focus of our study. We use nominal rates as they are the ones covered by the media and known to the public, but we include inflation as a control variable. The data on interest rates is collected from the Bank for International Settlements (BIS), an international organization owned by 63 central banks worldwide that in total accounts for 95% of global GDP (BIS, 2023).

4.2.2.2. Control variables

The period associated with the interest rate hikes in our sample period also coincides with other sources of macroeconomic uncertainty. To help isolate the effect of central bank interest rates, we control for other macroeconomic variables that are likely to affect VC investments, as has been done by previous research (e.g., Gompers & Lerner, 1998; Bellavitis et al., 2024). By controlling for other macroeconomic factors, we can more accurately isolate the effect of interest rates on VC investments, holding the other macroeconomic variables constant, as well as reducing the risk of omitted variable bias.

The data for the control variables were collected from Eurostat, OECD, and the office for national statistics, UK. Eurostat and OECD were chosen as they are well renowned and provide comprehensive databases for member- and non-member states. In addition, we complemented the inflation data for UK post-Brexit from the office for national statistics. Although these data sources are comprehensive, there are still a few cases in our sample where data points are missing, leading to some countries having to be excluded. Although this reduces our sample, it only does so by 2.6%, and we argue that the benefits of having consistent and available data from credible sources outweigh the costs of the omitted observations. Below is an explanation of the macroeconomic control variables we use in this study, available across time and countries.

We start by controlling for *inflation*, which captures the consumer price index, expressed as a percentage change year-over-year, reported on a monthly level. Since central banks use interest rates to control inflation, among other things, adding it as a control helps isolate the direct effect of interest rates on VC investments from the indirect effect via inflation. Including inflation as a control thus ensures that the estimated relationship between interest rates and VC investments is not distorted by the influence of inflation on both variables.

The size and growth of the economy where the investment is taking place may also affect VC investments, as a larger and fast-growing economy may be more attractive to investors. Thus, we control for both the size of the economy through the variable *GDP level*, expressed as in purchase-power-parity in dollars, and *GDP growth*, expressed as a percentage change from the previous quarter. Adding these controls allows us to account for the potential impact of economic conditions and makes the estimated effect of interest rates on VC investments less likely to be influenced by the size and growth of the economies. GDP has been log-transformed to account for nonlinearity.

We also control for the *unemployment rate* to account for the labor market conditions in the country, as it is another sign of the strength of the economy which may influence central banks' monetary policies.

In addition to interest rates, central banks can also affect the monetary policy through other instruments, such as the *money supply*, which we add to our controls. We use the narrow definition of money supply, which includes currency and overnight deposits. Money supply is reported as indexed values that have been log-transformed to account for nonlinearity.

Finally, we also control for *stock market returns,* calculated from the prices of common shares of companies that are traded on the domestic stock exchanges. This control is included to capture the health of the public markets, an arguably important factor, especially for late-stage VC-backed companies considering going public. This variable can also serve to approximate valuation, as public and private markets are exposed to similar factors in that regard, such as the cost of capital. Including this control variable can therefore help us isolate the effect of interest rates, separated from other factors of the public markets that can affect investment decisions. Stock market returns are reported as indexed values that have been log-transformed to account for nonlinearity.

4.3. Methodology

4.3.1. Panel regressions for H1, H2, and H3

To test hypotheses H1, H2, and H3, if overall VC investment activity is affected by interest rate changes, we run three separate panel data regressions on quarterly VC investment data. The regressions share the same independent variables but use different dependent variables for each hypothesis: raised amount, number of rounds, and average round size. We include country-, time-, and funding stage-fixed effects (stage-fixed effects hereafter) in our regressions for more reliable estimates of the relationships between dependent and independent variables. Country-fixed effects

control for omitted variables that vary across countries but remain constant over time, while time-fixed effects account for common time-specific factors such as economic cycles, regulatory changes, or global shocks. Stage-fixed effects helps control for characteristics that vary across funding stages but remains constant within a specific stage over time. While stage-fixed effects control for mean differences across funding stages, they do not account for a potentially varying relationship between interest rates and our dependent variables. Therefore, we test for the moderating effects of different funding stages in the next set of regressions presented in section 4.3.2.

The nature of our data causes us to observe heteroscedasticity, as the dependent variables vary across countries, time, and, naturally, funding stages. To account for this, we clustered our standard errors at a country level allowing us to capture within-country correlation. This is done for both our panel data and binomial logistic regressions. Ideally, we would've wanted to cluster at a year- and stage-level as well, but due to the small number of groups, seven years, three funding stages, and 26 countries, we risk introducing biases in the standard errors if doing so. However, we believe this approach is more theoretically and economically justified than for example using heteroscedasticity-robust standard errors, as it explicitly accounts for the potential clustering of observations within countries. We have also performed Wald tests for the various regressions, which verify that clustering the standard errors on a country level is appropriate. The results from these tests are summarized in Appendix 2. Finally, as part of our robustness tests in section 5.3, we applied heteroscedasticity-robust standard errors to our regression models to further validate the sensitivity of our findings.

4.3.2. Panel regressions for H4, H5, and H6

To test hypotheses H4, H5, and H6, we adopt a methodology similar to section 4.3.1, but now we aim to examine the differential impact of interest rate changes on separate stages of VC investments. We again run three separate fixed effect panel data regressions on our quarterly data, accounting for country- and time-fixed effects. However, instead of stage-fixed effects, we include interaction terms between the interest rate variable and stage-specific dummy variables for early- and late-stage investments, using seed-stage as our baseline. This allows us to observe differences in the effect of interest rates on the dependent variables across funding stages.

In this structure, the interest rate variable represents the effect on seed-stage investments. The interaction terms with early- and late-stage dummies capture the additional impact of interest rates on early- and late-stage investments, as compared to the effect on seed-stage investments. This approach

helps us test the abovementioned hypotheses and offers a more comprehensive understanding of how interest rate changes influence different stages of VC investments, both relative to each other and in absolute terms. The standard errors are again clustered on a country level.

4.3.3. Binomial logistic regression for H7

In addition to the fixed-effects panel data regressions, we complement our analysis with a binomial logistic regression to test the final hypothesis H7. This regression estimates the odds of a VC investment being in the seed stage after a one-unit increase in the corresponding independent variable. Specifically, it estimates the odds of VCs investing in seed-stage versus non-seed-stage (early or late stage), given changes in interest rates and other included control variables.

Whereas the regressions in section 4.3.2 test the effect of interest rates on the different continuous variables and how that effect varies across different funding stages, the binomial logistic regression allows us to see if changes in interest rates have made investors less or more likely to invest in seed-stage rounds compared to non-seed stage rounds. Hence, the two different regression methods complement each other and allow us to get a more nuanced understanding of how interest rates affect VC investments across different funding stages.

Although it can be argued that a multinomial or ordinal logistic regression could be empirically appropriate and allow us to disentangle the different effects of interest rates on the likelihood for early- and late-stage, respectively, we opted not to use it due to the nature of our dataset. Since a clear majority of the observations fall in the seed-stage category, this causes an imbalance that would be more severe if the data sample were split into three stages compared to just seed and non-seed. Running the other mentioned regressions could therefore lead to biased results towards the majority category. The binomial approach removes some complexity and thus results in a less unbalanced data set and more reliable results, although with a loss of nuance in the analysis. The standard errors are again clustered on a country level.

5. Results

This section provides an overview of the results obtained from the analyses. Section 5.1 provides descriptive statistics for the variables used in the regressions. Section 5.2 shows the output from our various regression models as well as an interpretation of the results in relation to our hypotheses. Finally, section 5.3 presents the different robustness tests conducted to test the sensitivity of our findings.

5.1. Descriptive statistics

Table 1 reports the annual distribution of funding rounds across the sample period. The number of funding rounds increased steadily during the sample period, with 6,331 rounds in 2021 being the most active year. Also noteworthy is the significant increase in the raised amount in 2021 to 99.27 billion, an approximately 180% increase from 2020. The year 2022 was the second most active VC year in terms of the number of rounds and total raised amount in the sample period. However, at a quarterly level, the VC activity in third and fourth quarter of 2022 dropped significantly, as evident in Figures 2 and 3.

Table 1: Summary statistics of the annual distribution of funding rounds

	Year	# of funding rounds	% of total	Total raised amount (€M)	Avg. round size (€M)	Avg. interest rate (%)
1	2016	3,344	9.88	14,326.27 M	4.28 M	0.57
2	2017	3,698	10.93	23,791.28 M	6.43 M	0.54
3	2018	4,193	12.39	21,059.96 M	5.02 M	0.87
4	2019	4,688	13.86	36,730.86 M	7.84 M	1.12
5	2020	4,975	14.71	35,756.88 M	7.19 M	0.50
6	2021	6,331	18.71	99,272.38 M	15.68 M	0.77
7	2022	5,602	16.56	73,359.66 M	13.10 M	1.88
8	2023/Q1	1,001	2.96	9,333.69 M	9.32 M	3.84

This table presents the annual distribution of funding rounds in terms of the number of rounds, total raised amount, and average round size, as well as the annual average central bank interest rate across all countries in the sample. The sample consists of 33,832 funding rounds completed between 2016 and Q1 2023 across 26 countries in Europe. *# of funding rounds* is the number of funding rounds in a particular year. *% of total* is the percentage of the funding rounds in a given year in relation to the total number of funding rounds in the sample. *Total raised amount* is the total amount in millions of EUR raised in a particular year. *Avg. round size* corresponds to the total raised amount in millions of EUR for a particular year divided by the total number of rounds in the same year. *Avg. interest rate (%)* is the aggregated average interest rate across the 26 countries in the sample in a particular year.

