



Vaasan yliopisto
UNIVERSITY OF VAASA

Patrik Kuosmanen

Macroeconomic impact on venture markets

Does the correlation exist?

School of Accounting and Finance
Master's Thesis in Finance
Master's Degree Programme in Finance

Vaasa 2022

UNIVERSITY OF VAASA**School of Accounting and Finance**

Author:	Patrik Kuosmanen		
Title of the Thesis:	Macroeconomic impact on venture markets: Does the correlation exist?		
Degree:	Master of Science in Economics and Business Administration		
Programme:	Master's Degree Programme in Finance		
Supervisor:	Anupam Dutta		
Year:	2022	Pages:	75

ABSTRACT:

Venture capital industry has been historically extensively researched due to its expanding size and the growing overall interest in it. However, macroeconomic perspective by its impact to the ventures growth potential and performance has been less at the center of previous studies. This study has concentrated on the macroeconomic environment and analyzed the potential consequences of its variations to the venture capital markets performance. The focus in the study has been on the United States venture capital markets due to its globally largest size, thereby providing strongest basis for finding significant outcomes within the research area. Furthermore, major risks affecting ventures are identified and key means for their management in the industry are presented.

This study has identified multiple remarkable factors for risk mitigation at the portfolio level within the venture capital markets. The empirical section of the research process is conducted by gathering data from approximately 26 years of specific macroeconomic variables and United States venture capital variables. The empirical research is executed by utilizing regression analysis. The venture capital variables in the regression analysis consist of total amount invested, number of deals and average deal size within the United States venture capital markets. The macroeconomic variables chosen for the regression analysis consist of United States 10-year treasury bonds yield, Russell 2000 index, initial public offerings, unemployment rate and industrial production index.

Overall, the principal era of interest and focus within the study includes the most recent covid crisis and previous economic crisis. The empirical findings of the accomplished analysis states that the United States venture capital markets are significantly correlated with the surrounding macroeconomy in certain aspects. Transitions within macroeconomy significantly affects the risk levels of ventures and therefore leads to risk mitigation or alternatively risk augmentation depending on investors risk preferences and defined risk-to-reward ratio. This provides essential insight to the venture capitalists decision making process regarding execution of ventures during perceived economic environment and eases evaluation of potential investments future growth prospects.

KEYWORDS: venture capital, macroeconomy, risk management, crises, regression analysis

VAASAN YLIOPISTO**Laskentatoimen ja rahoituksen yksikkö**

Tekijä:	Patrik Kuosmanen		
Tutkielman nimi:	Macroeconomic impact on venture markets: Does the correlation exist?		
Tutkinto:	Kauppatieteiden maisteri		
Oppiaine:	Rahoituksen maisteriohjelma		
Työn ohjaaja:	Anupam Dutta		
Valmistumisvuosi:	2022	Sivumäärä:	75

TIIVISTELMÄ:

Riskipääomasijoittamisen toimialaa on historiallisesti laajasti tutkittu sen laajenevan koon ja kasvavan yleisen kiinnostuksen vuoksi. Makrotaloudellinen näkökulma sen vaikutuksesta riskisijoitusten kasvupotentiaaliin ja suorituskykyyn on kuitenkin ollut vähemmän aiempien tutkimusten keskiössä. Tässä tutkimuksessa on keskitytty makrotaloudelliseen ympäristöön ja sen muutosten mahdollisiin vaikutuksiin riskipääomamarkkinoiden suoriutumisessa. Tutkimuksessa on keskitytty Yhdysvaltojen riskipääomamarkkinoihin sen maailmanlaajuisesti suurimman koon vuoksi, mikä tarjoaa vahvimman perustan merkittävien tulosten löytämiselle tutkimusalueella. Lisäksi tunnustetaan suurimmat riskisijoituksiin vaikuttavat riskit ja osoitetaan keskeisimmät keinot niiden hallintaan toimialalla.

Tässä tutkimuksessa on havaittu useita merkittäviä riskien lieventämiseen vaikuttavia tekijöitä riskipääomamarkkinoiden salkkutasolla. Tutkimusprosessin empiirinen osuus on toteutettu keräämällä tietoja noin 26 vuoden ajalta tietyistä makrotaloudellisista muuttujista ja yhdysvaltalaisista riskipääomamuuttujista. Empiirinen tutkimus on toteutettu regressioanalyysiä hyödyntämällä. Regressioanalyysin riskipääomamuuttujat koostuvat sijoitetusta kokonaismäärästä, sopimusten määrästä ja keskimääräisestä kaupan koosta Yhdysvaltojen riskipääomamarkkinoilla. Regressioanalyysiin valitut makrotaloudelliset muuttujat koostuvat Yhdysvaltain 10 vuoden valtion joukkolainojen tuotosta, Russell 2000 indeksistä, listautumisanneista, työttömyysasteesta ja teollisuustuotantoindeksistä.

Kaiken kaikkiaan tutkimuksen tärkein kiinnostuksen ja keskittymisen aikakausi sisältää viimeisimmän koronakriisin ja aiemmat talouskriisit. Saavutetun analyysin empiiriset havainnot osoittavat, että Yhdysvaltojen riskipääomamarkkinat korreloivat merkittävästi ympäröivän makrotalouden kanssa tietyiltä osin. Makrotalouden siirtymät vaikuttavat merkittävästi riskisijoitusten riskitasoon ja johtavat siten riskien lieventämiseen tai vaihtoehtoisesti riskien kasvatamiseen sijoittajien riskimieltymysten ja määritellyn riski-tuottosuhteen mukaan. Tämä antaa olennaisen kuvan pääomasijoittajien päätöksentekoprosessista koskien riskisijoitusten toteuttamista koetun taloudellisen ympäristön aikana, ja helpottaa potentiaalisten sijoitusten tulevien kasvunäkymien arviointia.

AVAINSANAT: riskipääoma, makrotalous, riskienhallinta, kriisit, regressioanalyysi

Contents

1	Introduction	8
1.1	Purpose of the study	9
1.2	Hypotheses	10
1.3	Structure of the study	11
2	Theoretical background	12
2.1	Risk management	12
2.2	Macroeconomic policy	16
2.2.1	Fiscal policy	17
2.2.2	Monetary policy	18
2.3	IPO, stock, and bond markets	19
3	Literature review	22
3.1	Private equity	22
3.1.1	Venture capital	24
3.1.2	Investment stages in venture capital	27
3.2	The definitions of risk	31
3.2.1	Risks in venture capital	32
3.3	Risk management in venture capital	34
3.4	Risk management's relation to performance	38
3.4.1	Performance in venture capital	40
3.5	Macroeconomic policy in covid crisis	43
3.5.1	Consequences of the policy decisions	44
4	Data and Methodology	45
4.1	Data	45
4.2	Methodology	45
4.2.1	Multi-regression model	46
5	Empirical results	48
5.1	Sample performance	48
5.2	Multi-regression analysis	53

5.2.1 Hypotheses findings	61
5.3 Limitations and suggestions for future research	63
6 Conclusions	65
References	67

Figures

Figure 1. The capital asset pricing model.	15
Figure 2. Expansionary and Contractionary Fiscal Policies to Shift Aggregate Demand.	18
Figure 3. Historical venture capital and buyout annual fundraising levels, 1995-2010.	22
Figure 4. Historical number of companies receiving funding, 1995-2010.	24
Figure 5. Historical commitments to venture capital by stage, 1980-2010.	28
Figure 6. KPMG Enterprise. (2019). Venture Pulse, Q2'19. Global Analysis of Venture Funding.	29
Figure 7. Diversification of risk in VC funds.	36
Figure 8. Value of \$1 invested in 1995 in an average venture capital fund by fund stage, 1996-2010.	41
Figure 9. eFront Insight. (2018). Return evolution of active VC funds. Returns, risks and liquidity of VC Funds in Q1 2018.	42
Figure 10. Total amount invested (\$B) in the sample data.	50
Figure 11. Number of deals in the sample data.	51
Figure 12. Average deal size (\$M) in the sample data.	52

Tables

Table 1. Descriptive statistics.	48
Table 2. Table on macroeconomic variables correlation.	49
Table 3. Multi-regression model with total amount invested (\$B) as dependent variable.	53
Table 4. Multi-regression model with number of deals as dependent variable.	56
Table 5. Multi-regression model with average deal size (\$M) as dependent variable.	59

Abbreviations

FED	federal reserve system
GDP	gross domestic product
GP	general partner
IPI	industrial production index
IPO	initial public offering
LBO	leveraged buyout
LP	limited partner
N	number of observations
PE	private equity
QE	quantitative easing
ROI	return on investment
SD	standard deviation
TBY	treasury bond yield
UR	unemployment rate
US	united states
VIF	variance inflation factors
VC	venture capital
VCC	venture capital company

1 Introduction

The business sector is full of companies looking for funding to expand their operations. The venture capital (VC) industry exists to assist small and entrepreneurial businesses. Many early-stage enterprises are having difficulty securing financing because they lack appropriate security for receiving a bank loan, for example. The lack of assets for suitable collateral such as buildings and merchandise requested by banks creates challenges for early-stage business ideas in terms of obtaining appropriate financing. In most cases, a company's goodwill is not regarded a valid criterion in securing financing. Venture capital companies (VCC) invest primarily in enterprises as financial intermediaries, filling the gap left by a lack of suitable funding for small and entrepreneurial businesses. VCCs are eager to assist potential future success stories in the process of turning a business idea into a viable firm. A successful investment in a potential company idea, on the other hand, necessitates multiple steps of risk management and teamwork between the investor and the investee. (LiPuma & Park, 2014; Okpala, 2012.)

The precise risk variables affecting venture capital will be thoroughly detailed in this thesis, with the macroeconomic risks affecting ventures being the key focus of the research. Risk materialization leads to portfolio losses and, as a result, is an obstacle to lucrative investments. Therefore, it is critical for VC firms to manage risks in their portfolio companies. Risks must be considered by venture capital firms as a factor affecting the overall performance of their investments.

The macroeconomic perspective within the VC industry's research has been very limited. The expanding importance and popularity of venture capital (VC) business has heightened the desire for clarity on the macroeconomic elements that influence VC performance. Investors should be mindful of potential macroeconomic risks to ventures. (Ning et al., 2015.)

1.1 Purpose of the study

The goal of this study is to build on the research I began in my bachelor's thesis by expanding on the components of the study that have statistically significant empirical outcomes, focusing on the venture capital business and its risks. The previous studies within venture capital have limitedly included the macroeconomic aspects combined with risk factors and risk management underlying the performance perspective.

Few studies have examined the impact of macroeconomic factors on venture capital performance in the past. However, until now, these studies have only covered the eras of the dotcom bubble and the financial crisis, with the most recent study covering data up to 2011. In the venture capital industry, the most recent 10-year era, including the covid crisis, has not been empirically studied from a macroeconomic performance perspective.

My bachelor's thesis findings were concentrated on the topic of risk management and its impact on a company's overall success. Multiple significant risk factors and strategies for dealing with the risks of venture capital investments were discovered in the study. The main goal of this research is to identify macroeconomic risks and factors that have influenced venture performance over the last ten years. The purpose is to apply what was learned in the bachelor's thesis regarding risk management approaches for dealing with macroeconomic risks in the venture capital industry.

The macroeconomic focus in this study will be on the potentially significant risks and uncertainties for the venture's performance. Economic crises and downturns have historically constituted important macroeconomic risks to ventures profitability (Ning et al., 2015). As a result, the study's macroeconomic focus will be on the covid crisis and the risks it may have caused to ventures. The empirical study will look at specific macroeconomic elements and how they changed during the crisis, as well as how these aspects influenced the ventures' performance. The goal is to identify a statistically sig-

nificant correlation between changes in specific macroeconomic conditions and the performance of ventures.

1.2 Hypotheses

The first hypothesis focuses on macroeconomic policy actions and their potential impact on venture capital investments. The United States (US) fiscal and monetary policy during the covid crisis was unprecedented in history, and its impact on global equities markets was unforeseeable. The hypothesis assumes that significant changes in equity markets have had an impact on venture capital industry performance as a result of legislative changes. The hypothesis will be empirically tested by looking at parameters such as policy actions and VC market performance to see whether there are any statistically significant correlations. The following is the initial hypothesis:

H1: The performance of the VC markets was significantly influenced by the Federal Reserve's policy actions in response to the covid crisis.

The second hypothesis describes the relationship between the stock and venture capital markets in the United States (US). According to the theory, the performance of particular stock indices is highly correlated with that of the venture capital markets. Small-cap indices, such as the Russell 2000, should be used to compare statistically significant results with the VC markets because venture sizes correspond fundamentally with small-cap enterprises. It's reasonable to suppose that strong stock market performance attracts a surge of new ventures and investors because favorable market conditions increase the probability of profitable ventures. The following is the second hypothesis:

H2: The behavior of the VC market is significantly associated with the stock market.

After the financial crisis, I identified major shifts in the tendencies of venture capitalists' investment behavior in my bachelor's thesis. The stage of the invested venture

and the amount of capital committed were two important variations in investment patterns. The pattern appeared to be following the level of economic uncertainty among investors' minds. Increased uncertainty tempts investors to make less risky later-stage investments that require a larger quantity of capital to invest in ventures. According to the hypothesis, the increased economic uncertainty caused by the covid crisis affected similarly venture capitalists' investment strategies as previous economic uncertainties and downturns. The following is the third hypothesis:

H3: The covid crisis' risk realization had no significant impact on venture capitalists' investment strategies.

1.3 Structure of the study

The remainder of the thesis is organized as follows. The theoretical background on the financial basis of this study is presented in Section II. For risk modeling and optimal portfolio assessments, finance theory contains a number of important methodologies and models. These finance theories, in combination with the theories that underpin the study's chosen hypothesis, will constitute the core of this section. Section III concentrates on the literature review by compiling the most significant previous results in the topic. The data and methodology behind the study's results and outcomes are presented in Section IV. Section V discusses the study's findings and limitations, as well as future research directions. Section VI concludes the whole thesis.

2 Theoretical background

2.1 Risk management

The goal of risk management is to understand the company's existing portfolio risks and the risks it is willing to accept in the future. Financial institutions must decide what kind of risks they are prepared to take and what steps they will take if certain risks are unacceptable. Risk decomposition is one of the most common risk management methodologies employed by financial organizations, with the goal of identifying and managing risks one at a time. The second key method is risk aggregation, which aims to mitigate risks by ensuring that the portfolio is properly diversified. (Hull, 2018.)

Risk management is a dynamic process that consists of a series of events (Wolke, 2017). Identifying, estimating, evaluating, treating, and monitoring any negative effects on performance are all part of successful risk management (Hain, 2011).

Multiple hedging techniques are employed to mitigate the adverse effects contributing to the investment in the field of risk decomposition by means of risk management approaches. Hedge often is created by using range of financial instruments, such as purchasing insurance against a variety of risks. The most frequent hedging approach involves the use of derivatives. Forwards, futures, options, and swaps are examples of derivatives whose value is based on the value of another asset. The basic purpose of derivatives is to protect an asset's value against unfavorable impacts such as foreign currency and interest rate changes. Hedge using derivatives may be done in a variety of ways, such as entering a contract with another party to buy a certain product at a specific fixed price in the future, therefore hedging against price changes in that asset. Hedging strategies might help you avoid cash shortages or financial trouble. (Brealey et al., 2017.)

