**T.C.**

**TURKISH-GERMAN UNIVERSITY**

**INSTITUTE OF SOCIAL SCIENCES**

**DEPARTMENT OF INTERNATIONAL FINANCE**

# THE IMPACT OF PRIVATE EQUITY AND VENTURE CAPITAL INVESTMENTS ON ECONOMIC GROWTH AND INNOVATION: EVIDENCE FROM OECD COUNTRIES

## MASTER'S THESIS

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**ISTANBUL, 2024**

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*I dedicate this thesis to the cherished memory of my late uncle, Dr. Halil ÖZCAN, who left us in January 2024. His memory will always be with us.*

# ABSTRACT


## THE IMPACT OF PRIVATE EQUITY AND VENTURE CAPITAL INVESTMENTS ON ECONOMIC GROWTH AND INNOVATION: EVIDENCE FROM OECD COUNTRIES

This study investigates the impact of private equity (PE) and venture capital (VC) investments on economic growth and innovation in OECD countries. Utilizing data spanning from 2007 to 2020 and employing panel data analysis methods, the research examines the effects of PE and VC investments on economic growth and innovation, as measured by GDP growth and patent applications respectively. Various econometric models and tests, including the Least Squares Dummy Variable (LSDV) estimator and the Generalized Method of Moments (GMM), have been used to address potential endogeneity issues and ensure the reliability of the findings.

The results demonstrate that both PE and VC investments have significant and positive effects on economic growth and innovation. PE investments are associated with higher GDP growth rates, while VC investments significantly increase the number of patent applications, reflecting enhanced innovative activities.

The research contributes to the theoretical understanding of the role of financial investments in economic development and provides empirical evidence supporting the positive impact of PE and VC investments on economic growth and innovation. The findings have important implications for policymakers and investors, highlighting the necessity of a sustainable and dynamic entrepreneurial and investment ecosystem to maximize the economic contributions of PE and VC investments.



**Keywords:**

Private Equity Investments,

Venture Capital Investments,

Economic Growth,

Innovation

**Date: 22.07.2024**

# ÖZET


## ÖZEL SERMAYE VE GİRİŞİM SERMAYESİ YATIRIMLARININ EKONOMİK BÜYÜME VE İNOVASYON ÜZERİNDEKİ ETKİSİ: OECD ÜLKELERİNDEN BİR KANIT

Bu çalışmada, özel sermaye (PE) ve girişim sermayesi (VC) yatırımlarının OECD ülkelerindeki ekonomik büyüme ve inovasyon üzerindeki etkisi araştırılmıştır. 2007 ile 2020 yılları arasını kapsayan veriler panel veri analiz yöntemleri kullanılarak PE ve VC yatırımlarının ekonomik büyüme ve inovasyon üzerindeki etkisi incelenmiştir. Çalışmada, potansiyel içsellik sorunlarını ele almak ve bulguların güvenilirliğini sağlamak amacıyla, Sabit Etkili Değişkenler (LSDV) tahmincisi ve Genelleştirilmiş Momentler Metodu (GMM) dahil olmak üzere çeşitli ekonometrik modeller ve testler kullanılmıştır.

Sonuçlar, PE ve VC yatırımlarının her ikisinin de ekonomik büyüme ve inovasyon üzerinde pozitif bir etkiye sahip olduğunu göstermektedir. PE yatırımları daha yüksek GSYİH büyüme oranları ile ilişkilendirilirken, VC yatırımlarının patent başvuru sayısını önemli ölçüde artırdığı sonucuna ulaşılmıştır.

Araştırma, finansal yatırımların ekonomik büyüme üzerindeki rolüne yönelik teorik yaklaşıma katkıda bulunmakta ve PE ve VC yatırımlarının ekonomik büyüme ve inovasyon üzerindeki pozitif etkisini destekleyen ampirik kanıtlar sunmaktadır. Bulgular, politika yapıcılar ve yatırımcılar için önemli çıkarımlar içermekte olup PE ve VC yatırımlarının ekonomiye sunduğu katkının etkinleştirilmesi için sürdürülebilir ve dinamik bir girişim ve yatırım ekosisteminin önemini ortaya çıkarmaktadır.



**Anahtar Kelimeler:**

Özel Sermaye Yatırımları,

Girişim Sermayesi Yatırımları,

Ekonomik Büyüme,

İnovasyon

**Tarih: 22.07.2024**

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# LIST OF ABBREVIATIONS

| Abbreviations | Meanings |
|---|---|
| ARDC | American Research and Development Corporation |
| AUM | Assets Under Management |
| EIB | European Investment Bank |
| EIF | European Investment Fund |
| EMPEA | Emerging Markets Private Equity Association |
| ESG | Environmental, Social, and Governance |
| ESOP | Employee Stock Ownership Plan |
| EVCA | European Private Equity and Venture Capital Association |
| FFF | Founders, Family, Friends |
| GDP | Gross Domestic Product |
| GIIN | Global Impact Investing Network |
| GMM | Generalized Method of Moments |
| ICAEW | Institute of Chartered Accountants in England and Wales |
| IEA | International Energy Agency |
| IMF | International Monetary Fund |

| | |
|---|---|
| IPO | Initial Public Offerings |
| LBO | Leveraged Buyout |
| LSDV | Least Squares Dummy Variable |
| M&A | Mergers and Acquisitions |
| MBI | Management Buy-in |
| MBO | Management Buyout |
| NVCA | National Venture Capital Association |
| OECD | Organisation for Economic Co-operation and Development |
| PE | Private Equity |
| POLS | Pooled Ordinary Least Squares |
| PPI | Producer Price Index |
| PSUR | Panel Seemingly Unrelated Regression |
| R&D | Research and Development |
| SMEs | Small and Medium-sized Enterprises |
| SSRN | Social Science Research Network |
| SUR | Seemingly Unrelated Regression |
| USD | United States Dollar |
| VC | Venture Capital |

# GLOSSARY

**Assets Under Management (AUM):** The total market value of the investments that a person or entity manages on behalf of clients.

**Creative Destruction:** A concept in economics that refers to the process by which new innovations replace outdated technologies, leading to economic growth and progress.

**Endogenous Growth Theory:** A theory which holds that economic growth is primarily the result of endogenous and not external forces. Investment in human capital, innovation, and knowledge are significant contributors to economic growth.

**Environmental, Social, and Governance (ESG):** Criteria used to evaluate a company's operations and performance in terms of sustainability and ethical impact.

**Founders, Family, Friends (FFF):** Informal sources of funding for startups, typically from the business founders, their family members, and friends.

**Generalized Method of Moments (GMM):** An econometric method that provides a way to estimate parameters in models with potentially endogenous variables.

**Gross Domestic Product (GDP):** The total value of all goods and services produced within a country over a specific time period, often used as a measure of economic performance.

**Initial Public Offerings (IPOs):** The first time that the stock of a private company is offered to the public, often used by companies to raise capital.

**Innovation:** The act of converting concepts or inventions into products and services that generate value or for which consumers are willing to pay.

**International Monetary Fund (IMF):** An international organization dedicated to promoting global monetary cooperation, ensuring financial stability, facilitating international trade, enhancing high employment and sustainable economic growth, and alleviating poverty worldwide.

**International Monetary Fund (IMF) Financial Development Index Database**: A comprehensive database developed by the IMF that measures the financial development of countries. It includes indicators that capture the depth, access, and efficiency of financial institutions and financial markets.

**Least Squares Dummy Variable (LSDV):** An econometric technique used in panel data analysis that involves the inclusion of dummy variables to control for individual-specific effects.

**Leveraged Buyout (LBO):** The acquisition of a company using a significant amount of borrowed money to meet the cost of acquisition.

**Management Buy-in (MBI):** When an external management team acquires a company and replaces the existing management team.

**Management Buyout (MBO):** When a company's management team purchases the assets and operations of the business they manage.

**Mergers and Acquisitions (M&A):** Transactions in which the ownership of companies, other business organizations, or their operating units are transferred or consolidated with other entities.

**Organisation for Economic Co-operation and Development (OECD**): An international organization of countries committed to democracy and the market economy, providing a platform to compare policy experiences, and coordinate domestic and international policies.

**Panel Data:** Data that contains observations on multiple phenomena over multiple time periods for the same firms or individuals.

**Panel Seemingly Unrelated Regression (PSUR):** A statistical method used to estimate multiple equations that are interrelated, commonly applied in panel data analysis.

**Private Equity (PE):** Capital investment made into companies that are not publicly traded, often used to fund new technologies, make acquisitions, expand working capital, and bolster and solidify a balance sheet.

**Producer Price Index (PPI):** An index that measures the average change over time in the selling prices received by domestic producers for their output.

**Research and Development (R&D):** Activities undertaken by companies to develop new products or improve existing products and services.

**Seemingly Unrelated Regression (SUR):** An econometric technique used to estimate multiple equations that are believed to be correlated with one another.

**Small and Medium-sized Enterprises (SMEs):** Businesses whose personnel numbers fall below certain limits, playing a significant role in the economy by providing employment and fostering innovation.

**Venture Capital (VC):** Financing that investors provide to startups and small businesses that are believed to have long-term growth potential.

# I. INTRODUCTION

This chapter outlines the key aspects of the research, including the thesis topic, purpose, and importance, followed by the problem statement, and concludes with an overview of the sources and methods employed in this study.

## 1.1 Thesis Topic

The topic of this thesis is “The Impact of Private Equity PE and Venture Capital VC Investments on Economic Growth and Innovation in OECD Countries”. The study focuses on how these forms of financial investments contribute to the overall economic performance and innovative capacity of firms within the economies. By analyzing data from 2007 to 2020, this research aims to provide empirical evidence on the significance of PE and VC investments in fostering economic development and innovative advancements. The thesis employs various econometric models to examine the relationship between these investments and key economic indicators such as GDP growth and patent applications, thus offering a comprehensive understanding of the role of financial investments in economic growth and innovation.

## 1.2 Thesis Purpose

The principal objective of this research is to conduct a comprehensive examination of the implications of privave equity and venture capital investments on economic growth and innovation, thereby offering a novel perspective to the extant literature in this domain. This overarching objective can be further delineated into the following sub-objectives.

Understanding the Principles of Private Equity and Venture Capital: To elucidate the conceptual framework of private equity and venture capital investments, shedding light on its foundational principles and operational mechanics.

Analysis of the Contribution of Private Equity and Venture Capital Investments to Economic Growth and Innovation: This endeavor seeks to analyze the manner in which private equity investments and venture capital investments facilitate economic growth and innovation, accentuating the pivotal role of this investment type in the processes of growth and innovative advancements.

Determining the Stage-wise Impact on Economic Development and Innovation: To ascertain the influence of different investment stages on economic development and innovation,

providing a granular understanding of how each phase contributes to the broader economic and innovative landscape.

Development of Policy Recommendations: Grounded in the findings, this research aspires to inter-conutry policy recommendations on the integration of private equity and venture capital investments into strategies for economic growth and innovation enhancement.

Laying the Groundwork for Future Research: By synthesizing the research outcomes, the study aims to proffer insights that can guide subsequent scholarly endeavors. This will facilitate a deeper comprehension of the influence of private equity and venture capital investments on economic growth and innovation, serving as an inspiration for emergent research trajectories.

The overarching aim of this research is to comprehensively elucidate the significance of private equity and venture capital investments within the context of economic growth and innovation, foster a profound understanding in this realm, and provide guidance to policy-maker.

## 1.3 Thesis Importance

The significance of this thesis lies in its comprehensive analysis of the role of private equity (PE) and venture capital (VC) investments in driving economic growth and innovation within OECD countries. The importance of this study can be summarized as follows:

Empirical Evidence on Financial Investments: By providing robust empirical evidence on the positive impacts of PE and VC investments, this thesis contributes to the broader understanding of how financial markets influence economic development. It addresses a critical gap in the literature by systematically analyzing the effects of these investments on key economic indicators such as GDP growth and patent applications.

Policy Implications: The findings of this research have significant implications for policymakers. Understanding the role of PE and VC in fostering economic growth and innovation can inform the development of policies that create a supportive environment for these investments. Policymakers can leverage these insights to craft regulations and incentives that promote a vibrant investment ecosystem, ultimately driving sustainable economic growth.

Guidance for Investors: For investors, this thesis provides valuable insights into the economic benefits of private equity and venture capital. By highlighting the mechanisms through which these investments contribute to economic performance and innovation, the study offers guidance on strategic investment decisions. Investors can use this information to identify

opportunities that correspond with their financial objectives and contribute to broader economic objectives.

Contribution to Theoretical Frameworks: This research enhances existing theoretical frameworks by integrating the role of financial investments in economic growth theories. It extends traditional models that focus on capital accumulation, labor, and technological progress by incorporating the impacts of PE and VC investments. This theoretical contribution provides a more holistic understanding of the drivers of economic development.

The importance of this thesis is multifaceted, offering empirical validation, policy guidance, investment insights and theoretical contributions. It underscores the critical role of private equity and venture capital in fostering economic growth and innovation, providing a foundation for future research and practical applications in the field of financial investments.

## 1.4 Problem Statement

The focus of this research is to investigate the effect of private equity and venture capital investments on economic growth and innovation, specifically within the context of 25 OECD countries spanning the years 2007 to 2020. Utilizing a panel regression framework, the study delves into the intricacies of how these investments influence economic dynamics and innovative endeavours. A central challenge addressed is discerning the non-linear influence of private equity and venture capital investments on these parameters. Existing literature presents a gap regarding the nature of this influence, especially during crisis periods, and whether the relationship is linear or not. By exploring the non-linear impact of private equity and venture capital investments on economic growth and innovation, and understanding its variations during crisis times, this research seeks to provide a comprehensive insight and contribute significantly to the academic discourse on the subject.

## 1.5 The Sources and the Methods of the Thesis

This thesis utilizes a comprehensive set of sources and methods to examine the impact of private equity (PE) and venture capital (VC) investments on economic growth and innovation within OECD countries. The primary data sources include financial reports, investment records, and economic indicators from reputable databases such as the International Monetary Fund (IMF), World Bank, and OECD databases. Additionally, academic journals, industry reports, and previous research studies provide a theoretical and empirical foundation for the analysis.

