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**Macroeconomic and Financial Determinants of
Venture Capital Investment across OECD Countries:
A Panel Analysis of Stage-Specific Effects**

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Abstract:

This master's thesis examines how different macroeconomic and financial conditions are associated with venture capital investment across OECD countries, with a particular focus on differences between investment stages. Using a panel dataset of 20 OECD countries over the period 2010–2021, the analysis combines between- and within-country panel regressions to evaluate the roles of GDP growth, the term spread, stock market returns, market volatility, and R&D expenditure. Venture capital investment is measured relative to GDP and disaggregated into seed, startup, and later-stage investment using harmonized OECD data.

The results indicate that within-country variation in macro-financial conditions is more strongly associated with venture capital investment than cross-country differences. R&D expenditure emerges as the strongest determinant, with a positive, statistically significant relationship across all stages. Financial market variables also play an important role: stock market returns are positively associated with early- and later-stage investment, while the term spread is negatively associated with earlier-stage investment. In contrast, GDP growth shows no statistically significant relationship with venture capital investment. Contrary to earlier research, market volatility is positively associated with investment across stages, suggesting a more complex relationship between uncertainty and venture capital activity than commonly assumed.

The findings provide evidence that the determinants of venture capital investment differ across stages, highlighting the importance of stage-specific analysis. Overall, the study contributes to the literature by emphasizing the role of changes in within-country dynamics and differences in investment stages in shaping venture capital investment across OECD economies.

KEYWORDS: VC, venture capital, macroeconomic determinants, financial market conditions, stage-specific effects,

VAASAN YLIOPISTO**Laskentatoimen ja rahoituksen yksikkö**

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TIIVISTELMÄ:

Tämä pro gradu -tutkielma tarkastelee erilaisten makrotaloudellisten ja rahoitusmarkkinamuuttujien yhteyttä venture capital -sijoitustoimintaan 20 OECD-maassa, painottaen erityisesti eri sijoitusvaiheiden välisiä eroja. Tutkimus pohjautuu vuodelt 2010–2021 kattavaan paneelidataan, ja analyysissä hyödynnetään sekä maiden välisiä että maiden sisäisiä regressiomalleja. Selittävinä muuttujina toimivat BKT:n kasvu, korkoero, osakemarkkinatuotot, osakemarkkinavolatiliteetti sekä tutkimus- ja kehitysmenot. Venture capital -sijoitukset on suhteutettu bruttokansantuotteeseen ja jaettu OECD:n yhdenmukaistetun, vertailukelpoisen luokituksen mukaisesti siemen-, alku- ja myöhemmän vaiheen sijoituksiin.

Tulosten mukaan maiden sisäinen ajallinen vaihtelu selittää venture capital -sijoitustoimintaa maiden välistä keskimääräistä vaihtelua paremmin. Tutkimus- ja kehitysmenot nousevat merkittävimmäksi yksittäiseksi selittäjäksi: niiden yhteys sijoitustoimintaan on positiivinen ja tilastollisesti merkitsevä kaikissa sijoitusvaiheissa. Myös rahoitusmarkkinamuuttujat ovat keskeisiä ja niissä havaitaan eroja eri sijoitusvaiheiden välillä. Osakemarkkinatuotot ovat positiivisesti yhteydessä erityisesti myöhemmän vaiheen sijoituksiin, kun taas korkoero on negatiivisesti yhteydessä varhaisempiin sijoitusvaiheisiin. BKT:n kasvulla ei havaita tilastollisesti merkitsevää yhteyttä sijoitustoimintaan. Aiemmasta tutkimuksesta poiketen markkinavolatiliteetti on positiivisesti yhteydessä sijoituksiin kaikissa vaiheissa, mikä viittaa epävarmuuden ja venture capital -sijoitustoiminnan välisen suhteen olevan oletettua monimutkaisempi.

Tulokset osoittavat, että venture capital -sijoitustoimintaan vaikuttavat tekijät eroavat sijoitusvaiheiden välillä, mikä korostaa vaihekohtaisen tarkastelun tärkeyttä. Tutkielma täydentää aiempaa kirjallisuutta osoittamalla, että maiden sisäinen dynamiikka ja sijoitusvaiheiden väliset erot ovat keskeisiä venture capital -sijoitustoiminnan ymmärtämisessä OECD-maissa.

AVAINSANAT: VC, venture capital, macroeconomic determinants, financial market conditions, stage-specific effects

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1 Introduction

Young, innovative companies play a crucial role in economic development by creating new technologies, boosting productivity, and introducing ideas that established companies are often unable or unwilling to pursue. Yet, these companies face structural financing constraints due to their lack of collateral, limited financial history, and uncertain future. Berger and Udell (1998) describe this situation within the financial growth cycle framework, in which young companies experience the highest degree of credit rationing because traditional lenders rely on verifiable information when assessing borrowers. These information problems reflect the broader agency issues identified by Jensen and Meckling (1976), who show that asymmetric information and different incentives make outside financing costly. In this environment, venture capital has emerged as a financing model that supports high-risk companies that cannot access conventional debt markets. Instead of relying on collateral, venture capital investors rely on intensive monitoring, active ownership, and staged contracting to evaluate and guide young companies through their early stages of development (Sahlman, 1990; Barry, 1994; Gompers & Lerner, 2001).

The influence of venture capital extends beyond the financing of individual companies. Because venture capitalists ultimately realize returns through initial public offerings or acquisitions, the whole industry is closely tied to the functioning of financial markets. Gompers and Lerner (2001) document that periods of strong initial public offering activity often coincide with expansions in venture capital fundraising and investment. Black and Gilson (1998) similarly argue that active and accessible exit markets are essential for recycling capital back into new venture capital funds. These links between venture capital activity and public markets suggest that the industry operates as part of a broader financial system in which investment incentives depend on the attractiveness of exit conditions and the availability of capital. Venture capital activity thus reflects not only the attributes of investee companies but also the broader macroeconomic and financial conditions that influence investor sentiment and the opportunities for value realization.

A growing body of literature indicates that venture capital investment is sensitive to macroeconomic and financial factors. Cross-country studies indicate that macroeconomic conditions influence venture capital investment volumes. Romain and van Pottelsberghe (2004) find that GDP growth and indicators of technological opportunity have significant positive effects on early-stage investment across OECD countries. Félix et al. (2013) report comparable results for European economies, showing that venture capital investment tends to increase during periods of stronger economic growth. Schertler (2007) further demonstrates that measures of national knowledge capital, including patent applications, R&D personnel, and R&D expenditure, are among the strongest determinants of venture capital investment in Europe, and that stock market performance is also important in shaping venture capital investment volumes. These findings show that venture capital is closely tied to broader macroeconomic conditions that influence both the supply of capital and the opportunities available for high-growth companies.

Financial market conditions reinforce these dynamics by shaping the environment in which exits occur and valuations are set, which is essential to venture capital investors' value creation. Pástor and Veronesi (2005) show that companies are more likely to go public when expected profitability improves, and equity valuations rise. Their analysis indicates that IPO waves tend to follow periods of strong market performance, which raises valuations for issuing companies and encourages them to go public. Since IPOs are a key exit mechanism for venture capital funds, favorable valuation environments strengthen venture capitalists' incentives to initiate new investments, while macro-financial tightening can limit access to external capital.

1.1 Purpose of the study

The purpose of this study is to examine how macroeconomic and financial conditions influence venture capital investment across OECD countries, with particular attention to potential differences across venture capital stages: seed, start-up, and later-stage. Venture capital is essential to financing young, innovative companies, yet its activity is

shaped by the broader economic environment in which investors and entrepreneurs operate. Understanding the sensitivity of venture capital investment to fluctuations in different macroeconomic and financial determinants is therefore important for interpreting how capital-flows into high-growth companies evolve over time and across countries.

This study focuses on the period from 2010 to 2021, a timeframe that includes both cyclical expansions and episodes of financial stress. These conditions create meaningful variation in the macro-financial environment and enable analysis of how venture capital responds to changes in economic opportunities and market sentiment. By using harmonized OECD data that separately report seed, start-up, and later-stage investment, the study also enables investigation of whether different stages of the venture capital cycle respond differently to shifts in macroeconomic and financial market conditions. This distinction is relevant because existing literature shows that companies' responses to changes in determinants vary between stages.

The objective of the study is not only to estimate the direction and magnitude of these relationships but also to provide a structured, comparative overview of how macroeconomic and financial variables shape the allocation of venture capital across countries. By analyzing stage-specific investment patterns in a consistent international dataset, the study contributes to a clearer understanding of the conditions that support the financing of startup companies.

1.2 Hypotheses development and research question

Venture capital investment is shaped by changes in the broader macroeconomic and financial environment, and existing empirical research provides several reasons to expect systematic relationships between these conditions and the allocation of capital to startup companies. Cross-country studies indicate that economic growth creates a more supportive environment for venture capital investment. Romain and van Pottelsberghe (2004) show that GDP growth is positively and significantly associated

with venture capital investment across OECD countries, while Félix et al. (2013) report similar findings for European economies, noting that venture capital investment tends to increase during periods of stronger economic performance. Dalal's (2022) meta-analysis reinforces this pattern by identifying macroeconomic variables, including GDP growth, as among the most consistent positive determinants of venture capital flows across countries. These results suggest that venture capital investment volume is likely to rise as economic activity increases, which motivates the first hypothesis of the thesis.

H1: GDP growth has a positive effect on venture capital investment.

Innovation capacity is another factor consistently linked with venture capital investment activity. Romain and van Pottelsberghe (2004) find that indicators of technological opportunity are positively related to venture capital investment. Schertler (2007) similarly shows that national knowledge capital, such as the number of patent applications, R&D personnel, and R&D expenditure, positively affects venture capital investment. Dalal (2022) identifies technological opportunity as one of the strongest determinants across studies, suggesting that economies with more active innovation systems generate more high-growth companies seeking external financing. These findings imply that venture capital investment activity is likely to be higher in countries that invest more in R&D.

H2: Higher R&D intensity is associated with higher venture capital investment.