The bigger the level of risk in the investment, the greater the expected return. The anticipated value of a variable is commonly defined by statisticians as its average value.

The anticipated value, according to statisticians, is the weighted average of all possible investment returns. The chance of a specific return occurring is equal to the weight allocated to that return in the computations of expected returns. (Hull, 2018.)

In portfolio analysis, the trade-off between risk and expected return is an area of interest. The spread of the portfolio return, or the uncertainty of returns, is used to evaluate risk in portfolio analysis using the mean-variance concept. Due to the ability to lower portfolio risk through diversification without affecting anticipated portfolio return, rational investors minimize portfolio variance within the mean-variance framework at a given level of expected return. It's more important to look at the co-movements between the assets in a portfolio than the mere sum of the variances of the assets in a portfolio when evaluating the overall risk of a portfolio based on its variance. (Markowitz, 1952.)

The statistical measure of covariance is used to calculate the co-movements of two random variables. The expected effect of their deviations from their individual expected values is covariance for two random variables X and Y :

$$\text{cov}(X, Y) = E[(X - \mu_x)(Y - \mu_y)] \quad (1)$$

where μ_x is the mean of X , and μ_y is the mean of Y . (Alexander, 2001.)

In the area of risk management, the ability to lower portfolio risks through diversification is crucial. The risk aggregation strategy's principal function is diversification. Choosing low-covariance investments is an important approach to manage risks since portfolio assets' independence from one another improves projected returns in response to the amount of risk in the portfolio.

The capital asset pricing model is a continuation of the portfolio analysis in the area of risk-expected-return trade-offs. The beta of a portfolio is a linear function of its covariance with the market portfolio in the capital asset pricing model. The level of systematic risk in the portfolio is described by beta. The only major risks in the capital asset pricing model are systematic risks that affect the whole stock market and cannot be mitigated via hedging or diversification. (Sharpe, 1964.)

The goal of beta is to determine the sensitivity of an investment's return to the return on a market portfolio. When beta is equal to zero, there is no systematic risk and the anticipated return equals the risk-free rate, but when beta is equal to one, we have the same systematic risk as the market portfolio. Values that exceed the market portfolio's systematic risk indicate that a portfolio's volatility, and hence the number of risks it contains, is greater than the market portfolios. The systematic risk that contributes to the risk premium is defined as:

$$\beta = \frac{\rho\sigma}{\sigma_M} \quad (2)$$

where $\rho\sigma$ is the covariance between the return of the investment and the market portfolio, and σ_M is the standard deviation of the return on the market portfolio. (Hull, 2018.)

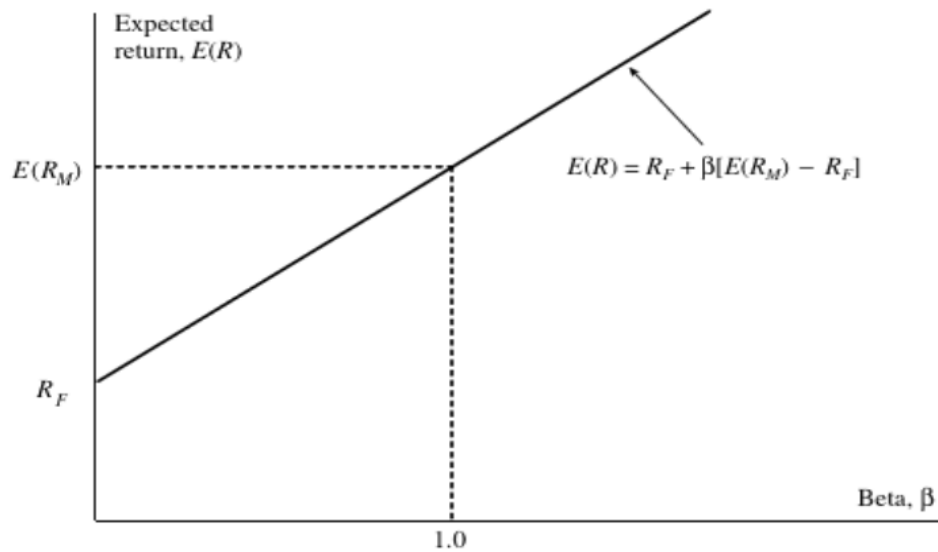


Figure 1. The capital asset pricing model (Hull, 2018).

Within combinations of risky assets, the capital asset pricing model establishes a simple linear relation between the expected return and standard deviation of a return. The capital asset pricing model has two risk components: a systematic risk component that characterizes the portfolio's correlation with the market portfolio, and a nonsystematic risk component that moves independently of the market portfolio. (Beaver et al., 1970; Sharpe, 1964.)

The capital asset pricing model is defined as:

$$E(R_i) = R_f + \beta_i [E(RM) - R_f] \quad (3)$$

where $E(R_i)$ is the expected return of a portfolio i , R_f is the risk-free rate, $E(RM)$ is the expected return of the market portfolio, and β is the beta of the portfolio i . (Hull, 2018.)

If the portfolio is well-diversified, the systematic risk, also known as market risk, is the sole meaningful risk element in the capital asset pricing model from the standpoint of

risk management. Diversification within the portfolio is achieved by the use of a risk aggregation strategy, which involves picking a large number of individual assets with low covariance. Due to diversification, the amount of nonsystematic risk, also known as company-specific risk, in the portfolio is kept to a minimum. The systematic risk is a risk component that cannot be diversified out of the portfolio, making it an important field in risk management that requires special attention from investors managing portfolio risks. Because a higher level of risk necessitates a higher level of expected returns, investors' risk preferences play a role in the trade-off between risks and expected returns. Behavioral finance may be used to the decision-making process. A risk-seeking investor is prepared to take on more risk in exchange for a better return. Risk-averse investors avoid taking risks and, as a result, accept lower returns on their investments.

2.2 Macroeconomic policy

The macroeconomic policy, which is composed of fiscal and monetary policies, is a crucial factor in the behavior of economies and financial markets. The primary goal of monetary policy is to maintain economic stability. The ideal level of economic balance is stable cumulative growth, in which boom and bust cycles are reduced in the economy as a whole. Changes in the amounts and allocations of taxes and government expenditures are among the variables needed to stabilize the economy. The acquired unemployment rate and detected level of inflation are related to the stabilizing policy activities. (Goodfriend, 2007.)

Policy decisions and past policy changes have had a substantial impact on the strength of boom-cycles and have had an efficient early protective effect on the cycles of economic downturns. The fundamental aspects of government engagement into market instabilities are fiscal and monetary policy. However, in the past, implemented policy measures have been shown to be overstated or underestimated as a result of significant activities producing unfavorable side effects on the equity markets. Government central banks make the majority of macroeconomic policy decisions. (Dosi et al., 2010.)

2.2.1 Fiscal policy

Fiscal policy is categorized into two categories: expansionary and contractionary. Expansionary policy is based on increased government interaction with the economy, and vice versa. The goal of expansionary policy is to boost economic activity in order to achieve greater growth rates. The goal of a contractionary policy is to limit economic activity in order to prevent the economy from overheating and producing negative consequences such as inflation. (Kaminsky et al., 2004.)

Fiscal policy theory is classified into several historical differing major theories. "The general theory of employment, interest, and money," by British economist John Maynard Keynes, is included among the most important theories. Keynesian economics describes his approach to fiscal policy. The key concepts of Keynesian economics form the foundation of expansionary fiscal policy. According to Keynesian economics, the government may enhance economic growth by stimulating demand. The major instruments for generating demand are infrastructure investments, unemployment benefits, and education, but it's important to remember that excessive activities lead to inflation, which limits consumption possibilities. Inflation diminishes the total value of money by raising prices. (Keynes, 1935.)

The key element of Keynesian economics is achieving the desired level of economic growth by increasing consumers' consumption possibilities, for example, by providing unemployment benefits, which raises company income, resulting in a positive multiplicative effect on the entire economy and its gross domestic product (GDP). The second politically pursued level of GDP is public expenditure on infrastructure and education, which creates jobs and encourages economic innovation and growth. (Keynes, 1935.)

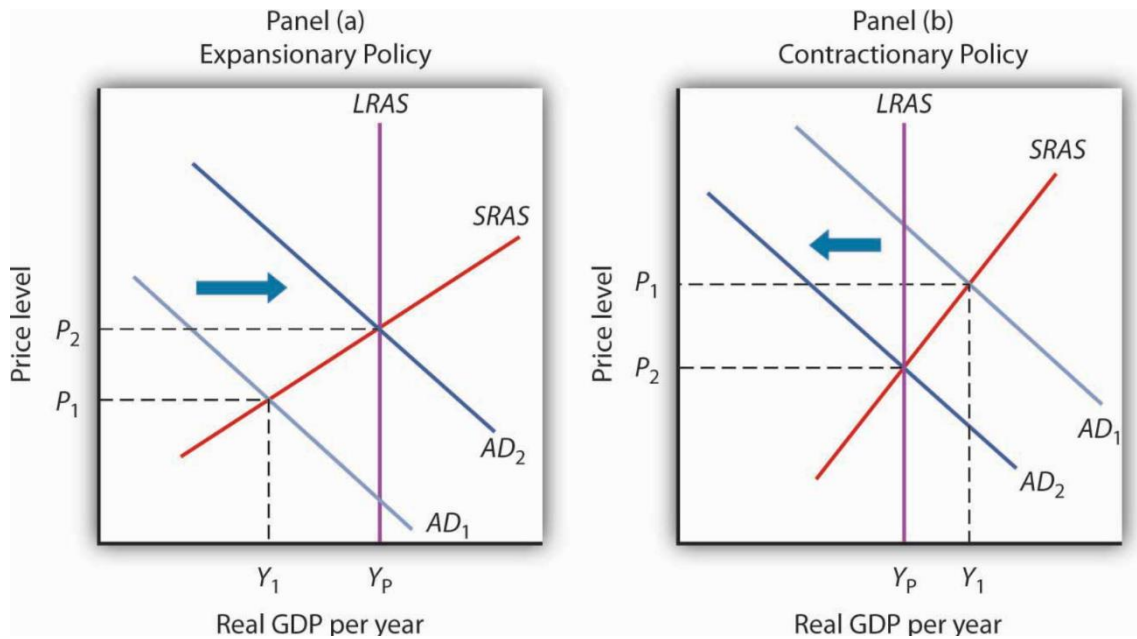


Figure 2. Expansionary and Contractionary Fiscal Policies to Shift Aggregate Demand (Case et al., 2012).

Panels (a) and (b) depict the expansionary and contractionary fiscal policies based on Keynesian economics. The economy is experiencing a recessionary gap ($Y_p > Y_1$) in Panel (a). An expansionary fiscal policy aims to move aggregate demand to AD_2 in order to reduce the gap by using government fiscal policy to boost economic activity. The economy faces an inflationary gap ($Y_1 > Y_p$) in Panel (b). A contractionary fiscal policy aims to lower aggregate demand to AD_2 in order to bridge the gap through lowering economic activity. The picture depicts how the ostensibly ideal pricing level is determined by fiscal policy decisions affecting economic activity as measured by GDP. (Case et al., 2012.)

2.2.2 Monetary policy

The main purpose of monetary policy is to have an impact on economic activity by interacting with the degree of equity in the economy. The major components of the relationship are changes in credit policy and money supply in the economy. Monetary policy is a tool for achieving or sustaining full employment or incremental economic development in the long run. Price stability, salaries, company investment levels, and indi-

vidual consumption capacity are all affected by the money quantity in circulation. As a result, at any specific time, monetary policy has a cumulative influence on the whole economy. (Goodfriend, 2007.)

Central banks make crucial choices on key interest rates as part of monetary policy. The important interest rate choices include deciding the lending rates to local banks, which affects and guides the rates that consumers and businesses pay for bank loans. As a result, important interest rate choices have an impact on credit policy, as well as the amount of credit and money in circulation across the economy. (Kaminsky et al., 2004.)

The quantity theory of money is described as:

$$MV = PQ \tag{4}$$

where M is the money supply, V is the velocity of money in circulation, P is the price level and Q is the quantity of goods and services transactions. (Friedman, 1956.)

Milton Friedman's equation assesses the balance obtained by combining aspects of the overall amount of money in circulation and the cumulative price level with the overall quantity level on used goods and services transactions. According to the idea, the amount of money in circulation in an economy quantifies the economy's price level and consumption level, and therefore money is a tool for achieving the desired level of economic activity and price stability. (Friedman, 1956.)

2.3 IPO, stock, and bond markets

An initial public offering (IPO) is a common way for a company to go public. The ability to raise money and funding for a business's expansion requirements from public investors is a major reason for a firm to go public. The IPO market moves in waves, with a relatively large amount of offers during economic booms and a much-reduced volume

during economic downturns. This is owing to the fact that the current economic condition has a substantial impact on a listing company's development prospects, altering public interest in listing firms and the amount of money and funding they require from an IPO. This is the primary explanation for fluctuations in the amount of IPO offerings during different economic cycles. (He, 2007.)

The prevalent belief that the stock markets are always efficient surrounds the stock markets. All accessible information is always contained and computed inside the stock prices in efficient markets expression. This phenomenon is known as the efficient market hypothesis, and it is part of the current financial theory's foundation. The hypothesis is based on the idea that individual investors make random investment decisions, causing random movement in stock prices, but the market as a whole is always correct, and stock prices only alter their real value when new information becomes available. This implies that fundamental and technical analyses are useless in making investing decisions. (Ying et al., 2019.)

Many people believe that stock markets can be predicted and that future stock values can be measured and calculated. Fundamental analysis, which estimates the current value of a company's future cash flows, is the most frequent method of doing so. This is accomplished by investigating a company's financial statement, balance sheet, dividend policy, and future growth prospects. The combination of these corporate data is used to determine if a firm's current stock price is overpriced or undervalued. According to fundamental analysis, stock prices will always return to the company's real value over time if certain valuation metrics are used. (Eiamkanitchat et al., 2017.)

Technical analysis is the second widely used stock analysis approach, which claims that stock prices move in predictable patterns and trends over time. The analytical approach is used to forecast future price movement using a combination of price and volume. As a result, technical analysis asserts that stock prices are predictable and that the efficient market hypothesis does not apply. (Eiamkanitchat et al., 2017.)

Individuals' behavior and decision-making processes in the financial environment are considered by behavioral finance. Behavioral finance questions the widely held belief that investors act rationally and considers psychological factors. Prospect theory, which is based on behavioral finance, is a well-known phenomenon in economics. Prospect theory is founded on the belief that people make investing decisions based on prior or given information. The theory assumes that potential profits are valued more highly than potential losses. This psychological bias has been observed in the global equity markets in the past, particularly during boom-cycles, when investors overestimate the probability of excess returns owing to favorable market performance while underestimating overall market risks. This psychological phenomenon affects many areas of equity markets, emphasizing the significance of adequately understanding behavioral finance theories. (Kahneman & Tversky, 1979.)

The bond market is the primary source of funding for publicly listed firms and governments to meet their long-term financial needs, which are generally met through debt obligations. Because bond yields are actively computed for various maturity bonds, bond markets represent the current situation of the global debt markets and interest rates. The segmented market hypothesis, which assumes that various maturity bonds have distinct investors, is a significant bond market theory. Individual and corporate bond investors prefer different maturities and have different goals when it comes to bond investments. As a result, specific maturity bond yields cannot be used to anticipate the yields of other bond maturities, and the bond markets as a whole are divergent. (Gürkaynak & Wright, 2012.)