The methodology employed in this study involves panel data analysis, which is well-suited for examining the dynamic relationships between PE and VC investments and economic outcomes over time. Specific econometric models, including the Least Squares Dummy Variable (LSDV) estimator and the Generalized Method of Moments (GMM), are used to address potential endogeneity issues and ensure robust and reliable results. These methods allow for a detailed examination of the causal effects of PE and VC investments on GDP growth and patent applications, offering insights into the mechanisms driving economic development and innovation.

The combination of diverse data sources and rigorous econometric methods provides a solid foundation for understanding the role of private equity and venture capital investments in fostering economic growth and innovation in OECD countries.

# II. LITERATURE REVIEW

In this chapter, the thesis explores a wide array of topics central to understanding the impact of private equity (PE) and venture capital (VC) investments on economic growth and innovation. The review begins with an examination of entrepreneurship, including the concepts of entrepreneurship, entrepreneur, and startup, as well as the history and developments of entrepreneurship, the entrepreneurship ecosystem and its stakeholders, and the various funding and financing phases of startup companies.

The review delves into alternative investments, providing a conceptual framework, historical developments, and a global outlook on alternative investments. The discussion then shifts to private equity investments, covering their conceptual framework, history, and worldwide outlook. Venture capital investments are similarly explored, followed by an analysis of the fundamental differences between PE and VC investments, including their investment strategies, priorities, and expected returns.

The literature review also examines innovation and its relationship with PE and VC investments, highlighting how these investments drive innovative activities. Finally, the review addresses economic growth and innovation, the relationship between economic growth, innovation and PE & VC investments, providing a comprehensive understanding of the economic implications of these financial investments.

## 2.1 Entrepreneurship

As a general perspective, entrepreneurship can be defined as the process of identifying, developing, and exploiting opportunities to create value through innovate products, services, or processes, often involving risk-taking and resource mobilization within uncertain environments.

### 2.1.1 Entrepreneurship, Entrepreneur, and Startup Concepts

The concept of entrepreneurship has been a focal point of scholarly debate and analysis for decades, leading to a multitude of definitions and theoretical perspectives. This diversity in understanding stems from the multifaceted nature of entrepreneurship itself, encompassing elements of innovation, risk-taking, and resource coordination. Various scholars have contributed to the evolving definition of entrepreneurship, each highlighting different aspects of the entrepreneurial process and its impact on economic systems. This chapter explores these varying definitions and roles of entrepreneurship, aiming to provide a comprehensive overview

of the field as it stands today. By examining the foundational theories proposed by prominent economists and the ongoing debates within the literature, this analysis seeks to shed light on the complexities and dynamics of entrepreneurship as a pivotal driver of societal and economic progress.

Schumpeter (1934) defined entrepreneurship as the act of innovation, whereas Knight (1921) emphasized that entrepreneurship is driven by individuals who are willing to take risks. Knight (1921) also noted that an entrepreneur's success could not be predicted, and that errors and uncertainties could only be anticipated beforehand. However, in the future, the entrepreneurial firm's behaviour is crucial for the dynamism of society Baumol, described the entrepreneur as the pinnacle of the hierarchy and identified him as the person who instils a specific role within the entrepreneurial spirit and brings new ideas to life. In the entrepreneurship literature, entrepreneurial roles and definitions have been frequently discussed. Dollinger (2008) nearly agrees with the definitions mentioned by writers focusing on entrepreneurship, noting that the term "entrepreneur" comes from the French root meaning "to undertake".

Knight (1921) views the entrepreneur as someone who takes on uncertainty. Schumpeter (1934) describes the entrepreneur as an innovator and industry leader. Casson (2003) characterises the entrepreneur as a decision-maker. Marshall (1920) sees the entrepreneur as a coordinator of resources within the economy. Kirzner (1973) identifies the entrepreneur as a person who is alert to opportunities. Schultz (1975) defines the entrepreneur as someone who allocates resources among alternative uses.

Exploring and capitalising on new opportunities are regarded as the core elements of entrepreneurship. Entrepreneurs who seize these opportunities develop new products and processes and establish innovative organisational structures. These entrepreneurial activities lead to the creation of new markets (Martinez et al., 2010). The significance of entrepreneurship within the economic system is highlighted by the heightened competition in the free market. Entrepreneurs of various ages undertake new ventures by converting inventions or ideas into viable business concepts (Gries and Naudé, 2011).

The explanation of entrepreneurship, in terms of definitions, scholars, and years, is provided in Table 1.

**Table 1:** Entrepreneurship Definitions by Scholars and Years

| Authors | Definitions | Years |
|---|---|---|
| Cantillon | Taking on risk by buying and reselling agricultural and manufactured goods. | 1734 |
| Beaudeau | The process of planning, effective management, systematic organization, and risk assumption constitutes entrepreneurship. | 1797 |
| Jean Baptiste Say | Entrepreneurship is characterized by the differentiation of income derived from capital gains. | 1803 |
| Knight, F. | Predicting and responding to market changes. | 1921 |
| Schumpeter | Market innovation through implementing new combinations of resources. | 1934 |
| Peter Drucker | Entrepreneurship involves the optimization of opportunities and potentials. | 1964 |
| Leibenstein | Performing necessary tasks to create or maintain an enterprise in markets that are not fully established or well-defined, where parts of the production process are not completely known. | 1968 |
| Kirzner | Recognizing and acting upon market opportunities. | 1979 |
| Brockhaus, | Major ownership and management of a business without being employed elsewhere. | 1980 |
| Hull, at all. | The organization and management of a business, assuming risk for profit. | 1980 |
| Gartner | The establishment of new organizations. | 1988 |
| Low and MacMillan | The formation of new enterprises. | 1988 |
| Stevenson and Jarillo | The process where individuals pursue opportunities regardless of the resources they currently have, whether independently or within organizations. | 1990 |
| Karl Vesper | Entrepreneurship is a multifaceted phenomenon that encompasses the interests and insights of psychologists, economists, politicians, and business professionals. | 1990 |

| | | |
|---|---|---|
| Lumpkin and Dess | Entering new markets or industries. | 1996 |
| Shane and Venkataraman | Discovering, assessing, and exploiting opportunities. | 2000 |
| Bruyat and Julien | A dynamic interaction between an individual and new value creation within a specific environment. | 2001 |
| Lackeus, L., and Williams M. | Creating value that benefits others. | 2016 |

**Source:** Adapted by the author.

Researchers do not have a consensus on the exact definition of entrepreneurship and the role of entrepreneurs (Amit, Glosten, Muller, 1993). Shane and Venkataraman (2000) noted that defining entrepreneurship solely by certain individuals' characteristics is impossible. They emphasized that, unlike previous studies that approached entrepreneurship from a conceptual area, today it is more often addressed in terms of firms like small businesses or new enterprises. For this reason, the authors argue that the biggest obstacle in forming a conceptual framework for entrepreneurship again lies in its definition.

Freeman and Engel (2007) assert that critical elements constituting a startup include the entrepreneur, investors, employees, technology, and the business model. Hebert and Link (1982) offer a synthetic definition of an entrepreneur as someone who specializes in making judgmental decisions that affect the use of goods, resources, or institutions. Evans (1942) describes an entrepreneur as a business executive associated with the organization of new business units, substantial expansions, and adapting to changing environments, highlighting the dynamic activities of entrepreneurs.

Mangia and Naffziger (2003) emphasize that an entrepreneur is more than just someone who starts a business, involving deeper characteristics and motivations that drive entrepreneurial actions.

An entrepreneur is an individual who identifies a business opportunity and assumes the financial, operational, and market risks to establish and grow a new venture. Entrepreneurs are often characterized by their innovation, creativity, and willingness to take on challenges in order to create and expand a business enterprise. They are pivotal in driving economic growth, fostering innovation, and generating employment opportunities. Entrepreneurs leverage

resources, plan strategically, and adapt to changing market conditions to achieve business success and profitability.

The term "Startup" has been explored extensively in academic literature, leading to a diverse range of definitions and theoretical perspectives. Despite the widespread interest and research, there remains a lack of consensus on a precise definition. Due to its novelty and the necessity for each discipline to approach startups from its own perspective, there is no universally accepted definition of startups (Haltiwanger et al., 2012; Adam, 2014). This ambiguity has hindered systematic knowledge advancement in the field of entrepreneurship. According to Knight, Greer, and De Jong (2018), a startup can be broadly understood through three key dimensions: ownership of equity, autonomy in strategic decision-making, and team entitativity. These dimensions help differentiate startups from other organizational forms and highlight their unique characteristics.

A startup is often defined as a new business venture initiated by entrepreneurs aiming to bring an innovative product or service to market. Schumpeter (1934), emphasized the role of innovation, describing startups as entities that drive market changes through new combinations of resources. Knight (1921), focused on the element of risk-taking, viewing startups as ventures that attempt to predict and respond to market changes. This perspective underscores the uncertainty and dynamic nature of startups, where success is often unpredictable. Further, startups are characterized by their organizational structure and the entrepreneurial team's role within this structure. For instance, startups involve the creation of new products, processes, and organizational structures to capitalize on market opportunities (Martinez et al., 2010). These ventures are distinguished by their ability to navigate uncharted territories, leveraging innovation and entrepreneurial skills to achieve growth and success in competitive markets. Additionally, startups are often driven by the entrepreneurial spirit, which includes the willingness to take risks, innovate, and coordinate resources efficiently. This entrepreneurial mindset is crucial for transforming ideas into viable business concepts and driving economic growth. The formation of startups is thus not only a business activity but also a significant contributor to economic development and societal progress Knight, A. P., Greer, L. L., & De Jong, B. (2018).

A Startup is a newly established business entity, typically founded by entrepreneurs who aim to develop a unique product or service and bring it to market. Startups are characterized by their innovative approaches, high potential for growth, and the significant risk involved. The formation and success of startups are often driven by the founders' ability to leverage new

opportunities, develop novel organizational structures, and navigate the challenges of an uncertain market environment.

The business models that startups employ constitute a crucial aspect of their definitions. Startups are often depicted as entities that transform markets by introducing and continuously refining innovative business models (Nanda and Rhodes-Kropf, 2013). According to Cockayne (2019), it would be insufficient to classify every new enterprise as a startup without considering factors such as novel business models, innovation, business scale, and the potential for rapid growth.

The literature review reveals that a startup company is defined as a new business initiated by entrepreneurs who combine their ideas and resources. With the advancement of technology in the 21st century, new features have been included in the definitions of startups (Low and MacMillan, 1988).

The OECD (2016) highlights the transformative impact of startups, defining them as innovative enterprises that address emerging challenges or generate new demand through the development of novel business models.

The explanation of a startup in terms of definitions, scholars, and years, is provided in Table 2.

**Table 2:** Startup Definitions by Authors and Years

| Authors | Definitions | Years |
|---|---|---|
| Chorev and Anderson | Startups are businesses that use advanced technology to create innovative products and/or services. | 2006 |
| Avnimelech and Teubal | Startups are young, high-tech companies whose main activity is to develop a new business idea through its initial stages. | 2006 |
| Ries | Startup ventures are companies established to produce new products and services in an environment of uncertainty. | 2011 |
| Marmer vd. | Startups are organizations that continuously renew themselves by progressing through various stages such as Discovery, Validation, Efficiency, Scaling, Survival, and Sustaining. | 2011 |

| | | |
|---|---|---|
| Graham | A Startup is a growth-oriented enterprise that requires venture capital and must have a solid exit strategy. | 2012 |
| Blank | Startups are companies that have renewable or scalable business models. | 2013 |
| Nanda, Rhodes-Kropf, | Startups are companies that play a transformative role in markets by introducing new business models and continuously developing these models | 2013 |
| Caf | Startups are ventures with high growth potential on a global or regional scale, created by an entrepreneurial team. | 2015 |
| Krejci et al. | A Startup is an emerging enterprise with potential for rapid growth and scalability, based on innovation and technology in its business model. | 2015 |
| Petru et al. | A Startup is a scalable company with low incremental costs and the potential for significant short-term growth. | 2019 |

**Source:** Adapted by the author.

In the entrepreneurship and startup ecosystem, different terms are used to classify startups based on their valuations:

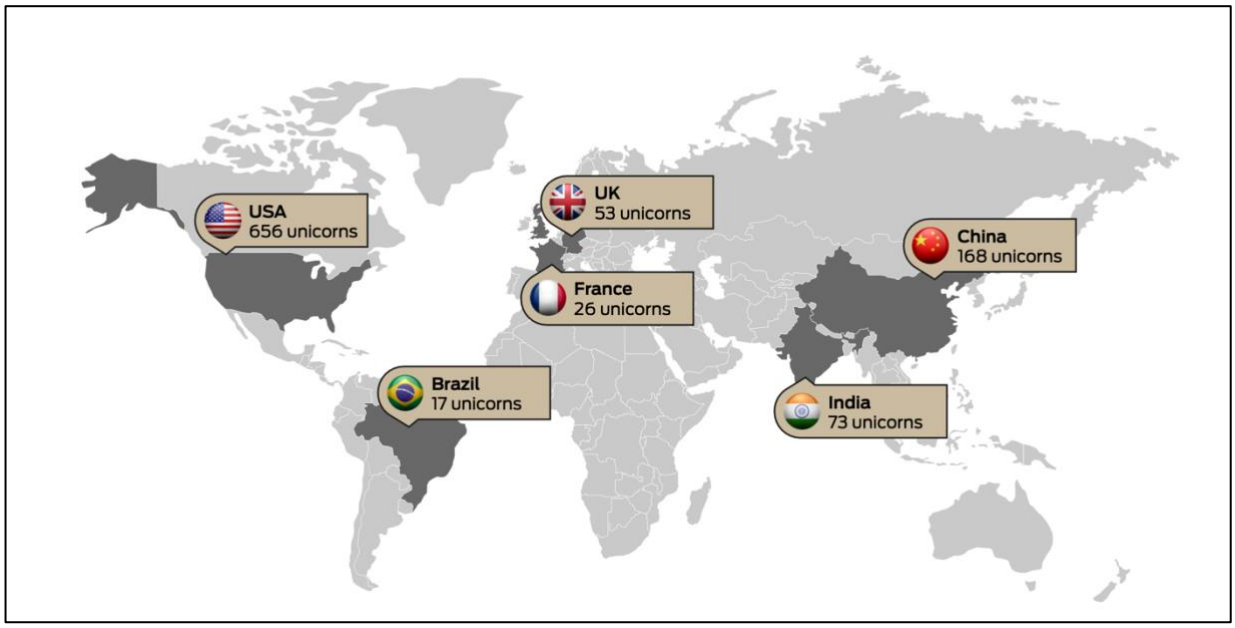
Unicorn: A unicorn Startup is a privately held company valued at over $1 billion. Venture capitalist Aileen Lee coined this term in 2013. Once considered rare, the number of unicorns has grown significantly in recent years due to an increase in venture capital funding and rapid advancements in the technology sector.