Furthermore, Appendix 3 presents the country distribution where funding rounds in the United Kingdom represent the largest fraction of the sample, 30.3% of the total observations. 11.0% of the rounds were made in France, followed by 10.0% in Germany. In addition, Turkey had the highest average interest rate over the sample period, 10.14%, and Switzerland had the lowest average interest rate, -0.32%.

Table 2 presents the sample distribution on a stage level. Seed-stage rounds corresponded to approximately 73% of the rounds in the sample whilst early- and late-stage rounds account for 21% and 6% of the rounds, respectively. The average amount raised per round across the entire sample was approximately 9.27 MEUR.

Table 2: Summary statistics of raised amount across different funding stages

Raised amount (EUR)	Obs.	% of total	Mean	S.D.	Min.	Max.
Seed stage	24,856	73.46	1.24 M	3.24 M	0.00 M	198.12 M
Early stage	6,983	20.64	14.09 M	25.50 M	0.00 M	665.31 M
Late stage	1,993	5.90	92.53 M	202.97 M	0.01 M	350.39 M
Total sample	33,832	100.00	9.27 M	55.03 M	0.00 M	3,503.90 M

This table presents the summary statistics of the total raised amount and the distribution of raised amount across different funding round stages. The sample consists of 33,832 funding rounds completed between the years 2016 and Q1 2023, across 26 different countries in Europe. *Obs.* represents the number of observations in each stage and in the total sample. *Mean* is the average raised amount per round in millions of EUR for each stage and in the full sample. *S.D.* is the standard deviation of the raised amount in millions of EUR per round for each stage and in the full sample. *Min.* and *Max.* represents the minimum and the maximum amount raised in millions of EUR in a funding round for a particular stage and the total sample. Note: The 0.00 M in the Min. column is due to rounding.

Table 3 reports summary statistics and Pearson correlations for the panel data set that includes data on funding rounds aggregated per quarter, funding stage, and country level. The average interest rate is 0.9%, while the average inflation rate is 3.61%. The average GPD growth per quarter and country is 0.56% and the average unemployment rate is 6.83%. The observed correlations suggest that, in general, lower interest rates are associated with higher VC investment activity, both as measured by the number and size of rounds. Additionally, GDP levels and money supply are positively correlated with VC activity, while unemployment rates and stock returns are negatively correlated with VC activity. The low correlation among the variables also suggests that the risk of multicollinearity in the regressions is low. Appendix 4 provides similar information but for an unaggregated level of analysis, as used in the binomial logistic regression.

Table 3: Descriptive statistics and Pearson correlations on a quarter, stage, and country aggregated level

	Variable	Obs.	Mean	S.D.	Min.	Max.	1	2	3	4	5	6	7	8	9	10
1	Log (Raised amount)	1,745	17.19	2.07	9.35	23.12										
2	Log (Number of rounds)	1,745	1.97	1.41	0.00	5.92	0.45*									
3	Log (Avg. round size)	1,745	15.23	1.92	9.35	21.12	0.75*	-0.26*								
4	Funding stage	1,745	0.82	0.80	0.00	2.00	0.39*	-0.52*	0.80*							
5	Interest rate	1,745	0.90	3.04	-0.75	24.00	-0.14*	-0.09*	-0.08*	-0.02						
6	Inflation	1,745	3.61	7.09	-2.40	85.40	-0.01	-0.04	0.02	-0.01	0.61*					
7	Log (GDP level)	1,745	13.36	1.28	9.72	15.52	0.56*	0.48*	0.26*	0.19*	0.13*	0.14*				
8	GDP growth	1,745	0.56	3.25	-20.99	18.42	0.03	-0.01	0.03	-0.01	0.02	0.01	-0.01			
9	Unemployment rate	1,745	6.83	3.64	2.00	24.70	-0.11*	-0.06	-0.08*	-0.02	0.16*	0.04	0.15*	0.02		
10	Log (Money supply)	1,745	4.95	0.20	4.60	5.71	0.08*	0.01	0.07*	0.00	0.26*	0.39*	0.09*	0.04	-0.13*	
11	Log (Stock returns)	1,745	4.78	0.27	3.90	6.48	-0.10*	-0.10*	-0.03	-0.05	0.25*	0.48*	-0.26*	0.09*	-0.25*	0.39*

This table presents the descriptive statistics and Pearson correlations on a quarter, stage, and country aggregated level for the main variables in the study: log-transformed stock returns, money supply, unemployment rate, GDP growth, GDP level, inflation, interest rate, funding stage, average raised amount per round, number of rounds, and raised amounts in EUR. The sample consists of 1,745 observations, and the table provides the mean, standard deviation (S.D.), minimum (Min.), and maximum (Max.) values for each variable. The Pearson correlations are reported in the lower triangular matrix, with the absolute correlations that are significant at the $p < 0.01$ level indicated by an asterisk (*).

5.2. Main results

5.2.1. The effect of interest rates on overall VC investment activity

To test hypotheses H1, H2, and H3, if overall VC investments are affected by interest rates, we run fixed effects panel regressions including the dependent and independent variables as specified in section 4. The result for each regression is shown in Table 4 in columns 1, 2, and 3 respectively.

Model specification H1 in Table 4 shows the panel regression results from testing our first hypothesis, with the total raised amount as the dependent variable. The estimated coefficient for interest rates is slightly positive but not statistically significant, suggesting that there is no significant relationship between interest rates and the total amount invested by VCs. Hence, this result contradicts our first hypothesis H1. Furthermore, inflation shows a significant negative relationship, while stock returns and GDP growth show a significant positive relationship.

Model specification H2 shows the panel regression results from testing our second hypothesis, with the number of rounds as the dependent variable. The estimated coefficient is negative, but not statistically significant, suggesting there is no significant relationship between interest rate and number of rounds. Hence, this result contradicts our second hypothesis. Again, inflation shows a significant negative relationship, and stock returns show a significant positive relationship.

Lastly, model specification H3 shows the panel regression results from testing our third hypothesis with the average round size as the independent variable. The coefficient is positive but not significant, hence contradicting our third hypothesis. Here, only GDP growth shows a significant positive relationship.

Notably, for all three models, the R-squared values are relatively high at 0.73-0.87, but the within R-squared values are very low, indicating that a lot of explanatory power is attributed to the fixed effects rather than within-fixed effects. However, this is not surprising as the stage-fixed effect likely explains much of the dependent variable's variance. This further warrants our decision to study the explicit effect of interest rate on an investment-stage stage level in model H4, H5, and H6.

To conclude, we do not find support that interest rates influence overall VC investment activity when measured in either the total amount invested, the number of rounds, or the average round size. However, it is worth noting that the current model specification with country- year- and stage-fixed effects reduces the degrees of freedom and statistical power given our relatively small sample size, which may affect our results. Hence, the results should be interpreted accordingly.

Table 4: Panel regressions of H1, H2, and H3

Model specification:	**H1**	**H2**	**H3**
Dependent variable:	Log (Raised amount)	Log (Number of rounds)	Log (Avg. round size)
Interest rate	0.0019	-0.0100	0.0119
	[0.0124]	[0.0140]	[0.0150]
Inflation	-0.0125***	-0.0090***	-0.0034
	[0.0030]	[0.0017]	[0.0032]
Unemployment rate	-0.0284	0.0163	-0.0446
	[0.0260]	[0.0109]	[0.0221]
GDP growth	0.0243*	0.0002	0.0242**
	[0.0115]	[0.0040]	[0.0087]
Log (GDP level)	-0.6540	-0.5626	-0.0913
	[0.5779]	[0.2822]	[0.5151]
Log (Money supply - Indexed)	-0.3952	0.0670	-0.4622
	[0.3169]	[0.1534]	[0.3092]
Log (Stock returns - Indexed)	0.5169*	0.3464***	0.1705
	[0.2394]	[0.0799]	[0.2119]
Fixed-Effects:			
Country	Yes	Yes	Yes
Year	Yes	Yes	Yes
Funding stage	Yes	Yes	Yes
Standard Errors: Clustered	by: Country	by: Country	by: Country
Observations	1,745	1,745	1,745
Wald Chi-Square	7.65***	7.04***	3.36**
R^2	0.727	0.871	0.771
Within R^2	0.010	0.012	0.009

This table presents the results of panel regressions for hypotheses H1, H2, and H3, examining the relationship between central bank interest rates and the logged raised amount in EUR, logged number of rounds, and logged average round size, respectively. The sample consists of 33,832 funding rounds completed between 2016-01-01 and 2023-03-31 across 26 European countries, aggregated on a per quarter, country, and stage basis. The aggregated number of observations corresponds to 1,745. The regressions include control variables for inflation, unemployment rate, GDP growth, log-transformed GDP level, log-transformed indexed money supply, and log-transformed indexed stock returns. All models employ fixed effects for country, year, and funding stage, and standard errors are clustered by country. The table reports coefficients, standard errors in brackets, and significance levels for each variable. Additionally, the table provides the number of observations, Wald Chi-Square statistics, overall R-squared, and within R-squared values for each model. ***' p<0.001, '**' p<0.01, '*' p<0.05.