3 Literature review

3.1 Private equity

A medium or long-term equity investment that is not publicly listed on an exchange is referred to as private equity (PE). Equity investments are made by private equity firms and individual investors and are kept for three to seven years. Because there is no exchange on which to trade shares or market makers for the assets, PE investments are typically illiquid. The majority of PE investments are made in firms by using venture capital or buyouts. A leveraged buyout (LBO) is a type of investment that aims to buy a business with a significant degree of debt (Stowell, 2013). Despite the fact that leveraged buyouts have historically been the main financial field in private equity, this thesis concentrates on venture capital. (Cendrowski et al., 2012.)

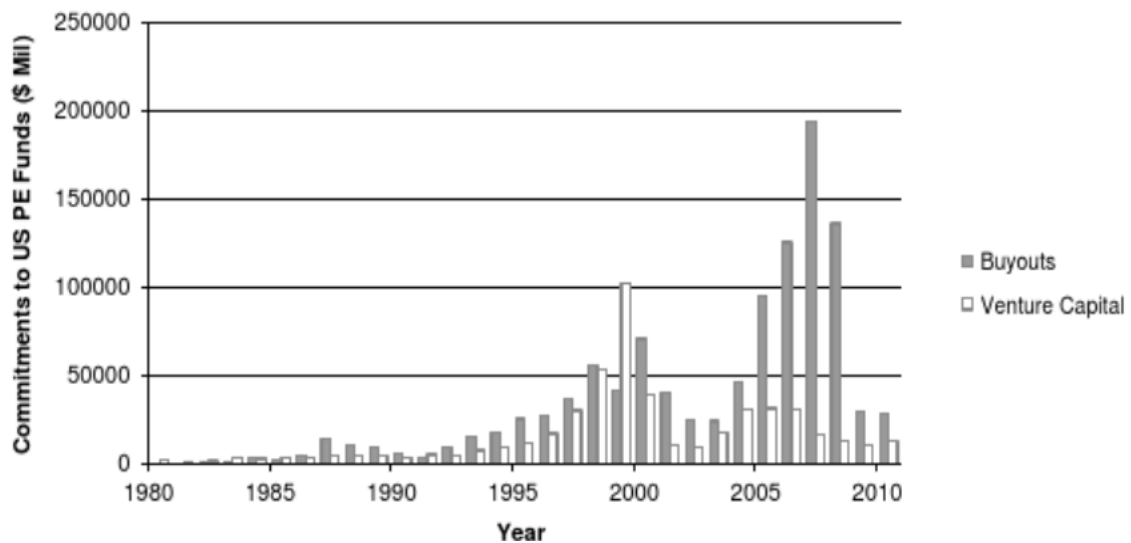


Figure 3. Historical venture capital and buyout annual fundraising levels, 1995-2010 (Cendrowski et al., 2012).

PE investments have risen dramatically at times in recent decades. PE investment activity has had mainly continuous accelerating growth, particularly during periods of rapid economic expansion. Low interest rates have been a key driver of increasing PE activity during periods of economic expansion. Credit market circumstances are a critical component in determining the success of a PE portfolio investment. This is because when

the cost of debt is low compared to the cost of equity, private equity companies want to borrow more money and get more advantageous borrowing terms and conditions. Prior to the financial crisis, private equity investors noticed mispricing in the credit markets, which encouraged them to undertake more deals, and larger deals, than ever before. When there is a sustained period of strong equity returns and a favorable interest rate environment, private equity transactions have historically climbed and will continue to expand in the future. (Stowell, 2013.)

As the economy expands, more prospective enterprises seeking funding emerge. When the chances for success of potential portfolio firms look to be favorable, positive economic development attracts PE investors' attention. The boom cycle is characterized by abundant credit and lax debt covenants, exposing PE investors to larger risks if the economy abruptly shifts. Economic expansion has been followed by recessions, such as the financial crisis, which had significant repercussions on the portfolio businesses of PE firms, and hence on the risks and returns in the PE industry. When credit is scarce and corporate profitability are weak, such as during recessions, boom cycle features will be followed by reduced activity. The bust cycle is defined by portfolio companies' debt defaults and bankruptcies, which have a significant impact on PE funds' performance. (Stowell, 2013.)

As a result, while historically more investments have been made in firms via VC, LBO is still the most financially lucrative area in the PE industry. This is owing to the fact that LBOs have significantly greater financial operations than VCs. An LBO investment normally entails the total purchase of the target firm, whereas a VC investment usually entails a small amount of money.

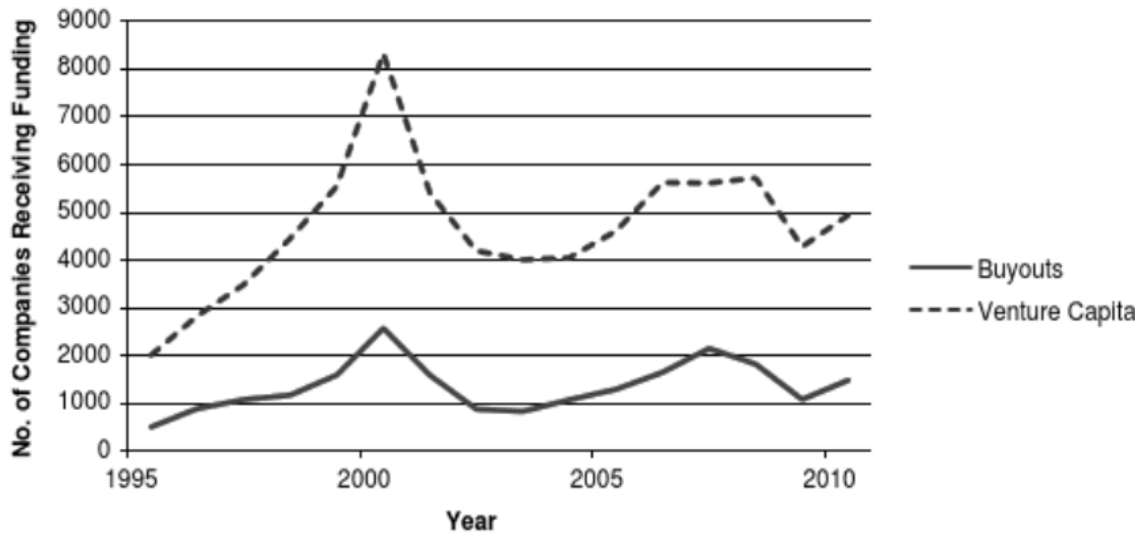


Figure 4. Historical number of companies receiving funding, 1995-2010 (Cendrowski et al., 2012).

PE investments can take the form of fund investments in PE firms' managed funds or direct investments in the fund's portfolio companies. Because they share the costs and obligations of running the business, PE companies managing the funds are typically referred to as general partners. Limited partners have made investments in PE funds that control a portion of the portfolio firms' shares and are thus only participants in the company for the amount of their entire pledged capital contributions. When the firm is sold, the profits (or losses) from the investment are realized. The remaining revenues are distributed to limited partners; however, PE firms will get a percentage of the fund's income, including any fund management fees paid by the limited partners (Stowell, 2013). (Cendrowski et al., 2012.)

3.1.1 Venture capital

The purpose of venture capital investments is to offer early-stage equity funding to private firms that have the potential to develop rapidly. The investors' principal strategy is to finance just the most innovative and financially appealing projects in the hopes of making a profit. Injecting both financial and human capital into fledgling early-stage private companies is a strategy for making them profitable. The ultimate goal of a ven-

ture capital investment is to aid growth, raise sales, and ultimately monetize the investment through a liquidity event. VC investments are made in cash, and the investor obtains a piece of the ownership in the investee company. The engagement of venture capital firms or individual investors in portfolio businesses stems from stock ownership and, as a result, their participation in the costs and obligations of running the business. VC investors are distinguished from other forms of equity investors by their involvement in portfolio businesses operations, such as coaching, counseling, and networking. (Talmor & Vasvari, 2011.)

The development of early-stage investment financing frequently follows a predictable pattern. Entrepreneurs often self-fund the development of a concept, technology, or product in the early stages. After evaluating the underlying commercial concept or company strategy, an entrepreneur collaborates with a "business angel" investor who gives early equity capital, known as seed-funding stages, to attract future investments. Following the development of a workable business plan, early-stage companies will require more funding. Additional funding will be required to help the firm expand and develop further, such as for research and development, operational growth, and consumer attraction. VC addresses this funding gap by giving not just capital but also experience in order for potential early-stage startups to grow. (Talmor & Vasvari, 2011.)

General partners (GPs) invest and manage VC funds, while passive limited partners (LPs) provide cash. Due of the smaller deal sizes, VC funds are less financially secure than buyout funds. Due to VC firms' considerable post-investment participation in portfolio businesses, there are also a restricted quantity of money handled in VC. Due of the difficulty in getting cash from institutional investors, VC firms usually focus on differentiating themselves from other VC funds. Differentiating elements in VC funds include the target company's industry or sector, as well as the portfolio company's development stage. (Talmor & Vasvari, 2011.)

Factors such as the portfolio company's development stage have a direct influence on the fund's anticipated returns and risks. Earlier stage investments come with a greater risk profile and, as a result, higher anticipated returns for the VC fund. The preferred risk-to-reward ratio in a venture capital fund is influenced by the preferences of general and limited partners.

VC funds often do not invest in the startup and seed phases because the equity needs in comparison to the portfolio company's upside potential are too small for the VC companies' resources. Early-stage investments are often the initial round of funding provided by a venture capital company, and so carry the highest level of risk due to the lack of insight into the investment's potential for success. Because the firm is yet untested, the amount of money offered is often less in the early stages. More funding will be given when visibility increases and certain difficulties are overcome, allowing a venture capital firm to become more confident in the company's chances of success. Staged financing refers to the process of providing cash to a portfolio firm in stages, with the option to exit the transaction at any time during the financing process (Wang & Zhou, 2004). (Talmor & Vasvari, 2011.)

Historically, VC funds have been allocated to different stages of a portfolio company's growth. There have been differing views on whether or not development stage investments should be included in the venture capital field. Because VC investments may be completed at various phases, narrowing the field of venture capital should focus on how the investment will be done rather than the investment stage. Because of the fund's dependencies between risk and anticipated returns, the majority of VC investments have historically been made as early-stage investments. By investing in early-stage companies, VC funds are ready to take on more risk, resulting in larger expected returns and, as a result, bigger potential profits at the liquidity event.

One of the main abilities of a successful VC firm is accurate valuation of a prospective investee business. There have been occasions in the VC sector when promising early-

stage firms were backed at exorbitant valuations, resulting in losses for VC investors at the liquidity event stage, despite the fact that they were profitable and growing rapidly. Overvaluation of an early-stage business may be caused by entrepreneurs' unrealistic expectations for the company's future performance, or by the investment manager's incapacity to appropriately appraise the investee firm's valuation in relation to its future performance at the point of VC investment. Valuation based on an overstated goodwill or future development potential of a promising inventive early-stage firm might result in the company's incapacity to profit from a liquidity event. (Demaria, 2013.)

Syndication is a significant part of the venture capital sector. In syndication, the portfolio company's lead investor initiates the initial round of fundraising and invites additional investors to join the same or following rounds. The willingness of invited investors to invest is contingent on their interest in the startup. After the fundraising is closed, the lead investor builds social relationships with the entrepreneur and becomes heavily involved in the administration of the startup (Brander et al., 2002). Typically, invited investors do not have social links to the entrepreneur or have considerable involvement in the start-up's operational management. The strategic network of a venture capital firm and its partners is made up of complementary resources that help a financed company create and grow. In order to obtain tacit information about a startup concept before investing, social networks are utilized to handle ambiguity. Syndication across networks decreases the investment's uncertainties and risks. (Ferrary, 2010.)

3.1.2 Investment stages in venture capital

This chapter outlines the various stages of the venture capital industry's ventures. Seed-stage investments, early-stage investments, and later-stage investments are the three primary stages of ventures undertaken in the VC industry. The venture capitalist overseeing the investment portfolio's risk preferences contribute to the intended relationship between these different stage ventures inside the portfolio.

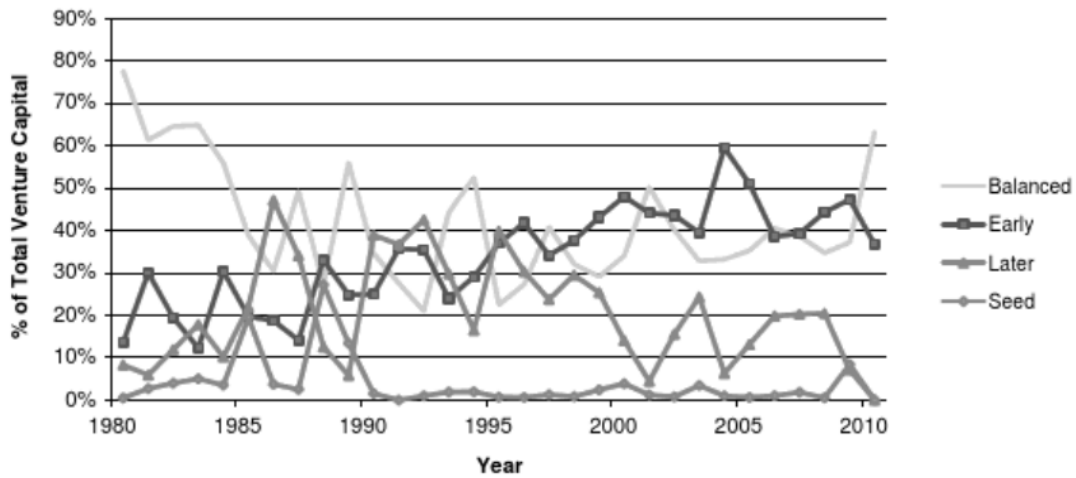


Figure 5. Historical commitments to venture capital by stage, 1980-2010 (Cendrowski et al., 2012).

Early-stage investments have historically been the most popular in the venture capital industry, probably because these enterprises offer the best risk-reward ratio. Between 2000 and 2010, the distinction between early-stage and later-stage companies grew noticeably. The disparity began to widen during the techno boom, presumably as a result of the large number of appealing early-stage firms in which venture capitalists were prepared to invest due to the favorable growth prospects and high anticipated returns in these projects. Historically, venture capitalists have been ready to take on bigger risks due to their ambition to make a large number of early-stage investments in comparison to the entire sector. The number of seed-stage investments completed was low in comparison to other investment stages, which might be because the equity needs in relation to the portfolio company's subsequent upside potential are too small for VC firms' resources (Talmor & Vasvari, 2011). Due to the diversification benefits that contribute to a positive risk-to-expected-return ratio, a balanced portfolio of various stage ventures has grown in popularity.