Decacorn: A decacorn refers to a company valued at over $10 billion, making them less common than unicorns. These companies have demonstrated substantial growth and have achieved significant market influence.

Hectocorn: Hectocorns are exceptionally rare and prestigious, with valuations exceeding $100 billion. These industry giants have disrupted markets and become widely recognised and established brands.

As of March 2024, there are over 1,220 unicorns around the world. Total cumulative valuation is nearly $3,888 billion around the word. Variants include a decacorn, valued at over $10 billion, and a hectocorn, valued at over $100 billion (CB Insights, 2024).

**Figure 1:** Word Unicorn Map




**Source:** Adapted by author from CB Insights.

The following table presents the distribution of unicorn companies by the 15 countries, indicating the number of unicorns and their corresponding percentages as of March 20, 2024, based on data from the CB Insights Global Unicorn Club.

**Table 3:** Number of Unicorns by Countries

| Countries | Number of Unicorns | Percentages (%) |
|---|---|---|
| United States | 656 | 53.47 |
| China | 168 | 13.70 |
| India | 73 | 5.95 |
| United Kingdom | 53 | 4.32 |
| Germany | 30 | 2.44 |
| France | 26 | 2.12 |
| Israel | 25 | 2.04 |
| Brazil | 17 | 1.39 |
| Canada | 11 | 0.90 |
| South Korea | 21 | 1.71 |
| Australia | 9 | 0.73 |
| Sweden | 6 | 0.49 |
| Singapore | 16 | 1.30 |
| Japan | 7 | 0.57 |
| Netherlands | 9 | 0.73 |

**Source:** Adapted by the author from CB Insights.

The subsequent table illustrates the sectoral distribution of unicorn companies, reflecting their respective percentages within the global unicorn ecosystem as of March 20, 2024, according to data from the CB Insights Global Unicorn Club.

**Table 4**: The Distribution of Unicorns Across Various Sectors

| Sectors | Percentages (%) |
|---|---|
| Fintech | 21.2 |
| Internet Software & Services | 18.7 |
| E-commerce & Direct-to-Consumer | 10.3 |
| Artificial Intelligence | 8.8 |
| Health | 7.3 |
| Consumer & Retail | 6.2 |
| Data Management & Analytics | 5.3 |
| Cybersecurity | 4.6 |
| Supply Chain, Logistics & Delivery | 4.2 |
| Auto & Transportation | 3.5 |
| Hardware | 3.1 |
| EdTech | 2.8 |
| Mobile & Telecommunications | 2.3 |
| Media & Entertainment | 1.9 |

**Source:** Adapted by the author from CB Insights

### 2.1.2 History and Developments of Entrepreneurship

Zimmerman (2008) examined the historical development of entrepreneurship under three main frameworks of Classical theorists, Neoclassical theorists and Modern theorists.

Some researchers suggest that early entrepreneurial behavior can be seen in the "big man" phenomenon in Melanesian society (Stewart, 1990) or the adventurer concept in feudal societies (Nerlich, 1987). Nevertheless, it was economists who first developed scholarly theories on entrepreneurship. Most academics categorize these economists' work into Classical (up to about 1850), Neoclassical (up to about 1950), and Modern (up to about 1980) streams. The Modern stream is particularly notable for bringing entrepreneurial theory into the realm of behavioral sciences. Due to the extensive amount of research available, in this part of the research it will be focused on the most influential contributors to the history of entrepreneurship theory.

The exploration of classical entrepreneurial theory begins with examining the origin of the term. The word "entrepreneur" originates from the French words "entre" and "preneur," signifying "to take between" or "to undertake" (Bird & West, 1997). This term was initially

recorded in the French dictionary Dictionnaire de la Langue Française in 1437 (Landstrom, 1999). The meanings of these words correspond with early entrepreneurial theories developed by Richard Cantillon (1734), who depicted entrepreneurs as intermediaries who assumed the risks associated with the production, circulation, and exchange of goods. Cantillon, an Irish trader working in Paris during Europe's shift from the feudal system, formulated the initial commercial theory of entrepreneurship (Hoselitz, 1960; Redlich, 1949).

During the feudal era in Europe, production and consumption were limited to small, self-contained villages, which explains the initial focus on intermediaries or mercantile approaches in early entrepreneurial concepts (Landes, 1966). The transition from feudalism was driven by technological advancements, such as Gutenberg's movable type (1455), Pacioli's double-entry bookkeeping (1494), advanced agricultural practices like three-field cropping, Biringuccio's metallurgical improvements (1540), and the Huygens brothers' inventions of a mechanical clock and telescope (1654 and 1656). Improvements in shipbuilding and navigation further expanded trade beyond traditional boundaries (Harland & Myers, 1984). These social, political, and technological changes moved society from a feudal order to market-driven systems, necessitating freer enterprise forms, contractual agreements, and a formal monetary system (Polanyi, 1968; Casson, 1992; Crump, 1981).

Some scholars addressed the entrepreneurship concepts indirectly. Adam Smith (1776) introduced several well-known concepts that laid the groundwork for modern economic theory and established a lasting link between economic and entrepreneurial theory. Smith highlighted three fundamental economic forces: land, labor, and capital; proposed the idea of the invisible hand guiding the marketplace; and emphasized the importance of the division of labor. Additionally, he introduced the concept of projectors, describing them as individuals who undertake projects for profit.

Neoclassical economics, which has been the dominant economic theory since the late 19th century, developed methodologies using scientific methods to explain market and individual behaviors in free-market, decentralized economies (Glancey, 2000). Alfred Marshall, a distinguished economist active from the late 1890s to 1924, made substantial contributions to entrepreneurship theory through his general equilibrium theory. Marshall asserted that the price and output of goods are dictated by the law of supply and demand (Marshall, 1920). His principal contribution to entrepreneurship theory was acknowledging the importance of an organizer in the production process (Bowman, 1990). Marshall introduced the concept that there are four factors of production—land, labour, capital, and organization—contrary to Smith's three factors.

This highlighted the role of an organizer who coordinates production, takes risks, and provides leadership (Bowman).

Schumpeter's impactful work on entrepreneurship is widely acknowledged, culminating in the establishment of the Harvard Research Center in Entrepreneurial History by Arthur H. Cole in 1946. This center effectively linked the disciplines between economics and entrepreneurship, initiating the first entrepreneurship course in 1947 and subsequently leading to the creation of the Arthur Rock Center for Entrepreneurship (Eddison, 2006).

Until the culmination of Schumpeter's work, the progression of entrepreneurship theory was primarily advanced by economists. This development was cumulative, with each new insight building upon previous efforts, and was generally well-structured. However, following Schumpeter's era, the literature on entrepreneurship became increasingly fragmented and more challenging to synthesize. Landstrom (1999) classifies post-Schumpeterian advancements into two principal categories: the Harvard tradition, which was an adaptation of Schumpeter's views further developed by Arthur Cole; and the human action tradition, which was heavily influenced by the works of von Hayek and von Mises.

The Harvard tradition conceptualizes entrepreneurship as encompassing three primary dimensions: systemic changes in the economy, the establishment of organizations to facilitate the commercialization of innovations, and the recognition that the entrepreneurial role is to generate profits through the production and distribution of goods and services (Landstrom, 1999). Arthur H. Cole, a prominent Harvard economist, bolstered and expanded Schumpeter's framework by arguing that any comprehensive economic theory must include the entrepreneur as a central catalyst (Cole, 1946). Cole also insisted that entrepreneurship studies should integrate research methodologies from various disciplines. He delineated the field of entrepreneurship into three areas: the structure of entrepreneurial organizations, motivational studies, and the processes of entrepreneurial change (Cole, 1959). Despite Cole's significant contributions leading to a decade of intensive research, the closure of the Harvard Research Center in Entrepreneurial History in 1958 left the field in a state of disarray (Hughes, 1978).

### 2.1.3 Entrepreneurship Ecosystem and Its Stakeholders

Similar to a biological ecosystem, a business ecosystem consists of networks of large and loosely connected organizations. Just as in biological systems, where the fate of a single species ultimately affects the entire network, each member of a business ecosystem shares the fate of the network, regardless of their apparent power. The components of the ecosystem interact with each

other, and the health and performance of each component and the actors within it depend on the health and performance of the entire ecosystem. Similarly, every action taken by an institution impacts the network and the institution itself, either positively or negatively. Given the significant influence actors have on each other in terms of stability and productivity, it is expected that each actor assumes different roles and the ecosystem exhibits a heterogeneous structure (Lansiti, Levien, 2004).

The core focus of an entrepreneurial ecosystem strategy lies in identifying the components that constitute the entrepreneurial ecosystem and understanding how it evolves. This strategy is employed to elucidate the unique, complex development of ecosystems, which do not adhere to a fixed order (Isenberg, 2011).

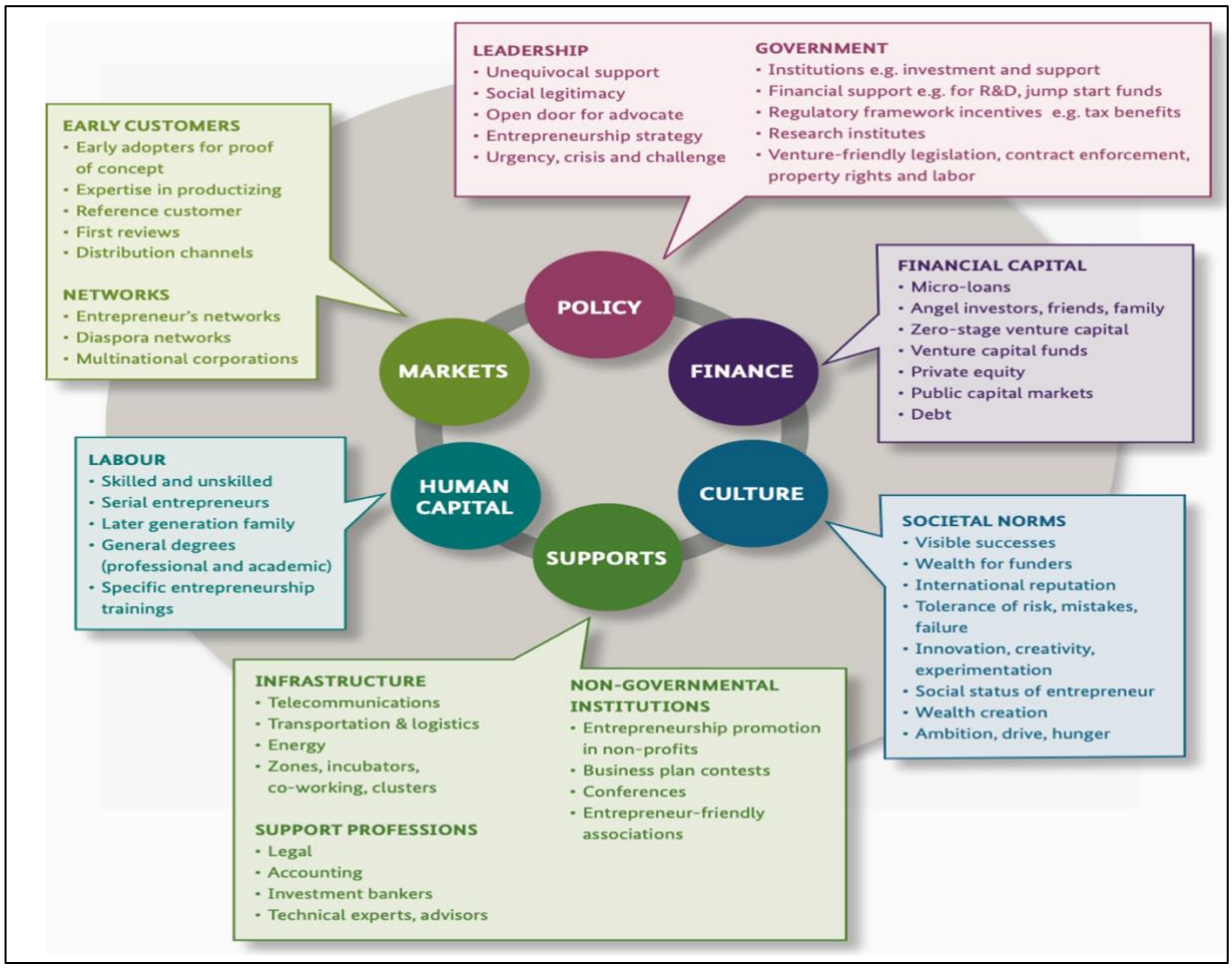
Mack and Mayer (2016) conceptualize the entrepreneurial ecosystem as the dynamic components of entrepreneurial systems that drive new firm creation within distinct regional contexts. They further underscore those regions with heightened entrepreneurial activity should be conceptualized as integrated systems (Neck et al., 2004; Mack & Mayer, 2016).

The Aspen Network of Development Entrepreneurs (ANDE) has developed a series of tools and resources to elucidate entrepreneurial ecosystems. In 2013, ANDE reviewed nine different ecosystem approaches, which include:

1. Babson College - Babson Entrepreneurship Ecosystem Project,
2. Council on Competitiveness - Asset Mapping Roadmap,
3. George Mason University - Global Entrepreneurship and Development Index,
4. Hwang, V.H. - Innovation Rainforest Blueprint,
5. Koltai and Company - Six + Six,
6. GSM Association – Information and Communication Technology Entrepreneurship,
7. Organisation for Economic Co-operation and Development – Entrepreneurship Measurement Framework,
8. World Bank - Doing Business,
9. World Economic Forum - Entrepreneurship Ecosystem.

Isenberg, (2011) identified six fundamental pillars constituting an entrepreneurial ecosystem: policy, finance, culture, supports, human capital, and markets.