Interest-rate conditions also shape the underlying macroeconomic environment, affecting venture capital investment. Romain and van Pottelsberghe (2004) find that both short-term and long-term interest rates have effects on venture capital investment and emphasize the importance of the term spread, the difference between long-term and short-term rates, as a forward-looking indicator of financing conditions. They report that the larger the spread, the lower investors' willingness to commit capital to riskier investments. Their interpretation aligns with earlier evidence showing that the slope of

the yield curve signals expectations of future economic conditions (Estrella & Hardouvelis, 1991). Because venture capital investment returns are realized far in the future, conditions that influence expectations about long-horizon profitability are likely to matter.

H3: A larger term spread is associated with lower venture capital investment.

Financial-market conditions further influence the incentives of both entrepreneurs and investors. Several studies highlight the role of stock market performance in shaping capital availability and the attractiveness of exit opportunities. Pástor and Veronesi (2005) show that companies are more likely to go public following periods of strong stock market performance and improved profitability, thereby increasing the valuations available to issuers. Kaplan and Schoar (2005) demonstrate that commitments to private equity and venture capital funds rise after strong stock market returns, which indicates that fundraising conditions are procyclical with stock market performance.

At the same time, periods of heightened uncertainty appear to reduce venture capital investment activity. Lahr and Mina (2014) show that higher stock market volatility signals weaker investment conditions, while Pástor and Veronesi (2005) find that IPO activity declines as volatility increases. Because exit markets are central to the venture capital cycle, higher volatility may weaken incentives to initiate new investments. These findings together support the expectation that venture capital responds positively to stock market performance and negatively to uncertainty.

H4: Stronger stock market performance increases venture capital investment, while higher stock market volatility reduces it.

A further question arises from the literature: do these determinants affect all stages of venture capital investment differently? Several studies indicate that stage-specific patterns exist. Jeng and Wells (2000) find that certain institutional and macroeconomic

variables influence early-stage and later-stage venture capital investment differently, while Lahr and Mina (2014) document that macroeconomic shocks produce cyclical movements in venture capital investment across seed, early-stage, expansion, and late-stage investments. Kerr and Nanda (2015) also suggest that early-stage companies face the greatest financing risk because they rely more heavily on repeated rounds of external funding, which makes them especially sensitive to fluctuations in capital availability. Although Dalal (2022) finds no statistically significant average differences across stages in a wide set of studies, she notes that this may be due to inconsistencies and under-reporting in the underlying datasets rather than the absence of differences between stages. Combined, these insights suggest that macroeconomic and financial determinants may not influence all stages of venture capital investment in a uniform manner.

H5: The effects of macroeconomic and financial determinants on venture capital investment differ across stages.

Against this background, the study will address the following research question:

How do macroeconomic and financial determinants influence venture capital investment across OECD countries, and do these effects differ between seed, start-up, and later-stage investment?

1.3 Research gap

Although existing research provides evidence on the macroeconomic and financial determinants' effects on venture capital activity, several gaps remain in understanding how these relationships operate across countries and investment stages. Much of the early cross-country literature focuses on aggregate venture capital flows and does not examine whether different investment stages respond differently to macro-financial conditions. Studies such as Romain and van Pottelsberghe (2004) and Félix et al. (2013) provide valuable evidence on the influence of GDP growth, interest rates, and

technological opportunity, but they focus primarily on total or early-stage investment and do not systematically compare stage-specific responses. Schertler (2007) offers detailed evidence for European economies but similarly treats early and expansion investment as broad categories rather than examining the full sequence from seed to later stage. As a result, the extent to which macroeconomic variables shape venture capital investment differently across stages remains only partially understood.

The literature that analyzes stage-specific patterns yields mixed findings and highlights limitations in existing data. Jeng and Wells (2000) show that certain determinants, such as labor-market rigidities and IPO activity, do not affect early-stage and later-stage investment in the same way, yet they also acknowledge that their results may be incomplete due to difficulties in identifying all variables that drive early-stage investment. Lahr and Mina (2014) document cyclical movements across stages and show that macroeconomic shocks affect seed, early-stage, expansion, and late-stage investments differently, but their research is limited to the effects of market shocks. Kerr and Nanda (2015) argue that early-stage companies face heightened financing risk, implying that they should be more sensitive to financial conditions, but they do not test this effect in a cross-country setting with harmonized stage definitions. These studies indicate that stage differences exist, yet they leave open questions about how consistently they appear across countries and over time.

Furthermore, meta-analytic evidence underscores the need for more precise and comparable data when analyzing stage differences. Dalal (2022) concludes that, on average, determinants do not differ significantly across stages, but explicitly notes that this finding may be due to shortcomings in primary datasets, including under-reporting of early-stage deals and inconsistencies in how stages are defined across countries. This suggests that the absence of strong stage differences in prior work may be more due to data limitations than to the true behavior of venture capital markets.

Taken together, these observations indicate a clear research gap. Existing studies show that macroeconomic and financial conditions influence venture capital investment, but they do not fully explain whether these effects differ across seed, start-up, and later-stage investments when measured with harmonized, comparable international data. The limitations highlighted by Jeng and Wells (2000), the cyclical patterns documented by Lahr and Mina (2014), the theoretical arguments of Kerr and Nanda (2015), and the dataset concerns raised by Dalal (2022) all point to the need for research that applies harmonized and consistently defined stage measures across countries. By using OECD seed, start-up, and later-stage investment series, this study aims to address this gap and provide a structured analysis of how different macro-financial determinants affect venture capital investment across stages.

1.4 Structure of the study

This thesis is structured as follows. Chapter 1 introduces the research topic and outlines the study's motivation. It defines the research purpose, presents the research question and hypotheses, and identifies the research gap that the thesis aims to address. The introduction situates the study within the broader literature on venture capital and macroeconomic and financial determinants, providing the foundation for the analysis.

Chapter 2 presents the study's theoretical framework. It discusses venture capital as a financial intermediary and reviews its key characteristics, including fund structures, staged financing, investor involvement, and exit mechanisms. This chapter establishes the theoretical background necessary for understanding how venture capital investment may respond to changes in macroeconomic and financial conditions.

Chapter 3 reviews the relevant empirical literature. It summarizes prior research on the macroeconomic and financial determinants of venture capital investment, with particular attention to GDP growth, interest rates, innovation and R&D activity, stock market performance, and volatility. The chapter also reviews existing evidence on stage-

specific differences in venture capital investment and highlights the limitations of earlier studies.

Chapter 4 describes the study's empirical framework. It presents the data sources, variable definitions, and descriptive statistics, and explains the methodology employed in the analysis. The chapter outlines the use of between- and within-regressions and motivates the stage-specific approach adopted in the empirical analysis.

Chapter 5 reports and discusses the empirical results. The findings from the between- and within-regressions are presented and interpreted, with emphasis on differences across venture capital investment stages. The chapter also evaluates the empirical support for the hypotheses presented in Chapter 1.

Finally, Chapter 6 concludes the study. It summarizes the main findings, discusses their implications for understanding venture capital investment across OECD countries, and outlines the analysis's limitations and directions for future research.

2 Theory

2.1 Venture capital as a financial intermediary

Startup companies face structural financing challenges because they typically lack collateral, financial records, and predictable cash flows, which makes traditional debt financing difficult, since banks depend on concrete information and verifiable financial statements when evaluating borrowers. Berger and Udell (1998) describe this dynamic as part of the “financial growth cycle,” where companies at the earliest stage experience the highest degree of credit rationing. Their framework highlights that most start-ups cannot meet the requirements traditional lenders use to manage risk. These constraints are closely connected to the broader agency-theoretic insights of Jensen and Meckling (1976), who model the relationship between managers and outside investors as an agency relationship in which agents do not always act in the best interests of principals. In their framework, outside equity and debt holders incur monitoring costs, managers may incur bonding costs, and there remains a residual loss due to the difference between managerial decisions and those that would maximize outside investors’ interests. In early-stage companies, these information problems are often exacerbated by technological uncertainty and the lack of market validation, making conventional debt financing poorly suited to them.

Venture capital evolved as a form of financing specifically designed to operate under these types of uncertainty conditions. Instead of relying on collateral or historical performance, venture capitalists use governance, incentive design, and monitoring to mitigate the information problems. Venture capital organizations finance high-risk, potentially high-reward startup companies by purchasing equity stakes while the companies are still privately held (Gompers & Lerner, 2001). The latter goal is to profit by increasing the value of these companies, taking them public, and selling that equity (Gompers & Lerner, 2000). Sahlman (1990) shows that venture capital contracts and governance arrangements give investors substantial control over their portfolio companies. Venture capitalists typically obtain representation on the company’s board

and structure their investments so they can keep firm control, for example, by staging capital infusions and retaining the ability to replace managers or shut down the venture if performance is unsatisfactory (Sahlman, 1990). These mechanisms allow investors to observe managerial behavior and intervene when necessary. Barry (1994) emphasizes that venture capitalists remain deeply involved in their portfolio companies, combining capital with consulting and monitoring. Barry (1994) reports that venture capitalists spend significant time working with their portfolio companies, often serving on boards and helping recruit and restructure management teams. This direct engagement reduces information asymmetry by improving transparency and aligning managerial decisions with investor interests.

2.1.1 Structure of venture capital funds

Venture capital funds are usually organized as limited liability partnerships, in which a specialized private equity firm serves as the general partner and outside investors are the limited partners (Kaplan & Sensoy, 2015). The defining feature of this structure is that limited partners, often including institutional investors such as pension funds, endowments, insurance companies, banks, other financial institutions, and wealthy individuals, contribute the majority of capital, but delegate management of the capital to the general partner (Da Rin et al., 2013; Kaplan & Sensoy, 2015). The limited partner's liability is limited to the amount of committed capital, and they rely on the general partner's expertise to source, manage, and exit investments (Kaplan & Sensoy, 2015). Limited partners invest through these partnerships because selecting and monitoring appropriate investee companies requires specialized skills and resources that most institutions lack internally (Lerner et al., 2007).