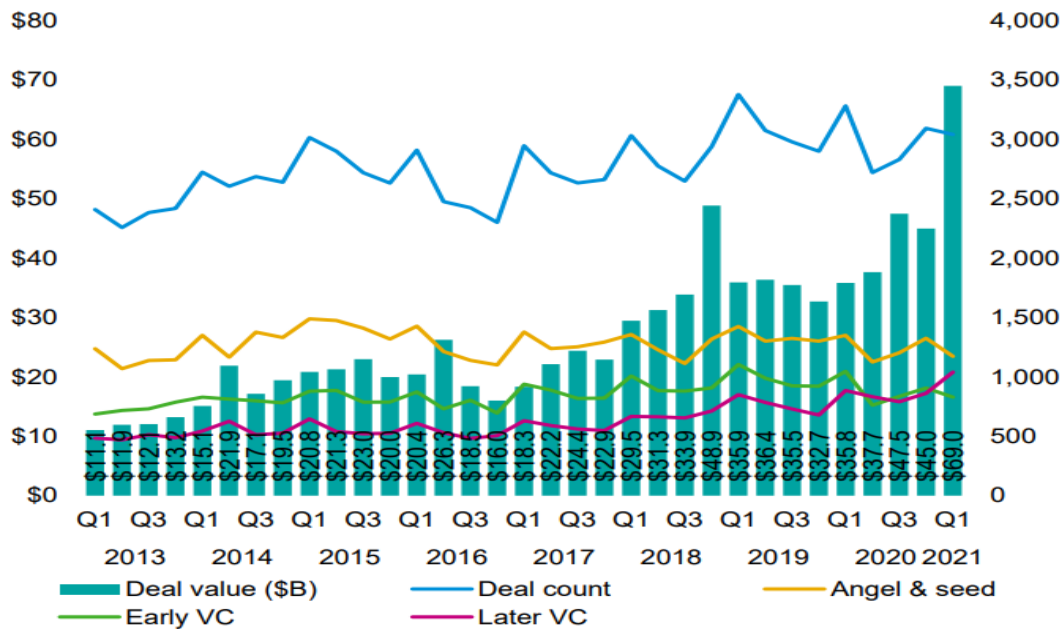


Figure 6. KPMG Enterprise. (2021). Venture Pulse, Q1'21. Global Analysis of Venture Funding. Collected 2022-01-10 from address <https://assets.kpmg/content/dam/kpmg/xx/pdf/2021/04/venture-pulse-q1-2021-report-global.pdf>

The economic recovery following the financial crisis has been rapid, affecting the venture capital business as well. On the time period of 2013-2015, the chart from the past decade of venture funding in US shows a tremendous surge in investment activity within the venture capital industry. The improved economic environment has facilitated the implementation of riskier ventures, as seen by increasing venture capital investment activity. Execution of riskier investments in a stable economic environment has also contributed to an increase in the number of seed-stage and early-stage investments, which have higher risks but also higher anticipated returns and profit potential. During the period 2013-2015, seed-stage and early-stage ventures grew substantially in comparison to later-stage investments, which remained relatively unchanged.

The attraction of larger profit opportunities comprising earlier-stage investments might stem from the ideal risk-to-reward ratio. VC investors are prepared to take greater chances in a stable economic environment because they believe that the possibility of the risks being realized in the venture is lower during times of high economic growth compared to the probability of superior performance.

Regardless of the strong economic growth, the quantity of capital invested in ventures remained relatively consistent between 2013 and 2015, which might be attributed to the ratio of completed earlier-stage investments to later-stage investments. Because of the lower value and capital needs in the early phases of these ventures, the capital invested in early-stage ventures is often smaller. The fact that investment managers use risk management techniques such as staged financing inside early-stage ventures to control the risks associated with the venture's development may also have an impact on the reduced amount of cash spent during earlier fundraising rounds.

During the period of 2016-2021, the relationship between executed early-stage ventures and later-stage ventures has shifted. In compared to the period 2013-2015, the number of completed earliest-stage ventures has steadily fallen. This might be owing to the heightened uncertainty in the economic environment, which has contributed to apprehension in making these risky investments. The total investment activity in the venture capital industry has however accelerated in recent years, possibly owing to the fact there has been a sustained period of strong equity returns and a favorable interest rate environment, which tends to increase the overall activity within the VC industry. Because later-stage venture activity has grown rapidly while activity in accomplished earlier-stage ventures has dropped, activity in later-stage ventures has grown in comparison to earlier-stage ventures. This might be because, in this uncertain macroeconomic environment, venture capitalists favor later-stage ventures, which have a lower risk profile.

Between 2016 and 2021, the amount of money invested in the venture capital industry rose remarkably. This is intriguing since the amount of money spent in the VC industry has climbed but the number of ventures that have been completed has remained relatively stable. This might be because the number of completed later-stage ventures has risen in comparison to the total sector. Because the valuation of a later-stage company

and the capital requirements tend to be larger, later-stage ventures often have a greater amount of money invested during the fundraising round.

3.2 The definitions of risk

Despite the subject field's prominence, there is no commonly agreed definition of risk principles and fundamental concepts. There is a lack of clarity in the theoretical framework around risks in terms of their scientific foundations. Because it is impossible to avoid all risks in life, but only to select amongst them, the field of risks involves a decision-making process. Individuals and other decision makers must be able to evaluate risks from the perspective of their risk preferences, which is required by the rational decision process. The term "risk" is used in a variety of contexts and is divided into several categories, such as commercial risk, economic risk, political risk, and so on. (Andretta, 2014; Kaplan & Garrick, 1981.)

Risk may be described as the unknown nature of a situation's outcome. Uncertainty refers to the fact that we don't know whether or not a specific event will occur, when it will occur, or what the implications will be if it does. Risks, according to this definition, are the repercussions of an action in terms of the activity's ambiguity and severity. Uncertainty may be defined as our inability to anticipate the future, such as the future value of an asset. (Aven & Renn, 2009; Aven, 2010.)

The dimensions of risk are the probability and severity of adverse events (Lowrance, 1976). Probability is a technique that is used to describe uncertainty in a variety of situations, such as distributing values for a future possible outcome. Uncertainty is frequently referred to as a synonym for probability. Severity refers to the degree of potential negative consequences, such as the number of financial losses incurred during the realization of risks. (Aven & Renn, 2009; Aven, 2011.)

3.2.1 Risks in venture capital

The possibility of experiencing all of the negative impacts associated with the venture capital industry is known as risk (Aven, 2011). During the early stages of their company development, young entrepreneurial enterprises face a number of risks. The lack of expertise that entrepreneurs may have in running a business poses a number of risks to early-stage venture capital investments. Agency risk, liquidity risk, technology risk, market risk, human resources risk, internationalization risk, and macro risk are all major risks that VC investments face (Proksch et al., 2016).

Because VCCs suffer substantial risk by investing in ventures owing to knowledge asymmetries between the investor and the entrepreneur, behavioral issues such as the principal agent problem are one of the major agency risks in VC investments (LiPuma & Park, 2014). The biggest agency risks impacting VC investments are believed to be potential concerns of adverse selection and moral hazard between the entrepreneur and the VCC (Bengtsson & Sensoy, 2011; Lu et al., 2006). Due to their diverse interests and the difficulties of overseeing the activities of the portfolio firm, the agency risk is produced by either venture investors or entrepreneurs following their own interests (Fiet, 1995).

Liquidity risk refers to the VCC's exit risk in initial public offering markets, considering the danger of not being able to properly exit the portfolio business. VCCs alter their investment decisions based on the degree of liquidity risk in the investment, according to the analysis of liquidity risk. VC investors engage more in high technological risk investments on early-stage ventures during periods of high liquidity risk, signaling projected illiquidity in exit markets, in order to postpone their exit requirements. When exit markets are liquid, venture capitalists rush to exit by investing more in later-stage enterprises. (Cumming et al., 2005.)

Early-stage firms' technologies and products are frequently not market-ready, posing technological risks (Proksch et al., 2016). Technology risk is often referred to as product

and development risk. VCCs use due diligence to assess the risk of a technology or product before investing in a venture. Young ventures' goods may not be created on time, or the technology may not perform as intended, resulting in product development delays or greater expenses. The product development process for early-stage companies might take many years, be fraught with risk, and necessitate significant financial resources. (Stranz, 2017.)

The commercialization of breakthrough technology or a product is proving tough for early-stage companies. Early-stage companies lack the marketing capabilities needed to bring their idea or product to market and expand the company to take advantage of the opportunity. Marketing resources, such as successful campaigns and promotions, access to target customers, and efficient distribution channels, are required for the commercialization of technology or product. Competition, market size and growth, obstacles to entry, and the probability of consumer acceptance are all major market risks that must be considered when bringing a new technology or product to market (Kaplan & Strömberg, 2003). In a competitive industry, resources are needed to be ready to react rapidly to rivals' activities. (Wang et al., 2012.)

Human resource risks consider the quality, expertise, and competence of the manager or management team in charge of the venture (Proksch et al., 2016). Factors impacting management performance include a lack of financial planning and attention, as well as the potential that the management is young and inexperienced (Kaplan & Strömberg, 2003). The potential of an enterprise to prosper is significantly influenced by the presence of skilled and dedicated management. VC businesses that have both general and specialized human capital in their management teams have fewer failed projects (Dimov & Shepherd, 2005).

Because internationalization entails a high level of risk, VC firms fund smaller and fewer frequent rounds of money for enterprises that internationalize opportunistically (LiPuma & Park, 2014). Internationalization can be hampered by a variety of factors, includ-

ing challenges accessing a foreign market, cultural barriers, and currency rate fluctuations. Macro risk refers to the market dynamics that influence a company's performance. Inflation, the business cycle, and interest rates are examples of market variables. Interest rates and inflation may have an impact on the economy. Fundamental changes in economic conditions, such as the tech boom and the financial crisis, have a significant impact on the risk preferences and investment strategies of VC investors. Investors secure fewer transactions with a smaller average amount per deal in the initial financing sequences during difficult economic times, focusing more on later-stage enterprises with lower risk. During periods of rapid economic expansion and boom cycles, investment activity is reversed, and risk tolerance is significantly increased. (Ning et al., 2015.)

3.3 Risk management in venture capital

Finance theory argues that investors may diversify their portfolios by selecting the appropriate assets for the desired level of risk. The assumptions that focus on the diversification advantages regarding the risks in a portfolio are supported by finance theory, such as mean-variance analysis and the capital asset pricing model. VC investment risks, on the other hand, comprise a significant amount of unsystematic risks that are difficult to diversify. (Manigart et al., 2002.)

In venture capital, correlation with other firms in the portfolio is utilized more than market-based techniques to assess risk. This is because VC portfolios have a high level of firm-specific volatility and assumably a weak connection with macroeconomic factors. Because controlling risks in a VC portfolio necessitates extensive use of risk decomposition focused on the unique domains of risks associated with VC, risk management in the VC industry must differ from fundamental finance theory in several areas. The examination and appraisal of new ventures, for example, are examples of risk decomposition. Due diligences in the domains of financial analysis, market analysis, and competitor analysis are used internally and externally to review and evaluate possible

ventures from the standpoint of the risk-reward relationship. (Kut et al., 2007; Lu et al., 2006.)

Portfolio diversification across multiple investment phases, sectors, and geographical regions is an example of risk aggregation in the world of VC investments (Kut et al., 2007). Investing in various stage ventures with a diverse relationship of risks impacting ventures results in a portfolio with a more favorable risk-to-expected-return ratio. Smaller covariance within portfolio investment performance is enabled by industry and geographical diversification, resulting in a lower degree of systematic risk in the portfolio.

In the venture capital sector, risk management solutions include governance systems and financial contracts. Financial contracts are being utilized to mitigate risks and agency costs associated with the amount of monitoring and participation inside the portfolio firm, such as behavioral-based contracts and outcome-based contracts. To control the rights of management and investors, governance procedures are implemented. Due to being able to monitor management effort and actions taken in the portfolio firm, experienced VC managers negotiate the right to join their portfolio companies' boards of directors in the financing contract. VC finance arrangements typically include variations in decision-making power based on the company's performance, such as the venture capitalist gaining greater control during periods of bad performance and devolving further to the background during periods of good performance (Kaplan & Strömberg, 2003). The governance mechanisms techniques also include the ability to stage financing and stop funding. (Bengtsson & Sensoy, 2011; Tan et al., 2008.)

As previously stated in this thesis, one of the significant agency risks in VC investments is principal agent problem (LiPuma & Park, 2014). Financial contracting, incentive systems, syndication, and staged financing are some of the risk management approaches utilized for significant agency risks. Financial contracts based on behavior help to guarantee that tasks, responsibilities, and control mechanisms are followed. Stock options for the entrepreneur and workers are examples of incentive mechanisms that are used to commit and encourage firm participants to the performance improvement process.

Due to the fact that investment made under syndication needs agreement on the chances of superior returns, syndication diversifies the risks of a venture to numerous participants and allows for a possible reduction in risks associated to adverse selection dilemmas. In the event that a venture does not develop as expected, staged financing offers the option to leave it. (Kut et al., 2007; Tan et al., 2008.)

By confirming the track record of the management team and board members, as well as conducting criminal background checks, the human resources risk linked with risks within management, such as adverse selection and moral hazard issues, may be quantified. The business plan's overall coherence, as well as the due diligence report's overall coherence, may help to address information inconsistencies (Tourani-Rad & England, 2003). If the agent's conduct can be observed, behavior-based contracts can be employed in due diligence during the pre-investment stage. In the post-investment phase, outcome-based contracts may be used to track pre-agreed targets and assess the likelihood of specific events occurring. (Kut & Smolarski, 2006; Smolarski et al., 2005.)

The exhibit displays the responses to a question asking firms if they used each type of diversification strategy. The possible ranks are 0 = No and 1 = Yes. The vertical scale displays the percentage of firms that indicated that they used a diversification strategy. The first pair of bars ("Diversify") shows the percentage of firms that used one or more of the diversification strategies.

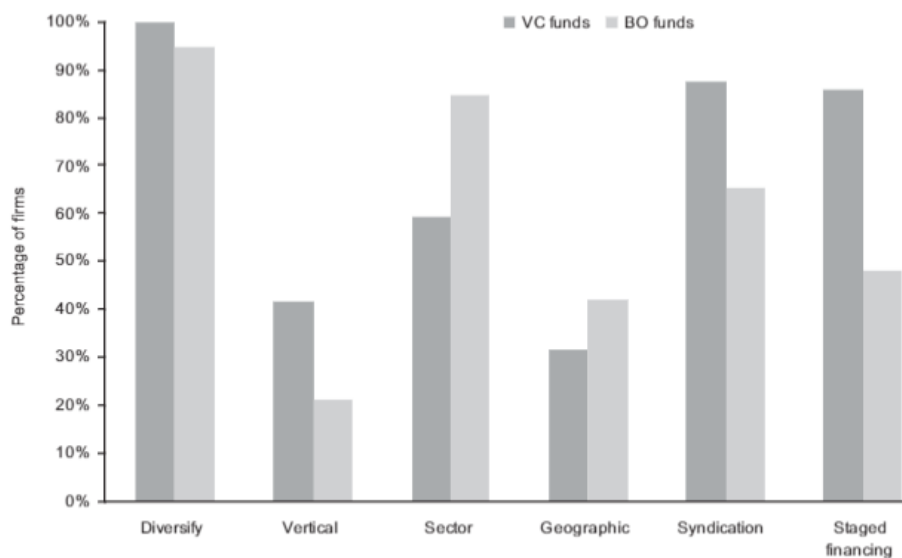


Figure 7. Diversification of risk in VC funds (Kut et al., 2007).