**Figure 2:** Isenberg's Model of an Entrepreneurship Ecosystem

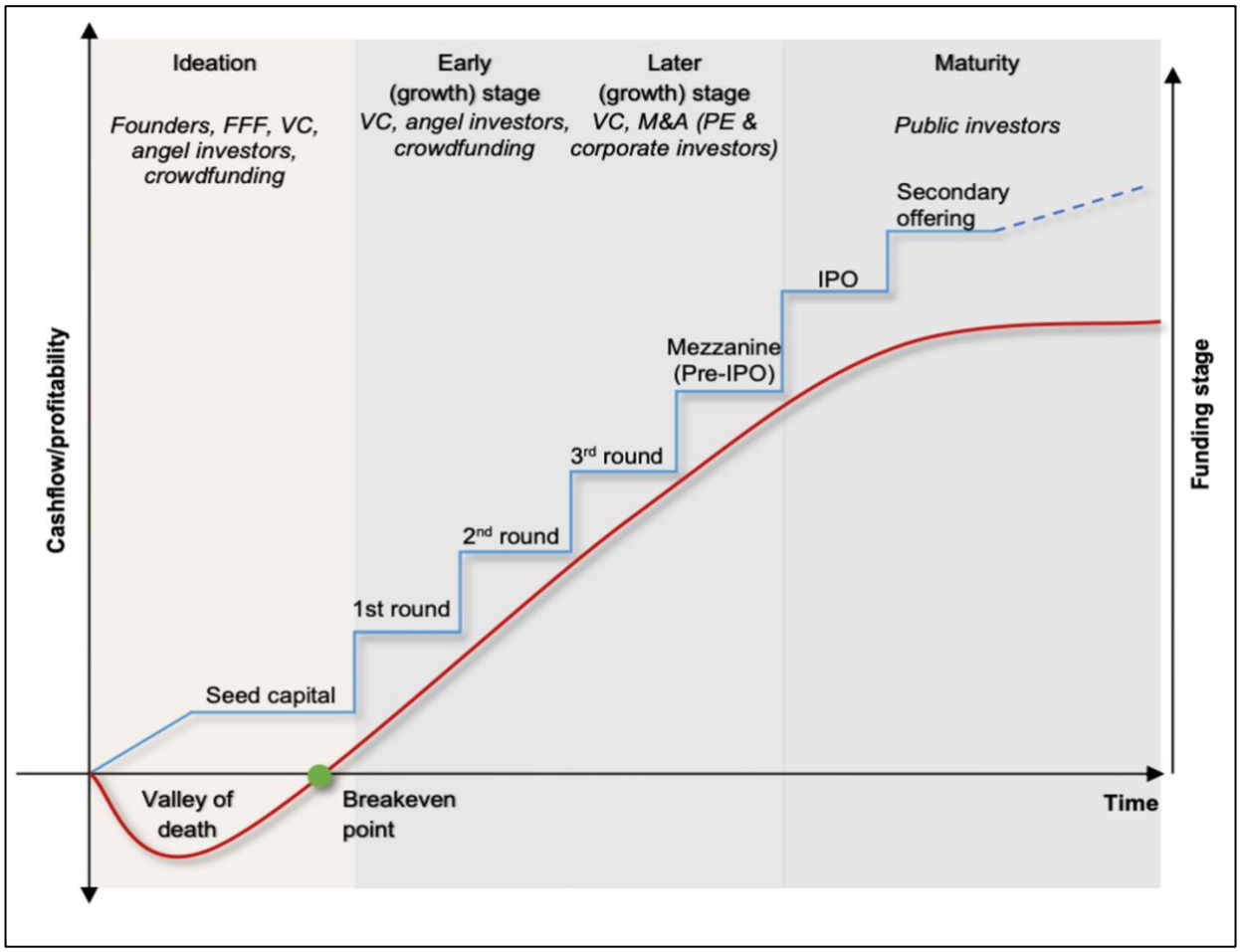



**Source:** Mason, C., & Brown, R. (2014). Entrepreneurial ecosystems and growth-oriented entrepreneurship. Final report to OECD, Paris, 30(1), 77-102

### 2.1.4 Funding Stages of Startup Companies

Startups generally adhere to a systematic life cycle in the figure 5, beginning with ideation (the formulation of a business concept) and concluding with the company's public or private sale (Botella-Carrubi, Maqueda-Llongo, & Valero-Moya, 2022). When a Startup identifies the necessity for external financing, venture capital (VC) becomes essential. This requirement is influenced by four key drivers corresponding to different phases of the business: "investment, profitability, cash flow, and sales growth" (Caselli & Negri, 2018, p. 10). Considering these factors, Caselli and Negri identified six stages of financial requirements evident throughout a business's life cycle: development, Startup, early growth, expansion, maturity, and crisis/decline.

**Figure 3**: The Funding Stages of Startup Companies




**Source:** As'ad Mohammad, 2023 Adapted by from Cardullo.

As illustrated in the Figure 3, Cardullo (1999) delineates a significant relationship between a business's life cycle and its corresponding funding stages, rounds, as well as their sources. He posits that as a business progresses through its life stages, it necessitates increasingly substantial funding, which is secured from various investor groups that share similar investment objectives, such as risk and return, and align with the specific characteristics of the funding stage.

In the ideation stage of a Startup, characterized by the highest degree of uncertainty and the fastest rate of cash depletion with minimal or no revenue, a situation often referred to as the "valley of death," the typical investors involved are founders, family, friends and fools (FFF), and angel investors. This stage is particularly precarious as the nascent venture has yet to demonstrate a viable product or market fit, and the financial risk is exceptionally high. Consequently, the funding typically secured at this stage comes from sources willing to take significant risks based on personal relationships or a strong belief in the visionary potential of the entrepreneur. Founders often bootstrap their ventures, relying on their personal savings and

contributions from their close network, while angel investors provide early capital in exchange for equity, motivated by the potential for high returns despite the inherent risks.

As the venture progresses and surpasses this critical ideation phase, it aims to achieve a breakeven point where revenues begin to cover the operational costs. Reaching this milestone allows the Startup to attract additional funding from a new class of investors, such as venture capitalists (VCs), who are looking for businesses that have moved past the initial idea and are beginning to demonstrate commercial viability. VCs typically invest through a series of funding rounds, each designed to support different stages of the company's growth, including product development, market entry, and scale-up.

Cumming and Johan (2014) underscore the difficulty of establishing universally accepted definitions of funding stages or rounds among venture capital practitioners and investors across various countries. They suggest that using a diagrammatic approach, such as Figure 5, provides a more meaningful framework to define funding stages within a VC context, irrespective of geographic location. This visual representation helps to standardize understanding by illustrating the sequential nature of funding rounds and their respective investor types.

In contrast, Klingler-Vidra (2016) delineates early-stage investments as Series A and B funding rounds for businesses that have already developed their products and distribution channels. These rounds typically focus on fine-tuning the business model, expanding the team, and beginning substantial marketing efforts. Later-stage investments, categorized as Series C and beyond, are aimed at financing companies with established cash flow and a growing customer base. These rounds are intended to support further expansion, market penetration, and sometimes international scaling. The distinct categorization by Klingler-Vidra highlights a structured progression of funding that aligns with the maturation of the business.

Identifying the specific types or categories of investors interested in different phases of a business presents a significant challenge in establishing consistent universal standards within the venture capital (VC) industry. Conventionally, venture capital funds are believed to primarily finance Startups during their seed and early stages. Nevertheless, recent trends suggest a shift where VCs are increasingly investing in later stages of business development (Dittmer, McCahery, and Vermeulen, 2014; Shane and Nicolaou, 2018; Dai, Chapman, and Shen, 2022). This trend has resulted in a funding gap for early-stage Startups, thereby creating an opportunity for alternative financing methods such as crowdfunding to address this gap (Tomczak and Brem,

2013). Crowdfunding platforms allow entrepreneurs to secure small amounts of capital from a large pool of investors, offering a practical solution for early-stage funding needs.

Moreover, as venture capital funds increasingly invest in later-stage businesses, their investment strategies begin to overlap with those of broader private equity (PE) funds. This convergence has implications for the traditional roles and distinctions between VC and PE funds, as highlighted by Cumming and Johan (2014). The blurring of lines between these two types of funds can affect market dynamics, investor expectations, and the types of companies that can access different sources of capital at various stages of their development.

The ideation stage of a Startup, marked by high uncertainty and significant financial risk, relies heavily on funding from founders, family, friends, and angel investors. As the business matures and reaches key milestones such as breakeven, it attracts further investment from venture capitalists through subsequent funding rounds. The evolving definitions and practices within the venture capital industry reflect the complex and dynamic nature of Startup financing, underscoring the need for flexible and context-specific approaches to understanding funding stages and investor types.

### 2.1.5 Financing Phases of Startup Companies

a) Seed Financing

This stage is also known by various names such as the ideation phase, research and development phase, project financing, and seed stage (İlgün, 2019). It represents the phase where an idea is proposed or a process is organized. At this stage, there is no cash flow. Entrepreneurs typically secure the necessary financing from their families, networks, angel investors, and private venture capital funds active in this area (Aydoğan Çete, 2021). During this phase, the entrepreneur must convince an investor to support their idea or product. Investors scrutinize the idea or product brought by the entrepreneur from technical and economic perspectives. Ideas and products presented to investors at this stage are usually untested and untried. Investors evaluate the feasibility of these ideas and products and decide whether to invest (Aydoğan Çete, 2021). Given the high level of uncertainty associated with investments at this stage, there is a significant risk that the entire invested capital could be lost, posing a substantial risk to investors (ERTÜRK, 2017, as cited in Aydoğan Çete, 2021).

Such investments typically require long-term financial support. This stage is considered one of the most challenging phases for venture capitalists, as the entrepreneur often has little beyond their project or idea. The likelihood of project failure is quite high. Statistics indicate that 70% of projects supported by venture capitalists are abandoned during the seed financing stage (Kantar, 2015; as cited in Fetahlıoğlu, 2020).

Various challenges can be encountered with investments at this stage. These include technological advancements shortening the product's lifespan, insufficient utilization of patent opportunities, weak competitiveness of the product, entrepreneurs persisting despite failure, lack of motivation among entrepreneurs, and ineffective management of funds (Yılmaz, 2010; as cited in İlgün, 2019).

b) Startup Financing

The phase following the seed stage is commonly referred to as the "Initial stage" or "Startup stage." At this point, entrepreneurs typically have reached a certain size and possess a management team to oversee operations. Additionally, established workflows and business processes are generally in place (Aydoğan Çete, 2021, p. 33). The incubation period is one of the most prevalent phases for investments. During this stage, the entrepreneur has developed the idea, prepared a business plan, and created prototypes; however, the product or service has yet to be commercialized. Given the significant investment required at this stage, investors usually expect high returns (Külahçı, 2015; as cited in Fetahlıoğlu, 2020, p. 38).

Although the investment risk remains high, investments at this stage are typically based on the entrepreneur's business plan. Therefore, investors may employ several strategies to mitigate risk, including (Aydoğan Çete, 2021):

Put Option: The investor acquires shares with the intention of selling them back.

Collateral: The investor secures valuable assets within the venture as collateral.

Privilege Creation: The investor purchases shares with privileges, such as management rights, to participate in the company's governance and reduce risk.

For an entrepreneur, the ability to effectively present the project to potential customers is critical. The entrepreneur must leverage not only capital support but also the knowledge and experience of the venture capitalist. The necessary startup capital at this stage is used for

preparations like office leasing and staffing. The project's success remains uncertain, and venture capitalists provide professional expertise and support (İşeri, 2001; as cited in İlgün, 2019,).

This phase typically spans 6-8 years. In the United States, it has been observed that out of every ten startups, two fail within the first 2-3 years, two survive up to five years, one generates significant profit, one achieves average revenue, and the remaining four produce insufficient returns (Kürşat et al., 2011, as cited in İlgün, 2019).

c) Level-Up Financing

The level up or acceleration phase is characterized by firms that have largely completed product and service development activities, possess a commercial product, have initiated revenue streams, and are striving to sustain their presence in a competitive environment by solidifying their customer base and expanding into new markets (Aydoğan Çete, 2021). During this stage, businesses may experience negative cash flows due to insufficient sales figures, necessitating additional capital infusion. This period can be viewed as a critical phase where companies intensify their efforts to establish a foothold in the market (Aydoğan Çete, 2021).

d) Early-Stage Financing

In this stage, businesses develop their products or services but has not yet enhanced their brand image or market share. Securing the necessary funds through traditional methods to achieve these goals is challenging. Additionally, the company may face significant managerial issues during this phase. To address these challenges, the financial and managerial support of venture capitalists becomes essential (Arslan Garipcin, 2017).

e) Expansion & Scaling-Up Financing

At this stage, businesses have completed their establishment, and their production and marketing phases have stabilized. The next steps involve expanding market share and increasing profitability through full-capacity production. Companies should conduct a thorough analysis of their current situation and set new objectives to enhance organizational and financial structures. These objectives may include securing funds for human resources and machinery investments or exploring new markets (Fetahlıoğlu, 2020). During this phase, the entrepreneur’s idea has transformed into a commercial product. The entrepreneur now faces competition and must strive to capture market share from competitors. The company focuses on offering the most cost-effective and high-quality product to its customers, including product differentiation efforts. Additionally, the company aims to reduce costs to reach the breakeven point as quickly as

possible (Aydoğan Çete, 2021). To achieve these activities and desired growth, additional capital is needed. Typically, venture capital funds provide the necessary financing at this stage. The level of investment risk has significantly decreased compared to earlier stages. Investments made during this phase have a higher success rate, primarily because the company now has a marketable product and a high potential to reach breakeven production scale. The entrepreneurial company is actively engaged in marketing its products and striving for higher revenues (Ertürk, 2017).

f) Bridge Financing

Bridge financing is a form of short-term investment typically provided to businesses planning to go public within six months to a year. This type of financing aims to meet the financial needs of the company during this transition period. During this stage, companies often experience rapid growth (Fetahlıoğlu, 2020). Warrants are commonly used in this type of financing, and it is observed that multiple venture capital firms often participate in providing this capital (İlgün, 2019, p. 20).

g) Mezzanine Financing

Meazzine Financing similar to bridge financing, typically has a maturity of less than two years. This type of funding is used to support a company during the period leading up to a significant transition, such as a sale, merger, or initial public offering, representing an interim phase. It is often provided through instruments such as high-yield bonds or preferred shares and can also be employed by the management of entrepreneurial firms for the purpose of acquiring the company (İlgün, 2019). This type of financing exhibits a hybrid structure, combining elements of both debt and equity (Fetahlıoğlu, 2020).

h) Exit Financing: IPO, MBO, LBO, MBI, ESOP, M&A

Acquisitions aimed at supporting entrepreneurs or entrepreneurial groups who possess expertise but lack the financial strength to buy businesses for various reasons are termed acquisition financing. The distinguishing feature of these investments is that the acquirers, whether from within or outside the target business, are entrepreneurs with extensive knowledge of the business being sold (İlgün, 2019). At the exit stage of a successful venture capital agreement, venture capitalists divest their investments, thereby realizing profits from the process (Vaidya, 2023). Venture capitalists may exit their investments by selling their shares or assets to company managers (Management Buyout: MBO), third parties (Leveraged Buyout: LBO), new

managers (Management Buy-in: MBI), or to the employees of the company (Employee Stock Ownership Plan: ESOP).