5.2.2. The effect of interest rates on VC investment activity across funding stages

To test hypotheses H4, H5, and H6, if the effect of interest rates on VC investments varies across funding stages, we run another set of fixed-effects panel regressions with the dependent and independent variables as specified in section 4.3.2. Contrary to the previous section, we do not include stage fixed effects. Instead, we include dummy variables for early- and late-stage rounds as well as interaction terms between the dummy and the interest rate variables, keeping seed-stage rounds as our baseline. This model specification allows us to further disentangle the various effects interest rates may have on different funding stages. The result for each panel regression per hypothesis is shown in Table 5, in columns 1, 2, and 3, respectively.

Model specification H4 in Table 5 shows the panel regression results from testing hypotheses 4a and 4b with the total raised amount as the dependent variable. The coefficient shows a positive relationship between interest rates and raised amounts in seed-stage rounds, significant at a 1% confidence level. Specifically, a one-point increase in interest rates is associated with a 4.8% increase in the invested amounts in seed stage rounds, holding all other variables constant. Conversely, the coefficients of the interaction terms suggest a negative relationship between interest rates and raised amounts in early- and late-stage rounds, compared to seed-stage. Both coefficients are significant at a 0.1% level. Specifically, a one-unit increase in interest rates is associated with an 8.95% decrease in the invested amount for early-stage and a 7.68 % decrease for late-stage rounds, relative to seed stage, holding all other variables constant. This corresponds to a 4.15% and a 2.88% decrease in absolute terms[1], respectively. Hence, the findings support our hypotheses 4a and 4b. Noteworthy is that inflation shows a strong significant negative relationship, however not moderated per stage.

Model specification H5 shows the panel regression results from testing hypotheses 5a and 5b with the number of rounds as the dependent variable. The coefficient for the interest variable shows a positive but not statistically significant relationship between interest rates and the number of seed-stage rounds. The interaction term between interest rates and early-stage rounds shows a negative relationship, significant at a 0.1% level. Specifically, a one-unit interest rate increase is associated with a 5.42% decrease in the number of early-stage rounds compared to seed-stage rounds, and a 4.20% decrease in absolute terms, holding all other factors constant. Similarly, the interaction term coefficient

[1] The absolute effects in the regressions with interaction terms are calculated by summing the coefficient for the interest rate variable and the coefficients of the interaction terms for early- and late-stage dummy variables, respectively.

between the interest rate and late-stage rounds suggests a negative relationship, however, not significant at a 5% level. Hence, the results support hypothesis 5a, but we do not find support for hypothesis 5b. Again, inflation shows a significant negative relationship.

Model specification H6 shows the panel regression results from testing hypotheses 6a and 6b with the average round size as the dependent variable. The coefficient for the interest rate variable shows a positive relationship between interest rates and the average round size for seed-stage rounds, significant at a 5% level. Specifically, a one-unit increase in interest rates is associated with a 3.58% increase in the average size of seed-stage rounds. Furthermore, the interaction terms suggest a negative relationship between interest rates and the average size for early- and late-stage rounds compared to seed-stage. Both coefficients are significant at a 1% and 0.1% level respectively. Specifically, for early-stage, a one-unit increase in interest rates is associated with a 3.53% decrease in average round size relative to seed-stage and a marginal increase of 0.05% in absolute terms. For late-stage, a one-unit increase in interest rates is associated with a 5.78% decrease in average round size relative to seed-stage and a 2.2% decrease in absolute terms. These findings support hypotheses 6a and 6b.

Finally, the R-squared values are high across all three columns. Furthermore, the within R-squared values are especially high for columns 2 and 3 and moderate for column 1 but have overall considerably improved compared to section 5.2.1. This increase is, however, expected since the funding stage is removed as a fixed effect and included as separate dummy variables instead.

To conclude this section, we generally find support for a varying effect of interest rates on VC investments across funding stages. Specifically, we find support that early-stage and late-stage investments are relatively more negatively affected by interest rates than seed-stage investments, except for the number of funding rounds for late-stage investments.

Table 5: Panel regressions of H4, H5, and H6

Model specification:	**H4**	**H5**	**H6**
Dependent variable:	Log (Raised amount)	Log (Number of rounds)	Log (Avg. round size)
Interest rate	0.0480**	0.0122	0.0358*
	[0.0131]	[0.0187]	[0.0137]
Inflation	-0.0122***	-0.0091***	-0.0032
	[0.0030]	[0.0017]	[0.0032]
Unemployment rate	-0.0273	0.0165	-0.0437
	[0.0255]	[0.0109]	[0.0222]
GDP growth	0.0245*	0.0001	0.0244**
	[0.0115]	[0.0040]	[0.0087]
Log (GDP level)	-0.6548	-0.5639	-0.0909
	[0.5745]	[0.2796]	[0.5137]
Log (Money supply - Indexed)	-0.4099	0.0736	-0.4835
	[0.3229]	[0.1472]	[0.3180]
Log (Stock returns - Indexed)	0.5184*	0.3512***	0.1673
	[0.2378]	[0.0787]	[0.2115]
Dummy variable - Early stage	0.8864***	-1.365***	2.252***
	[0.1007]	[0.0987]	[0.0432]
Dummy variable - Late stage	1.148***	-2.422***	3.570***
	[0.1372]	[0.0968]	[0.1001]
Interest rate x Early stage	-0.0895***	-0.0542***	-0.0353**
	[0.0153]	[0.0125]	[0.0103]
Interest rate x Late stage	-0.0768***	-0.0190	-0.0578***
	[0.0173]	[0.0227]	[0.0151]
Fixed-Effects:			
Country	Yes	Yes	Yes
Year	Yes	Yes	Yes
Standard Errors: Clustered	by: Country	by: Country	by: Country
Observations	1,745	1,745	1,745
Wald Chi-Square	51.0***	103.7***	369.2***
R^2	0.731	0.873	0.773
Within R^2	0.166	0.784	0.702

This table presents the results of panel regressions for hypotheses H4, H5, and H6, examining the relationship between central bank interest rates and the logged raised amount in EUR, logged number of rounds, and logged average round size, respectively, considering the interaction between interest rates and early and late-stage funding rounds. The sample consists of 33,832 funding rounds completed between 2016-01-01 and 2023-03-31 across 26 European countries, aggregated on a per quarter, country, and stage basis. The aggregated number of observations corresponds to 1,745. The regressions include control variables for inflation, unemployment rate, GDP growth, log-transformed GDP level, log-transformed indexed money supply, and log-transformed indexed stock returns, as well as dummy variables for early-stage and late-stage. All models employ fixed effects for country and year, and standard errors are clustered by country. The table reports coefficients, standard errors in brackets, and significance levels for each variable. Additionally, the table provides the number of observations, Wald Chi-Square statistics, overall R-squared, and within R-squared values for each model. ***' p<0.001, '**' p<0.01, '*' p<0.05.

5.2.3. The effect of interest rates on the odds of a funding round being seed vs non-seed

To test hypothesis H7, if increased interest rates have decreased the odds of VCs investing in non-seed rounds as compared to seed rounds, we run a binomial logistic regression as specified in section 4.3.3. The results are shown in Table 6.

The coefficients display the log-odds of a funding round being non-seed compared to seed stage for each unit increase in the predictor variable. The results show that the estimated coefficient for the interest rate variable is negative, meaning that higher interest rates have a negative effect on the log-odds of an investment round being non-seed compared to seed. Specifically, a one-unit increase in interest rates is associated with a log-odds ratio of -0.064, i.e., a decrease in the odds of VC investments being non-seed compared to seed-stage, holding all other factors constant[2]. Thus, the results are consistent with H7. The coefficients for the remainder of the control variables, except for Log (GDP level), are generally insignificant, indicating that these variables do not have a significant relationship with the likelihood of VC investments being in either stage.

To conclude, we find support that increasing interest rates negatively affect the likelihood of a VC investment being non-seed compared to a seed-stage investment.

[2] A log-odds ratio of -0.064 implies that for each one-unit increase in interest rates, the odds of a VC investment being non-seed versus seed-stage decrease by about 6.2%. Note that this is a change in odds, not a direct change in probability.

Table 6: Binomial logistic regression of H7

Model specification:	**H7**
Dependent variable:	Non-Seed
Interest rate	-0.064**
	[0.02]
Inflation	-0.011
	[0.012]
Unemployment Rate	-0.028
	[0.024]
GDP growth	0.002
	[0.003]
Log (GDP level)	0.275**
	[0.085]
Log (Money supply - Indexed)	-0.247
	[0.282]
Log (Stock returns - Indexed)	0.209
	[0.391]
Constant	-4.496
	[3.144]
Observations	33,832
Log Likelihood	-19,243.13
Wald Chi-square	350,656.9***

This table presents the results of a binomial logistic regression for hypothesis H7, examining the relationship between central bank interest rates and the odds of a funding round being classified as non-seed compared to seed. The sample consists of 33,832 funding rounds completed between 2016-01-01 and 2023-03-31 across 26 European countries. The dependent variable, non-seed, is a binary variable indicating whether a funding round is classified as non-seed (1) or seed (0). The regression includes control variables for inflation, unemployment rate, GDP growth, log-transformed GDP level, log-transformed indexed money supply, and log-transformed indexed stock returns. The table reports coefficients, standard errors in brackets, and significance levels for each variable. The standard errors are clustered by country. Additionally, the table provides the number of observations, Log Likelihood, and Wald Chi-Square statistics, indicating the overall model fit. ***' $p<0.001$, '**' $p<0.01$, '*' $p<0.05$.