Although Kut et al. (2007) included both VC and BO funds, this thesis focuses solely on the risk management domains in the VC market. According to the findings, all VC funds diversify their risks by employing some form of diversification. Syndication and staged financing are two of the most common methods employed by venture capital companies to diversify the risks in their portfolio. Syndication contributes to the management of risks in the field of agency risks in a venture, which have been identified as key risks in the venture capital business and so have a high relevance in the risk management process. Staged financing makes it easier to manage risks associated with a lack of understanding about a venture's future performance, which is always a concern when it comes to VC investments. (Kut et al., 2007.)

According to the study, only a small percentage of venture capital funds diversify risk by investing vertically or geographically. Vertical diversification refers to a company's decision to outsource various aspects of its supply chain, such as the manufacture and selling of a product, to multiple firms in order to lessen reliance on specific suppliers and customers (Chong et al., 2014). The relatively high transaction costs in VC may be one of the reasons for the low level of vertical diversification adopted. The home bias hypothesis might explain why there is such a low level of geographical diversification. When compared to international markets, investors favor their home markets since they are more acquainted and have better market expertise (Grinblatt & Keloharju, 2001). Many VC firms employ risk diversification by investing in many market sectors, which allows for a reduced level of systematic risk in the portfolio. (Kut et al., 2007.)

Traditional hedging, such as employing derivatives as a risk management tool, is rarely used in VC funds. This might be owing to derivatives prohibitions in fund management agreements with their sponsors, or it could be due to fund managers' lack of understanding of the risks that the venture faces and should be hedged. The overall lack of liquidity in various derivatives, as well as high transaction costs, make it difficult to execute derivatives effectively, contributing to the VC industry's limited use of derivatives. (Kut et al., 2007.)

Venture capitalists engage in projects with a greater degree of firm-specific risk with the goal of lowering that risk by the time of a liquidity event, such as an IPO, thereby improving the risk-to-reward ratio. Venture capitalists feel that their managerial abilities and resources enable them to handle risks better than the typical investor, and as a result, they are ready to take riskier investments. Before selling their shares to the public, venture investors prefer businesses that involve risks that they are best positioned to manage and mitigate. (Bamford & Douthett, 2013.)

3.4 Risk management's relation to performance

VC investments fail at a rate of 35 to 55 percent of the time, either by not generating a return on investment (ROI) for the investor or by filing for bankruptcy (Zacharakis & Meyer, 2000). Because of the high failure rate of VC investments, it is critical to control negative effects and risks that affect the venture, because well-executed risk management techniques may result in a decreased failure rate of VC-backed businesses (Proksch et al., 2016).

The investment manager's experience has been determined to be a key determinant in the VC fund's performance. Experienced fund managers have developed unique knowledge, allowing them to better help their portfolio firms by providing value and creating higher returns as a consequence of their guidance (Sapienza et al., 1996). The addition of more investment managers to a fund's management team through syndication, for example, enhances the amount of expertise participating in the fund, which contributes to its success. Having a large number of experienced investment managers has a major influence on the risk management process since experienced managers are better equipped to reduce losses owing to their knowledge. The development of improved returns for the portfolio firm as a consequence of their direction is also supported by experienced investment managers. Due to their capacity to control risks and

improve revenues, an experienced fund management team contributes to a favorable risk-to-reward ratio. (Lauterbach et al., 2007.)

The optimal portfolio size is critical for effectively managing independent portfolio firms. Due to the small number of ventures in a portfolio, investment managers are able to give more comprehensive managerial guidance to businesses. Larger funds increase the total consulting activity of investment managers, but management counsel per firm is diluted, resulting in a multiplicity of hazards inside portfolio firms. Due to the active managerial engagement, the portfolio firm and the investment manager lower the risks associated with the investment, resulting in less losses, and on the other hand, they assist increase the profit prospects of an investment. (Kanniainen & Keuschnigg, 2003; Lauterbach et al., 2007.)

Because sequentially implemented financing allows the potential of determining the risk factors and performance of the venture throughout different stages of funding, staged financing has been observed as a crucial component in lowering losses and maximizing profits for projects. Staged financing has less of an impact on an investment's profit prospects than it does on decreasing risks and, as a result, lowering the likelihood of the venture failing. (Lauterbach et al., 2007.)

VC companies are famous for employing incentive mechanisms with the goal of motivating and committing the participants of the portfolio business to higher performance. The use of incentive mechanisms such as stock options as incentive mechanisms for the entrepreneur and employees has an influence on the desire to grow the firm to a higher level of performance. The desire of all firm participants to invest in the portfolio company's development has been noted as favorably contributing to the venture's exceptional success. (Tan et al., 2008.)

It has been observed that more diversification within a fund's portfolio contributes to greater portfolio returns. Because higher diversification at the fund level compensates

for the increased risks inside individual ventures, diversification reduces the total risks of a portfolio, allowing investment managers to execute riskier individual projects. The higher the risk of each venture and the more accurately it is treated, the higher the average return on the portfolio level. Due to their collected expertise, experienced investment managers have higher diversification standards, resulting in a more favorable risk-to-reward ratio. Diversification at the industry level and diversification of the portfolio into different stages of ventures have a substantial impact on the venture's performance. Diversification improves portfolio performance, but it requires investment managers to diversify their portfolio into industries and stages in which they have specialized knowledge and expertise. (Buchner et al., 2017.)

VC managers that manage portfolios with a higher level of diversification invest more in early-stage ventures. The greater anticipated returns in these ventures lead to a willingness to participate in riskier early-stage businesses compared to later-stage companies. As previously stated, more portfolio level diversification reduces overall risk in the portfolio, allowing for the execution of riskier individual ventures. Early-stage businesses, for example, have the most promise, but they also have the greatest risk. If the greater risks were addressed and managed well by the VC managers, a relatively large number of risky ventures within the portfolio with the highest potential contributed to the fund's superior performance. (Buchner et al., 2017.)

3.4.1 Performance in venture capital

This section examines the variations in risk and return relationships through time, with a particular focus on the differences in the venture capital industry between the financial crisis and the following decade. In this section, the risks and returns in connection to performance are primarily focused on the development stage of the venture and the performance of various stage ventures during various eras.

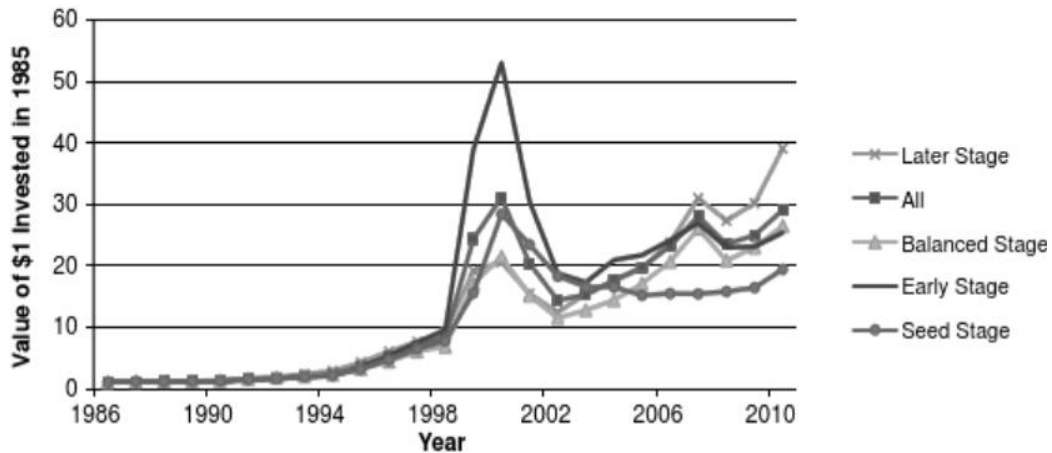


Figure 8. Value of \$1 invested in 1995 in an average venture capital fund by fund stage, 1996-2010 (Cendrowski et al., 2012).

During the techno boom, riskier early-stage investments contributed to higher returns in the risk-to-reward ratio. Early-stage portfolio firms with great development potential may have benefited from the favorable market condition and prospects for attaining rapid expansion during the techno boom, resulting in increased returns for investors for the time being. When the techno bubble burst, which was a result of the market's overvaluation in its entirety, early-stage investment earnings also plummeted. This might be seen as the acceptance of a high level of risk in these investments. The fact that early-stage investments maintained their attractiveness in the venture capital sector during the financial crisis is noteworthy; even early-stage businesses with greater amount of risk had lower returns during the financial crisis than later-stage businesses with less risks. This might be related to portfolio diversification, which reduces overall portfolio risks and allows venture capitalists to make riskier early-stage investments owing to their attractive anticipated returns, independent of prior performance. (Buchner et al., 2017.)

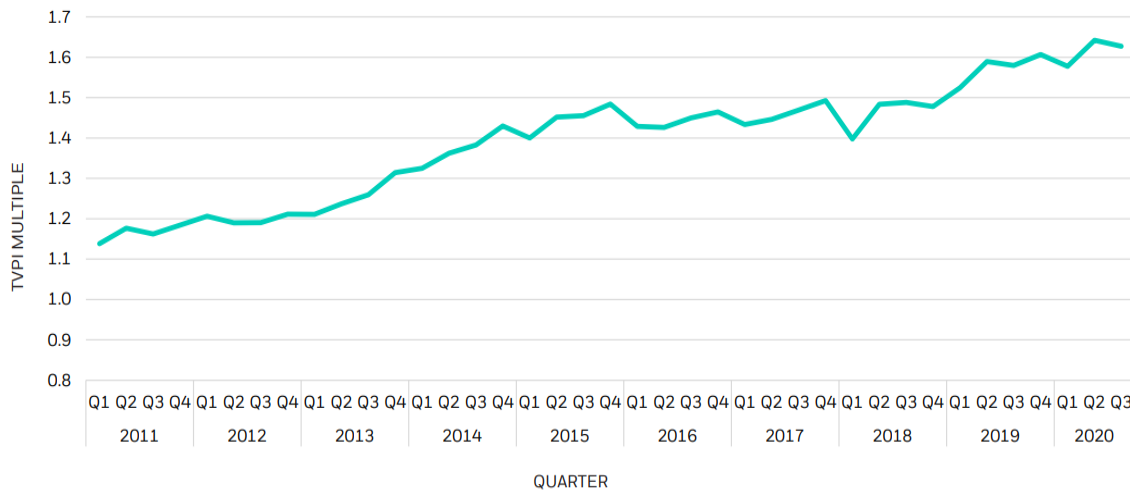


Figure 9. eFront Insight. (2020). Return evolution of active VC funds. Returns, risks and liquidity of VC Funds in Q3 2020. Collected 2022-02-02 from address <https://www.efront.com/research-papers/returns-risks-and-liquidity-of-vc-funds-in-q3-2020/>

The great overall success of VC funds in the past decades can be seen in the historical return evolution of funds in the VC industry. VC investments profitability increased significantly after the financial crisis, which might be a result of the VC industry's connection with the surrounding favorable economic environment. Favorable economic environment has been characterized with low cost of debt compared to the cost of equity, which has accelerated the overall investment activity in riskier categories, such as ventures. Due to the attractive profit potential, venture capitalists have been ready to take on greater risk during the period of rapid economic expansion following the financial crisis by investing more in riskier early-stage businesses. Due to the accomplished lucrative growth preceding these ventures liquidity event, the execution of these high-risk ventures has led recently to the increasingly profitable funds. Due to the excellent risk-to-reward ratio, high-risk VC investments have achieved extraordinary returns as a result of strong economic development. Using risk management techniques, venture capitalists have been able to turn risks into lucrative companies.

3.5 Macroeconomic policy in covid crisis

Macroeconomic policy decisions in US are executed by the Federal Reserve System (Fed), which is the central bank of the United States. The policy decisions made during covid crisis were unprecedented in scale, scope, and size. This chapter provides insight about the actions taken and their consequences within the overall economy.

The restrictions imposed in response to mounting worries of a covid crisis and its health ramifications accelerated a significant decline in economic activity in the United States. This compelled the central bank to act quickly to avoid an economic shock and recession brought on by the situation. Changes in monetary policy and the introduction of the emergency lending program were among the major policy choices. These policies were primarily focused on yield curve targets, general levels of economic activity, and efforts to lend credit to specific banks, enterprises, and other sectors of the economy. (Cachanosky et al., 2021.)

Central bank lowered interest rates in aim for ensuring that banks continue lending, thereby obtaining increased demand for general liquidity. The central bank reduced the rate charged from banks to borrow directly from them as part of the decision. This implemented reduction in bank rates has a direct impact on the final lending costs to numerous sectors of the economy, resulting in an increase in total lending and liquidity. The success of the liquidity injection was secured by temporarily easing bank capital and liquidity regulations. Correspondingly, the Fed implemented quantitative easing (QE) method for ensuring that money is injected into the economy to increase economic activity. The central bank effectuates QE by acquiring predetermined amounts of government bonds or other financial assets. Furthermore, the emergency lending program was launched to encourage indigent communities' financial institutions to augment their efforts in supporting small businesses and consumers in their community, thereby ensuring sufficient level of liquidity and consumption possibilities. The emergency lending program was established by the US treasury. (Cachanosky et al., 2021.)

3.5.1 Consequences of the policy decisions

The principal effect by the expansionary shock to the money supply included major acceleration in the economic activity, output growth and lower unemployment rate. These findings provide insight about the short-term success of the central banks macroeconomic policy decisions to the US economy. However, the long-term effects to as e.g., inflation and several other economic factors are not yet available for evaluation. (Feldkircher et al., 2021.)

The expansionary policy era has been characterized with low interest and inflation rates. This has had favorable significant accelerating effect on equity returns and lowering effect on long-term yields. Studies regarding this research area suggest that output growth, equity returns and overall economic development after the downturn caused by covid crisis would have been weaker without monetary policy stimulus provided by the US Fed. Findings regarding this expansionary era also suggest that the executed policy decisions triggered a stronger depreciation of the US dollar exchange rate, thereby boosting external competitiveness of the US economy. These results provide support regarding the macroeconomic basis behind the remarkable positive performance of the US VC markets. (Feldkircher et al., 2021.)

4 Data and Methodology

The data used in this research paper is based on the MoneyTree Report from *PriceWaterhouseCoopers/National Venture Capital Association*, with data provided by *Thomson Reuters*, and covers the period from Q1 1995 to Q1 2021. The macroeconomic data for this study was gathered from the *Thomson Reuters* database. The data and methodology utilized in the empirical analysis of this study will be introduced in this chapter.

4.1 Data

The data is based on the performance of US venture capital markets from Q1 1995 to Q1 2021. The sample comprises 105 quarterly observations on the evolution of US venture capital markets investments. The information is broken down into three sections: total amount invested (\$B), number of deals, and average deal size (\$M). The MoneyTree Report was used to determine the total amount invested (\$B) and the number of deals. The average deal size (\$M) is determined by dividing the total amount invested (\$B) by the number of deals completed in each quarter of the sample period.

The macroeconomic data includes 105 quarterly observations between Q1 1995 and Q1 2021. Macroeconomic variables consist of US 10-year treasury bonds yield (TBY), Russell 2000 index, initial public offerings (IPO), unemployment rate (UR), and industrial production index (IPI). The data is gathered from the *Thomson Reuters* database.

4.2 Methodology

The aim of this study is to analyze the correlation between macroeconomic variables and US VC markets. The collected data is utilized for achieving statistically significant empirical results on the co-movements and relationships between measured variables.

The statistically significant empirical results are indicated within the study with 5% significance level.