Initial Public Offering (IPO): An Initial Public Offering (IPO) refers to the process through which a private company offers shares of its stock to the public for the first time. This transition from private to public ownership is typically undertaken to raise capital from public investors and is often accompanied by increased regulatory scrutiny and the need for greater transparency in financial reporting (Ritter & Welch, 2002).

Management Buyout (MBO): A Management Buyout (MBO) is a transaction is a transaction in which the current management team of a company purchases a substantial portion or the entirety of the company's assets and operations. This form of buyout is often facilitated through the use of substantial leverage and is motivated by the management team's belief in the company's potential and desire for greater control and financial rewards (Wright, Hoskisson, & Busenitz, 2001).

Leveraged Buyout (LBO): A Leveraged Buyout (LBO) involves the acquisition of a company primarily through debt financing. The assets of the company being acquired typically serve as collateral for the loans, and the expectation is that the acquired company's cash flows will service the debt. LBOs are commonly employed to take public companies private, restructure companies, or transfer ownership (Kaplan & Strömberg, 2009).

Management Buy-in (MBI): In a Management Buy-in (MBI), an external management team purchases a controlling stake in a company and assumes operational control. This contrasts with an MBO, as the new management team comes from outside the company. MBIs are often seen in situations where the current management is underperforming, and new leadership is deemed necessary to improve the company's performance (Wright, Thompson, & Robbie, 1992).

Employee Stock Ownership Plan (ESOP): An Employee Stock Ownership Plan (ESOP) is a retirement plan that provides a company’s workforce with an ownership interest in the company. Companies establish ESOPs to align the interests of their employees with those of the shareholders, motivate employees, and provide an additional employee benefit. ESOPs can also serve as a mechanism for corporate financing and succession planning (Rosen, 2007).

Mergers and Acquisitions (M&A): Mergers and Acquisitions (M&A) encompass a range of strategic transactions in which the ownership of companies, business units, or their operating assets is transferred or consolidated. A merger typically involves the combination of two

companies into a single entity, whereas an acquisition involves one company purchasing another. These transactions are pursued for various strategic reasons, including achieving synergies, expanding market share, or entering new markets (Gaughan, 2010).

## 2.2 Alternative Investments

Alternative investments refer to asset classes outside traditional investments like stocks, bonds, and cash, encompassing assets such as private equity, venture capital, hedge funds, real estate, commodities, and collectibles, often charactized by lower liquidity, higher complexity, and the potential for portfolio diversification and enhanced returns.

### 2.2.1 Conceptual Framework of Alternative Investments

Alternative investments comprise a diverse array of financial assets that are not classified under traditional categories such as stocks, bonds, or cash. These typically encompass private equity, venyure capital hedge funds, real estate, commodities, and infrastructure. These investments typically include private equity, hedge funds, real estate, commodities, and infrastructure (BlackRock, 2020). The defining characteristics of alternative investments are their unique risk-return profiles, lower liquidity, and the need for specialized knowledge to manage and evaluate them effectively. Alternative investments often offer diversification advantages because of their low correlation with conventional asset classeswhich can help in reducing portfolio volatility (Moskowitz & Vissing-Jørgensen, 2002).

Private equity involves investing directly in private companies or buying out public companies to delist them from stock exchanges. This type of investment seeks to enhance value through strategic management and operational improvements (Kaplan & Strömberg, 2009). Hedge funds, on the other hand, employ diverse strategies including long-short equity, market-neutral, and event-driven approaches to achieve high returns (Fung & Hsieh, 2004). Real estate investments vary from direct ownership of properties to investments in real estate investment trusts (REITs), providing income through rent and capital appreciation (Ling & Archer, 2012).

Commodities such as gold, oil, and agricultural products are another form of alternative investment, valued for their intrinsic properties and their role as hedges against inflation (Gorton & Rouwenhorst, 2006). Infrastructure investments involve funding public works projects like highways, bridges, and energy facilities, which offer stable and predictable cash flows over the long term (Inderst, 2010).

### 2.2.2 History and Developments of Alternative Investments

The history of alternative investments can be traced back to the early 20th century with the establishment of the first hedge fund by Alfred Winslow Jones in 1949, which introduced the concept of hedging long positions with short sales (Lhabitant, 2004). Private equity emerged more prominently in the 1980s with the proliferation of leveraged buyouts, where firms acquired businesses primarily through debt financing (Kaplan & Strömberg, 2009).

Real estate has been a longstanding investment class, with organized markets for real estate investment trusts (REITs) emerging in the 1960s. These entities allowed investors to pool capital to invest in income-generating properties, thus democratizing access to real estate investments (Ling & Archer, 2012). Commodities have been traded for centuries, but the modern commodities market took shape with the establishment of organized futures exchanges in the 19th century (Gorton & Rouwenhorst, 2006).

The development of infrastructure as an investment class is relatively recent, gaining traction in the late 20th and early 21st centuries as governments sought private capital to fund public projects (Inderst, 2010). The rise of sustainability concerns and the push for renewable energy have further accelerated interest in infrastructure investments.

### 2.2.3 Worldwide Outlook on Alternative Investments

The global landscape for alternative investments has evolved significantly, driven by institutional investor demand for diversification and higher returns in a low-yield environment. According to Preqin (2020), the alternative assets industry is projected to grow to $14 trillion by 2023, with private equity and hedge funds being the largest segments.

In North America, private equity remains a dominant force, with the region housing a significant portion of the world's private equity firms. The industry's growth has been supported by robust capital markets, a conducive regulatory environment, and a culture of entrepreneurship (EVCA, 2019). Europe has also seen significant growth in alternative investments, particularly in private equity and real estate, despite regulatory challenges and economic uncertainties (Cambridge Associates, 2018).

In Asia, the alternative investments market has been expanding rapidly, driven by economic growth and increasing wealth. Countries like China and India have become major players in the private equity and venture capital spaces, attracting significant international capital

(Bain & Company, 2020). Additionally, sovereign wealth funds in the Middle East have been active in alternative investments, seeking to diversify their portfolios away from oil and gas revenues (Inderst & Della Croce, 2013).

Hedge funds have witnessed a shift towards greater transparency and regulation following the 2008 financial crisis. This shift has led to the emergence of more sophisticated strategies and an emphasis on risk management (Fung & Hsieh, 2011). The real estate market continues to thrive globally, with investors seeking stable income streams and capital appreciation, particularly in major urban centers (Ling & Archer, 2012).

The commodities market has experienced varying levels of interest, predominantly driven by geopolitical events, economic cycles, and technological progress. The emergence of renewable energy and the emphasis on sustainability have brought new dynamics to the commodities market, increasingly highlighting green commodities (IEA, 2020).Infrastructure investments have gained prominence due to their stable cash flows and low correlation with other asset classes. Governments worldwide are increasingly partnering with private investors to fund critical infrastructure projects, further bolstering the appeal of this investment class (World Bank, 2019).

In conclusion, the alternative investments landscape is diverse and dynamic, offering unique opportunities and challenges. As investors continue to seek higher returns and diversification, the significance of alternative investments in global portfolios is expected to grow. The ongoing evolution of regulatory frameworks, technological advancements, and market conditions will shape the future of this sector, requiring investors to stay informed and adaptable.

## 2.3 Private Equity Investments

Private equity investments involve purchasing equity in private companies, typically aiming for long-term growth and high returns beyond public market opportunities.

### 2.3.1 Conceptual Framework of Private Equity Investments

Private equity (PE) investments involve the acquisition of equity ownership in companies that are not publicly traded. These investments are typically made by private equity firms, venture capital firms, and institutional investors, aiming to enhance the value of the target companies through strategic, operational, and financial improvements (Kaplan & Strömberg, 2009). The core objective of private equity investments is to achieve substantial capital gains upon exit, which can be accomplished through initial public offerings (IPOs), sales to other companies, or secondary buyouts (Cumming & Johan, 2014).

The private equity investment process can be broadly categorized into several stages: fundraising, deal sourcing, investment, management, and exit. During the fundraising stage, private equity firms raise capital from Private equity firms secure funds from institutional investors, including pension funds, insurance companies, and wealthy individuals. (Metrick & Yasuda, 2011). Deal sourcing involves identifying and evaluating potential investment opportunities. Once a target company is identified, the private equity firm performs comprehensive due diligence to evaluate the company's financial condition, market position, and growth potential (Gompers & Lerner, 2001).

Post-investment, private equity firms actively engage in the management of portfolio companies. This involvement often includes restructuring operations, optimizing capital structures, and providing strategic guidance to enhance business performance (Harris, Jenkinson, & Kaplan, 2014). The exit stage is critical, as it determines the returns generated from the investment. Successful exits typically occur through IPOs, mergers and acquisitions (M&A), or sales to other private equity firms (secondary buyouts) (Kaplan & Strömberg, 2009).

### 2.3.2 History and Developments of Private Equity Investments

The origins of private equity can be traced back to the early 20th century, with the establishment of firms that engaged in private investments. However, the modern private equity industry began to take shape in the mid-20th century with the formation of American Research and Development Corporation (ARDC) in 1946, which is often credited with pioneering venture capital (Gompers, 1994). ARDC's successful investment in Digital Equipment Corporation in

the 1950s demonstrated the potential of private equity investments to generate substantial returns.

The 1980s marked a significant period of growth for the private equity industry, driven by the proliferation of leveraged buyouts (LBOs). Firms such as Kohlberg Kravis Roberts & Co. (KKR) became prominent players, executing high-profile LBOs like the acquisition of RJR Nabisco (Baker & Smith, 1998). This era also saw the emergence of specialized private equity funds focusing on distressed assets, growth capital, and sector-specific investments (Kaplan & Strömberg, 2009).

The 1990s and early 2000s witnessed further maturation of the private equity industry, with significant capital inflows and the globalization of investment activities. Private equity firms expanded their reach to emerging markets, seeking opportunities in regions like Asia, Latin America, and Eastern Europe (Ahlstrom & Bruton, 2006). The industry also experienced increased regulatory scrutiny and the establishment of best practices for governance and transparency (Phalippou & Gottschalg, 2009).

In the wake of the 2008 financial crisis, the private equity industry encountered challenges, including reduced access to leverage and heightened regulatory oversight. However, the industry rebounded in the subsequent decade, benefiting from low interest rates and strong investor appetite for alternative assets (Robinson & Sensoy, 2016). Today, private equity continues to evolve, with firms increasingly focusing on environmental, social, and governance (ESG) factors in their investment strategies (Gompers et al., 2020).

### 2.3.3 Worldwide Outlook on Private Equity Investments

The global private equity market has shown remarkable growth over the past few decades, becoming a vital component of the global financial system. According to Bain & Company (2020), global private equity assets under management (AUM) reached $4.5 trillion in 2019, reflecting strong investor demand and robust fundraising activities. North America remains the largest market for private equity, accounting for over half of the global AUM (Preqin, 2020).

In the United States, private equity plays a significant role in the economy, supporting businesses across various sectors. The industry's impact is evident in job creation, innovation, and economic growth. Research by the American Investment Council (2020) highlights that private equity-backed companies employed over 11 million people and contributed significantly

to GDP growth. Additionally, the U.S. private equity market continues to attract international capital, further bolstering its position as a global leader (Kaplan & Schoar, 2005).

Europe represents another major hub for private equity investments. The European market has matured significantly, driven by favorable regulatory frameworks and a diverse investor base. Countries like the United Kingdom, Germany, and France have well-established private equity industries, with a strong focus on buyouts and growth capital (EVCA, 2019). The European Investment Fund (EIF) has also played a crucial role in supporting the growth of private equity in the region, particularly for small and medium-sized enterprises (SMEs) (Groh et al., 2010).

Asia-Pacific is a rapidly growing market for private equity, driven by economic growth, rising middle-class populations, and increasing entrepreneurial activity. China and India are the largest markets in the region, attracting substantial private equity investments in industries including technology, healthcare, and consumer goods (Bain & Company, 2020). The region's private equity landscape is characterized by a mix of local and international firms, contributing to its dynamic growth.

Emerging markets in Latin America, Africa, and the Middle East are also gaining traction as attractive destinations for private equity investments. These regions offer significant growth potential, driven by demographic trends, urbanization, and economic reforms. Private equity firms are increasingly exploring opportunities in these markets, seeking to capitalize on their untapped potential and contribute to sustainable development (EMPEA, 2020).

The future of private equity investments is likely to be shaped by several key trends. The integration of ESG factors into investment strategies is becoming increasingly important. Investors are recognizing the value of sustainable and responsible investing, which can enhance long-term returns and mitigate risks (Gompers et al., 2020). Technological advancements are transforming the private equity industry, with firms leveraging data analytics, artificial intelligence, and digital tools to enhance decision-making and operational efficiency (Deloitte, 2019). The rise of impact investing is influencing the private equity landscape. Impact investors aim to achieve beneficial social and environmental impacts while also securing financial profits. are increasingly aligning their strategies with impact investing principles, addressing global challenges such as climate change, poverty, and healthcare access (GIIN, 2020). Fourth, the COVID-19 pandemic has highlighted the resilience and adaptability of private equity-backed

companies. The industry has demonstrated its ability to navigate economic uncertainties and support portfolio companies through periods of crisis (Bain & Company, 2020).

Private equity investments have evolved into a sophisticated and influential asset class, playing a pivotal role in the global economy. The conceptual framework of private equity highlights its unique characteristics and investment process, while the historical development underscores its growth and maturation. The worldwide outlook on private equity investments reveals a dynamic and expanding market, with significant opportunities and challenges. As the industry persists in evolving, private equity firms must adapt to changing market conditions, regulatory landscapes, and investor preferences to sustain their growth and impact.