5.3. Robustness tests

We run several robustness tests to test the sensitivity of our findings. Bellow follows an overview of each test and the corresponding results.

5.3.1. Robustness test 1: Heteroscedasticity-robust standard errors

As a first test to analyze the sensitivity of our findings, we re-estimate all the H1-H7 regressions using heteroscedasticity-robust standard errors as opposed to clustering the standard errors around each country. The results from these regressions are presented in Appendix 5. The findings are similar in significance levels as our initial findings, except for a slight loss in significance for the interaction between seed-stage investments and interest rates in H6, which is no longer statistically significant at the conventional 5% level, but still marginally significant with a p-value of 6.08%. We also see a general loss of significance for the interaction between late-stage and interest rates. However, caution should be exercised when interpreting these results as the heteroscedasticity-robust standard errors may not fully account for the clustering structure of the data, particularly when the number of observations within each cluster is small. As we do have some countries with relatively few observations, this may contribute to the observed loss in significance. Specifically, we expect to see serial correlation within countries as well as unobserved heterogeneity at a country level, which may not be fully captured by the heteroscedasticity-robust standard errors. This does, however, further justify our decision to use clustered standard errors in the main regression.

5.3.2. Robustness test 2: Rounds with confirmed European investors

Our main results generally support our H4-H6 hypotheses. To further validate these findings, we re-run only the H4-H6 regressions but reduce the sample to only include rounds where the lead VC investors are confirmed to be located in Europe. As mentioned in 4.1, we would ideally want to do this to ensure that our findings are not driven by observations with investors from outside Europe, where regulations and market characteristics could be different. However, doing so results in losing approximately 65% of the total observations, which do not necessarily correspond with non-European investors, as the majority are excluded due to lack of data on investor location. Not only does this cause us to lose statistical power but can also lead to a selection bias, such as the observations with available data may be made by more prominent investors, and hence are more well covered.

The results, presented in Table 7, generally align with our main findings, although with some loss of significance for the seed- and late-stage investments. However, this is likely due to the loss in statistical power due to the significant reduction in observations. The main difference is when testing H5, as the coefficients for the interaction between interest rates and late-stage rounds become significantly positive. The early-stage interaction term remains significantly negative as in our main findings. The change in the coefficient of the late-stage interaction term can result from a 69% drop in seed-stage observations, which is used as the baseline comparison, in addition to the relatively few late-stage observations, 774 in total across all countries and years.

An alternative explanation for the different observed effect on the number of late-stage rounds could be that there is an underlying economic relationship specific to European investors that is different from the overall sample. For example, European investors could have different risk preferences, which might lead them to invest in relatively more late-stage rounds when interest rates increase. However, since we lack data on the investor characteristics of the excluded observations, it is challenging to determine the exact cause. Nevertheless, based on previous studies, it is very likely that the majority of observations without investor data still involve European investors (e.g., Bradley et al. 2019; Demertzis & Guetta-Jeanrenaud, 2022). Therefore, while we cannot rule out the possibility of unobserved factors influencing the results, it is unlikely that this is driven solely by non-European investors. Nonetheless, this result could warrant further research on the potential impact of unobserved factors between European and non-European investors.

Table 7: Regressions on H4-H6 with confirmed European investors

Model specification:	**H4 - European inv.**	**H5 - European inv.**	**H6 - European inv.**
Dependent variable:	Log (Raised amount)	Log (Number of rounds)	Log (Avg. round size)
Interest rate	0.0214	-0.0022	0.0236
	[0.0276]	[0.0140]	[0.0164]
Inflation	-0.0032	-0.0046	0.0013
	[0.0053]	[0.0029]	[0.0045]
Unemployment rate	-0.012	0.0283	-0.0403
	[0.0383]	[0.0201]	[0.0343]
GDP growth	0.014	-0.0051	0.0191**
	[0.0082]	[0.0036]	[0.0061]
Log (GDP level)	-0.1283	0.3915	-0.5199
	[0.5610]	[0.3208]	[0.4151]
Log (Money supply - Indexed)	-0.0228	-0.0484	0.0256
	[0.5610]	[0.1845]	[0.4337]
Log (Stock returns - Indexed)	0.9276**	0.3383*	0.5893*
	[0.3131]	[0.1240]	[0.2513]
Dummy variable - Early stage	1.261***	-0.7659***	2.027***
	[0.0782]	[0.0880]	[0.0520]
Dummy variable - Late stage	1.259***	-1.828***	3.087***
	[0.1478]	[0.0910]	[0.1255]
Interest rate x Early stage	-0.0747***	-0.0295**	-0.0452***
	[0.0138]	[0.0086]	[0.0108]
Interest rate x Late stage	0.0739	0.0583*	0.0156
	[0.0365]	[0.0233]	[0.0313]
Fixed-Effects:			
Country	Yes	Yes	Yes
Year	Yes	Yes	Yes
Standard Errors: Clustered	by: Country	by: Country	by: Country
Observations	1,434	1,434	1,434
Wald Chi-Square	63.7***	47.0***	451.8***
R^2	0.730	0.795	0.768
Within R^2	0.270	0.612	0.680

This table presents the results of panel regressions for hypotheses H4, H5, and H6, examining the relationship between central bank interest rates and the logged raised amount in EUR, logged number of rounds, and logged average round size, respectively, considering the interaction between interest rates and early and late-stage funding rounds. The sample consists of funding rounds completed between 2016-01-01 and 2023-03-31 across 26 European countries, aggregated on a per quarter, country, and stage basis. Unlike the sample used in the main analysis, only investment rounds where the investors are confirmed to be located in Europe have been included. This reduces the sample to 11,925 funding rounds, leading to a reduction in aggregated observation to 1,434. The regressions include control variables for inflation, unemployment rate, GDP growth, log-transformed GDP level, log-transformed indexed money supply, and log-transformed indexed stock returns, as well as dummy variables for early-stage and late-stage. All models employ fixed effects for country and year, and standard errors are clustered by country. The table reports coefficients, standard errors in brackets, and significance levels for each variable. Additionally, the table provides the number of observations, Wald Chi-Square statistics, overall R-squared, and within R-squared values for each model. ***' p<0.001, '**' p<0.01, '*' p<0.05.

5.3.3. Robustness test 3: Without PE investors

Our main analysis includes investment rounds conducted by VC firms as well as PE firms investing in late-stage startups, following Crunchbase's definition. However, it could be argued that VC and PE firms, although similar concerning fund structures and investors, could be affected differently by changes in macroeconomic factors, such as interest rates, due to generally different investment time horizons, debt funding strategies, and maturity of their portfolio companies. Therefore, as a third robustness test, we exclude all PE investments in our sample and re-ran the H4-H6 regressions. In total, 859 late-stage observations are excluded from the sample. The results presented in Table 8 are similar to our main results, except for lost significance for the interaction term between late-stage investments and interest rates. However, this loss in significance could potentially be explained by the loss in statistical power due to a 57% reduction in late-stage observations, and may not be due to PE investments being affected differently.

Table 8: Regressions on H4-H6 without PE investors

Model specification:	**H4 - PE Excluded**	**H5 - PE Excluded**	**H6 - PE Excluded**
Dependent variable:	Log (Raised amount)	Log (Number of rounds)	Log (Avg. round size)
Interest rate	0.0550**	0.0191	0.0359**
	[0.0152]	[0.0174]	[0.0102]
Inflation	-0.0130***	-0.0112***	-0.0018
	[0.0027]	[0.0025]	[0.0036]
Unemployment rate	-0.0407	0.0087	-0.0494*
	[0.0227]	[0.0102]	[0.0179]
GDP growth	0.0193*	0.0014	0.0179**
	[0.0075]	[0.0042]	[0.0051]
Log (GDP level)	-1.042	-0.7164*	-0.3253
	[0.5459]	[0.3007]	[0.4611]
Log (Money supply - Indexed)	-0.3485	0.1046	-0.453
	[0.3833]	[0.1424]	[0.3575]
Log (Stock returns - Indexed)	0.6801**	0.4603***	0.2197
	[0.1861]	[0.0761]	[0.1729]
Dummy variable - Early stage	0.8845***	-1.373***	2.258***
	[0.0997]	[0.0973]	[0.0418]
Dummy variable - Late stage	0.7214***	-2.794***	3.515***
	[0.1245]	[0.0990]	[0.0896]
Interest rate x Early stage	-0.0902***	-0.0546***	-0.0356**
	[0.0149]	[0.0117]	[0.0102]
Interest rate x Late stage	-0.0213	0.0143	-0.0356
	[0.0290]	[0.0199]	[0.0266]
Fixed-Effects:			
Country	Yes	Yes	Yes
Year	Yes	Yes	Yes
Standard Errors: Clustered	by: Country	by: Country	by: Country
Observations	1,652	1,652	1,652
Wald Chi-Square	28.2***	156.4***	482.0***
R^2	0.778	0.878	0.837
Within R^2	0.164	0.810	0.775

This table presents the results of panel regressions for hypotheses H4, H5, and H6, examining the relationship between central bank interest rates and the logged raised amount in EUR, logged number of rounds, and logged average round size, respectively. The sample consists of 32,977 funding rounds completed between 2016-01-01 and 2023-03-31 across 26 European countries, aggregated on a per quarter, country, and stage basis. Unlike the sample used in the main analysis, investment rounds conducted by PE firms have been excluded from the sample, leading to a reduction in aggregated observations to 1,652. The regressions include control variables for inflation, unemployment rate, GDP growth, log-transformed GDP level, log-transformed indexed money supply, and log-transformed indexed stock returns. All models employ fixed effects for country and year, and standard errors are clustered by country. The table reports coefficients, standard errors in brackets, and significance levels for each variable. Additionally, the table provides the number of observations, Wald Chi-Square statistics, overall R-squared, and within R-squared values for each model. ***' p<0.001, '**' p<0.01, '*' p<0.05.