4.2.1 Multi-regression model

The study is executed by using multi-regression analysis for measuring the co-movements and relationships of the collected variables. The statistically significant empirical results of the multi-regression analysis are indicated with 5% significance level. Multi-regression model consists of US VC markets variables data as dependent variables and macroeconomic variables data as independent variables. Multi-regression analysis is divided into three different models consisting of individual set of dependent variables and constant set of independent variables. Dependent variables consist individually in single model of total amount invested (\$B), number of deals and average deal size (\$M). Each dependent US VC markets variable has its own model with constant independent macroeconomic variables set that consist of US 10-year treasury bonds yield (TBY), Russell 2000 index, initial public offerings (IPO), unemployment rate (UR), and industrial production index (IPI) in all models.

The multi-regression analysis in this study includes logarithmic transformations. Logarithmic transformations are used as log-linear form transformations in the multi-regression model. The log-linear model is a function whose logarithm equals the linear combination of the model's parameters. In log-linear analysis, the objective is to figure out which model components must be kept in order to best account for the data and get statistically significant findings. (Hardy et al., 2004.)

Hypothesis testing in the multi-regression analysis is executed by using ordinary least squares (OLS) estimation. OLS is the most common form of statistical linear regression that is being used for predicting unknown values from an existing data set. The basis of least squares is used by OLS to choose the parameters of a linear function of a group of explanatory variables. The primary principle behind OLS is to reduce the sum of

squares of differences between the observed dependent variable in a dataset and those predicted by the independent variable's linear function. (Wooldridge, 2010.)

In an ordinary least squares regression analysis, the variance inflation factor (VIF) is a tool for assessing the severity of multicollinearity. When multiple independent variables in the model show a linear relationship with each other, the regression analysis encounters a multicollinearity problem. Multicollinearity increases the variance of the regression model and makes a variable's coefficient consistent, but the findings of the analysis are untrustworthy. The number of augmented variances induced by multicollinearity is measured by VIF. The factor's baseline is the fact values greater than 10 indicate significant multicollinearity within the regression analysis, which must be rectified by adjusting the included independent variables in the regression model. (Salmeron et al., 2018.)

5 Empirical results

In this section, the empirical findings regarding the previously described data and methodology are presented. The section starts with a sample analysis which first reports the correlation between implemented macroeconomic variables and continues with presenting the US VC markets sample performance. Furthermore, the results on the three accomplished models of the study within the multi-regression analysis are presented.

5.1 Sample performance

Table 1. Descriptive statistics.

Variable	N	Min	Max	Mean	SD	Skewness	Kurtosis
Total amount invested (\$B)	105	1.7	62.1	12.0	10.3	1.9	4.7
Average deal size (\$M)	105	3.4	35.8	9.5	5.2	2.1	6.4
Deals	105	434	2161	1105	374	0.8	0.0
10-year TBY (%)	105	0.7	7.5	3.8	1.6	0.2	-1.0
Russell 2000 (\$)	105	261	2221	813	428	1.0	0.2
IPO	105	10	533	117	77	2.1	7.4
UR (%)	105	3.6	13.0	5.8	1.8	1.4	1.6
IPI (\$)	105	72	104	94	8	-1.1	0.6

This table presents the descriptive statistics of all variables included in the study's regression analysis. The descriptive statistics include sample size (N), minimum value, maximum value, mean value, standard deviation (SD), skewness and kurtosis of each variable. The values of the variables descriptive statistics are presented in the same form as in the database.

Table of the descriptive statistics provides significant insight and background about the values and forms of the study's included variables data set for better understanding the transitions of the dependent or independent variables.

Table 2. Table on macroeconomic variables correlation.

	10-year TBY	Russell 2000	IPO	UR	IPI
10-year TBY	1.00				
Russell 2000	-0.77	1.00			
IPO	0.35	-0.06	1.00		
UR	-0.36	-0.04	-0.08	1.00	
IPI	-0.69	0.69	-0.34	-0.13	1.00

This table presents the correlation between the implemented macroeconomic variables chosen for the study. Values between 0 and 1 represent positive correlation between metrizable variables. Values between -1 and 0 represent negative correlation between metrizable variables.

Table of correlations shows that Russell 2000 and IPI have strong positive correlation between each other. The correlation of IPI with the stock index is inevitable due to the fact industrial productivity highly affects companies' prospects on superior results, thus affecting the stock market performance. Strong positive correlation between these variables indicates significant linear relationship between them, thereby creating potential multicollinearity problem to the regression analysis. The potential multicollinearity problem within the regression model is tested and analyzed by utilizing VIF before progressing with the findings of the regression analysis.

Significant negative correlation is detected between TBY and Russell 2000 index. Similarly, strong negative correlation is identified between TBY and IPI. The remarkable negative correlation between TBY and these specific variables is probably related to the fact rising treasury bonds yield, which is connected to the interest rate level, represent tighten macroeconomic policy. This has negative effects on these other variables movements and performance, thereby making the relationship between these specific variables and TBY strongly inverse. The correlation values in the table provide relevant insight on the samples internal movement for better understanding the outcomes and results that the selected variables provide within the study.

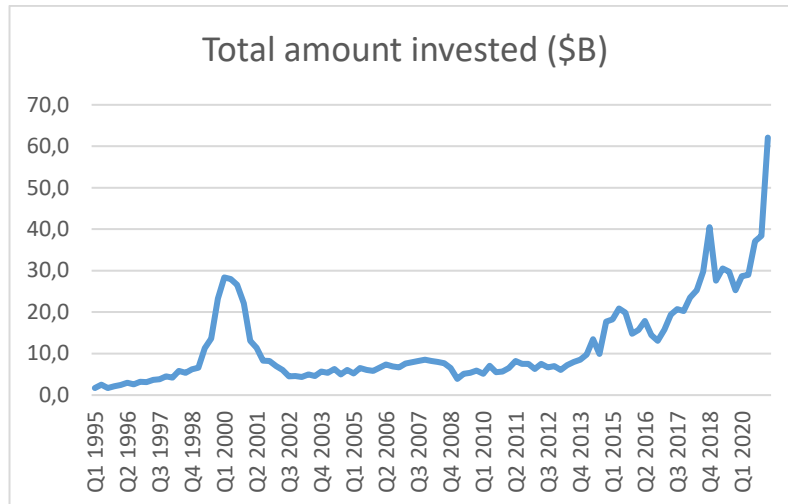


Figure 10. Total amount invested (\$B) in the sample data.

Historically, the dot-com bubble period was outstanding in the US VC markets. The rapid peak in the investment activity, which significantly diverges from the average development, describes the era well. The markets were unleashed from the reality regarding companies' future growth prospects. The total amount invested in the US VC markets has increased rapidly by multiplying sixfold in the past decade after the slowdown caused by the financial crisis. The chart illustrates the quarterly number of investments being made in the industry. VC markets in the US have had positive mainly continuous growth in investment activity after the financial crisis and the uncertainty caused by it. The development in investment activity seems to have followed the growth path of the economy as a whole and the financial markets, which is logical due to the fact VC markets behavior is strongly linked with the stock market's performance. Significant boom in the total amount invested has occurred after the COVID crisis, by the investment activity reaching levels seen never before. Light monetary policy operated by the Fed due to the crisis has increased the money supply and impacted the economic activity and money circulation remarkably. This has affected the VC markets thoroughly by increasing the investment possibilities of venture capitalists, thus causing investments to increase in its entirety within the industry.



Figure 11. Number of deals in the sample data.

Executed deals within the US VC markets peaked furiously during the dot-com boom cycle. The peak of the cycle has not been reached again in retrospect. The number of deals in the US VC markets has increased relatively steadily within the past decade after the significant decline caused by the financial crisis. Interesting is that the development of deals has not significantly followed the rapid growth path of the total amount invested after the covid crisis. The number of deals has not reached the decades highs at the end of the chart, which tells us that the VC markets in the US has been more focused on specific deals within the current boom of the financial markets. This has been noticed to occur in VC markets during times of increased uncertainty regarding the future development of ventures. Venture capitalists secure fewer deals by concentrating only in the most promising and arguably profitable projects, thus lowering their overall level of risks caused by uncertainties within the markets.

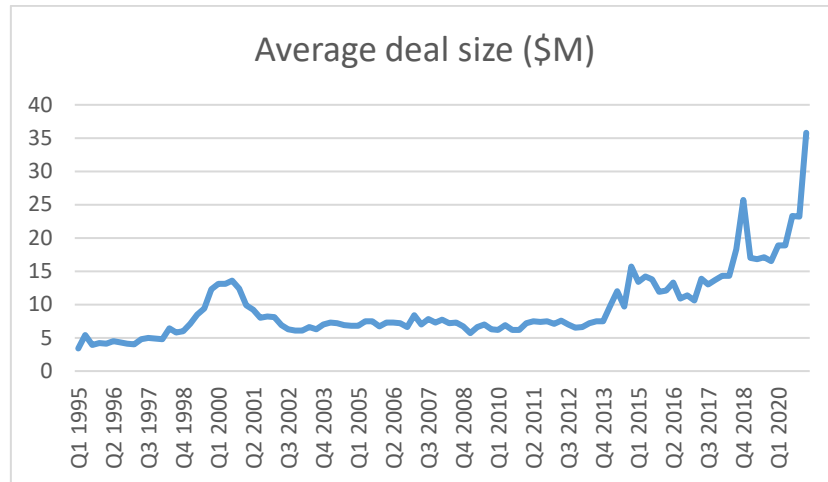


Figure 12. Average deal size (\$M) in the sample data.

The average deal size has remarkably correlated with the total amount invested, which is reasonably obvious because average deal size tends to increase while the overall level of invested capital accelerates within the markets. Although, the number of deals is also a factor affecting these calculations and their behavior because the average deal size is an outcome of the other variables movements. The higher level of average deal size demonstrates the increased proportion of later-stage investments in VC markets, which tends to reflect higher capital demands. Normally, later-stage investments relatively rise in VC markets during increased uncertainty within the overall market due to the fact these investments already have demonstrated the success and profitability of their projects. Similarly, strong boom-cycles increase the overall interest within the VC industry on promising ventures due to their favorable growth prospects, which tends to strengthen the total amount of achieved capital investments within singular ventures.

5.2 Multi-regression analysis

Table 3. Multi-regression model with total amount invested (\$B) as dependent variable.

	10-year TBY	Russell 2000	IPO	UR	IPI	Adj. R ²
Coefficient (t-statistic)	-0.026 (-0.378)	0.000*** (4.273)	0.001** (2.421)	-0.072** (-2.052)	0.029*** (3.275)	0.686
Centered VIF	7.810	4.999	1.569	2.392	3.020	

This table reports the estimated coefficients from multi-regression model with total amount invested (\$B) as dependent variable and United States 10-year treasury bonds yield, Russell 2000 index, initial public offerings, unemployment rate and industrial production index as independent variables. Centered VIF illustrates the potential multicollinearity between independent variables in the model. VIF value less than 10 demonstrate that no severe multicollinearity exists in the model. Statistical significance at 1%, 5% and 10% levels are denoted by ***, ** and *, respectively.

The formula to multiple regression with total amount invested (\$B) as dependent variable is as follows:

$$\log(\text{total amount invested } \$B) = \beta_0 + \beta_1 TBY + \beta_2 russ + \beta_3 IPO + \beta_4 UR + \beta_5 IPI + \omega \quad (5)$$

Multiple regression is run to obtain estimates $\hat{\beta}_1, \hat{\beta}_2, \hat{\beta}_3, \hat{\beta}_4$ and $\hat{\beta}_5$ for the slope coefficients. The adjusted r-squared of the regression model is 0.686, which means that 68,6% of the variance for total amount invested (\$B) is explained by macroeconomic variables in the model. This indicates that the movement of dependent variable can be extensively explained by independent variables movements in the regression model, thus strengthening the statistical significance of the results provided by the regression model. The centered variance inflation factors (VIF) of the regression model demonstrate that no severe multicollinearity exists in the model between independent variables, thereby we can proceed with the results of the model. The results of multiple regression with total amount invested (\$B) as dependent variable are as follows:

$$\log(\text{total amount invested } \$B^{\wedge}) = -0.997 + (-)0.026TBY + 0.000russ + 0.001IPO + (-)0.072UR + 0.029IPI \quad (6)$$

The results implications in all multi-regression models within the study will be calculated by using log-linear form formula. The log-linear form formula is as follows:

$$\% \Delta y = (100\beta_x) \Delta x \quad (7)$$

The result for independent variable *russ* in log-linear form formula is: $\% \Delta \text{total amount invested } \$B = (100 \times 0.000) \Delta russ = \beta_2 = 0,0\%$. This result is statistically significant with 5% significance level. Interpretations: 1% increase in Russell 2000 index results in 0,0% increase in total amount invested (\$B) assuming all other macroeconomic variables remain unchanged.

The correlation value between Russell 2000 index and the invested amount of capital within the US VC markets is statistically significant. However, the relation of these variables movements is nonexistent. The increase in the value of Russell 2000 index has no effect on the investment activity of VC markets. This indicates that the public small-cap equities performance is not statistically related to the transitions in the invested amount of capital within the US VC markets.

The result for independent variable *IPO* in log-linear form formula is: $\% \Delta \text{total amount invested } \$B = (100 \times 0.001) \Delta IPO = \beta_3 = 0,1\%$. This result is statistically significant with 5% significance level. Interpretations: 1% increase in initial public offerings results in 0,1% increase in total amount invested (\$B) assuming all other macroeconomic variables remain unchanged.

Regression analysis finds statistically significant correlation between initial public offerings and invested amount of capital within the US VC markets. The relation between IPOs and US VC markets is slightly positive and the overall increase within the amount

of initial public offerings has a similar effect on the invested amount of capital. However, the relation between these variables movements is notably low. The IPOs tend to increase during strong economic cycles similarly with the total amount invested within the US VC industry due to the favorable future growth prospects of promising ventures. Therefore, it is reasonable that the relation between these variables has been historically positive.

The result for independent variable UR in log-linear form formula is: $\% \Delta total\ amount\ invested\ \$B = (100 \times (-)0.072)\Delta UR = \beta_4 = -7,2\%$. This result is statistically significant with 5% significance level. Interpretations: 1% increase in unemployment rate results in 7,2% decrease in total amount invested (\$B) assuming all other macroeconomic variables remain unchanged.

This result is statistically significant and demonstrates the negative correlation between UR and US VC markets. The macroeconomic environment seems to have significant impact on US VC markets movements as measured by the overall amount of invested capital. The increased unemployment rate reflects weakened macroeconomic environment. This raises uncertainty within the overall financial markets and as an influence leads venture capitalists on executing less investments on risky ventures. Accelerating economic uncertainty positions ventures that are dependent on future growth prospects within the economy less attractive from the viewpoint of risk-to-reward ratio.

The result for independent variable IPI in log-linear form formula is: $\% \Delta total\ amount\ invested\ \$B = (100 \times 0.029)\Delta IPI = \beta_5 = 2,9\%$. This result is statistically significant with 5% significance level. Interpretations: 1% increase in industrial production index results in 2,9% increase in total amount invested (\$B) assuming all other macroeconomic variables remain unchanged.

This result implies the statistically significant correlation and relation between IPI and total invested amount of capital within the US VC markets. The industrial production

index demonstrates the productivity of the industrial economy and therefore measures significant proportion of macroeconomic output. The positive relation to VC markets capital level results from the fact robust productivity strengthens the probability of successful project development and therefore triumphant ventures. Favorable productivity environment attracts increasing interest on ventures that are able to utilize the advanced output prospects, thereby obtaining future growth momentum. This positive support from the macroeconomy provides basis on the ventures to achieve successful funding rounds with larger cumulative quantities of capital.