## 2.4 Venture Capital Investments

Venture capital investments involve funding early-stage companies with high growth potential, often in exchange for equity, aiming for significant returns as the companies' scale.

### 2.4.1 Conceptual Framework of Venture Capital Investments

Venture capital (VC) investments represent a critical component of the entrepreneurial finance landscape, providing funding to high-growth potential startups in exchange for equity stakes. This form of financing is particularly vital for early-stage companies that lack access to traditional capital markets due to their inherent risk profiles (Gompers & Lerner, 2001). The venture capital process is cyclical and involves several key stages: fundraising, investing, managing, and exiting (Sahlman, 1990).

The fundraising stage is where venture capital firms Companies secure capital from limited partners (LPs) including pension funds, endowments, and wealthy individuals. These funds are pooled into a venture fund, which is then used to invest in promising startups (Gompers & Lerner, 2001). Once the capital is secured, venture capitalists begin the investment phase, identifying potential startups through extensive due diligence processes, which include evaluating business models, market potential, the capabilities of the founding team and the legal status of the startup (Kaplan & Strömberg, 2004).

After the investing, venture capitalists often take an active role in the management of the portfolio companies. This involvement may encompass strategic guidance and operational support, and governance oversight to help these startups scale effectively (Hellmann & Puri, 2002). The final stage, exiting, involves realizing the returns on investment through mechanisms such as initial public offerings (IPOs), mergers and acquisitions (M&A), and secondary sales. The exits are critical for venture capitalists as they demonstrate the viability of their investments and enable them to return capital to their LPs (Gompers & Lerner, 1994).

### 2.4.2 History and Developments of Venture Capital Investments

The origins of venture capital can be traced back to the mid-20th century. The establishment of American Research and Development Corporation (ARDC) in 1946 is often cited as the birth of modern venture capital. ARDC's investment in Digital Equipment Corporation (DEC) in the 1950s is one of the first major success stories in venture capital history, highlighting the potential for substantial returns (Hsu & Kenney, 2005).

The venture capital industry saw significant growth during the 1980s, driven by technological advancements and regulatory changes that facilitated entrepreneurial activity. The emergence of Silicon Valley as a global technology hub was particularly influential, with venture capital playing a key role in the growth of companies like Apple, Microsoft, and Intel (Kenney & Florida, 2000). This period also saw the establishment of significant legal and institutional frameworks that supported the expansion of the venture capital industry (Lerner, 1994).

The 1990s and early 2000s marked the era of the dot-com boom and bust, which had profound effects on the venture capital landscape. While many internet startups failed during this period, the bubble also produced some of the most successful technology companies of today, including Amazon and Google. The lessons learned during this volatile period led to more disciplined investment practices and a greater emphasis on due diligence and sustainable business models (Kortum & Lerner, 2000).

In recent years, the venture capital industry has continued to evolve, driven by globalization, technological innovation, and the rise of new financing models. The proliferation of accelerators and incubators has provided early-stage startups with additional resources and support, further fueling the growth of the venture capital ecosystem (Cohen & Hochberg, 2014). Additionally, the rise of impact investing and the integration of environmental, social, and governance (ESG) criteria into investment strategies reflect broader trends towards responsible investing within the venture capital community (Clark, Feiner, & Viehs, 2015).

### 2.4.3 Worldwide Outlook on Venture Capital Investments

The global venture capital market has shown robust growth, with significant activity across North America, Europe, Asia, and emerging markets. According to a report by the National Venture Capital Association (NVCA), the United States remains the largest market for venture capital, driven by a strong culture of entrepreneurship, well-developed financial markets, and a supportive regulatory environment (NVCA, 2020).

In North America, particularly in the United States, the venture capital industry is a major driver of innovation and economic growth. Silicon Valley continues to be the epicenter of venture capital activity, hosting a large concentration of venture capital firms and technology startups. The region's ecosystem benefits from a network of experienced investors, talented entrepreneurs, and supportive infrastructure, which collectively contribute to its dynamism (Florida & Kenney, 1988).

Europe's venture capital market has matured significantly over the past two decades, with notable hubs in the United Kingdom, Germany, and France. The European Investment Fund (EIF) has played a crucial role in supporting venture capital activities across the continent, particularly for early-stage investments. Despite the relatively smaller scale compared to the United States, Europe's venture capital ecosystem has seen substantial growth in sectors like fintech, biotech, and cleantech (Groh, von Liechtenstein, & Lieser, 2010).

In Asia, the venture capital landscape is characterized by rapid expansion and significant investment flows, particularly in China and India. These markets have seen a surge in entrepreneurial activity, driven by economic growth, rising consumer markets, and increased access to technology. China's venture capital market, in particular, has grown exponentially, with major investments in sectors such as e-commerce, artificial intelligence, and biotechnology (Ahlstrom & Bruton, 2006). India's venture capital ecosystem is also thriving, with substantial investments in technology, healthcare, and consumer services (Gupta & Sapienza, 1992).

Emerging markets in Latin America, Africa, and the Middle East are increasingly becoming attractive destinations for venture capital investments. These regions offer untapped opportunities driven by demographic trends, economic reforms, and digital transformation. Venture capital in these markets is helping to address local challenges by investing in sectors such as fintech, agritech, and healthcare (Bruton, Ahlstrom, & Puky, 2009). The rise of regional venture capital firms and international investors' interest in these markets highlights the global expansion of the venture capital industry.

The future outlook for venture capital investments is shaped by several key trends. The integration of ESG factors into investment decisions is becoming more prominent as investors seek to align financial returns with positive social and environmental impact (Bocken, 2015). The advancement of technology, particularly in areas like artificial intelligence, blockchain, and biotechnology, continues to create new investment opportunities and reshape traditional industries (Goldfarb, Kirsch, & Miller, 2007). The widespread emergence of alternative financing models, including crowdfunding and initial coin offerings provides startups with diverse funding sources, complementing traditional venture capital. These models enable broader access to capital and can democratize the investment landscape, although they also present regulatory challenges and risks (Mollick, 2014). Fourth, the COVID-19 pandemic has underscored the resilience and adaptability of venture capital-backed companies, particularly in sectors such as digital health, remote work technologies, and e-commerce (Kuckertz et al., 2020).

Venture capital investments play a pivotal role in fostering innovation and economic growth globally. The conceptual framework of venture capital highlights its unique characteristics and stages, while the historical development underscores its evolution and adaptation to changing market dynamics. The worldwide outlook reveals a vibrant and expanding venture capital ecosystem, with significant opportunities and challenges across different regions. As the industry continues to evolve, venture capital firms must navigate new trends, regulatory landscapes, and investor expectations to sustain their growth and impact.

## 2.5 Differences Between PE & VC Investments Concepts

Private equity and venture capital represent two distinct approaches within the field of alternative investments, with private equity targeting mature companies for strategic value enhancement and venture capital focusing on early-stage startups with high growth potential, each accepting varying degrees of risk for potential returns.

### 2.5.1 Basic Differences Between PE & VC

Private equity (PE) and venture capital (VC) are both forms of investment that involve the allocation of capital into private companies, but they differ significantly in terms of their investment focus, stages of company development, and risk profiles. PE typically involves the acquisition of well-established firms, typically with the objective of restructuring, enhancing efficiency, and ultimately selling the company for a profit (Kaplan & Strömberg, 2009). These investments are characterized by large capital commitments and lower risk relative to VC, as PE firms usually invest in mature companies with predictable cash flows and established market positions (Gompers, Kaplan, & Mukharlyamov, 2016).

In contrast, VC focuses on early-stage startups with high growth potential. These companies often operate in innovative sectors such as technology, biotechnology, and clean energy (Gompers & Lerner, 2001). The investment horizon for VC is typically longer, and the risk is higher due to the uncertainty associated with new and unproven business models (Hellmann & Puri, 2002). VC firms usually take minority stakes and provide active management support, leveraging their expertise to help the startups scale (Kortum & Lerner, 2000).

### 2.5.2 Investment Strategies, Priorities, and Expected Returns

The investment strategies of PE and VC differ significantly due to their focus on different stages of a company's life cycle and their distinct objectives. PE firms often employ strategies such as leveraged buyouts (LBOs), where they use a combination of equity and significant

amounts of borrowed funds to acquire companies (Kaplan & Strömberg, 2009). One of the main objective's is to improve the company's value through operational improvements, cost reductions, and strategic growth initiatives before selling it at a higher valuation (Harris, Siegel, & Wright, 2005). PE firms prioritize stable cash flows, market leadership, and the potential for significant cost savings (Acharya et al., 2013).

In contrast, VC firms invest in startups at various stages of development, from seed funding to later-stage investments. Their primary strategy is to identify and nurture high-potential companies that can achieve exponential growth. VC investments are generally equity investments with a focus on achieving substantial capital gains through exits such as initial public offerings (IPOs) or acquisitions by larger firms (Gompers & Lerner, 2004). The expected returns in VC are highly variable, with the potential for significant losses offset by the possibility of outsized gains from a few successful investments (Kaplan & Schoar, 2005).

The priorities of PE and VC firms also reflect their different approaches. PE firms prioritize financial engineering, strategic management, and cost efficiency to drive value creation in their portfolio companies (Gilligan & Wright, 2010). They often take controlling stakes and implement significant changes to optimize the company's operations and financial structure (Jensen, 1989). On the other hand, VC firms prioritize innovation, market disruption, and the scalability of business models. They typically provide not only financial resources but also mentorship, strategic guidance, and access to networks to help startups achieve rapid growth (Gompers & Lerner, 2001).

The expected returns in PE and VC also differ due to the nature of their investments. PE investments tend to offer more predictable returns, albeit lower, due to the mature nature of the companies they target and the use of leverage to amplify returns (Kaplan & Strömberg, 2009). VC investments, however, are characterized by a high-risk, high-reward profile, with returns driven by the success of a small number of portfolio companies that achieve significant market impact (Kortum & Lerner, 2000). This difference in risk and return profiles underscores the complementary roles that PE and VC play in the broader investment landscape.

While both private equity and venture capital involve investing in non-publicly traded companies, their approaches, strategies, and expected outcomes are distinct. PE focuses on mature companies with established operations, aiming for value creation through strategic and operational improvements. VC, on the other hand, targets early-stage startups with high growth potential, supporting their development through active involvement and aiming for substantial

capital gains. Understanding these differences is crucial for investors seeking to diversify their investment choices and achieve their financial objectives through alternative investments.

## 2.6 Innovation

Innovation is widely recognized as a key driver of economic growth and competitiveness. It encompasses the creation and application of new ideas, processes, products, or services that significantly improve or transform existing paradigms (Schumpeter, 1934). As such, innovation is not limited to technological advancements but also includes new business models, organizational structures, and market approaches (OECD, 2018). The continuous process of innovation allows firms to maintain their competitive edge, adapt to changing market conditions, and address emerging consumer needs (Teece, Pisano, & Shuen, 1997).

In the context of economic theory, Joseph Schumpeter's concept of "creative destruction" underscores the importance of innovation in disrupting established markets and creating opportunities for new entrants (Schumpeter, 1942). This dynamic process is essential for the evolution of industries and the broader economy. Innovation can occur incrementally, through small and continuous improvements, or radically, through breakthroughs that fundamentally alter industries (Dosi, 1982). Both forms of innovation play critical roles in sustaining long-term economic growth and enhancing productivity (Romer, 1990).

Research has shown that innovation is closely linked to a firm's ability to leverage internal and external knowledge sources (Cohen & Levinthal, 1990). The concept of absorptive capacity, which refers to a firm's ability to recognize, assimilate, and apply external knowledge, is crucial for fostering innovation (Zahra & George, 2002). Firms with high absorptive capacity are better positioned to capitalize on external technological opportunities and integrate them into their innovation processes (Cohen & Levinthal, 1990).

Moreover, the innovation ecosystem, which includes universities, research institutions, government agencies, and private enterprises, plays a vital role in supporting innovation (Etzkowitz & Leydesdorff, 2000). The interaction and collaboration among these entities facilitate the flow of knowledge, resources, and capabilities necessary for innovation (Chesbrough, 2003). Public policies and regulatory frameworks also significantly impact the innovation landscape by providing incentives for research and development (R&D) and creating an enabling environment for entrepreneurial activities (Nelson & Winter, 1982).

### 2.6.1 The Relationship Between Innovation and PE & VC Investments

Private equity (PE) and venture capital (VC) investments are instrumental in fostering innovation within firms. These forms of financing provide both the essential capital and strategic direction, managerial expertise, and networks that are crucial for innovative activities (Kortum & Lerner, 2000). PE and VC investors typically target high-growth potential companies that are at the forefront of technological advancements and innovative practices (Gompers & Lerner, 2001).

VC investments, in particular, are closely associated with the early stages of a firm's life cycle, where the need for innovation is most pronounced (Gompers & Lerner, 2004). Venture capitalists often invest in Startups that are developing cutting-edge technologies or disruptive business models. This early-stage financing is critical for transforming innovative ideas into marketable products or services (Hellmann & Puri, 2000). Studies have demonstrated that VC-backed firms are more likely to invest in R&D and achieve higher levels of innovation output compared to non-VC-backed firms (Kortum & Lerner, 2000).

PE investments, on the other hand, are typically associated with more mature companies that require capital for scaling their operations and enhancing their competitive position (Kaplan & Strömberg, 2009). PE investors support innovation by restructuring and professionalizing portfolio companies, thereby enabling them to implement more effective R&D strategies and innovation processes (Lerner, Sorensen, & Strömberg, 2011). The infusion of capital and managerial expertise helps these firms to explore new growth opportunities and maintain their innovative edge (Acharya, Gottschalg, Hahn, & Kehoe, 2013).

The symbiotic relationship between PE & VC investments and innovation is evident in the positive impact on firm performance and economic growth. PE and VC-backed firms often exhibit superior financial performance, higher productivity, and greater market share compared to their non-backed counterparts (Kaplan & Schoar, 2005). This enhanced performance is largely attributed to the emphasis on innovation and the ability to leverage PE and VC resources effectively (Chemmanur, Loutskina, & Tian, 2014).