5.3.4. Robustness test 4: Revised sample period

As a fourth robustness test, we re-run the H4-H6 regressions but with a reduced sample period which only includes observations between 2020-01-01 and 2022-12-31. This test aims to explore the sensitivity of our findings to variations in market conditions that emerged during and after 2020, as seen in Figures 2 and 3. This period saw an extraordinary surge in investment activity in the European VC market, driven by factors such as high liquidity and accelerated demand for tech-enabled solutions prompted by the Covid-19 pandemic (e.g., LaBerge et al., 2020; Dogra & Murugaboopathy, 2021). Furthermore, to mitigate the potential risk of an enhanced relationship between interest rates and VC activity, we exclude the first quarter of 2023 and thus reduce the number of periods with generally increasing interest rates.

While reducing the sample to only focus on a subset of the entire period can provide insightful information, there is a risk of losing statistical power from reducing the sample size. This could lead to a loss of precision and reduced significance in the obtained coefficients. Furthermore, while excluding the first quarter of 2023 can reduce the risk of enhancing the relationship between interest rates and VC activity, it could also result in an incomplete picture of the dynamics between these variables. It is, therefore, important to interpret these results accordingly.

Table 9 presents the results from the robustness test, which are identical to our main findings except for a loss in significance in model H6 between interest rates and the average round size for early stage, although the coefficient is still negative. The relationship between interest rates and raised amount respectively the number of rounds for early-stage investments remains significantly negative. Additionally, in model H5, the coefficient between interest rates and the number of late-stage rounds is now significant, in contrast to our main analysis.

Overall, the results suggest that our main findings are generally resilient to the exclusion of one quarter of increased interest rates and the reduction of the sample to a shorter period characterized by significantly higher VC activity compared to the preceding years. These results provide further support for the negative impact of increased interest rates on early and late-stage rounds, as compared to seed-stage.

Table 9: Regressions on H4-H6 with revised sample period

Model specification:	**H4 – Revised Sample**	**H5 – Revised Sample**	**H6 – Revised Sample**
Dependent variable:	Log (Raised amount)	Log (Number of rounds)	Log (Avg. round size)
Interest rate	0.0773*	0.0064	0.0708**
	[0.0311]	[0.0296]	[0.0208]
Inflation	-0.0243***	-0.0131***	-0.0112*
	[0.0048]	[0.0030]	[0.0042]
Unemployment rate	-0.0497	-0.0161	-0.0336
	[0.0631]	[0.0331]	[0.0578]
GDP growth	0.0205	-0.001	0.0214
	[0.0139]	[0.0045]	[0.0115]
Log (GDP level)	-0.8257	-0.4712	-0.3545
	[0.9484]	[0.3970]	[1.038]
Log (Money supply - Indexed)	1.356	0.1842	1.172
	[0.9880]	[0.3306]	[0.8876]
Log (Stock returns - Indexed)	1.485**	0.5223*	0.9630**
	[0.4171]	[0.2082]	[0.3237]
Dummy variable - Early stage	0.8812***	-1.356***	2.237***
	[0.1184]	[0.1130]	[0.0592]
Dummy variable - Late stage	1.303***	-2.406***	3.710***
	[0.1460]	[0.1087]	[0.1321]
Interest rate x Early stage	-0.0887*	-0.0711***	-0.0176
	[0.0378]	[0.0158]	[0.0239]
Interest rate x Late stage	-0.1332***	-0.0528*	-0.0804***
	[0.0241]	[0.0214]	[0.0198]
Fixed-Effects:			
Country	Yes	Yes	Yes
Year	Yes	Yes	Yes
Standard Errors: Robust	by: Country	by: Country	by: Country
Observations	759	759	759
Wald Chi-Square	21.3***	194.3***	748.4***
R^2	0.743	0.880	0.783
Within R^2	0.211	0.793	0.720

This table presents the results of panel regressions for hypotheses H4, H5, and H6, examining the relationship between central bank interest rates and the logged raised amount in EUR, logged number of rounds, and logged average round size, respectively. The sample consists of 16,908 funding rounds completed between 2020-01-01 and 2022-12-31 across 26 European countries, aggregated on a per quarter, country, and stage basis. The aggregated number of observations in the revised sample period corresponds to 759. The regressions include control variables for inflation, unemployment rate, GDP growth, log-transformed GDP level, log-transformed indexed money supply, and log-transformed indexed stock returns. All models employ fixed effects for country and year, and standard errors are clustered by country. The table reports coefficients, standard errors in brackets, and significance levels for each variable. Additionally, the table provides the number of observations, Wald Chi-Square statistics, overall R-squared, and within R-squared values for each model. ***' p<0.001, '**' p<0.01, '*' p<0.05.

5.3.5. Robustness test 5: Binomial logistic reg. with samples from robustness test 2-4

As a final robustness test, we re-run the binomial logistic regression used to test H7 using the various data sets used in robustness tests 2-4. The results for each of the three regressions are summarized in Table 10 and are consistent with the results in our main analysis.

Table 10: Regressions on H7 with samples from robustness tests 2-4

Model specification H7:	**European Inv.**	**No PE- Inv.**	**Revised sample period**
Dependent variable:	Non-Seed	Non-Seed	Non-Seed
Interest rate	-0.065**	-0.070***	-0.066***
	[0.03]	[0.022]	[0.013]
Inflation	-0.022*	-0.01	-0.013*
	[0.012]	[0.012]	[0.008]
Unemployment Rate	-0.002	-0.029	-0.019
	[0.026]	[0.024]	[0.023]
GDP growth	0.006	0.001	0.002
	[0.004]	[0.003]	[0.003]
Log (GDP level)	0.292***	0.271***	0.267***
	[0.094]	[0.089]	[0.092]
Log (Money supply - Indexed)	-0.630**	-0.246	-0.501
	[0.273]	[0.312]	[0.373]
Log (Stock returns - Indexed)	0.544	0.178	0.406
	[0.432]	[0.407]	[0.362]
Constant	-4.128	-4.376	-4.030
	[3.479]	[3.346]	[3.402]
Observations	11,925	32,977	16,908
Log Likelihood	-7,614	-18,097	-9,657
Wald Chi-square	209,349***	302,785***	394,558***

This table presents the results of the robustness test on the binomial logistic regressions for hypothesis H7, examining the relationship between central bank interest rates and the odds of a funding round being classified as non-seed compared to seed. The sample used in the robustness test "European Inv." consists of only observations with investor locations confirmed to be in Europe are included. In "No PE-Inv." rounds conducted by PE investors investing in startups have been excluded. In "Revised sample period", the sample is reduced to a sub-sample as explained in section 5.3.4, the sample period is between 2020-01-01 and 2022-12-31. The dependent variable, non-seed, is a binary variable indicating whether a funding round is classified as non-seed (1) or seed (0). The regression includes control variables for inflation, unemployment rate, GDP growth, log-transformed GDP level, log-transformed indexed money supply, and log-transformed indexed stock returns. The table reports coefficients, standard errors in brackets, and significance levels for each variable. The standard errors are clustered by country. Additionally, the table provides the number of observations, Log Likelihood, and Wald Chi-Square statistics, indicating the overall model fit. '***' p<0.001, '**' p<0.01, '*' p<0.05.

6. Discussion

This section discusses our main findings presented in section 5. Section 6.1 presents a summary of the results of our tested hypotheses, as well as a discussion and possible explanations for the obtained results. Finally, section 6.2 presents a discussion of this study's main limitations and potential areas for future research.

6.1. Summary of the main findings

Table 11 presents an overview of the results obtained in our main analysis and robustness tests summarized by each hypothesis tested. We classify the hypothesis as supported if the results across the main analyses and the robustness tests consistently support the hypothesis. We classify it as partially supported if it is supported across the main analysis as well as in at least one of the robustness tests. Finally, we classify the hypothesis as not supported if the results in the main analyses as well as in the robustness tests do not support the hypothesis. These results will be discussed further in the coming sections.