The correlation between TBY and invested amount of capital within the US VC markets is not statistically significant and therefore the results of their negative relation are not included in this section.

Table 4. Multi-regression model with number of deals as dependent variable.

	10-year TBY	Russell 2000	IPO	UR	IPI	Adj. R ²
Coefficient (t-statistic)	0.013 (0.372)	0.000*** (2.682)	0.000*** (2.688)	-0.027 (-1.510)	0.020*** (4.380)	0.576
Centered VIF	7.810	4.999	1.569	2.392	3.020	

This table reports the estimated coefficients from multi-regression model with number of deals as dependent variable and United States 10-year treasury bonds yield, Russell 2000 index, initial public offerings, unemployment rate and industrial production index as independent variables. Centered VIF illustrates the potential multicollinearity between independent variables in the model. VIF value less than 10 demonstrate that no severe multicollinearity exists in the model. Statistical significance at 1%, 5% and 10% levels are denoted by ***, ** and *, respectively.

The formula to multiple regression with number of deals as dependent variable is as follows:

$$\log(\text{deals}) = \beta_0 + \beta_1 \text{TBY} + \beta_2 \text{russ} + \beta_3 \text{IPO} + \beta_4 \text{UR} + \beta_5 \text{IPI} + \omega \quad (8)$$

Multiple regression is run to obtain estimates $\hat{\beta}_1, \hat{\beta}_2, \hat{\beta}_3, \hat{\beta}_4$ and $\hat{\beta}_5$ for the slope coefficients. The r-squared of the regression model is 0.576, which means that 57,6% of the variance for number of deals is explained by macroeconomic variables in the model. This indicates that the movement of dependent variable can be mainly explained by independent variables movements in the regression model, thus strengthening the statistical significance of the results provided by the regression model. The centered variance inflation factors (VIF) of the regression model demonstrate that no severe multicollinearity exists in the model between independent variables, thereby we can proceed with the results of the model. The results of multiple regression with number of deals as dependent variable are as follows:

$$\log(\widehat{deals}) = 4.817 + 0.013TBY + 0.000russ + 0.000IPO + (-)0.027UR + 0.020IPI \quad (9)$$

The result for independent variable *russ* in log-linear form formula is: $\% \Delta deals = (100 \times 0.000) \Delta russ = \beta_2 = 0,0\%$. This result is statistically significant with 5% significance level. Interpretations: 1% increase in Russell 2000 index results in 0,0% increase in number of deals assuming all other macroeconomic variables remain unchanged.

The correlation value between the Russell 2000 index and the number of deals in the US venture capital markets is statistically significant. However, there is no relationship between the motions of these variables. The rise in the value of the Russell 2000 index has no influence on the number of VC deals. This suggests that the performance of public small-cap equities is not statistically connected to changes in the number of deals within the US VC markets.

The result for independent variable *IPO* in log-linear form formula is: $\% \Delta deals = (100 \times 0.000) \Delta IPO = \beta_3 = 0,0\%$. This result is statistically significant with 5% significance level. Interpretations: 1% increase in initial public offerings results in 0,0% in-

crease in number of deals assuming all other macroeconomic variables remain unchanged.

A statistically significant correlation value exists between initial public offerings and the number of deals in the US venture capital markets, according to regression analysis. However, the disclosed correlation value is zero, and because there is no relationship between the transitions in the number of IPOs and US VC deals, the overall increase in the number of IPOs has no influence on the number of executed deals by venture capitalists at a specific moment.

The result for independent variable *IPI* in log-linear form formula is: $\% \Delta \text{deals} = (100 \times 0.020) \Delta IPI = \beta_5 = 2,0\%$. This result is statistically significant with 5% significance level. Interpretations: 1% increase in industrial production index results in 2,0% increase in number of deals assuming all other macroeconomic variables remain unchanged.

The relation between industrial production index and number of deals is positive and the correlation between these variables is statistically significant. This result provides remarkable information regarding relative transitions in the proportions of investments within the US VC markets during specific changes in macroeconomic environments improvement. Higher industrial productivity favors early-stage companies by increasing their businesses products or services trajectory capabilities and growth prospects, assuming their output is linked to the industrial sector. Similarly with the earlier findings regarding invested amount of capital within the US VC markets during favorable industrial outputs advancement, more ventures attract investors interest while their businesses productivity is high, and their output is scalable. This macroeconomic progress leads to extensive overall number of executed deals within the US VC markets.

The correlation between *TBY* and number of deals within the US VC markets is not statistically significant and therefore the results of their positive relation are not included

in this section. Similarly, the correlation between UR and number of deals is not statistically significant and the results between these variables are also ignored from this section.

Table 5. Multi-regression model with average deal size (\$M) as dependent variable.

	10-year TBY	Russell 2000	IPO	UR	IPI	Adj. R ²
Coefficient (t-statistic)	-0.039 (-0.979)	0.000*** (5.101)	0.000* (1.821)	-0.045** (-2.224)	0.009* (1.802)	0.712
Centered VIF	7.810	4.999	1.569	2.392	3.020	

This table reports the estimated coefficients from multi-regression model with average deal size (\$M) as dependent variable and United States 10-year treasury bonds yield, Russell 2000 index, initial public offerings, unemployment rate and industrial production index as independent variables. Centered VIF illustrates the potential multicollinearity between independent variables in the model. VIF value less than 10 demonstrate that no severe multicollinearity exists in the model. Statistical significance at 1%, 5% and 10% levels are denoted by ***, ** and *, respectively.

The formula to multiple regression with average deal size (\$M) as dependent variable is as follows:

$$\log(\text{average deal size } \$M) = \beta_0 + \beta_1 TBY + \beta_2 russ + \beta_3 IPO + \beta_4 UR + \beta_5 IPI + \omega \quad (10)$$

Multiple regression is run to obtain estimates $\hat{\beta}_1, \hat{\beta}_2, \hat{\beta}_3, \hat{\beta}_4$ and $\hat{\beta}_5$ for the slope coefficients. The r-squared of the regression model is 0.712, which means that 71,2% of the variance for average deal size (\$M) is explained by macroeconomic variables in the model. This indicates that the movement of dependent variable can be mostly explained by independent variables movements in the regression model, thus strengthening the statistical significance of the results provided by the regression model. The centered variance inflation factors (VIF) of the regression model demonstrate that no severe multicollinearity exists in the model between independent variables, thereby we can proceed with the results of the model. The results of multiple regression with average deal size (\$M) as dependent variable are as follows:

$$\log(\text{average deal size } \$M) = 1.087 + (-)0.039TBY + 0.000russ + 0.000IPO + (-)0.045UR + 0.009IPI \quad (11)$$

The result for independent variable *russ* in log-linear form formula is: $\% \Delta \text{average deal size } \$M = (100 \times 0.022) \Delta russ = \beta_2 = 0,0\%$. This result is statistically significant with 5% significance level. Interpretations: 1% increase in Russell 2000 index results in 0,0% increase in average deal size (\$M) assuming all other macroeconomic variables remain unchanged.

The correlation value between Russell 2000 index and the average deal size within the US VC markets is statistically significant. However, no relationship exists between the movements of these variables. The increase in the value of Russell 2000 index has no effect on the average deal size of VC markets. This indicates that the public small-cap equities performance is not statistically related to the transitions in the average deal size within the US VC markets.

The result for independent variable *UR* in log-linear form formula is: $\% \Delta \text{average deal size } \$M = (100 \times (-)0.045) \Delta UR = \beta_4 = -4,5\%$. This result is statistically significant with 5% significance level. Interpretations: 1% increase in unemployment rate results in 4,5% decrease in average deal size (\$M) assuming all other macroeconomic variables remain unchanged.

The correlation between UR and average deal size is statistically significant and negative. The result signifies that higher unemployment rate tends to decrease the average deal size within the US VC markets at specific moment. The reasons behind this relation are similar to the earlier findings within this study. It has been discovered that venture capitalists secure fewer deals with smaller deal sizes in the VC markets in a situation of weakened economic cycle, thereby mitigating their portfolios overall exposure and risks caused by the unfavorable macroeconomic development. Mitigating the

overall risks of the portfolio is reasonable if the economic volatility increases. Unemployment rate is an indicator of the economic stability and therefore related to the risk preferences within the VC markets.

Because the correlation between TBY and average deal size in US VC markets is not statistically significant, the results of their inverse relationship are not presented in this section. Similarly, the correlation value between IPOs and average deal size is not statistically significant and the results between these variables are ignored from this section. Furthermore, the correlation between IPI and average deal size does not provide any statistically significant results and their relationship is excluded from the findings.

5.2.1 Hypotheses findings

Earlier findings within the study states that macroeconomic policy actions taken by the Fed affected positively to achieved equity returns after the covid crisis. Principal reasons behind this relation have been the expansionary policy era characterized with accelerated liquidity and lower interest rates within the economy. Achievements due to the taken policy actions include output growth, lower unemployment rate and accelerated economic activity. These findings provide macroeconomic basis to the development of the US VC markets. Expansionary macroeconomic policy era has impacted VC markets by accelerating rapid growth in invested amount of capital and average deal size. The number of executed deals has also increased constantly as illustrated in the sample performance section. This demonstrates the relation between taken policy actions and US VC markets performance.

Results of the empirical research suggest that specific macroeconomic variables have statistically significant correlation with the VC variables included in the regression analysis. The results indicate positive correlation of the specific VC variables development with IPO and IPI. Negative correlation in the study to the VC variables movements is identified with UR. These relations demonstrate the impact of macroeconomic policy

actions to VC industry by as e.g., providing insight about the fact decreasing unemployment rate has positive influence on the US VC markets performance due to their inverse relationship. The first hypothesis of the study suggest that the performance of the VC markets was significantly influenced by the Federal Reserve's policy actions in response to the covid crisis. The results of this study and the provided background about the relationship between taken policy actions and US VC variables provide basis to the fact the Fed had significant impact to the performance of the VC markets, therefore we approve the first hypothesis.

Findings regarding the covid crisis era indicate superior performance of equity markets after the expansionary policy actions taken by the Fed within the economy, as stated earlier. The superior equity market returns favor ventures by making their future growth prospects attractive by the time of liquidity event, which venture capitalists implement as e.g., via initial public offering. Liquidity event via IPO is lucrative with a remarkably higher probability during booming equity markets, which accelerates overall interest within companies going public. Ventures are frequently compared to small-cap enterprises due to the similarities characterizing significant proportion of ventures. Therefore, it is logical to compare ventures performance with small-cap index. The second hypothesis suggest that the behavior of the VC market is significantly associated with the stock market. This study has examined the second hypothesis by analyzing the potential correlation of Russell 2000 index in relation to the VC variables included within the regression analysis. The results of the regression analysis do not indicate any statistically significant correlation or relation between movements of the included equity market variable and VC variables; therefore, we reject the second hypothesis.

Findings regarding actions in the VC industry during specific macroeconomic environment suggest that venture capitalists balance their investment decisions based on the observed amount of risks in the overall markets. Later-stage ventures tend to relatively rise within the overall industry during times of increased economic uncertainty. This is owing to the fact venture capitalists mitigate portfolio risks by investing into ventures

with lower risk profile. Later-stage ventures are characterized with less assumed dependence on the macroeconomic environment, which had significant modifications due to the covid crisis. However, the macroeconomic modifications decided by the Fed had effectively positive cumulative impact on the economic environment and equity markets. Results of this study's regression analysis suggest that observed macroeconomic variations significantly accelerated the performance of the US VC markets during the covid crisis, after initially reducing activity at the beginning of the crisis.

Venture capitalists augmented the average executed deal sizes during the covid crisis, which is common within the overall VC industry at times of increased uncertainty. The macroeconomic policy modifications accomplished by the Fed made investment environment more favorable for ventures due to the accelerated economic liquidity and lower interest rates. Favorable market phenomenon attracts growing interest within venture capitalists by improving the future growth prospects of promising ventures, thereby accelerating the number of executed deals and total amount of invested capital in its entirety. The third hypothesis suggests that the covid crisis' risk realization had no significant impact on venture capitalists' investment strategies. Historically, overall investments in the VC industry tend to rise during times of favorable market conditions and relative proportion of later-stage ventures increases during times of growing uncertainty. Results regarding the venture capitalists' investment strategies during covid crisis are similar to the earlier findings within the US VC markets, therefore we approve the third hypothesis.

5.3 Limitations and suggestions for future research

The principal limitations of this study include the restricted number of variables and data included within the empirical research. The data of the US VC industry was limited into total amount invested and number of deals, consequently the average deal size was calculated as an outcome of their variations. The stage of the venture and the sectoral separation of ventures were ignored from the gathered data and the accom-

plished regression analysis. The main reason for disregarding these variables was due to the fact the study would have included excessively variables in the empirical research for achieving adequate statistically significant results within the desirable research area.

The future research within this same research area could include these ignored variables from this accomplished study. The aim of the future research could focus on the variations of singular stage ventures and sectoral separations of ventures during certain macroeconomic environment. The results of this accomplished study suggest that later-stage ventures relative proportion increments during times of increased economic uncertainty. However, the exact amounts of specific stage actualized ventures at certain moment are disregarded from the analysis. Future research could calculate the exact proportion of various stage ventures as for e.g., during covid crisis era and define detailed conclusions regarding venture capitalists' investment strategies based on the achieved findings.

The second aspect of the future research could focus within the sectoral separations of actualized ventures as for e.g., during covid crisis. The future research within this research area could suggest that specific macroeconomic environment attracts growing interest on certain sector ventures. This assumption could be studied by gathering sectoral US VC markets data from the covid crisis era and research whether macroeconomic policy modifications by the Fed affected significantly on the interest of certain sectors within the VC markets. Similarly, the study could research whether the interest in certain sector ventures diminishes during specific changes within the macroeconomic environment.

In addition to the future research options mentioned above, similar research regarding the correlation between VC markets and macroeconomy could be carried out on another terrain. The future research could focus as for e.g., on the European venture capital markets and their behavior in relation to the surrounding macroeconomy.

6 Conclusions

This study has gathered data from the past approximately 26 years for better understanding the historical development and variations at the US VC markets, particularly during crisis eras. Correspondingly, data of particular macroeconomic variables has been gathered from the same era for providing insight about the historical macroeconomic changes. This study has especially focused on the covid crisis era and its impact on the VC markets due to the fact the newest economic crisis era has not been extensively studied in the VC industry. The literature review of the study has identified multiple significant methods for risk mitigation at the portfolio level within the VC industry. The research has also detected certain behavioral and risk preference modifications within VC investors during times of increased economic uncertainty. Similarly, venture capitalists adjust their level of risks at times of favorable market environment. These findings provide basis to the fact modifications within the US VC industry are connected to the surrounding macroeconomic environment.

The principal purpose of the study has been finding significant correlation between macroeconomic variables and US ventures performance. The aim of finding statistically significant relationship between particular macroeconomic variables and US VC markets has been accomplished by utilizing regression analysis for measuring their potential correlations. The results of the regression analysis confirm the assumed relationship between macroeconomy and US VC markets. The findings provide statistical significance regarding the macroeconomic transitions impact to the ventures' development and performance. However, the statistically significant correlation with the VC markets applies only partially to the included macroeconomic variables. Certain macroeconomic variables consisting of as for e.g., included stock index within this study do not indicate any statistically significant relation to the VC markets variations. These findings provide essential insight on the detected relationship during the research era between equity markets and overall macroeconomy with the US VC markets performance.