General partners control the fund's investment strategy and operational activities. They raise the funds, screen and select portfolio companies, provide managerial and strategic support, and manage exits. They also commit their own capital, typically at least one percent of the total committed capital (Kaplan & Sensoy, 2015). The general partner earns compensation through an annual management fee and a share of the fund's profits,

known as the carried interest (Kaplan & Sensoy, 2015). Annual management fees typically range from 1,5 to 2,5 percent, while the carried interest is often fixed at 20 percent (Kaplan & Schoar, 2005; Kaplan & Sensoy, 2015).

The relationship between limited and general partners is formalized through a partnership agreement, which specifies the fund's life cycle (typically 10 years), the nature of its activities, the share of profits, etc. (Lerner et al., 2007). Limited partners commit to a fixed amount of invested capital at the beginning of the agreement, but this capital is not transferred immediately. Instead, the general partner issues capital calls over the investment period to fund investments and fees. General partners typically make investments during the first years of the fund's cycle, while later years are devoted to value creation and realization activities rather than new investments (Kaplan & Sensoy, 2015).

The illiquid nature of venture capital also shapes the roles within the partnership. Unlike investors in mutual funds or hedge funds, limited partners in venture capital funds cannot redeem their capital during the life of the fund, because the nature of venture capital funds' investment cycle can make too-early liquidations of portfolio companies very costly (Kaplan & Sensoy, 2015). This rigidity reflects the long-term nature of venture capital investing and the high costs associated with the inopportune liquidation of private companies. For this reason, limited partners must rely heavily on the governance mechanisms embedded in the partnership agreement and on their ability to choose skilled general partners (Lerner et al., 2007).

2.1.2 Venture capital funds' investee companies

Venture capital funds invest in startup companies. In the academic literature, there is no single, universally accepted definition of a startup company. Montani et al. (2020) note that the term is used in different ways across studies and that there is no unanimous definition in the existing literature. Ressin (2022) similarly concludes that despite the growing attention on startup companies, a generally accepted conceptualization has yet

to be developed, and that definitions have evolved over time. Cockayne (2019) shows that the term “startup” is often a fuzzy one, and sometimes contradictory understandings of startup companies exist.

Birley and Westhead (1994) describe startup companies as small, new, and independent businesses established by individuals to be self-employed. Granlund and Taipaleenmäki (2005) link startup companies more closely to particular sectors and growth patterns, defining them as companies that are either targeting fast growth or already growing rapidly, operating in the information and communications technology and biotech industries, and referring to them as “new economy firms.” Davila and Foster (2005) define a company as a startup if it has a minimum of 50 and a maximum of 150 employees, is less than 10 years old, is an independent organization, and operates in a limited geographic area. Kollmann et al. (2016) identify similar qualities in startup companies, adding that the company has a highly innovative technology or business model and aims for rapid, high-growth.

While defining the characteristics of startup companies, it becomes evident that while there exists no single, universally accepted definition, several key themes consistently emerge across different academic literature. Despite the diversity in definitions, it is clear that startup companies are typically characterized by their small size, novelty, and the aim of achieving rapid growth. These companies often emerge in response to perceived opportunities in dynamic, technology-driven sectors, such as information and communication technology and biotechnology. Startup companies are commonly distinguished by their innovative approaches in new technology, business models, or market engagement strategies. The temporal aspect also plays a critical role, with a consensus that these companies are in the early stages of their lifecycle, often within the first 10 years of operation. Furthermore, the geographical scope and operational scale of startup companies tend to be limited, although aspirations for extensive market reach exist. While the exact parameters may vary, the essence of a startup company revolves

around innovation, growth potential, and the entrepreneurial spirit of its founders, aiming to come up with new niches or disrupt already existing markets.

2.1.3 Staged financing

One important feature of venture capital is staged financing. Instead of committing the full investment upfront, capital is released in a sequence of funding rounds tied to measurable milestones. Kaplan and Strömberg (2004) analyze both within-round and between-round staging in venture capital contracts. They show that a larger part of funding is made contingent on clear milestones when internal risks are higher. They interpret this as *ex ante* staging, which helps good companies signal their type and allows venture capitalists to screen out bad companies. They also find that higher external risk is associated with shorter time between financing rounds. With each round, venture capitalists update their expectations of the company's prospects based on technical progress, early market feedback, or managerial performance. This structure reduces the cost of failure because investors can stop funding if results are weaker than expected. Staged financing is a distinctive feature of the venture capital model, allowing investors to manage uncertainty by releasing capital incrementally against measurable milestones rather than committing the full investment upfront, reducing risk (Bergemann et al., 2013; Kaplan & Strömberg, 2004).

Sahlman (1990) argues that staged financing also improves incentive alignment, since entrepreneurs must show credible progress before receiving additional capital. The sequential funding pattern shows that uncertainty in innovative companies declines gradually, rather than immediately after the investment decision. Kaplan and Strömberg (2004) relate staging and investors' liquidation rights to a real-options type interpretation, suggesting that tighter *ex post* staging under higher external risk increases the value of the investor's option to abandon the project rather than continue funding when performance is unsatisfactory. This flexibility is valuable for investors when future outcomes are highly unpredictable.

2.1.4 Venture capitalists' impact on portfolio companies

Venture capitalists also play a notable role in developing the organizational capabilities of their portfolio companies. Hellmann and Puri (2002) find that companies backed by venture capital tend to professionalize earlier and adopt more formal managerial processes than comparable companies without venture capital investment. Their study shows that venture capitalists contribute not only financing but also expertise, industry networks, and strategic guidance that help young companies scale more effectively. These contributions include improving management teams, strengthening internal processes, and refining business strategies (Hellman and Puri, 2002).

All these actions increase the company's legitimacy to potential customers and future investors. Similarly, Barry (1994) notes that venture capitalists contribute more than capital; they spend substantial time working with their portfolio companies, including helping them to raise additional funds, and use their industry contacts to help to develop portfolio companies. By providing these services, venture capitalists support the transition of early-stage companies toward structured growth, which helps explain why venture capital -backed companies often grow faster and achieve better outcomes than companies without such backing.

2.1.5 The role of exit markets

Another differing feature of venture capital financing compared with other forms of financing is its dependence on functioning exit markets. Venture capitalists ultimately realize returns when portfolio companies go public or are sold, which makes the functioning of IPO and acquisition markets essential to the entire investment cycle. Gompers and Lerner (2001) show that periods of strong IPO activity have historically coincided with expansions in venture fundraising and investment, which reflects how successful exits directly feed the supply of new capital. Their evidence shows that public-market conditions shape both the profitability of exits and investors' willingness to commit new funds. Janeway et al. (2021) further document that, despite the ten-year

fund structure, which should theoretically shield venture capital from short-term market fluctuations, booms and busts in financing still persist as a common feature of the industry, partly driven by the cyclical nature of IPO markets and the correlation between venture capital returns and public market performance. Ljungqvist et al. (2006) further document that favorable equity market sentiment increases the attractiveness of both IPOs and acquisitions, leading companies to pursue exits when valuations are high.

These dynamics also influence how and why venture capitalists support their portfolio companies. As stated earlier, Hellmann and Puri (2002) find that venture capital-backed companies professionalize faster. This suggests that venture capitalists help prepare companies for future financing or sale. Overall, current research indicates that the venture capital model is closely tied to the cycles of public equity markets, with exit opportunities shaping the flow of new investments and the development of portfolio companies (Gompers & Lerner, 2001; Ljungqvist et al., 2006; Hellman & Puri, 2002).

2.1.6 Summary

Together, the academic literature portrays venture capital as a specialized financial intermediary designed to address the informational and incentive problems inherent in financing early-stage companies. The challenges outlined by Berger and Udell (1998) and Jensen and Meckling (1976) illustrate why young companies struggle to obtain traditional financing, while Sahlman (1990) and Barry (1994) explain how venture capitalists use governance and monitoring to overcome these problems. Kaplan and Strömberg (2004) highlight the importance of staged financing as a flexible mechanism for venture capitalists to manage uncertainty, and Hellmann and Puri (2002) demonstrate how venture capitalists contribute to organizational development and long-term growth. Gompers and Lerner (2001), Ljungqvist et al. (2006), and Hellman and Puri (2002) finally situate venture capital within the broader financial system by emphasizing the central role of exit markets for venture capital. These components together form the theoretical basis for understanding venture capital's function as a financial intermediary.

3 Literature review

3.1 Macroeconomic variables

3.1.1 GDP growth

Cross-country studies generally suggest that venture capital activity is procyclical, with investment volumes rising during periods of stronger macroeconomic performance. Romain and van Pottelsberghe (2004) develop a panel model for 16 OECD countries in which venture capital intensity, measured as early-stage investment relative to GDP, is explained by macroeconomic conditions, interest rates, and indicators of technological opportunity. Their estimates show that GDP growth has a positive, statistically significant effect on venture capital investment, consistent with the idea that venture capital financing increases during periods of economic growth, as both the supply of capital and the demand from high-growth firms rise (Romain & van Pottelsberghe, 2004). Félix et al. (2013) report similar evidence from European countries, finding that the GDP growth rate is a significant and positive sign in their regressions for venture capital investment, alongside variables such as interest rates, R&D expenditure, and exit-market activity. Together, these results support the view that venture capital is procyclical, with periods of stronger real economic growth associated with higher venture capital investment. (Romain & van Pottelsberghe, 2004; Félix et al., 2013).

A broader synthesis of the cross-country literature reaches a comparable conclusion. In a meta-analysis of 30 empirical studies on country-level venture capital activity, Dalal (2022) shows that macroeconomic variables and technological opportunities are among the largest positive factors driving venture capital investment volume, while financial-market development and institutional quality also matter. Although the meta-analysis examines various macro indicators, GDP growth appears to be a key driver of venture capital investments, according to the underlying studies (Dalal, 2022). Simultaneously, the evidence on GDP is not completely uniform (Dalal, 2022). Jeng and Wells (2000) include GDP growth in their panel analysis of 21 countries, hypothesizing it to be an

important driver but finding it statistically insignificant, whereas IPO volume emerges as the dominant determinant of venture capital investment in their models.