Table 11: Summary of hypotheses and results

Hypothesis	Description	Result
H1	Increased interest rates decrease the total amount invested by VCs.	Not supported
H2	Increased interest rates decrease the number of rounds invested in by VCs.	Not supported
H3	Increased interest rates decrease the average amount invested in each round by VCs.	Not supported
H4a	Increased interest rates decrease the amount invested by VCs in early-stage rounds more than in seed-stage rounds.	Supported
H4b	Increased interest rates decrease the amount invested by VCs in late-stage rounds more than in seed-stage rounds.	Partially supported
H5a	Increased interest rates decrease the number of early-stage rounds invested in by VCs more than seed-stage rounds.	Supported
H5b	Increased interest rates decrease the number of late-stage rounds invested in by VCs more than seed-stage rounds.	Not supported
H6a	Increased interest rates decrease the average amount invested by VCs in early-stage rounds more than in seed-stage rounds.	Partially supported
H6b	Increased interest rates decrease the average amount invested by VCs in late-stage rounds more than in seed-stage rounds.	Partially supported
H7	Increased interest rates decrease the odds of VCs investing in early- or late-stage rounds, as compared to seed-stage investments.	Supported

This table provides a summary of the hypotheses and the results obtained from the empirical analyses in the study. Each hypothesis is briefly described, followed by a report on whether the hypothesis was supported, partially supported, or not supported by the empirical findings. The hypotheses are classified as supported if the results across the main analyses and the robustness tests consistently support the hypothesis, as partially supported if it is supported across the main analysis as well as in at least one of the robustness tests, and as not supported if the results in the main analyses as well as in the robustness tests do not support the hypothesis. Hypotheses H1-H3 focus on the general effect of increased interest rates on venture capital investments, H4a-H6b investigate the differential impact of increased interest rates on seed, early, and late-stage investment, and H7 examines the likelihood of investors investing in early- or late-stage investments compared to seed stage investments in response to increased interest rates.

6.1.1. No support for an effect of higher interest rates on overall VC investment activity

The results obtained from our H1-H3 regressions do not support our hypotheses and the financial reasoning we based them on, as we did not find a negative effect of increasing interest rates on overall VC investment activity. Our results contrast the limited previous research focusing on interest rates and overall VC investments, which found a positive relationship between interest rates and VC investments (Van Pottelsberghe & Romain, 2004; Bellavitis & Matanova, 2017). However, the studies focused on other regions and a period with different macroeconomic and monetary policy conditions where the VC market also was less active and widespread. Thus, the differing results may not be that surprising.

As seen in Figures 2 and 3, we observe an overall decline in both the number of rounds and the total raised amount as interest rates increase. However, our results indicate that interest rates provide no significant explanatory power for the decrease in investment activity. Instead, in models H1 and H2, inflation appears to be a key explanatory variable having a negative effect on the dependent variables, total raised amount and the number of rounds. A possible explanation for this could be that inflation has a leading effect, while interest rates often lag and represent a response to changes in inflation. It is possible that VCs may anticipate changes in other macroeconomic factors, such as interest rates, in response to inflationary changes. However, this explanation is largely speculative and warrants further research. It is also worth noting that the increasing inflation during our sample period coincided with other sources of macroeconomic uncertainty related to the Covid-19 pandemic and Russia's invasion of Ukraine, which could have amplified the observed relationship between inflation and VC investment activity. This potential limitation will be further discussed in 6.2.

Another possible explanation for the results could be the model specification used when testing H1, H2, and H3. Although we controlled for stage-fixed effects, the underlying assumption of a constant effect of interest rates across all funding stages is likely oversimplified, as there are significant variations among funding stages in terms of the number of rounds and average round sizes. Therefore, the H4-H6 models were introduced to account for stage-specific variations and to better isolate the effects of interest rates on each stage, leading to more robust and meaningful findings that align better with the complexities of the VC landscape. However, considering the stage-specific variations observed in H4-H6, the findings from H1-H3 appear less surprising as we did not observe a negative effect of interest rate on seed-stage rounds, which represents the majority of observations in our sample, but rather the opposite.

6.1.2. Different effects of interest rates across funding stages

As presented in section 5.2.2, the results from our second set of regressions showed a more complex relationship between interest rates and VC investment activity when studied across different funding stages. These results generally align with our H4-H7 hypotheses and point to the importance of considering the heterogeneity of VC investments.

Specifically, we found that interest rates and seed-stage rounds have a significant positive relationship in terms of raised amounts and average round size, with no significant effect on the number of rounds. Conversely, we found that interest rates have a negative relationship with VC investments for early- and late-stage relative to seed-stage rounds, apart from the number of late-stage rounds, which did not show significant results. These effects are also similar in absolute terms for late- and early-stage investments, apart from interest rates having a negligible effect on the average round size for early-stage investments. Finally, we found that the odds of a round being seed stage is positively affected by rising interest rates, as compared to non-seed.

Although no previous literature, to our knowledge, has directly examined the heterogeneous effects of interest rates on VC investments, our results can arguably be put into the context of studies exploring the effect of other macroeconomic factors on VC investments across stages. While our results contrast Bellavitis et al. (2021), who found negative effects of Covid-19 on seed-stage investments, comparing the impact of Covid-19 disruptions to gradual changes in the monetary policy might be challenging. Howell et al. (2020) also reported negative effects on early-stage investments during recessions, but their results are difficult to compare as they don't differentiate seed-stage from early-stage. Our results can, however, be considered in line with previous findings by Block & Sandner (2009), who documented that a reduction in VC funding following the financial crisis was only evident for later-stage rounds, which they define as all rounds after seed stage. They attribute this to newly founded firms being able to postpone their funding plans, whereas later-stage firms may be willing to take on funding at less favorable conditions as they more urgently need capital. Although this explanation is also plausible in this case, we provide an alternative and expanded reasoning below, organized by the respective effects of interest rates on each funding stage.

6.1.2.1. Negative effect of rising interest rates on early- and late-stage rounds

Our findings show that for late-stage investments, the number of rounds is not affected by higher interest rates, while the total raised amount and average round size significantly decrease. Similar to

what has been proposed by Block & Sandner (2009), this could be a result of late-stage firms not being able to postpone funding and instead must raise capital in smaller rounds or at lower valuations in this relatively new transition period with increasing interest rates. A contributing factor could be that late-stage companies typically have larger capital requirements to support their ongoing operations and growth initiatives and hence must raise capital more urgently. Consequently, this category of firms may maintain the number of funding rounds on aggregate but raise lower amounts on average due to the increased cost of capital, possibly leading to lower valuations. However, this explanation should be interpreted with caution due to our relatively small sample size of late-stage rounds, and the somewhat inconclusive results obtained in our robustness tests.

Furthermore, our findings indicate that for early-stage investments, higher interest rates have a larger negative impact on the total raised amount and the number of rounds, while the average round size is only marginally affected and, if anything, slightly positive in absolute terms. The results suggests that the observed decrease in the total raised amount for early-stage rounds can be attributed to a reduction in the number of rounds rather than a substantial change in the average round size. This is somewhat puzzling, as one might expect that increased interest rates would increase the cost of capital and lower valuations, thus resulting in primarily smaller round sizes, all else being equal. However, it should be noted that an unchanged average round size may not necessarily imply unaffected valuations, as mentioned in section 4.2.1.

One possible explanation for the obtained result is that investors in early-stage rounds might become more selective in a higher-interest rate environment, leading to fewer but relatively larger funding rounds. This could result from VC investors becoming increasingly risk-averse, prompting a "flight to quality" effect among the early-stage rounds, where they increasingly focus on investing in companies with, for example, relatively stronger business models or that have already achieved significant traction in their respective markets. This results in a more competitive funding landscape in which predominantly higher-quality companies with relatively higher valuations receive funding. In this scenario, although higher interest rates could lead to smaller rounds overall, only the relatively larger ones receive investments. As a result, the average round size remains stable even though the total number of early-stage rounds has decreased. A possible explanation for why this supposed selective investment environment is not observed for later-stage rounds could be that they have less operational risk due to their generally larger and more mature operations. Furthermore, these companies have already undergone a selection process through previous rounds of funding in order

to reach the late stage. Therefore, VCs could still be willing to invest in the same number of companies, but the average rounds sizes could decrease due to higher capital costs.

6.1.2.2. Positive effect of rising interest rates on seed-stage rounds

Another interesting finding is the generally positive relationship between interest rates and seed-stage investments. Although this may be surprising at first, we argue that this can be explained by VC investors possibly perceiving investments in seed-stage companies as relatively less exposed to the effects of rising interest rates compared to later stages. Several factors may contribute to this perception. First, seed-stage investments are generally associated with smaller amounts invested in each round, which could make the impact of interest fluctuations relatively less severe in absolute monetary value. Second, since seed-stage companies are in their early development stage, investors may prioritize factors such as innovation and growth potential rather than financial considerations. This, combined with relatively longer investment horizons, can result in seed-stage investors placing less emphasis on precise valuations compared to later-stage investors. Finally, seed-stage investors may be relatively more risk-tolerant due to the nature of seed-stage investments, as they are often associated with higher uncertainty, resulting in a different risk-return profile compared to later-stage investors. Therefore, the risk premium for seed investments would always be comparatively higher, making the impact of an increase in another element of the cost of capital, such as interest rates, relatively less important. The argument that companies' risk and return profiles at different stages of development vary significantly also aligns with earlier studies (Gompers & Lerner, 2000).