Results of this study suggest that venture capitalists have historically adjusted their investor behavior during certain macroeconomic environment by as for e.g., taking excessively or degressively risks with their investments. This behavior has affected the evolution of ventures during singular eras by accelerating or diminishing activity within the VC industry during certain detected level of risks and uncertainty. These findings and insights of this study provide significant information on the presumable future evolution of the US VC markets during particular transitions within the surrounding macroeconomy. This endorses venture capitalists on implementing certain modifications with the risk levels within investment portfolios based on their risk preferences and obtained knowledge on the affections of specific macroeconomic transitions to their portfolios and singular ventures future achievable performance.

References

- Alexander, C. (2001). *Market models: A guide to financial data analysis*. John Wiley & Sons.
- Andretta, M. (2014). Some Considerations on the Definition of Risk Based on Concepts of Systems Theory and Probability. *Risk Analysis*, 34(7), pp. 1184-1195. doi:10.1111/risa.12092
- Ang, J. S. (1992). On the Theory of Finance for Privately Held Firms. *Journal of Small Business Finance*, Vol. 1: Iss. 3, pp. 185-203.
- Aven, T., & Renn, O. (2009). On risk defined as an event where the outcome is uncertain. *Journal of Risk Research*, 12:1–11.
- Aven, T. (2010). On how to define, understand and describe risk. *Reliability Engineering and System Safety*, 95(6), pp. 623-631. doi:10.1016/j.ress.2010.01.011
- Aven, T. (2011). On some recent definitions and analysis frameworks for risk, vulnerability, and resilience. *Risk analysis : an official publication of the Society for Risk Analysis*, 31(4), p. 515. doi:10.1111/j.1539-6924.2010.01528.x
- Bamford, C. & Douthett, E. (2012). Venture capital and risk management: Evidence from initial public offerings. *Risk Governance and Control: Financial Markets and Institutions*, 2(1), pp. 30-40. doi:10.22495/rgcv2i1art4
- Beaver, W., Kettler, P. & Scholes, M. (1970). The Association between Market Determined and Accounting Determined Risk Measures. *The Accounting Review*, 45(4), pp. 654-682.

- Bengtsson, O. & Sensoy, B. (2011). Investor abilities and financial contracting: Evidence from venture capital. *Journal Of Financial Intermediation*, 20(4), pp. 477-502. doi:10.1016/j.jfi.2011.02.001
- Brander, J. A., Amit, R. & Antweiler, W. (2002). Venture-Capital Syndication: Improved Venture Selection vs. The Value-Added Hypothesis. *Journal of Economics & Management Strategy*, 11(3), pp. 423-452. doi:10.1111/j.1430-9134.2002.00423.x
- Brealey, R. A., Myers, S. C. & Allen, F. (2017). *Principles of corporate finance* (Twelfth edition. International student edition.). New York, NY: McGraw-Hill Education.
- Buchner, A., Mohamed, A. & Schwienbacher, A. (2017). Diversification, risk, and returns in venture capital. *Journal of Business Venturing*, 32(5), pp. 519-535. doi:10.1016/j.jbusvent.2017.05.005
- Cachanosky, N., Cutsinger, B. P., Hogan, T. L., Luther, W. J. & Salter, A. W. (2021). The Federal Reserve's response to the COVID-19 contraction: An initial appraisal. *Southern economic journal*, 87(4), 1152-1174. <https://doi.org/10.1002/soej.12498>
- Case, K. E., Fair, R. C. & Oster, S. M. (2012). *Principles of economics* (10th, global ed.). Pearson Education.
- Cendrowski, H., Martin, J. P., Petro, L. W. & Wadecki, A. A. (2012). *Private Equity: History, Governance, and Operations*. Hoboken: John Wiley & Sons.
- Chong, Y. Q., Wang, B., Yue Tan, G. L. & Cheong, S. A. (2014). Diversified firms on dynamical supply chain cope with financial crisis better. *International Journal of Production Economics*, 150(C), pp. 239-245. doi:10.1016/j.ijpe.2013.12.030

- Coleman, S. (2004). The "Liability of Newness" and Small Firm Access to Debt Capital: Is There a Link? *The Journal of Entrepreneurial Finance & Business Ventures*, 9(2), pp. 37-59.
- Cumming, D., Fleming, G. & Schwienbacher, A. (2005). Liquidity Risk and Venture Capital Finance. *Financial Management*, 34(4), pp. 77-105. doi:10.1111/j.1755-053X.2005.tb00119.x
- Demaria, C. (2013). *Introduction to Private Equity : Venture, Growth, LBO and Turn-Around Capital* (2nd Edition). Wiley.
- Dimov, D. P., & Shepherd, D. A. (2005). Human capital theory and venture capital firms: exploring "home runs" and "strike outs". *Journal of Business Venturing*, 20 (1), 1–21. doi:10.1016/j.jbusvent.2003.12.007
- Dosi, G., Fagiolo, G. & Roventini, A. (2010). Schumpeter meeting Keynes: A policy-friendly model of endogenous growth and business cycles. *Journal of economic dynamics & control*, 34(9), 1748-1767. <https://doi.org/10.1016/j.jedc.2010.06.018>
- eFront Insight. (2020). *Return evolution of active VC funds. Returns, risks and liquidity of VC Funds in Q3 2020*. Collected 2022-02-02 from address <https://www.efront.com/research-papers/returns-risks-and-liquidity-of-vc-funds-in-q3-2020/>
- Eiamkanitchat, N., Moontuy, T. & Ramingwong, S. (2017). Fundamental analysis and technical analysis integrated system for stock filtration. *Cluster computing*, 20(1), 883-894. <https://doi.org/10.1007/s10586-016-0694-2>

- Feldkircher, M., Huber, F. & Pfarrhofer, M. (2021). Measuring the effectiveness of US monetary policy during the COVID-19 recession. *Scottish journal of political economy*, 68(3), 287-297. <https://doi.org/10.1111/sjpe.12275>
- Ferrary, M. (2010). Syndication of Venture Capital Investment: The Art of Resource Pooling. *Entrepreneurship Theory and Practice*, 34(5), pp. 885-908. doi:10.1111/j.1540-6520.2009.00356.x
- Fiet, J. O. (1995). Risk avoidance strategies in venture capital markets. *Journal of Management Studies*, 32 (4), 551 – 574. doi: 10.1111/j.1467-6486.1995.tb00788.x
- Friedman, M. (1956). *Studies in the quantity theory of money*. University of Chicago Press.
- Goodfriend, M. (2007). How the World Achieved Consensus on Monetary Policy. *The Journal of economic perspectives*, 21(4), 47-68. <https://doi.org/10.1257/jep.21.4.47>
- Grinblatt, M., & Keloharju, M. (2001). How Distance, Language, and Culture Influence Stockholdings and Trades. *Journal of Finance*, 56(3), pp. 1053-1073. doi:10.1111/0022-1082.00355
- Gürkaynak, R. S. & Wright, J. H. (2012). Macroeconomics and the Term Structure. *Journal of economic literature*, 50(2), 331-367. <https://doi.org/10.1257/jel.50.2.331>
- Hain, S. (2011). Risk perception and risk management in the Middle East market: Theory and practice of multinational enterprises in Saudi Arabia. *Journal of Risk Research*, 14(7), pp. 819-835. doi:10.1080/13669877.2011.571777

- Hardy, M. A., Bryman, A., Hazelrigg, L., Jamshidian, M., Maynard, M., Smith, D., . . . Atkinson, P. (2004). *Handbook of data analysis*. SAGE Publications.
- He, P. (2007). A Theory of IPO Waves. *The Review of financial studies*, 20(4), 983-1020. <https://doi.org/10.1093/revfin/hhm004>
- Hull, J., & Hull, J. (2018). *Risk management and financial institutions* (Fifth edition.). Hoboken, New Jersey: John Wiley & Sons, Inc.
- Kahneman, D. & Tversky, A. (1979). Prospect Theory: An Analysis of Decision under Risk. *Econometrica*, 47(2), 263-291. <https://doi.org/10.2307/1914185>
- Kaminsky, G. L., Reinhart, C. M. & Végh, C. A. (2004). When It Rains, It Pours: Procyclical Capital Flows and Macroeconomic Policies. *NBER macroeconomics annual*, 19, 11-53. <https://doi.org/10.1086/ma.19.3585327>
- Kanniainen, V., & Keuschnigg, c. (2003). The Optimal Portfolio of Start-up Firms in Venture Capital Finance. *Journal of Corporate Finance*, 6, pp. 241-289. [doi.org/10.1016/S0929-1199\(02\)00021-4](https://doi.org/10.1016/S0929-1199(02)00021-4)
- Kaplan, S. & Garrick, B. J. (1981). On The Quantitative Definition of Risk. *Risk Analysis*, 1(1), pp. 11-27. doi:10.1111/j.1539-6924.1981.tb01350.x
- Kaplan, S., & Strömberg, P. (2003). Financial contracting theory meets the real world: An empirical analysis of venture capital contracts. *Review of Economic Studies*, 70(2), pp. 281-315. doi:10.1111/1467-937X.00245
- Keynes, J. M. (1935). *The general theory of employment, interest, and money*.

KPMG Enterprise. (2021). *Venture Pulse, Q1'21. Global Analysis of Venture Funding*.
 Collected 2022-01-10 from address
<https://assets.kpmg/content/dam/kpmg/xx/pdf/2021/04/venture-pulse-q1-2021-report-global.pdf>

Kut, C., & Smolarski, J. (2006). Risk management in private equity funds: a comparative study of Indian and Franco-German funds. *Journal of Developmental Entrepreneurship*, 11(1), pp. 35-55. doi:10.1142/S1084946706000258

Kut, C., Pramborg, B., & Smolarski, J. (2007). Managing financial risk and uncertainty: The case of venture capital and buy-out funds. *Global Business and Organizational Excellence*, 26(2), pp. 53-64. doi:10.1002/joe.20132

Lauterbach, R., Welpel, I., & Fertig, J. (2007). Performance differentiation: Cutting losses and maximizing profits of private equity and venture capital investments. *Financial Markets and Portfolio Management*, 21(1), pp. 45-67. doi:10.1007/s11408-006-0039-x

LiPuma J. A., & Park, S. (2014). Venture capitalists' risk mitigation of portfolio company internationalization. *Entrepreneurship Theory and Practise*, 38, 1183-1205. doi:10.1111/etap.12033

Lowrance, W. W. (1976). Of Acceptable Risk: Science and the Determination of Safety. *Journal of The Electrochemical Society*, 123(11), p. 373C. doi:10.1149/1.2132690

Lu, Q., Hwang, P., & Wang, C. (2006). Agency risk control through reprisal. *Journal of Business Venturing*, 21(3), pp. 369-384. doi:10.1016/j.jbusvent.2005.08.001

- Manigart, S., De Waele, K., Wright, M., Robbie, K., Desbrières, P., Sapienza, H. J., & Beekman, A. (2002). Determinants of required return in venture capital investments: A five-country study. *Journal of Business Venturing*, 17(4), pp. 291-312. doi:10.1016/S0883-9026(00)00067-7
- Markowitz, H. (1952). Portfolio selection*. *The journal of finance*, 7(1), 77-91. doi:10.1111/j.1540-6261.1952.tb01525.x
- Ning, Y., Wang, W., & Yu, B. (2015). The driving forces of venture capital investments. *Small Business Economics*, 44(2), pp. 315-344. doi:10.1007/s11187-014-9591-3
- Okpala, K. E. (2012). Venture capital and the emergence and development of entrepreneurship: A focus on employment generation and poverty alleviation in Lagos State.(Report). *International Business and Management*, 5(2), p. 130. doi:10.3968/j.ibm.1923842820120502.1060
- Proksch, D., Stranz, W., Pinkwart, A., & Schefczyk, M. (2016). Risk management in the venture capital industry: Managing risk in portfolio companies. *The Journal of Entrepreneurial Finance*, 18(2), pp. 1-33.
- Salmeron, R., Garcia, C. B. & Garcia, J. (2018). Variance Inflation Factor and Condition Number in multiple linear regression. *Journal of statistical computation and simulation*, 88(12), 2365-2384. <https://doi.org/10.1080/00949655.2018.1463376>
- Sapienza, H. J., Manigart, S., & Vermeir, W. (1996). Venture capitalist governance and value added in four countries. *Journal of Business Venturing*, 11(6), pp. 439-469. doi:10.1016/S0883-9026(96)00052-3

- Sharpe, W. F. (1964). Capital asset prices: a theory of market equilibrium under conditions of risk*. *Journal of Finance*, 19(3), pp. 425-442. doi:10.1111/j.1540-6261.1964.tb02865.x
- Smolarski, J., Verick, H., Foxen, S., & Kut, C. (2005). Risk management in Indian venture capital and private equity firms: A comparative study. *Thunderbird International Business Review*, 47(4), pp. 469-488. doi:10.1002/tie.20063
- Stowell, D. P. (2013). *Investment banks, hedge funds, and private equity* (2nd ed.). Waltham, MA: Academic Press.
- Stranz, W. (2017). *Risk and Return Management of Venture Capital Companies in the Post-Investment Phase*. Doctor of Economics, HHL Leipzig Graduate School of Management, Leipzig, Germany.
- Talmor, E., & Vasvari, F. (2011). *International Private Equity*. Wiley.
- Tan, J., Zhang, W., & Xia, J. (2008). Managing Risk in a Transitional Environment: An Exploratory Study of Control and Incentive Mechanisms of Venture Capital Firms in China. *Journal of Small Business Management*, 46(2), pp. 263-285. doi:10.1111/j.1540-627X.2008.00243.x
- Tourani-Rad, A., & England, B. (2003). Characteristics of Venture Capital Firms and Investment Appraisals: Australian Evidence*. *The Journal of Entrepreneurial Finance and Business Ventures*, 8(2), 71-85.
- Wang, H., Wuebker, R., Han, S., & Ensley, M. (2012). Strategic alliances by venture capital backed firms: An empirical examination. *Small Business Economics*, 38(2), pp. 179-196. doi:10.1007/s11187-009-9247-x

- Wang, S., & Zhou, H. (2004). Staged financing in venture capital: Moral hazard and risks. *Journal of Corporate Finance*, 10(1), pp. 131-155. doi:10.1016/S0929-1199(02)00045-7
- Wolke, T. (2017). *Risk Management*. Oldenbourg: De Gruyter Oldenbourg.
- Wooldridge, J. M. (2010). *Econometric analysis of cross section and panel data* (2nd ed.). MIT Press.
- Ying, Q., Yousaf, T., Ain, Q. u., Akhtar, Y. & Rasheed, M. S. (2019). Stock Investment and Excess Returns: A Critical Review in the Light of the Efficient Market Hypothesis. *Journal of risk and financial management*, 12(2), 97. <https://doi.org/10.3390/jrfm12020097>
- Zacharakis, A., & Meyer, G. (2000). The potential of actuarial decision models: Can they improve the venture capital investment decision? *Journal of Business Venturing*, 15(4), pp. 323-346. doi:10.1016/S0883-9026(98)00016-0