European evidence also indicates that GDP growth is only one part of a broader macro-financial environment that shapes venture capital investment. While Félix et al. (2013) identify a significant effect of GDP growth, Schertler (2007) finds that measures of national knowledge capital, such as patent applications, R&D personnel, and R&D expenditure, have the strongest and most robust positive impact on venture capital investments in Europe. In her models, stock market returns are also positively related to venture capital investment, whereas several other macro controls, including lending rates and capital gains tax rates, do not systematically explain investment volumes (Schertler, 2007). These findings suggest that, at least within Europe, venture capital does not respond solely to the business cycle but also strongly to the underlying innovation base and to conditions in public equity markets that affect valuation and exit opportunities.

Overall, these studies suggest that while GDP growth is a theoretically intuitive driver of venture capital activity, its empirical relationship with investment may be weaker than expected. This may reflect the difficulty of distinguishing between the multiple supply- and demand-side factors that jointly shape venture capital activity (Da Rin et al., 2013).

3.1.2 Interest rates and term spread

Interest rates are an important part of the macro-financial environment in which venture capital operates, as they influence both the cost of external finance and the valuation of future cash flows. The effects of interest rates on venture capital are diverse, since changes in rates influence both the supply of venture capital funds and the financing behavior of entrepreneurs (Félix et al. 2013). On the supply side, higher interest rates raise the attractiveness of alternative safer investments like bonds, which tends to reduce capital inflows into venture capital funds (Félix et al. 2013; Gompers & Lerner, 2000). On the demand side, there are two effects: higher borrowing costs reduce the

number of viable business projects but simultaneously increase the appeal of venture capital as a financing source (Félix et al. 2013).

When borrowing is difficult or costly, higher interest rates increase the premium borrowers face and amplify the effects of negative economic shocks. Bernanke et al. (1999) show that monetary tightening reduces borrowers' net worth and widens the wedge between the expected return on capital and the safe rate, thereby restricting access to external finance and weakening investment. Their "financial accelerator" mechanism implies that companies with weak balance sheets are especially sensitive to interest rates, since an increase in financing costs disproportionately affects borrowers who lack internal funds or collateral (Bernanke et al., 1999). While their framework is not specific to venture capital, the underlying logic applies directly: early-stage companies typically operate with limited cash reserves and intangible assets, making them vulnerable to increases in financing costs that tighten overall external capital availability.

Empirical research confirms that interest rates shape the volume of venture capital activity across countries. Romain and van Pottelsberghe (2004) analyze data for 16 OECD economies and find that both the short-term and long-term interest rates have a positive and significant effect on venture capital investment, suggesting that general financing conditions influence the willingness of entrepreneurs to seek external capital from venture capital funds, which is in line with Félix et al. (2013). They note that the effect is stronger on the demand side (Romain & van Pottelsberghe, 2004). Their model also incorporates the term spread, defined as the difference between long- and short-term interest rates, as a forward-looking indicator of macroeconomic conditions, reflecting the idea that venture capital decisions depend not only on current monetary conditions but also on expectations about future economic performance, which shape the risk-return profile of long-horizon investments. They explicitly state that what matters is not only the level of short-term or long-term interest rates, but also the difference between them, the spread (Romain & van Pottelsberghe, 2004). The larger the spread, the less

venture capital providers are attracted to risky investments (Romain & van Pottelsberghe, 2004). They report that the term spread has a stronger effect on the supply side and that a larger spread is associated with lower venture capital investment. (Romain & van Pottelsberghe, 2004).

The economic meaning of the term 'spread' has been extensively explored in macro-finance research. Estrella and Hardouvelis (1991) demonstrate that a steeper yield curve predicts stronger future economic activity, whereas an inverted yield curve signals a recession. They show that the predictive power of the yield curve arises because long-term interest rates incorporate expectations about the future path of short-term rates and the cyclical dynamics of economic growth (Estrella & Hardouvelis, 1991). Because venture capitalists invest in companies whose cash flows lie far in the future and whose success depends on the broader economic environment, forward-looking indicators such as the term spread are likely to matter for investment decisions. When the yield curve steepens, signaling expectations of future economic expansion, investors may expect a more favorable environment for companies to scale and for realizing exits, thereby increasing venture capital investment even before macroeconomic conditions actually improve.

Interest-rate conditions also influence venture capital through their impact on valuations and exit markets. Pástor and Veronesi (2005) develop a model of IPO timing in which companies are more likely to go public when expected market returns are low and expected aggregate profitability is high, conditions associated with lower discount rates and higher equity valuations. Their empirical evidence shows that IPO waves tend to follow periods of strong market performance and improved profitability, which raise valuations offered to issuing companies and encourage private companies to go public (Pástor & Veronesi, 2005). Because IPOs represent a key exit channel for venture-backed companies, low discount-rate environments indirectly strengthen venture capital investment incentives by improving the expected returns from future exits. This

mechanism links monetary conditions to venture capital not solely through the cost of funds but also through the valuation of long-horizon growth opportunities.

Collectively, these contributions demonstrate that interest rates and the term structure influence venture capital activity through several different channels. These findings provide a strong rationale for including the term spread as an independent variable in this thesis's empirical models of venture capital investments, as it captures key macro-financial conditions that affect both the supply of capital from investors and companies' investment incentives.

3.1.3 Innovation and R&D

Cross-country research consistently shows that innovation capacity is one of the strongest predictors of venture capital investment. Romain and van Pottelsberghe (2004) find that indicators of technological opportunity, such as the stock of knowledge and the number of triadic patents, are positively and significantly associated with venture capital investment. Their results imply that countries with higher R&D investment generate more high-growth startups, thereby increasing demand for venture capital financing. Schertler (2007) reports similar evidence, showing that measures of national knowledge capital, including patent applications, R&D personnel, and gross domestic expenditures on R&D, have a strong, consistent positive effect on venture capital investment.

A broader synthesis of the literature points to the same conclusion. The meta-analysis of Dalal (2022) reviews 30 empirical studies and identifies technological opportunity as one of the main positive factors affecting venture capital investment, alongside macroeconomic conditions and financial-market development. Although the studies use different measures of innovation, the overall pattern shows that economies with a stronger R&D sector and patenting activity attract more venture capital investment (Dalal, 2022). The evidence suggests that demand for venture capital increases with the intensity of innovation.

Innovation cycles also shape how venture capitalists allocate their funds. Nanda and Rhodes-Kropf (2013) show that during hot markets, venture capitalists are more willing to invest in more experimental and novel startup companies. Companies funded in these hot markets file more patents and receive more citations than companies financed in colder markets. Although this does not directly measure the effect of R&D investment levels, it demonstrates that innovation plays an important role in determining both the volume and the character of venture capital investment (Nanda & Rhodes-Kropf, 2013).

3.2 Financial market variables

3.2.1 Stock market returns

Stock market conditions influence venture capital activity by shaping the valuation environment in which young firms eventually exit, and private equity funds raise capital. Pástor and Veronesi (2005) develop a model of IPO timing in which market conditions have three dimensions: the expected market return, expected aggregate profitability, and prior uncertainty about the profitability of potential IPOs. Companies are more likely to go public when expected market returns are lower and expected profitability is higher, a combination that corresponds to higher equity valuations, and their empirical evidence shows that IPO waves tend to be preceded by “stock market run-ups and improvements in profitability” (Pástor & Veronesi, 2005). Because IPOs are a central exit route for venture-backed firms, their results imply that stock market performance directly shapes the attractiveness of exits and, by extension, the incentives for early-stage investors to commit capital to high-growth firms.

A related effect occurs through fundraising for private equity and venture capital funds. Kaplan and Schoar (2005) examine how market conditions influence the entry of new partnerships and the capital raised by first-time funds. They show that both current and lagged S&P 500 returns have a positive, statistically significant relationship with the number of new partnerships started each year, and that first-time funds raise larger amounts of capital after periods when public- and private-equity markets have

performed well (Kaplan & Schoar, 2005). These results indicate that commitments from institutional investors to private equity and venture capital funds are procyclical with the public-market performance. Consistent with this, as reviewed by Janeway et al. (2021), experienced venture capitalists rationally respond to public market signals by increasing investment in hot sectors, suggesting that stock market performance conveys genuine information about investment opportunities to them rather than merely reflects sentiment.

European evidence further underscores the link between stock market performance and venture capital activity. Using panel data, Schertler (2007) finds that “the stock market returns of fast-growing firms have a positive and significant impact on the volume and the number of investments in the early and expansion stages”. She states that higher returns are associated with greater increases in venture capital investment and notes that the results align with previous research, such as Gompers and Lerner (1999). In her models, these stock market returns are a robust determinant of venture capital activity, alongside measures of national knowledge capital such as patent applications, R&D personnel, and R&D expenditure (Schertler, 2007).

At the same time, the empirical relationship between stock market conditions and venture capital is not uniform across all studies. Jeng and Wells (2000) examine 21 countries and include stock market capitalization growth as a regressor, but they find that it is not statistically significant once IPO activity is included in the model. In their analysis, IPO volume dominates stock market capitalization growth, suggesting that exit-market conditions are the primary financial-market determinant of venture capital investment in their sample (Jeng & Wells, 2000).

3.2.2 Stock market volatility

Stock market volatility is an important indicator of the level of uncertainty that investors face when assessing future cash flows, asset values, and overall market conditions. Lahr and Mina (2014) examine this relationship directly by using the VIX index as a measure

of uncertainty about companies' prospects and stock returns, noting that rising volatility reflects a deterioration in investment opportunities. According to their analysis, higher stock market volatility raises expected and actual stock returns, which reduces stock prices and weakens the financial conditions under which companies operate. This mechanism is relevant for venture capital because investment opportunities in startup companies are closely tied to expectations regarding future market valuations and the cost of capital. When volatility increases, the worsening in investment conditions can discourage investors from allocating funds to riskier, early-stage companies (Lahr & Mina, 2014).