The geographic concentration of PE and VC investments in innovation hubs, such as Silicon Valley, underscores the importance of a supportive ecosystem for fostering innovation (Kenney & Florida, 2000). These hubs provide a conducive environment for the exchange of ideas, talent, and capital, which are essential for sustaining high levels of innovation (Feldman, 2001). The presence of established firms, Startups, research institutions, and a vibrant

entrepreneurial culture creates a dynamic network that drives continuous innovation (Saxenian, 1994).

PE and VC investments play a pivotal role in driving innovation across various stages of a firm's development. By providing capital, expertise, and strategic support, PE and VC investors enable firms to pursue innovative activities that enhance their competitiveness and contribute to economic growth. The relationship between innovation and PE & VC investments highlights the importance of an integrated approach that combines financial resources with an enabling ecosystem to support sustainable innovation.

## 2.7 Economic Growth

Economic growth is essential for improving living standards, reducing poverty, and enhancing the overall welfare of society. It enables higher income levels, better health care, and education, as well as improved infrastructure (Todaro & Smith, 2011). According to neoclassical growth theories, economic growth results from increases in capital stock, labor, and technological progress (Solow, 1956). Endogenous growth theories, on the other hand, emphasize the role of innovation, knowledge spillovers, and human capital development in driving sustained growth (Romer, 1990).

Historical data suggests that countries that have consistently invested in education, infrastructure, and technology have experienced more rapid and sustained economic growth (Lucas, 1988). Additionally, sound macroeconomic policies, political stability, and effective institutions are also critical for fostering an environment conducive to growth (Acemoglu, Johnson, & Robinson, 2001).

### 2.7.1 The Relationship Between Economic Growth and PE & VC Investments

Private Equity (PE) and Venture Capital (VC) investments play a significant role in fostering economic growth. These forms of investment provide essential funding to businesses, particularly startups and high-growth companies, enabling them to scale operations, innovate, and enhance productivity (Gompers & Lerner, 2001). PE and VC investments are critical for bridging the financing gap faced by new and innovative firms that often struggle to secure funding through traditional financial institutions (Kaplan & Strömberg, 2009).

VC investments are particularly vital for early-stage companies with high growth potential but significant risk (Kortum & Lerner, 2000). By providing capital, as well as strategic and managerial support, VC investors help these companies overcome initial challenges, develop

new products, and penetrate markets. This support can lead to technological advancements and productivity improvements, which are crucial for economic growth (Samila & Sorenson, 2011).

PE investments, on the other hand, often focus on more mature companies that require restructuring, expansion, or efficiency improvements. Through PE investments, companies can access the capital needed for mergers and acquisitions, operational improvements, and international expansion (Lerner, Sorensen, & Strömberg, 2009). This infusion of capital and expertise helps companies grow more rapidly and sustainably, contributing to overall economic development (Bernstein, Lerner, Sorensen, & Strömberg, 2010).

Empirical studies have shown a positive correlation between PE and VC investments and economic growth. For example, a study by Kortum and Lerner (2000) found that VC investment significantly increases patenting activity, suggesting that VC fosters innovation. Another study by Samila and Sorenson (2011) indicated that regions with higher levels of VC activity experience faster employment growth and increased business formation.

PE and VC investments contribute to the diffusion of new technologies and best practices across industries and regions. By supporting innovative firms, these investments promote the commercialization of new technologies, leading to increased productivity and economic growth (Hellmann & Puri, 2000). Additionally, the competitive pressure exerted by VC-backed firms can drive incumbent firms to innovate and improve efficiency, further enhancing economic performance (Nanda & Rhodes-Kropf, 2013).

The relationship between economic growth and PE & VC investments is robust and multifaceted. PE and VC investments provide critical funding and support for businesses at various stages of development, fostering innovation, productivity, and overall economic growth. By bridging the financing gap and promoting technological advancements, these investments play a vital role in the economic development of countries worldwide.

# III. RESEARCH METHODOLOGY AND ANALYSIS

This chapter, the thesis outlines the research methodology and analysis used to investigate the impact of private equity and venture capital investments. It begins with a discussion of the underlying theory and approach, followed by the formulation of research hypotheses and the selection of appropriate econometric models. The chapter then describes the data and variables used in the analysis, including dependent, independent, and control variables, along with their sources and types. Quantitative data analysis methods are detailed, particularly focusing on panel regression analysis, which includes static panel data models and the Least Squares Dummy Variable (LSDV) estimator, as well as the Panel Seemingly Unrelated Regression (PSUR) model. The section concludes with an overview of the estimation methods employed in the study.

## 3.1 Theory and Approach

This section delves into the significant impact of venture capital (VC) and private equity (PE) on innovation and economic growth. The studies examined reveal that VC and PE investments substantially enhance innovative activities, accelerate economic growth, and generate new employment opportunities. Empirical analyses conducted across different geographical regions and sectoral contexts demonstrate that VC and PE foster innovation and growth through various mechanisms and under the influence of multiple factors. Factors such as social capital, networking, and regional economic conditions have been shown to shape these relationships. These findings provide important insights for policymakers and investors, suggesting how strategic direction and support for VC and PE investments can be optimized. In conclusion, the positive effects of venture capital and private equity on innovation and economic growth underscore the importance of sustaining and enhancing investments and support in these areas, offering valuable guidance for future strategic initiatives.

The relationship between venture capital and innovation is a critical area of interest. Faria and Barbosa (2014) investigated whether VC fosters innovation using panel data from 17 European Union countries. Their dynamic panel data model revealed that VC, particularly in later stages, significantly enhances innovation as measured by patent applications. Control variables included R&D expenditure and GDP growth to ensure robustness. Using panel data analysis, they discovered that while VC positively affects innovation initially, this effect diminishes beyond a certain threshold, highlighting the complexity of VC's impact. Similarly,

Schertler (2003) examined the role of VC in promoting entrepreneurship and economic growth across U.S. states using panel data analysis. The study found that VC investment significantly increases new business formation rates and employment growth, contributing to overall economic growth. Key control variables included regional R&D expenditure and education levels.

Kobeissi and Wang (2009) analyzed the impact of VC on local economic growth in 394 U.S. labor market areas from 1993 to 1999. Their panel data regression results showed that total VC investments positively affect local employment growth and economic performance, although early-stage VC investments did not significantly impact employment growth.

Lerner and Kortum (2001) explored how VC financing impacts innovation and economic growth using data from various countries. Their analysis demonstrated a positive correlation between VC investment, increased patenting activity, and economic growth. The study utilized cross-country regression models, controlling for R&D expenditure and educational attainment.

Hellmann and Puri (2000) assessed the effects of VC on firm-level innovation and growth using a dataset of VC-backed firms across various sectors. Regression models indicated that VC significantly enhances firms' R&D spending and patenting activity, leading to substantial growth in market share and revenues.

Zhang et al. (2013) examined the impact of VC on economic growth in Israel using the Cobb-Douglas production function model. They found that VC investments significantly contribute to Israel's economic growth through technological innovation and increased GDP, with control variables including human capital and technological infrastructure.

Chorev and Anderson (2006) analyzed success factors in Israeli high-tech startups, focusing on human resources and R&D activities. Their qualitative study revealed that VC support is crucial for startup success, significantly influencing economic growth through enhanced innovation and technological advancement.

Wen and Yang (2018) investigated the impact of VC on innovation in China's high-tech industries using panel data analysis. They found that VC significantly boosts R&D activities and patent filings, highlighting the crucial role of VC in the high-tech sector. Control variables included firm size, industry, and regional economic conditions.

Peneder (2010) explored the role of VC in economic growth in emerging markets using panel data from various countries. The analysis indicated that VC investments positively affect

new business formation and economic growth. Key control variables included market size, economic stability, and regulatory frameworks.

Kaplan and Strömberg (2004) conducted an experimental conjoint analysis to identify key criteria for private equity (PE) investments. They found that PE investors prioritize firm potential, management quality, and market size, shedding light on the decision-making process in PE investments.

Gompers and Lerner (2001) assessed the impact of VC on the growth of high-tech firms using panel data from U.S. firms. Their study revealed that VC significantly boosts R&D activities and market expansion in high-tech sectors. Control variables included firm age and industry sector.

Timmons and Bygrave (1986) analyzed the role of VC in financing innovation and promoting economic growth. Using historical data and case studies, they found that VC is essential for funding innovative projects that drive economic development. The study highlighted the importance of VC in fostering technological advancements and economic expansion.

Samila and Sorenson (2011) examined the effects of VC on innovation and growth in high-tech firms using panel data. The study found that VC significantly increases R&D spending and patent applications, leading to higher growth rates in these firms. Control variables included firm age, industry, and market conditions.

Pistoresi and Venturelli (2013) investigated the role of social capital and networking in enhancing the impact of VC on innovation. Their mixed-methods approach found that strong social networks and capital significantly increase the effectiveness of VC investments in promoting innovative activities.

Hirukawa and Ueda (2011) explored threshold effects in the relationship between VC and innovation using panel data from multiple countries. They discovered that the positive impact of VC on innovation diminishes after reaching a certain investment level, indicating a complex dynamic. Their regression models included control variables such as industry characteristics and firm age.

The reviewed studies demonstrate that venture capital (VC) and private equity (PE) investments enhance innovative activities, accelerate economic growth, and create new employment opportunities. Empirical analyses conducted across different geographical regions

and sectoral contexts indicate that VC and PE promote innovation and growth through various mechanisms and under the influence of multiple factors.

## 3.2 Data and Variable

This section delineates the data sources, types of data, and the variables employed in the empirical analysis.

### 3.2.1 Data Description, Sources, Types and Sample

This section provides a detailed overview of the data utilized in the research, including descriptions, sources, types, and the sample.

Data Description: The data employed in this study spans from 2007 to 2020, covering various economic indicators across multiple countries. The primary focus is on variables related to economic growth and innovation, specifically GDP growth and patent applications.

Data Sources: The data is sourced from reputable international databases to ensure reliability and comprehensiveness. Key sources include:

1. International Monetary Fund (IMF) Financial Development Index Database: Provides data on GDP growth and financial development indices, which rank countries based on the depth, accessibility, and efficiency of their financial institutions and markets.
2. OECD Entrepreneurship Financing Database: Supplies data on venture capital and private equity investments across OECD countries, including detailed information on investment stages and amounts.

Data Types: The dataset includes both dependent and independent variables, as well as control variables, each categorized as follows:

Dependent Variables: GDP Growth (annual %) and total patent applications.

GDP Growth (annual %): Measures the economic performance of a country on an annual basis.

Total Patent Applications: Includes resident and non-resident patent applications, analyzed using their logarithmic values.

Independent Variables: Venture capital and private equity investment sizes, categorized by investment stages (seed, early stage, later stage).

Sample: The sample consists of data from multiple OECD countries, with varying availability across different countries and years. The comprehensive list of countries with available data is presented below:

Countries with Available Data: Australia, Austria, Belgium, Canada, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Israel, Italy, Japan, Latvia, Lithuania, Luxembourg, Mexico, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, United Kingdom, United States.

Countries without Available Data: Chile, Colombia, Costa Rica, Czechia, Iceland, New Zealand, Türkiye. Include government spending, inflation, consumer prices, stocks traded, trade (% of GDP), and unemployment rates.

The data utilized in this research is meticulously gathered from established databases, ensuring a robust foundation for analyzing the economic and innovation-related variables across multiple OECD countries over the period from 2007 to 2020. The comprehensive coverage and categorization of data types facilitate a thorough and detailed examination of the relationships between venture capital, private equity investments, and economic growth and innovation.

### 3.2.2 Dependent Variables

There are two dependent variables in this research. These are GDP growth (annual %) and total patent applications consist of resindents and nonresidents.

GDP growth (annual %) defined as “growth” in the models and refers to the Gross Domestic Product (GDP) Growth Rate (annual %). This metric measures the economic performance of a country on an annual basis and indicates how much the economy has grown or shrunk compared to the previous year.

The total number of patent applications, defined as “patents” in the models, represents the combined volume of resident and non-resident patent applications. The logarithms (log) of the patent applications have been taken in the analysis and defines as “lpatent”.

The data gained from International Monetary Fund (IMF) Financial Development Index Database. Financial Development Index (FD), ranks countries based on the depth, accessibility, and efficiency of their financial institutions and markets. It is a composite measure that combines the Financial Institutions Index and the Financial Markets Index (https://data.imf.org/?sk=f8032e80-b36c-43b1-ac26 ü 493c5b1cd33b&sid=1481126573525&ref=mondato-). The data covers from 2007 to 2020 for each dependent variable.

### 3.2.3 Independent Variables

The independent variables are venture capital and private equity investment size. The data gained from OECD Entrepreneurship Financing Database (https://stats.oecd.org/Index.aspx?DataSetCode=VC_INVEST). The database has contains xx OECD countries venture capital and private equity investments size in USD Dollar, million between 2007 and 2020.

Data for the United States covers venture capital investments from various investors, excluding those fully financed by corporations or business angels. In Europe, the data includes venture capital investments (Seed, Startup, and Later stages) made by formal fund managers, such as those managing private equity funds, mezzanine funds, co-investment funds, and rescue/turnaround funds. Excluded are investments from business angels, incubators, infrastructure funds, real estate funds, distressed debt funds, primary funds-of-funds, or secondary funds-of-funds. The recorded investment amount reflects only the equity invested by formal fund managers, not the entire financing round's value. Additionally, growth capital or buyout investments in companies currently or formerly backed by venture capital are excluded.

In the OECD Entrepreneurship Financing Database, venture capital is defined as the total of early stage (including pre-seed, seed, Startup, and other early stages) venture capital and private equity (later stage). Due to the differing definitions of venture capital stages and private equity among various associations and data providers, the original data have been re-aggregated to fit the OECD's classification of venture capital stages.

The list of OECD Entrepreneurship Financing Database by countries, data availability and data source.