It is plausible that varying risk preferences between seed- and later-stage investors may contribute to the positive effect of rising interest rates on seed-stage rounds. However, our results could also be attributed to some default early- or late-stage investors reevaluating their investment strategy in response to the rising interest rates, leading them to shift their focus towards seed-stage investments. While VCs typically focus on specific stages, some may change their investment strategies over time (Metrick & Yasuda, 2011). Assuming a fixed supply of investable seed-stage companies, this would lead to more investors targeting the same number of seed-stage investments. The increased demand for seed-stage companies could result in higher valuations or larger amounts raised at the same valuations, as our results indicate. This could also contribute to the increased likelihood of rounds being seed over non-seed, as seen in our binomial logistic regressions. Unfortunately, it is difficult to disentangle these effects further as we lack detailed information about the specific investors driving the observed results. However, this highlights a potential area for further research to better

understand the dynamics of investor behavior and the factors influencing their investment preferences in the context of rising interest rates.

It should also be noted that all aspects of the observed positive relationship between seed-stage investments and interest rates were not robust across all our robustness tests, as we marginally lost significance on a 5% level for the average round size with robust standard errors, as well as a general loss of significance when drastically reducing the number of observations when only including confirmed European investors. However, as explained in section 5.3.2, the results from the later robustness test should be interpreted with caution. Thus, we don't believe them to significantly compromise our main findings.

6.2. Limitations and future research

The main limitation of this study is arguably the sample period, as we are only able to observe three-quarters of generally increasing central bank interest rates in Europe. While our study has contributed interesting findings about the initial impact of rising interest rates on VC investments, they should be viewed as preliminary. It is also worth mentioning that the VC market, and the financial markets at large, have experienced unprecedented growth in recent years, with the second-to-last year in our studied period, 2021, being a record year. Thus, our results may also coincide with a "return to normal" growth trajectory of the VC market and financial markets in general. Therefore, further research is necessary to determine whether these results will remain consistent in the future or if they are merely a representation of a transitory period.

Furthermore, the studied period is generally associated with increasing interest rates from a low-interest rate environment, however, with slight variations on a country level. Hence, our analysis allows us to estimate the effects of interest rates in primarily one direction. Although we expect the theoretical relationships between interest rates and cost of capital to hold in the opposite direction, the specific dynamics and mechanisms through which interest rates affect different funding stages could differ and therefore warrant further investigation. Although this could be alleviated by extending the sample period, a previous period with high sustained interest rates and subsequent decreases has not been observed for a long time. We argue that the European VC markets have changed significantly since then, making such a comparison less relevant.

Finally, a common concern in these types of analysis is the influence of unobserved factors. Although we included a range of macroeconomic factors and have controlled for time-, stage-, and

country-fixed effects in our models to mitigate this concern, the risk of omitted variable bias remains. For example, a contributing factor to the observed heterogeneity between the stages could be that seed-stage companies may be more active in emerging sectors that are prioritized by VC investors. Another factor could be to control for the supply of VC funding, i.e., funds ready to be invested. However, we were not able to access the data necessary to study either of these factors in our analysis. Similarly, another potential factor could be to control for VC demand from entrepreneurs. However, we argue that this is difficult to estimate and that the methodologies used by previous studies, such as using search-engine trends (Bellavitis and Matanova, 2017), are flawed. Nevertheless, this could be an interesting angle for future research.

Finally, it is important to note that the fixed effects and control variables might not fully account for the unique impacts of specific events, such as the pandemic or Russia's invasion of Ukraine. Disentangling the effects of broad economic shocks from the specific effects of interest rate changes is a complex task that our study can only partially address. However, as we include several macroeconomic factors, such as inflation which is likely to be affected by these specific events, our methodology captures a significant portion of these effects. Despite these limitations, we are confident the observed relationship between interest rates and VC investments across funding stages is still valid.

7. Conclusion

In this study, we aimed to investigate the potential impact of rising central bank interest rates on VC investment activity, a topic we argue was previously understudied. Our objective was to provide empirical evidence on the subject, which we consider particularly relevant at present, as several European economies are transitioning from a prolonged period of low or zero-interest rates. Through our research, we address this gap in the literature and contribute to a greater understanding of the broader European VC environment and the heterogeneous effects that monetary policy changes can have on startups at different stages of growth.

Our findings indicate that even in an environment of rising interest rates, new innovations may still be supported as investments in young seed-stage startups seem to increase. However, a funding gap for mature startups could emerge if rising interest rates lead to reduced VC investments in later-stage startups. Furthermore, these companies may face compounded difficulties as increased interest rates could affect other financing options as well, including higher cost of debt and less favorable public market conditions. This could lead to increased bankruptcies, job reductions, and capital losses among later-stage firms.

However, the evidence we present should be considered relatively preliminary, as we were only able to examine approximately three-quarters of increasing interest rates in our sample period. Nonetheless, our findings could still provide valuable insights for policymakers, investors, and other stakeholders in the VC industry as they navigate this transition period.

To conclude, our study provides valuable insights into the initial impact of rising interest rates on European VC investments, highlighting the importance of considering the heterogenous effects on different funding stages. While our research has contributed to a better understanding of these relationships, unanswered questions still remain. Future research is therefore warranted to increase our knowledge of the complex interplay between monetary policy and venture capital investments across funding stages.

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9. Appendix

Appendix 1: List of variables used in the regression analyses

Name	Description	Source
Raised Amount	The total amount raised by startups per quarter, country, and funding stage.	Crunchbase
Number of Rounds	The number of funding rounds per quarter, country, and funding stage.	Crunchbase
Average Round Size	The average amount raised per funding round per quarter, country, and funding stage.	Crunchbase
Funding Stage	A category variable that classifies if a funding round is considered a seed-, early- or late-stage investment.	Crunchbase
Interest rate	The central bank interest rate in the respective country of each investment.	BIS
Inflation	The consumer price index in the respective country of each investment, expressed as a percentage change year-over-year, reported on a monthly level.	Eurostat, UK office of national statistics
GDP Level	The size of the economy in the respective country of each investment, expressed as in purchase-power-parity in dollars.	OECD
GDP Growth	The growth of the economy in the respective country of each investment, expressed as a percentage change of GDP from the previous quarter.	OECD
Unemployment Rate	The unemployment rate in the respective country of each investment.	OECD
Money Supply	The currency and overnight deposits in the respective country of each investment.	OECD
Stock Market Returns	Calculated from the prices of common shares of companies that are traded on the stock exchanges in the respective country of each investment.	OECD

This table presents lists the variables used in this thesis along with a description and source.

Appendix 2: Wald Chi-Square test results

Model specification	Type of Standard Errors		
	Standard	Heteroscedasticity-Robust	Clustered: Country
Fixed effect regression			
H1	2.45*	2.23*	7.65***
H2	2.99**	2.37*	7.04***
H3	2.24*	2.37*	3.36**
H4	30.70***	39.60***	51.00***
H5	562.20***	558.80***	103.70***
H6	364.30***	434.00***	369.20***
Binomial Logistic Regression			
H7	5,221,555***	5,284,178***	350,656***

This table presents the Wald Chi-Square statistics for the main analysis regression models used to test whether the coefficients of the independent variables are significantly different from zero. The null hypothesis is that the independent variables have no effect on the dependent variable. The results for H1-H6 correspond to the fixed effect panel regressions, and H7 corresponds to the binomial logistic regression. Each regression was run with standard-, heteroscedasticity-robust-, and clustered standard errors, where the clustered standard errors are clustered by country. ***' p<0.001, '**' p<0.01, '*' p<0.05.

Appendix 3: Country distribution and average central bank interest rates

	Country	Number of rounds	% of rounds	Avg. interest rate (%)
1	United Kingdom	10,252	30.30	0.59
2	France	3,727	11.02	0.39
3	Germany	3,372	9.97	0.39
4	Spain	2,150	6.35	0.39
5	Switzerland	1,767	5.22	-0.32
6	Netherlands	1,583	4.68	0.39
7	Sweden	1,471	4.35	0.35
8	Italy	1,406	4.16	0.39
9	Finland	835	2.47	0.39
10	Turkey	804	2.38	10.14
11	Hungary	800	2.36	3.29
12	Ireland	752	2.22	0.39
13	Belgium	731	2.16	0.39
14	Poland	722	2.13	2.49
15	Denmark	704	2.08	-0.20
16	Norway	508	1.50	1.12
17	Estonia	505	1.49	0.39
18	Austria	438	1.29	0.39
19	Portugal	367	1.08	0.39
20	Czech Republic	318	0.94	1.12
21	Luxembourg	142	0.42	0.39
22	Greece	138	0.41	0.39
23	Latvia	137	0.40	0.39
24	Iceland	105	0.31	4.37
25	Slovakia	56	0.17	0.39
26	Slovenia	42	0.12	0.39
	Total	**33,832**	**100.00**	**1.12**

This table presents the summary statistics of the total number of rounds, % of total number of rounds, and average central bank interest rates for each country included in the sample. The sample consists of 33,832 funding rounds completed between the years 2016 and Q1 2023 across 26 different countries in Europe. *Number of rounds* represents the aggregated number of Funding rounds in a specific country over the sample period. *% of rounds* is the percentage of the funding rounds in each country in relation to the total number of funding rounds in the sample. *Avg. Interest Rate (%)* is the aggregated average interest rate across the 26 countries in the sample in a particular year.