Volatility also plays a role in the literature on equity issuance. Pastor and Veronesi (2005) show that changes in market return volatility are closely linked to the timing of initial public offerings. Their model shows that IPO volume is negatively associated with recent increases in market return volatility, suggesting that companies delay going public in more volatile markets. Since IPOs form an important exit route for venture capital funds, this evidence implies that increased volatility can create a less attractive exit environment. When volatility reduces the likelihood or profitability of exiting through an IPO, venture capitalists face greater uncertainty regarding the realization of their returns. This can translate into weaker incentives to initiate new investments, because, as Jeng and Wells (2000) state, the main risk of venture capitalists is not getting their money back; thus, a viable exit mechanism is extremely important, also consistent with Black and Gilson's (1998) findings about the importance of IPOs' availability as exit channels. Pastor and Veronesi (2005) also show that market return volatility serves as a proxy for changes in the equity premium, reinforcing the notion that volatile periods increase the required compensation for bearing risk. This may therefore suppress activity in markets that rely heavily on risk capital, which is what venture capital at its core is about.

3.3 Venture capital investments between stages

Research on the determinants of venture capital investment has recognized that the drivers of investment may vary across different stages of the venture capital cycle (Jeng

& Wells, 2000; Lahr & Mina, 2014; Dalal, 2022). Several cross-country studies separate between early-stage and later-stage activity and provide evidence that some macroeconomic and institutional variables affect these stages differently. Jeng and Wells (2000) examine the determinants of venture capital and separately analyze early- and later-stage investments. Their results show that labor market rigidities negatively affect early-stage investment but not later-stage investment. They argue that the negative consequences of rigid labor markets, such as limited flexibility in hiring and dismissal, are particularly relevant for early-stage companies, which face the highest probability of bankruptcy (Jeng & Wells, 2000).

Jeng and Wells (2000) also report that the market for initial public offerings, although an important determinant of overall venture capital activity, is not statistically significant in their early-stage regression, even though it becomes significant in their within-regression. They interpret this inconsistency by noting that they may not have identified all the variables affecting early-stage venture capital in the between-regression (Jeng & Wells, 2000). They hypothesize that one possibility is the volume of trade sales, which could influence exit opportunities and thereby weaken the measured relationship between IPO markets and early-stage venture capital investment (Jeng & Wells, 2000). Their research shows that different determinants do not have uniform effects across stages: early-stage investment is more strongly influenced by labor-market frictions, while later-stage investment shows a clearer relationship with public-market exit conditions (Jeng & Wells, 2000).

Lahr and Mina (2014) show that the distribution of venture capital investment stages in Europe reflects both macroeconomic shocks and the characteristics of companies receiving financing. Their summary statistics indicate that seed and early-stage investments typically involve younger companies, smaller deal sizes, and fewer investors than in later-stage investments, whereas expansion and acquisition deals are larger and involve more investors.

Lahr and Mina (2014) also document strong cyclical movements across stages and differences in the time effects of their regressions. During the financial crisis, the likelihood of expansion investments declined, and the likelihood of late-stage investments increased, while during the dotcom period, the effects were opposite. In contrast, closer to their research, they find positive time effects on early-stage investment but negative effects on seed investment, with neither detectable during the dotcom period (Lahr & Mina, 2014). Lahr and Mina (2014) interpret the increase in late-stage activity not as a sign of strong exit expectations but as investors supplying additional capital to help portfolio companies survive while waiting for exit markets to recover. A matching analysis comparing investments before and after the onset of the crisis supports their interpretation: compared to the preceding period, early- and late-stage financing increased in 2008-2009, while seed and expansion investments declined (Lahr & Mina, 2014). Overall, Lahr and Mina's (2014) evidence strongly supports the view that each stage responds differently to macroeconomic conditions.

The heterogeneity in determinants across stages also aligns with theoretical arguments on how venture capitalists finance young firms. Kerr and Nanda (2015) highlight that start-up companies operate under extreme uncertainty and are typically financed in multiple stages, with start-ups returning to capital markets at regular intervals to raise additional capital. They argue that the need for repeated, staged financing exposes early-stage companies to what they call financing risk, meaning the possibility that additional capital may not be available when new financing rounds are needed (Kerr & Nanda, 2015). Kerr and Nanda (2015) note that because early-stage companies rely more heavily on the continuation of external funding, they are more exposed to fluctuations in financial conditions. Kerr and Nanda (2015) emphasize that early-stage companies depend on reaching milestones, as they are often financed in stages, making them more sensitive to shifts in investor sentiment and capital availability. The findings of Kerr and Nanda (2015) add to the differences across venture capital investment stages.

At the same time, meta-analytic evidence suggests that stage-specific effects should be interpreted with caution. Dalal (2022) conducts a meta-analysis of the determinants of venture capital investment, analyzing 30 studies and comparing the estimated effects of these determinants on early- and late-stage investment. The analysis concludes that there is no significant difference in the effects of these determinants across stages, and Dalal (2022) concludes that venture capital is not heterogeneous across stages on average. However, Dalal (2022) also notes that this finding may reflect shortages in venture capital datasets, including under-disclosure of early-stage deals, inconsistencies in stage definitions, and differences in reporting across countries. This note, along with the already discussed results of other empirical research, implies that the apparent similarity of determinants across stages reported by Dalal (2022) likely arises from data limitations rather than from the absence of differences between stages. This observation underscores that stage-specific analysis requires harmonized, comparable data across countries, which the OECD dataset used in this thesis provides.

Overall, the evidence indicates that venture capital determinants differ across stages when examined within individual cross-country studies. Early-stage investment appears more sensitive to financing-related uncertainties, while later-stage investment is more closely associated with exit market conditions. Also, economic downturns seem to affect stages unevenly, with late-stage investment becoming relatively more prominent in crises and seed investment declining. The findings of Dalal (2022) raise caution that inconsistencies in data availability and stage definitions complicate research on these differences. This motivates empirical research that applies consistently defined stage measures across countries, such as the OECD seed, start-up, and later-stage investment series used in this thesis.

4 Empirical framework

4.1 Data

4.1.1 Data collection

The empirical analysis uses an unbalanced panel dataset covering 20 OECD countries over the period 2010–2021. Venture capital investment data is obtained from the OECD Entrepreneurship Financing Database, which reports annual investment volumes by stage, including seed, start-up and other early-stage, and later-stage venture capital. These investment amounts represent the capital provided by venture capital funds to portfolio companies in the reporting country, regardless of the investor's geographic location.

For European countries, the underlying data source is the European Data Cooperative, which aggregates industry-verified data submitted by national private equity and venture capital associations and complements this data with audited information from public sources when needed. The dataset excludes investments by business angels, incubators, infrastructure funds, real estate funds, distressed debt funds, and primary or secondary fund-of-funds, ensuring that the reported figures reflect the activity of venture capital investors only. For the United States, the data originates from the NVCA and PitchBook. Angel, incubator, and similar investments that are part of a venture capital round are included if they involve cash-for-equity and not a buyout or services in kind. The Canadian data is collected by the Canadian Venture Capital and Private Equity Association.

To create comparability across economies of different sizes, all venture capital investment series are divided by nominal GDP to obtain investment intensity measures. For each country and year, the dependent variables include total venture capital investment relative to GDP, as well as the three stage components reported by the OECD: seed investment to GDP, start-up and other early-stage investment to GDP, and later-

stage venture capital investment to GDP. These stage definitions follow a harmonized classification of venture capital activity that is consistently applied across OECD member countries. This is particularly relevant given concerns raised in the literature, such as those by Dalal (2022), about inconsistent stage definitions and under-reporting of early-stage deals. Using OECD harmonized data eases several of these concerns by relying on coordinated and standardized reporting and classification.

The independent variables are also obtained from OECD sources. Annual GDP growth rates are sourced from the OECD Quarterly Real GDP Growth database. Short-term interest rates are measured by three-month money market rates, while long-term interest rates are measured by ten-year government bond yields. Both series are collected from the OECD Financial Market Database, and the term spread is calculated as the difference between the long-term and short-term rates. Research and development intensity is measured using gross domestic expenditure on research and development as a percentage of GDP, collected from the OECD Main Science and Technology Indicators database. Stock market returns are calculated from the OECD share price index series, which is based on data from the OECD Financial Market Database. Annual stock market returns are computed as the change in the share-price index. Stock market volatility is the average of the 360-day volatility of the national stock market index. The data is retrieved from the World Bank's Global Financial Development Database.

4.1.2 Variable definitions

The dependent variables measure annual venture capital investment intensity. For each country and year, total VC/GDP expresses the ratio of total venture capital investment to nominal GDP, while the stage-specific dependent variables capture seed/GDP, start-up and other early-stage/GDP, and later-stage/GDP. This structure follows the OECD's classification of investment stages and enables empirical analysis of heterogeneous patterns across these stages. Reflecting the insights from the literature review, these

variables are intended to capture differences in the determinants that distinguish stages from one another.

The macroeconomic independent variables are GDP growth, the term spread, and R&D expenditure. GDP growth measures the annual percentage change in real GDP. The term spread captures the slope of the yield curve and is calculated as the difference between ten-year and three-month government bond yields. Higher values indicate expectations of stronger economic conditions, consistent with the forward-looking interpretation of the yield curve in macro-finance research, such as Estrella and Hardouvelis (1991). R&D expenditure as a share of GDP represents national innovation capacity and proxies for the technological opportunity available to potential high-growth companies.

The financial-market variables include stock market returns and stock market volatility. Stock market returns measure overall stock market performance, which influences both fundraising conditions for venture capital funds and exit valuations for portfolio companies. Volatility measures uncertainty in stock markets and reflects the variability of expected future returns. As Pástor and Veronesi (2005) note, higher volatility is associated with reduced IPO activity, which is particularly relevant to the analysis of later-stage venture capital investment.

4.1.3 Descriptive statistics

Table 1 reports descriptive statistics for the variables used in the empirical analysis. The table presents the number of observations, the mean, the standard deviation, and the minimum and maximum values for each variable. Because the panel is unbalanced, the number of observations varies across variables depending on data availability.

Table 1 Descriptive Statistics

Variable	N	Mean	Std. Dev.	Min	Max
Venture capital investment (% of GDP)	956	0.035	0.073	0.000	1.126
Market volatility	956	19.099	5.773	7.804	36.069
Term spread	912	1.431	1.404	-0.569	9.974
Stock market return	876	0.055	0.115	-0.235	0.357
R&D expenditure (% of GDP)	928	2.169	0.754	0.723	3.705
GDP growth	956	1.937	3.416	-10.940	24.624

This table reports descriptive statistics for all variables used in the regression analyses. The sample consists of annual country-level observations. N denotes the number of non-missing country-year observations for each variable.

4.2 Methodology

This study examines the relationship between macroeconomic and financial conditions and venture capital investment across OECD countries using panel regression analysis. The empirical strategy is designed to analyze both cross-country differences and within-country time variation in venture capital activity, while remaining closely aligned with the methodologies used in earlier cross-country studies on venture capital determinants. In particular, the methodological approach of the thesis follows Jeng and Wells (2000), one of the most widely cited and influential studies in this research area. The objective of the methodology is to provide a structured empirical assessment of how selected macro-financial variables are associated with venture capital investment across countries and over time.

The analysis is conducted using an annual panel of 20 OECD countries over the period 2010–2021. Venture capital investment is measured as a share of GDP to ensure comparability across countries of different economic sizes. All empirical models are estimated separately for total venture capital investment and for each venture capital stage, including seed, start-up and other early-stage, and later-stage investment. This

stage-specific approach aligns with the existing literature, which emphasizes that venture capital investment stages are characterized by distinct risk profiles, financing needs, and sensitivities to macroeconomic and financial conditions.

The empirical framework employs two complementary panel regression approaches. First, between-regressions are used to examine how average macroeconomic and financial conditions are associated with average levels of venture capital investment across countries. Second, within regressions with country fixed effects are employed to analyze how changes in macroeconomic and financial conditions within a given country over time are related to changes in venture capital investment. Together, these approaches allow the analysis to capture both persistent cross-country differences and time variation within countries.

The use of both between- and within-regressions closely mirrors the approach of Jeng and Wells (2000), who emphasize the importance of separating cross-sectional from within-country variation when analyzing international venture capital data. While this thesis does not attempt to replicate their analysis directly, it adopts a similar methodological approach to ensure comparability with established findings in the literature.

4.2.1 Between regressions

The between regressions are estimated using country-level averages over the sample period. In these specifications, each country contributes a single observation for each venture capital stage, representing its average venture capital investment intensity and average values of the explanatory variables. The between estimator, therefore, captures persistent cross-country differences and relates them to structural differences in macroeconomic and financial conditions.

The between regression equation is the following:

$$\overline{VC}_i^{(s)} = \alpha^{(s)} + \beta_1^{(s)} \overline{GDPG}_i + \beta_2^{(s)} \overline{TS}_i + \beta_3^{(s)} \overline{RD}_i + \beta_4^{(s)} \overline{RET}_i + \beta_5^{(s)} \overline{VOL}_i + v_i^{(s)}$$

Where:

- $\overline{VC}_i^{(s)}$ = Average venture capital investment of stage relative to GDP in country i over the sample period
- s = Venture capital investment stage, including total, seed, early stage, and later-stage investment
- \overline{GDPG}_i = Average annual real GDP growth rate in country i
- \overline{TS}_i = Average term spread in country i , measured as the difference between the ten-year government bond yield and the three-month money market rate
- \overline{RD}_i = Average research and development expenditure as a share of GDP in country i
- \overline{RET}_i = Average annual stock market return in country i
- \overline{VOL}_i = Average stock market volatility in country i , measured as the average of the 360-day volatility of the national stock market index
- $\alpha^{(s)}$ = Stage-specific intercept term
- $v_i^{(s)}$ = Country-specific error term

This approach is particularly useful for analyzing variables that exhibit limited short-term variation but substantial heterogeneity across countries. However, the between-regressions do not control for unobserved country-specific characteristics that may be correlated with both venture capital investment and the explanatory variables. For this reason, the results from the between-estimations are interpreted descriptively and complemented by within-country regressions that explicitly control for time-invariant heterogeneity.

4.2.2 Within regressions

To examine within-country dynamics, the study employs fixed-effects panel regressions that, following Jeng and Wells (2000), include country fixed effects but exclude year fixed effects. Country fixed effects absorb all time-invariant country characteristics, such as institutional frameworks, legal systems, financial market structures, and long-standing cultural factors. As a result, identification in these models relies exclusively on variation within countries over time. Excluding year fixed effects preserves common time variation in the explanatory variables and allows the analysis to capture how global macroeconomic and financial developments are reflected in venture capital investment across countries. Including year fixed effects would absorb much of this variation and could obscure economically meaningful relationships in a relatively short panel.

However, this choice carries a limitation that should be acknowledged. Without year fixed effects, the models cannot separate the effect of country-specific changes in macroeconomic and financial conditions from the influence of global shocks that affect all countries simultaneously. The sample period includes episodes of significant global disruption, most notably the aftermath of the 2008 financial crisis in the early part of the sample and the COVID-19 pandemic in the later part. These events introduced sharp, synchronized movements in macroeconomic and financial conditions across OECD countries. To the extent that these global shocks drive both the explanatory variables and venture capital investment simultaneously, the estimated coefficients may partly reflect common global dynamics rather than country-specific responses to macro-financial conditions. The exclusion of year fixed effects is therefore a deliberate methodological choice that improves comparability with earlier literature but introduces a limitation that should be kept in mind when interpreting the results.

The within regression equation is the following:

$$VC_{it}^{(s)} = \alpha_i^{(s)} + \beta_1^{(s)} GDPG_{it} + \beta_2^{(s)} TS_{it} + \beta_3^{(s)} RD_{it} + \beta_4^{(s)} RET_{it} + \beta_5^{(s)} VOL_{it} + \varepsilon_{it}$$

Where:

- $VC_{it}^{(s)}$ = Venture capital investment stage relative to country i in year t
- s = Venture capital investment stage, including total, seed, early stage, and later-stage investment
- $GDPG_{it}$ = Annual real GDP growth in country i in year t
- TS_{it} = Term spread in country i in year t , measured as the difference between the ten-year government bond yield and the three-month money market rate
- RD_{it} = Research and development expenditure as a share of GDP in country i in year t
- RET_{it} = Annual stock market return in country i in year t
- VOL_{it} = Stock market volatility in country i in year t , measured as the average of the 360-day volatility of the national stock market index
- $\alpha_i^{(s)}$ = Country fixed effects capturing time-invariant country-specific characteristics
- ε_{it} = Error term

4.2.3 Explanatory variables and estimation

All explanatory variables included in the regressions are time-varying. The macroeconomic variables consist of GDP growth, the term spread, and research and development expenditure as a share of GDP. The financial-market variables include stock market returns and stock market volatility. These variables are selected based on prior literature and are intended to capture economic growth prospects, financing conditions, innovation capacity, valuation environments, and market uncertainty.

All models are estimated using ordinary least squares. Standard errors are not clustered, consistent with the baseline approach adopted by Jeng and Wells (2000). The absence of clustering is explicitly acknowledged, and statistical inference is interpreted conservatively. In line with Jeng and Wells (2000), no dynamic panel estimators, instrumental variables, or other causal identification techniques are employed.

A limitation of this approach is that ordinary least squares panel regressions identify associations rather than causal effects. The estimates may be affected by reverse causality, as venture capital activity could itself contribute to macroeconomic and financial conditions, and by omitted variable bias arising from unobserved factors that influence both venture capital investment and the explanatory variables. These endogeneity concerns are discussed further in the limitations section.

4.2.4 Stage-specific analysis

A central feature of the empirical methodology is the explicit separation of venture capital investment by stage. Rather than pooling different stages into a single dependent variable, all regressions are estimated separately for total venture capital investment, seed investment, start-up and other early-stage investment, and later-stage investment. This approach aligns with the existing literature, which suggests that different stages of venture capital investment respond differently to macroeconomic and financial conditions, and complements the earlier work of Jeng and Wells (2000). Estimating separate models by stage allows these differences to be examined explicitly and avoids imposing restrictive assumptions of homogeneous effects across stages. By relying on harmonized OECD data and maintaining a consistent empirical framework across stages, the analysis provides a transparent and comparable assessment of how macroeconomic and financial determinants are associated with venture capital investment at different stages of the venture capital investment cycle.

5 Results and discussion

This chapter presents the empirical results of the analysis on the macroeconomic and financial determinants of venture capital investment across OECD countries. The results are based on the between-country regressions reported in Table 2 and the within-country regressions reported in Table 3. All coefficients are interpreted as associations rather than causal effects, and the discussion focuses on the sign, magnitude, and statistical significance of the estimates, as well as on differences across venture capital stages. The chapter's structure follows the conventional distinction between cross-country and within-country variation, in line with the empirical approach adopted by Jeng and Wells (2000).

5.1 Between-country results

Table 2 reports the results from the between regressions, where each observation corresponds to a country-level average over the sample period. These regressions capture how persistent differences in average macroeconomic and financial conditions across countries are associated with differences in average venture capital investment intensity, measured as venture capital investment relative to GDP.

Table 2 Regression Results: Between-Country Estimates

	Total VC	Seed VC	Early-stage VC	Later-stage VC
Market volatility	-0.0119 (0.0086)	-0.0012 (0.0007)	-0.0054 (0.0031)	-0.0053 (0.0049)
Term spread	0.0292 (0.0311)	0.0019 (0.0025)	0.0123 (0.0113)	0.0151 (0.0176)
Stock market return	0.2371 (0.7889)	0.0388 (0.0632)	0.1073 (0.2867)	0.0910 (0.4478)
R&D expenditure (% of GDP)	0.0465 (0.0372)	0.0018 (0.0030)	0.0176 (0.0135)	0.0272 (0.0211)
GDP growth	0.0053 (0.0178)	0.0001 (0.0014)	0.0020 (0.0065)	0.0031 (0.0101)
Constant	0.1312 (0.1999)	0.0190 (0.0160)	0.0694 (0.0727)	0.0428 (0.1135)
Observations	20	20	20	20
R-squared	0.248	0.257	0.307	0.208

Standard errors are reported in parentheses. The dependent variable is venture capital investment relative to GDP. All regressions are estimated using country-level averages, corresponding to between-country estimations. Early-stage refers to start-up and other early-stage venture capital investments as defined by OECD.