Appendix 4: Descriptive statistics and Pearson correlations for sample on a round level

	Variable	Obs.	Mean	S.D.	Min.	Max.	1	2	3	4	5	6	7	8	9
1	Log (Raised amount)	33,832	13.83	2.03	6.72	21.98									
2	Funding stage	33,832	0.32	0.58	0.00	2.00	0.67*								
3	Seed vs. Non-Seed Funding stage	33,832	0.27	0.44	0.00	1.00	0.66*	0.93*							
4	Interest rate	33,832	0.66	2.37	-0.75	24.00	-0.08*	-0.05*	-0.06*						
5	Inflation	33,832	3.51	6.15	-2.70	85.40	0.01	-0.04*	-0.05*	0.64*					
6	Log (GDP level)	33,832	14.30	1.05	9.72	15.52	0.16*	0.10*	0.11*	0.09*	0.08*				
7	GDP growth	33,832	0.48	3.93	-20.99	18.42	0.01	0.00	0.00	0.02*	0.02*	-0.01			
8	Unemployment rate	33,832	6.23	3.39	1.70	24.70	-0.11*	-0.06*	-0.06*	0.16*	0.02*	-0.06*	0.04*		
9	Log (Money supply - Indexed)	33,832	4.96	0.19	4.60	5.71	0.06*	-0.02*	-0.03*	0.26*	0.40*	0.07*	0.06*	-0.09*	
10	Log (Stock returns - Indexed)	33,832	4.74	0.23	3.90	6.48	-0.02*	-0.04*	-0.04*	0.30*	0.50*	-0.33*	0.07*	-0.22*	0.32*

This table presents the descriptive statistics and Pearson correlations on a round level for the main variables in the study: log-transformed stock returns, money supply, unemployment rate, GDP growth, GDP level, inflation, interest rate, funding stage, average raised amount per round, number of rounds, and raised amounts in EUR. The sample consists of 33,832 observations, and the table provides the mean, standard deviation (S.D.), minimum (Min.), and maximum (Max.) values for each variable. The Pearson correlations are reported in the lower triangular matrix, with the absolute correlations that are significant at the $p < 0.01$ level indicated by an asterisk (*).

Appendix 5 (1/3): Robustness test 1: Regressions on H1-H7 with heteroscedasticity-robust standard errors

Model specification:	**H1 - Robust**	**H2 - Robust**	**H3 - Robust**
Dependent variable:	Log (Raised amount)	Log (Number of rounds)	Log (Avg. round size)
Interest rate	0.0019	-0.0100	0.0119
	[0.0276]	[0.0118]	[0.0236]
Inflation	-0.0125	-0.0090*	-0.0034
	[0.0088]	[0.0046]	[0.0062]
Unemployment rate	-0.0284	0.0163	-0.0446
	[0.0307]	[0.0160]	[0.0231]
GDP growth	0.0243**	0.0002	0.0242***
	[0.0089]	[0.0044]	[0.0073]
Log (GDP level)	-0.6540	-0.5626*	-0.0913
	[0.6119]	[0.2804]	[0.4963]
Log (Money supply - Indexed)	-0.3952	0.0670	-0.4622
	[0.3826]	[0.1938]	[0.3180]
Log (Stock returns - Indexed)	0.5169	0.3464**	0.1705
	[0.2713]	[0.1168]	[0.2186]
Fixed-Effects:			
Country	Yes	Yes	Yes
Year	Yes	Yes	Yes
Funding stage	Yes	Yes	Yes
Standard Errors: Robust	Heteroscedasticity -robust	Heteroscedasticity-robust	Heteroscedasticity-robust
Observations	1,745	1,745	1,745
Wald Chi-Square	2.23*	2.37*	2.37*
R^2	0.727	0.871	0.771
Within R^2	0.010	0.012	0.009

This table presents the results of panel regressions for hypotheses H1, H2, and H3, examining the relationship between central bank interest rates and the logged raised amount in EUR, logged number of rounds, and logged average round size, respectively. The sample consists of 33,832 funding rounds completed between 2016-01-01 and 2023-03-31 across 26 European countries, aggregated on a per quarter, country, and stage basis. The aggregated number of observations corresponds to 1,745. The regressions include control variables for inflation, unemployment rate, GDP growth, log-transformed GDP level, log-transformed indexed money supply, and log-transformed indexed stock returns. All models employ fixed effects for country, year, and funding stage, and standard errors are heteroscedasticity-robust. The table reports coefficients, standard errors in brackets, and significance levels for each variable. Additionally, the table provides the number of observations, Wald Chi-Square statistics, overall R-squared, and within R-squared values for each model. ***' p<0.001, '**' p<0.01, '*' p<0.05.

Appendix 5 (2/3): Robustness test 1: Regressions on H1-H7 with heteroscedasticity-robust standard errors

Model specification:	**H4 - Robust**	**H5 - Robust**	**H6 - Robust**
Dependent variable:	Log (Raised amount)	Log (Number of rounds)	Log (Avg. Round size)
Interest rate	0.0480*	0.0122	0.0358
	[0.0235]	[0.0111]	[0.0191]
Inflation	-0.0122	-0.0091*	-0.0032
	[0.0074]	[0.0036]	[0.0060]
Unemployment rate	-0.0273	0.0165	-0.0437
	[0.0305]	[0.0160]	[0.0231]
GDP growth	0.0245**	0.0001	0.0244***
	[0.0088]	[0.0044]	[0.0073]
Log (GDP level)	-0.6548	-0.5639*	-0.0909
	[0.6067]	[0.2777]	[0.4952]
Log (Money supply - Indexed)	-0.4099	0.0736	-0.4835
	[0.3797]	[0.1937]	[0.3139]
Log (Stock returns - Indexed)	0.5184*	0.3512**	0.1673
	[0.2641]	[0.1127]	[0.2166]
Dummy variable - Early stage	0.8864***	-1.365***	2.252***
	[0.0495]	[0.0279]	[0.0392]
Dummy variable - Late stage	1.148***	-2.422***	3.570***
	[0.0853]	[0.0339]	[0.0769]
Interest rate x Early stage	-0.0895***	-0.0542***	-0.0353*
	[0.0178]	[0.0088]	[0.0146]
Interest rate x Late stage	-0.0768	-0.0190	-0.0578
	[0.0474]	[0.0099]	[0.0459]
Fixed-Effects:			
Country	Yes	Yes	Yes
Year	Yes	Yes	Yes
Standard Errors: Robust	Heteroscedasticity -robust	Heteroscedasticity-robust	Heteroscedasticity-robust
Observations	1,745	1,745	1,745
Wald Chi-Square	39.6***	558.8***	434.0***
R^2	0.731	0.873	0.773
Within R^2	0.166	0.784	0.702

This table presents the results of panel regressions for hypotheses H4, H5, and H6, examining the relationship between central bank interest rates and the logged raised amount in EUR, logged number of rounds, and logged average round size, respectively, considering the interaction between interest rates and early and late-stage funding rounds. The sample consists of 33,832 funding rounds completed between 2016-01-01 and 2023-03-31 across 26 European countries, aggregated on a per quarter, country, and stage basis. The aggregated number of observations corresponds to 1,745. The regressions include control variables for inflation, unemployment rate, GDP growth, log-transformed GDP level, log-transformed indexed money supply, and log-transformed indexed stock returns, as well as dummy variables for early-stage and late-stage. All models employ fixed effects for country and year, and standard errors are heteroscedasticity-robust. The table reports coefficients, standard errors in brackets, and significance levels for each variable. Additionally, the table provides the number of observations, Wald Chi-Square statistics, overall R-squared, and within R-squared values for each model. ***' p<0.001, '**' p<0.01, '*' p<0.05.

Appendix 5 (3/3): Robustness test 1: Regressions on H1-H7 with heteroscedasticity-robust standard errors

Model specification:	**H7 - Robust**
Dependent variable:	Non-Seed
Interest rate	-0.064***
	[0.01]
Inflation	-0.011***
	[0.004]
Unemployment Rate	-0.028***
	[0.004]
GDP growth	0.002
	[0.003]
Log (GDP level)	0.275***
	[0.015]
Log (Money supply - Indexed)	-0.247***
	[0.074]
Log (Stock returns - Indexed)	0.209**
	[0.081]
Constant	-4.497***
	[0.599]
Observations	33,832
Log Likelihood	-19,243.13
Wald Chi-square	5,284,178***

This table presents the results of a binomial logistic regression for hypothesis H7, examining the relationship between central bank interest rates and the odds of a funding round being classified as non-seed compared to seed. The sample consists of 33,832 funding rounds completed between 2016-01-01 and 2023-03-31 across 26 European countries. The dependent variable, non-seed, is a binary variable indicating whether a funding round is classified as non-seed (1) or seed (0). The regression includes control variables for inflation, unemployment rate, GDP growth, log-transformed GDP level, log-transformed indexed money supply, and log-transformed indexed stock returns. The table reports coefficients, standard errors in brackets, and significance levels for each variable. The standard errors are heteroscedasticity-robust. Additionally, the table provides the number of observations, Log Likelihood, and Wald Chi-Square statistics, indicating the overall model fit. ***' p<0.001, '**' p<0.01, '*' p<0.05.