Overall, the between-country results show relatively weak statistical relationships between the explanatory variables and venture capital investment. For total venture capital investment, none of the macroeconomic or financial variables are statistically significant at conventional levels. Market volatility enters with a negative coefficient, while the term spread, stock market returns, R&D expenditure, and GDP growth all display positive coefficients. However, the lack of statistical significance suggests that, within this sample of 20 OECD countries, cross-country differences in average venture

capital investment intensity are not strongly associated with differences in these average macro-financial indicators.

A similar pattern emerges when examining the stage-specific regressions. For seed-stage venture capital investment, all estimated coefficients are statistically insignificant. The coefficients on GDP growth, the term spread, stock market returns, and R&D expenditure are positive, while the coefficient on market volatility is negative; none of these estimates is statistically significant at conventional levels. The magnitudes of the coefficients are also small, which is consistent with the relatively low share of seed-stage investment in GDP and the limited cross-country variation in average seed investment intensity.

For early-stage venture capital investment, the between-estimates again show no statistically significant associations. The coefficients on GDP growth, the term spread, stock market returns, and R&D expenditure are positive, while the coefficient on market volatility is negative, but none of these estimates are statistically significant at conventional levels. The standard errors are large relative to the point estimates, indicating substantial uncertainty around the coefficients. Overall, these results suggest that persistent cross-country differences in early-stage venture capital activity are not well explained by average differences in macroeconomic conditions, financial market performance, or innovation intensity within the sample period.

The results for later-stage venture capital investment are consistent with this general pattern. None of the estimated coefficients is statistically significant at conventional levels. The coefficients on GDP growth, the term spread, stock market returns, and R&D expenditure are positive, while market volatility is negative; similarly, across other stages, none of these estimates are statistically significant. The standard errors are relatively large compared to the point estimates, reflecting the small number of countries and the limited degrees of freedom inherent in the between specification.

Across all stages, the R-squared values range from approximately 0.21 to 0.31, indicating that the models explain a modest share of the cross-country variation in average venture capital investment intensity. In sum, the between-country results suggest that, within this sample and time period, structural differences in average macroeconomic and financial conditions are not strongly associated with differences in venture capital investment across countries. This finding is consistent with the view that cross-country venture capital patterns may be driven by additional institutional or structural factors not captured in the present specification, as well as by the limited statistical power of the between estimator in small samples. These results should therefore be interpreted with caution.

5.2 Within-country results

Table 3 reports the results from within-country regressions that exploit variation over time within countries while controlling for time-invariant country characteristics. In contrast to the between-country results, the within estimates reveal several statistically significant relationships between macro-financial variables and venture capital investment, observed across all venture capital investment stages.

Table 3. Regression Results: Within-Country Estimates

	Total VC	Seed VC	Early-stage VC	Later-stage VC
Market volatility	0.0038*** (0.0011)	0.0002** (0.0001)	0.0011*** (0.0004)	0.0025*** (0.0006)
Term spread	-0.0085* (0.0042)	-0.0009** (0.0004)	-0.0041** (0.0016)	-0.0035 (0.0025)
Stock market return	0.1104* (0.0478)	0.0056 (0.0040)	0.0320* (0.0182)	0.0727** (0.0286)
R&D expenditure (% of GDP)	0.1092*** (0.0223)	0.0082*** (0.0019)	0.0419*** (0.0085)	0.0590*** (0.0133)
GDP growth	0.0023 (0.0017)	0.0001 (0.0001)	0.0007 (0.0006)	0.0016 (0.0010)
Constant	-0.3766*** (0.0726)	-0.0265*** (0.0061)	-0.1401*** (0.0277)	-0.2100*** (0.0435)
Country fixed effects	Yes	Yes	Yes	Yes
Observations	203	203	203	203
R-squared	0.758	0.772	0.757	0.723

Standard errors are reported in parentheses. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively. All regressions are estimated using within-country variation and include country fixed effects. The dependent variable is venture capital investment relative to GDP. Early-stage refers to start-up and other early-stage venture capital investments as defined by OECD.

For total venture capital investment, several within-country relationships emerge. Market volatility shows a positive, statistically significant association with venture capital investment relative to GDP, suggesting that periods of heightened stock market uncertainty are associated with increased investment activity. In contrast, the term spread is negatively and significantly related to venture capital investment, suggesting

that a steeper yield curve is associated with lower investment intensity over time within countries. Stock market returns exhibit a positive, statistically significant relationship, suggesting that stronger equity market performance is associated with higher venture capital investment. Similarly, R&D expenditure as a share of GDP is positively and significantly associated with investment. By contrast, altering the hypothesis and previous literature, GDP growth does not show a statistically significant relationship.

The seed-stage results show a more muted pattern compared to total investment. Market volatility is positively and statistically significantly associated with seed-stage investment, although the magnitude of the coefficient is clearly smaller than in the total venture capital specification. The term spread enters with a negative and statistically significant coefficient, indicating that a steeper yield curve is associated with lower seed-stage investment within countries over time. In contrast, stock market returns are not statistically significant in the seed-stage regression, suggesting a weaker relationship between stock market performance and seed-stage investment. R&D expenditure remains positively and statistically significantly related to seed-stage investment, while GDP growth is again not statistically significant.

For early-stage venture capital investment, several variables exhibit statistically significant relationships. Market volatility is positively and significantly associated with early-stage investment, indicating that periods of higher uncertainty coincide with increased investment activity. The term spread enters with a negative, statistically significant coefficient, consistent with the patterns observed in the total- and seed-stage regressions. Stock market returns are positively and significantly related to early-stage investment, with a larger coefficient than in the seed-stage specification. R&D expenditure continues to show a strong positive association, whereas GDP growth remains statistically insignificant.

The later-stage venture capital results broadly follow the pattern observed for early-stage investment, although some differences in magnitude are evident. Market volatility

is positively and statistically significantly associated with later-stage investment, although with a smaller coefficient than in the early-stage specification. The term spread is negative but not statistically significant, suggesting a weaker relationship with later-stage investment within countries over time. Stock market returns are positively and statistically significantly related to later-stage investment, with the largest coefficient out of all stages in within-regressions. R&D expenditure remains positively and significantly associated with investment, while GDP growth again fails to reach statistical significance.

Across all within regressions, the R-squared values are relatively high, ranging from approximately 0.72 to 0.77, reflecting the models' explanatory power after including country fixed effects. The contrast between within- and between-country results highlights the importance of within-country time variation in explaining venture capital investment dynamics. While persistent cross-country differences are weakly related to the included variables, changes in macroeconomic and financial market conditions within countries are more closely associated with changes in venture capital investment over time.

5.3 Comparison across stages

Comparing the results across venture capital stages reveals several notable patterns. First, the within-country results indicate that the sensitivity of venture capital investment to macro-financial conditions varies across stages, rather than showing a uniform pattern across the investment cycle. The term spread exhibits a clear negative association with seed and early-stage investment, while its relationship with later-stage investment is statistically insignificant. This pattern suggests that forward-looking financing conditions are more closely associated with investment decisions at earlier stages, where, as Kerr and Nanda (2015) state, financing risk and reliance on future funding rounds are more pronounced.

Stock market returns show a stage-dependent pattern as well. While stock market returns are not statistically significant for seed-stage investments, they are positively and

significantly associated with early- and later-stage investments. The magnitude of the coefficient increases across stages, indicating a stronger association between stock market performance and venture capital investment at later stages. This pattern is consistent with the greater dependence of later-stage investment on exit conditions and valuation environments, as later-stage companies are closer to potential exits through public markets or acquisitions.

Market volatility shows a positive association across all stages in the within regressions, contrary to the initial hypothesis. The magnitude of the coefficient is larger for early and later-stage investments. These results suggest that periods of higher market volatility coincide with higher venture capital investment within countries, particularly at later stages. While this association may reflect complex dynamics among uncertainty, valuation adjustments, and investment timing, the positive sign is consistent across stages within the specification.

R&D expenditure as a share of GDP is positively and statistically significantly associated with venture capital investment at all stages in the within regressions. The coefficient is largest for total venture capital investment, and among the stage-specific regressions, it is largest for later-stage investment, followed by early-stage and seed-stage investment. This pattern indicates that increases in national innovation intensity are closely associated with increases in venture capital investment across the entire venture capital investment cycle, with the strongest stage-specific association appearing in later-stage investment.

GDP growth, in contrast, does not exhibit statistically significant associations in the within regressions for any stage. This suggests that within-country variation in economic growth is not systematically related to changes in venture capital investment over the sample period. This finding contrasts with the hypothesis and with parts of the prior literature, such as Romain & van Pottelsberghe (2004) and Félix et al. (2013), who emphasize the procyclical nature of venture capital activity. The results indicate that

other factors, such as financial market conditions and innovation intensity, play a more prominent role in explaining time variation in investment within countries in this sample.

When compared with the between-country results, these stage-specific patterns emphasize that heterogeneity across stages is more evident in within-country dynamics than in cross-country averages. The absence of significant between-country effects across stages suggests that long-run structural differences in macroeconomic and financial conditions do not translate directly into systematic differences in venture capital investment by stage within this sample.

5.4 Summary of main findings and hypotheses

First, the hypothesis that stronger economic growth is associated with higher venture capital investment (H1) is not supported by the empirical analysis. GDP growth is statistically insignificant in both the between-country and within-country regressions across all venture capital stages. This finding suggests that short-term fluctuations in economic growth within countries, as well as persistent differences in average growth rates across countries, are not systematically associated with venture capital investment intensity once other macro-financial factors are accounted for. Similar to Jeng and Wells (2000), although hypothesizing GDP growth to be a meaningful determinant, the results find it to be statistically insignificant at all stages of the study's sample.

A possible explanation is that GDP growth may capture broad macroeconomic conditions that are already reflected in more direct financial and innovation-related variables, such as stock market performance and R&D expenditure. As a result, its independent effect may be weakened once these factors are included.

Second, the hypothesis that higher R&D intensity is associated with higher venture capital investment (H2) receives strong support in the within-country regressions. Increases in R&D expenditure as a share of GDP are positively and statistically significantly associated with venture capital investment across all stages, including seed,

early-stage, and later-stage investment. In contrast, the between-country regressions do not reveal statistically significant associations between average R&D intensity and venture capital investment. This pattern indicates that changes in innovation activity within countries over time are closely linked to changes in venture capital investment, while long-run cross-country differences in innovation intensity are less informative in explaining average investment levels.

Third, the hypothesis that a larger term spread is associated with lower venture capital investment (H3) receives partial support. In the within-country regressions, the term spread is negatively and statistically significantly associated with total, seed-stage, and early-stage venture capital investment, while its association with later-stage investment is statistically insignificant. These results suggest that within-country changes in forward-looking financing conditions are particularly relevant for earlier stages of venture capital investment, where financing risk is heightened.

Fourth, the hypothesis concerning financial market conditions (H4) receives only partial support. Stock market returns are positively and statistically significantly associated with early-stage and later-stage venture capital investment in the within-country regressions, while the association is weaker and statistically insignificant for seed-stage investment. This pattern indicates that periods of stronger stock market performance are more closely associated with venture capital investment at later stages, where exit conditions and valuation environments play a larger role.

In contrast, stock market volatility does not display the hypothesized negative relationship with venture capital investment. Instead, volatility is positively and statistically significantly associated with venture capital investment across all stages in the within-country regressions, while remaining insignificant in the between-country specifications. As such, the results do not support the expectation that higher market uncertainty is associated with lower venture capital investment.

The positive association between market volatility and venture capital investment warrants closer examination, as it contradicts both the initial hypothesis and findings from prior literature. Lahr and Mina (2014) and Pástor and Veronesi (2005) both document a negative relationship between uncertainty and venture capital investment activity, arguing that higher volatility weakens exit conditions and reduces incentives to initiate new investments.

Several mechanisms may explain why the results diverge from this expectation. First, venture capital funds often operate under pre-committed capital structures with fixed investment horizons, meaning that general partners are contractually obligated to deploy capital within the fund's investment period regardless of short-term market conditions. This institutional feature may insulate venture capital investment from the kind of uncertainty-driven pullback observed in more liquid asset classes. Second, the volatility measure used in this study captures realized historical fluctuations in national stock market indices over a 360-day window, rather than forward-looking uncertainty measures such as the VIX index employed by Lahr and Mina (2014). Realized volatility reflects past market movements and may not capture investor expectations about future conditions in the same way, which could contribute to the differing result. Third, the sample period includes 2020–2021, during which many OECD countries simultaneously experienced elevated market volatility and a surge in venture capital investment, partly driven by low interest rates and abundant liquidity. This coincidence of high volatility and high investment during the COVID-19 period may strengthen the positive association within the sample.

Taken together, these considerations suggest that the relationship between market volatility and venture capital investment is more nuanced than a simple negative association and may depend on the institutional structure of venture capital funds, the volatility measure employed, and the broader macroeconomic context of the sample period.

Finally, the hypothesis that the effects of macroeconomic and financial determinants differ across venture capital stages (H5) is supported by the empirical findings. Both the magnitude and statistical significance of several coefficients vary across seed, early-stage, and later-stage investments. In particular, seed- and early-stage investments appear more sensitive to the term spread, while later-stage investments show a clearer association with stock market returns. R&D expenditure is the strongest determinant and remains positively associated across all stages, although the magnitude of the coefficients differs. Contrary to the initial hypothesis, the pattern is similar in market volatility. GDP growth shows no significance at any stage. Overall, these results indicate that venture capital investment stages respond differently to changes in macroeconomic and financial conditions, especially when examined through within-country variation over time.

Across all hypotheses, the results highlight that venture capital investments across OECD countries are more closely associated with within-country changes rather than persistent cross-country differences, especially in financial market conditions and innovation activity. The sensitivity of venture capital investments to these factors varies across stages, underscoring the importance of stage-specific analysis when examining their determinants.

6 Conclusions

This thesis examined how macroeconomic and financial conditions are associated with venture capital investment across OECD countries, with particular emphasis on differences between seed, early-stage, and later-stage investment. Using an annual panel of twenty OECD countries and harmonized stage-specific data from the OECD, the study applied between-country and within-country regressions to analyze how changes in economic growth, innovation activity, interest-rate conditions, and financial market dynamics relate to venture capital investment intensity. The empirical approach closely followed the framework of earlier cross-country studies, most notably Jeng and Wells (2000), and the results were interpreted as associations rather than causal effects.

The results show that venture capital investment across OECD countries is more closely linked to within-country changes in macroeconomic and financial conditions than to persistent cross-country differences. The between-country regressions do not reveal statistically significant relationships, suggesting that average differences in GDP growth, term spread, financial market conditions, or innovation intensity across countries do not systematically explain differences in venture capital investment levels within the sample. In contrast, the within-country regressions identify several robust associations, indicating that changes in financial market conditions and innovation activity within countries are associated with changes in venture capital investment over time, with differences across venture capital investment stages.

Innovation activity emerges as the most consistent determinant of venture capital investment. Increases in research and development expenditure as a share of GDP are positively associated with venture capital investment across all stages: seed, early-stage, and later-stage. This finding highlights the importance of national innovation capacity in supporting venture capital investments and suggests that venture capital investment responds to changes in the underlying innovation environment, the effect being consistent across all stages.

Financial market conditions also play an important role. Stock market returns are positively associated with venture capital investment, particularly at later stages, where exit conditions and valuation environments are more relevant. The term spread is negatively associated with venture capital investment at earlier stages, suggesting that forward-looking financing conditions are especially important for seed and early-stage investments, where financing risk and dependence on future funding rounds are greatest. Stock market volatility shows a positive association with venture capital investment within countries, a result that contradicts the initial hypothesis but remains consistent across stages in the within-country analysis.

In contrast, GDP growth does not exhibit a statistically significant relationship with venture capital investment in either the between-country or within-country regressions. This finding suggests that venture capital investment is not directly driven by short-term changes in economic growth, consistent with Jeng and Wells (2000). Instead, venture capital investment appears to respond more strongly to factors that shape financing conditions, risk perceptions, and the availability of high-growth investment opportunities.

The stage-specific analysis provides further insights. The magnitude and significance of several determinants vary across venture capital stages, supporting the view that seed, early-stage, and later-stage investments are affected differently by macroeconomic and financial determinants. Earlier stages show stronger sensitivity to changes in the term spread, while later-stage investment exhibits a clearer association with stock market returns. Research and development expenditure is positively associated with venture capital investment at all stages, although the strength of the relationship differs. Results are the same with stock market volatility in the study's sample. These findings underline the importance of distinguishing between venture capital investment stages when analyzing investment determinants and add to the evidence of earlier studies.

Overall, the results contribute to the existing literature by highlighting the importance of within-country dynamics and stage-specific patterns in venture capital investment. The findings align with earlier work emphasizing the roles of financial markets and innovation activity in shaping venture capital investment, while also adding evidence similar to that of Jeng and Wells (2000), suggesting that traditional macroeconomic indicators, such as GDP growth, may play a more limited role once these factors are considered. By using harmonized OECD stage-specific data, the study addresses some data limitations highlighted in prior research, such as Dalal (2022), and provides a clearer picture of how venture capital investment responds to changes in the macroeconomic and financial environment.

6.1 Practical implications

The study's results highlight the central role of R&D expenditure in supporting venture capital activity. The strong and consistent positive association between R&D intensity and venture capital investment across all stages suggests that public investment in innovation infrastructure, such as funding for universities, research institutions, and R&D tax incentives, may create conditions that attract venture capital into an economy. This finding implies that policies aimed at stimulating venture capital activity are likely to be more effective when they target the underlying innovation environment rather than focusing solely on direct financial market interventions.

The stage-specific results indicate that seed, early-stage, and later-stage venture capital do not respond identically to macroeconomic and financial conditions, which carries relevant implications for both policy design and investment decision-making. For policymakers, this heterogeneity suggests that uniform policy measures aimed at stimulating venture capital activity across the board may be insufficient. Policies that support later-stage investment, such as measures that improve stock market conditions or facilitate exit opportunities, may not equally benefit seed and early-stage financing, where companies are furthest from exit and more dependent on the continued availability of external capital. Conversely, the strong association between R&D

expenditure and venture capital investment across stages suggests that innovation-oriented policy environments may be relevant throughout the entire venture capital cycle. The findings of the study reinforce the importance of treating venture capital as a heterogeneous asset class rather than a uniform category and suggest that both policy and investment frameworks should be sensitive to the distinct characteristics and financing dynamics of each stage of the venture capital cycle.

6.2 Limitations

Despite these contributions, the study has limitations that should be acknowledged. First, the regression models do not constitute a causal identification strategy. The analysis is based on ordinary least squares panel regressions, which are suitable for examining associations between macroeconomic and financial conditions and venture capital investment, but do not establish causality. In particular, the estimates may be affected by endogeneity concerns such as reverse causality and omitted variable bias. Reverse causality may arise if venture capital activity itself contributes to macroeconomic conditions, innovation, or financial market development, rather than only responding to them. Omitted variable bias may arise if unobserved country-specific or time-varying factors influence both venture capital investment and the explanatory variables included in the models. Therefore, the estimated coefficients should be interpreted as associations rather than causal effects.

Second, the sample comprises a relatively small number of OECD countries and a limited time period, which limits statistical power, particularly in the between-country regressions.

Third, the within-country models include country fixed effects but exclude year fixed effects, following Jeng and Wells (2000). As discussed in the methodology section, this means that common global shocks, including the aftermath of the financial crisis and the COVID-19 pandemic, are not separately identified and may influence the estimated coefficients.

Finally, although the OECD data provide harmonized stage definitions, measurement challenges remain, especially for earlier stages, where, according to Dalal (2022), underreporting may persist.

6.3 Future research

These limitations point to several avenues for future research. Further studies could extend the analysis by incorporating institutional and regulatory variables that may help explain persistent cross-country differences in venture capital investment. Alternative empirical strategies could be used to more explicitly explore causal mechanisms. Expanding the dataset to include more recent years or non-OECD countries would also provide additional insights into how venture capital investment responds to changing global conditions. Finally, future research could combine stage-specific investment data with direct measures of exit activity to further clarify the role of financial markets in shaping venture capital investment dynamics.

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