**Table 5:** OECD Countries Data Availability and Data Sources

| Countries | Data Availability | Direct Data Sources |
|---|---|---|
| Australia | Exist. | Invest Europe, Invest Europe Yearbook. |
| Austria | Exist. | Invest Europe, Invest Europe Yearbook. |
| Belgium | Exist. | Invest Europe, Invest Europe Yearbook. |
| Canada | Exist. | CVCA - Canada's Venture Capital and Private Equity Association. |
| Chile | Does not exist. | - |
| Colombia | Does not exist. | - |
| Costa Rica | Does not exist. | - |
| Czechia | Does not exist. | |
| Denmark | Exist. | Invest Europe, Invest Europe Yearbook. |
| Estonia | Exist. | Invest Europe, Invest Europe Yearbook. |
| Finland | Exist. | Invest Europe, Invest Europe Yearbook. |
| France | Exist. | Invest Europe, Invest Europe Yearbook. |
| Germany | Exist. | Invest Europe, Invest Europe Yearbook. |
| Greece | Exist. | Invest Europe, Invest Europe Yearbook. |
| Hungary | Exist. | Invest Europe, Invest Europe Yearbook. |
| Iceland | Unbalanced Panel Data | - |
| Ireland | Exist. | Invest Europe, Invest Europe Yearbook. |
| Israel | Exist. | PwC MoneyTree until 2013, CBS - Central Bureau of Statistics from 2014 onwards. |
| Italy | Exist. | Invest Europe, Invest Europe Yearbook |
| Japan | Exist. | VEC - Venture Enterprise Center. |
| Latvia | Exist. | Invest Europe, Invest Europe Yearbook |
| Lithuania | Exist. | Invest Europe, Invest Europe Yearbook |
| Luxembourg | Exist. | Invest Europe, Invest Europe Yearbook |
| Mexico | Does not exist. | - |
| Norway | Exist. | Invest Europe, Invest Europe Yearbook |
| New Zealand | Does not exist. | - |
| Poland | Exist. | Invest Europe, Invest Europe Yearbook |

| | | |
|---|---|---|
| Slovak Republic | Exist. | Invest Europe, Invest Europe Yearbook |
| Portugal | Exist. | Invest Europe, Invest Europe Yearbook |
| Slovenia | Exist. | Invest Europe, Invest Europe Yearbook |
| Spain | Exist. | Invest Europe, Invest Europe Yearbook |
| Sweden | Exist. | Invest Europe, Invest Europe Yearbook |
| Switzerland | Exist. | Invest Europe, Invest Europe Yearbook |
| Türkiye | Does not exist. | - |
| United Kingdom | Exist. | Invest Europe, Invest Europe Yearbook. |
| United States | Exist. | NVCA/PitchBook - National Venture Capital Association/PitchBook quarterly report. |

**Source:** Adapted by the author.

Venture Capital Investments defined as "seed" and "earlyst" in the models and refer to refer to the financing provided to startups and small businesses with high growth potential by investors.

Private Equity Investments defined as "laterst" in the models and refers to capital provided by private equity firms to acquire equity ownership in companies, often to restructure and improve their performance, increase their value, and ultimately sell them for a profit. Unlike venture capital, which typically targets early-stage startups, private equity usually focuses on more established businesses that are not publicly traded.

The logarithms (log) of the venture capital and private equity investments have been taken in the analysis and defines as "lseed", "learlyst" and "llaterstage".

### 3.2.4 Control Variables

The control variables are Goverment spending, Inflation, consumer prices (annual %), Stocks traded, Trade (% of GDP), Unemployment, total (% of total labor force). The data obtained from International Monetary Fund (IMF) Financial Development Index Database. The data covers from 2007 to 2020.

The control variables are defined as "consumption", "inflation", "trade" and "unemployment" in the models.

Dummy variables have been used to analyze the effects of the independent variables on the dependent variables during the 2008 financial crisis.

## 3.3 Hypothesis and Econometric Models

Research hypotheses and models have been developed to investigate the effects of venture capital (VC) and private equity (PE) on innovation and economic growth. Hypotheses have been formulated to systematically examine the relationships between the independent variables, VC and PE investments, and the dependent variables, patent counts, and GDP growth.

Based on the theoretical framework and literature review, 7 hypotheses have been constructed to test the effects of VC and PE at different stages of investment. These hypotheses address whether VC and PE investments have a statistically significant impact on patent counts and economic growth. By empirically testing these hypotheses, the study aims to contribute to a deeper understanding of the influence of VC and PE on economic dynamics and innovation ecosystems.

### 3.3.1 Research Hypothesis and Econometric Models

This section presents hypotheses and econometric models to test the impact of private equity (PE) and venture capital (VC) and investments on economic growth and innovation.

These hypotheses and models are designed to examine whether VC investments significantly influence patent counts and GDP growth, thereby contributing to a comprehensive understanding of their role in driving economic and innovative outcomes.

**Hypothesis for VC Investments:**

H1: Venture capital investments contribute positively to economic growth.
H2: Venture capital investments contribute positively to innovation.
H3: There is a differentiation on innovation and economic growth based on different stages of venture capital investments.
H4: The impact of venture capital investments on economic growth and innovation is not subject to change during crisis periods.

The Model for Hypothesis1:

1: $growth_{it} = \beta_0 + \rho growth_{it-1} + \beta_1 total_{it} + \beta_2 cons_{it} + \beta_3 inflation_{it} + \beta_4 trade_{it} + \beta_5 unemp_{it} + u_{it}$

The Model for Hypothesis 2:

2: $patent_{it} = \beta_0 + \beta_1 total_{it} + \beta_2 cons_{it} + \beta_3 inflation_{it} + \beta_4 trade_{it} + \beta_5 unemp_{it} + u_{it}$

The Models for Hypothesis 3**:**

3: $growth_{it} = \beta_0 + \rho growth_{it-1} + \beta_1 lseed_{it} + \beta_2 cons_{it} + \beta_3 inflation_{it} + \beta_4 trade_{it} + \beta_5 unemp_{it} + u_{it}$

4: $growth_{it} = \beta_0 + \rho growth_{it-1} + \beta_1 learlyst_{it} + \beta_2 cons_{it} + \beta_3 inflation_{it} + \beta_4 trade_{it} + \beta_5 unemp_{it} + u_{it}$

5: $lpatent_{it} = \beta_0 + \beta_1 lseed_{it} + \beta_2 cons_{it} + \beta_3 inflation_{it} + \beta_4 trade_{it} + \beta_5 unemp_{it} + u_{it}$

6: $lpatent_{it} = \beta_0 + \beta_1 learlyst_{it} + \beta_2 cons_{it} + \beta_3 inflation_{it} + \beta_4 trade_{it} + \beta_5 unemp_{it} + u_{it}$

The Models for Hypothesis 4:

7: $patent_{it} = \beta_0 + \beta_1 total_{it} + \beta_2 D_{it} total_{it} + \beta_3 cons_{it} + \beta_4 inflation_{it} + \beta_4 trade_{it} + \beta_5 unemp_{it} + u_{it}$

8: $lpatent_{it} = \beta_0 + \beta_1 lseed_{it} + \beta_2 D_{it} lseed_{it} + \beta_3 cons_{it} + \beta_4 inflation_{it} + \beta_4 trade_{it} + \beta_5 unemp_{it} + u_{it}$

9: $lpatent_{it} = \beta_0 + \beta_1 learlyst_{it} + \beta_2 D_{it} learlyst_{it} + \beta_3 cons_{it} + \beta_4 inflation_{it} + \beta_4 trade_{it} + \beta_5 unemp_{it} + u_{it}$

Where $D_{it}$=1 for 2008, and 0 otherwise.

These hypotheses and models are intended to assess whether PE investments have a statistically significant effect on patent counts and GDP growth, providing insights into their influence on economic and innovative performance.

**Hypothesis for PE Investments:**

H5: Private equity investments contribute positively to economic growth.
H6: Private equity investments contribute positively to innovation.
H7: The impact of private equity investments on economic growth and innovation is not subject to change during crisis periods.

The Model for Hypothesis 5:

10: $growth_{it} = \beta_0 + \rho growth_{it-1} + \beta_1 llaterst_{it} + \beta_2 cons_{it} + \beta_3 inflation_{it} + \beta_4 trade_{it} + \beta_5 unemp_{it} + u_{it}$

The Model for Hypothesis 6:

11: $lpatent_{it} = \beta_0 + \beta_1 llaterst_{it} + \beta_2 cons_{it} + \beta_3 inflation_{it} + \beta_4 trade_{it} + \beta_5 unemp_{it} + u_{it}$

The Model for Hypothesis 7:

12: $lpatent_{it} = \beta_0 + \beta_1 llaterst_{it} + \beta_2 D_{it} llaterst_{it} + \beta_3 cons_{it} + \beta_4 inflation_{it} + \beta_4 trade_{it} + \beta_5 unemp_{it} + u_{it}$

**Hypothesis for PE and VC Investments:**

These hypotheses and models are intended to assess whether PE and VC investments together have a statistically significant effect on patent counts and GDP growth, providing insights into their influence on economic and innovative performance.

H8: Private Equity and Venture Capital investments contribute positively together to economic growth.

H9: Private Equity and Venture Capital investments contribute positively together to innovation.

The Model for Hypothesis 8 and 9:

13: $growth_{it} = \beta_0 + \rho growth_{it-1} + \beta_1 total_{it} + \beta_2 cons_{it} + \beta_3 inflation_{it} + \beta_4 trade_{it} + \beta_5 unemp_{it} + u_{it}$

14: $patent_{it} = \beta_0 + \beta_1 total_{it} + \beta_2 cons_{it} + \beta_3 inflation_{it} + \beta_4 trade_{it} + \beta_5 unemp_{it} + u_{it}$

## 3.4 Quantative Data Analysis

In this study, quantitative data analysis has been utilized. Quantitative Data Analysis (QDA) is the structured empirical examination of observable phenomena using statistical, mathematical, or computational methods. The main objective of QDA is to create and utilize models, theories, and hypotheses relevant to the phenomena under investigation. This process allows researchers to draw meaningful conclusions based on numerical data, providing a clear and objective way to understand complex issues. By using quantitative methods, researchers can test hypotheses and examine relationships between variables with a high degree of accuracy and reliability. The analysis involves several critical steps to ensure the integrity and validity of the results (Creswell, 2014; Field, 2013; Trochim, Donnelly, & Arora, 2016).

1. Data Collection: This initial step involves gathering measurable data through various means such as surveys, experiments, or secondary data sources. The quality of data collection significantly impacts the reliability of the analysis (Creswell, 2014).
2. Data Cleaning and Preparation: Ensuring the data is accurate and ready for analysis is crucial. This step may involve handling missing values, removing outliers, and standardizing formats. Proper data cleaning helps in minimizing errors and biases in the analysis (Field, 2013).
3. Descriptive Statistics: This involves summarizing and exploring the data through measures such as mean, median, mode, standard deviation, and graphical representations

like histograms and box plots. Descriptive statistics provide a foundational understanding of the data's general characteristics (Field, 2013).

4. Inferential Statistics: nferential statistics are employed to draw predictions or conclusions about a population from a data sample. This encompasses hypothesis testing. This includes hypothesis testing, regression analysis, and confidence intervals, allowing researchers to generalize findings from the sample to the broader population (Trochim, Donnelly, & Arora, 2016).
5. Data Interpretation: The final step involves drawing conclusions and making decisions based on the results of the statistical analysis. This step often involves discussing the implications of the findings in the context of the research questions or hypotheses. Effective interpretation helps in understanding the broader impact of the results and provides a basis for future research (Creswell, 2014; Field, 2013).

### 3.4.1 Panel Data Analysis

The panel data analysis is examined in the study. Panel data are formed by combining cross-sectional observations of units over a specific period. The number of units is denoted by N, while the time observations are represented by T. In econometrics, researchers sometimes use these two types of data—cross-sectional data and time series data—separately. However, in some economic and financial analyses, one dimension is insufficient, necessitating the use of both. This is because cross-sectional data provide information related to a specific period, whereas time series data offer information about various periods for a particular unit. Panel data, therefore, can provide information about both units and periods (Yerdelen Tatoğlu, 2018). When observations for all units are available for every time period in a panel dataset, it is referred to as a balanced panel data set. If there are missing data for some units at certain times, resulting in incomplete observations for all units, this is known as an unbalanced panel data set (Yerdelen Tatoğlu, 2018).

The most general form of a simple panel data model is shown in equation (1):

$$Y_{it} = \alpha_{it} + \sum_{k=1}^{K} \beta_{kit} X_{kit} + e_{it}$$

In equation (1), i represents the cross-sections or units, t denotes the time dimension, Y is the dependent variable, α is the intercept parameter, β refers to the slope parameters, and e is the error term. The subscripts i and t indicate that the variables, parameters, and error terms take on

different values for each cross-section and time period. In this model, both the intercept and slope parameters vary across time and units (Yerdelen Tatoğlu, 2021).

There are several advantages to using panel data compared to cross-sectional data or time series data.

1. Control of Individual Heterogeneity: Panel data account for heterogeneity among individuals, firms, or countries. Cross-sectional or time series analyses that do not control for this heterogeneity may lead to biased results.
2. Informative Data: Panel data contain more variability and provide more informative data, which contributes to reducing multicollinearity among variables and increasing degrees of freedom and efficiency.
3. Measurement of Unobserved Effects: Effects that cannot be easily measured using only cross-sectional or time series data can be better defined and measured using panel data.
4. Complex Models: Panel data allow for the construction of more complex models than those based solely on time series or cross-sectional data, facilitating the analysis of behavioral models through various tests.
5. Micro Panel Data: Micro panel data, created from individuals, households, or firms, offer more accurate measurements compared to macro data, reducing or eliminating biases from aggregation.
6. Macro Panel Data: These data sets create longer time series through cross-sections, providing asymptotic distributions that address issues in unit root tests found in time series analyses. Before estimating models in panel data analysis, certain assumptions need to be tested, and a methodological sequence must be followed. In the initial stage of panel data applications, it is crucial to consider the number of observations, correlations among units, and whether the variables exhibit unit roots or are stationary before selecting the model. The data size encompasses both the time and unit dimensions. (Yerdelen Tatoğlu, 2021).

Due to the time span of the analyzed panel data series, the data constitutes an unbalanced panel. Therefore, unit root tests have not been applied in this research.

The analyzed model's numbers and their corresponding analysis methods are listed in the table below.

**Table 6:** The Model Numbers, Model Types and Analysis Types

| Model Numbers | Model Types | Analysis Types |
|---|---|---|
| 1 | Dynamic Panel Data Model | System GMM |
| 2 | Static Panel Data Model | LSDV |
| 3 | Dynamic Panel Data Model | System GMM |
| 4 | Dynamic Panel Data Model | System GMM |
| 5 and 6 | Panel Seemingly Unrelated Regression | PSUR |
| 7 | Static Panel Data Model | LSDV |
| 8 and 9 | Panel Seemingly Unrelated Regression | PSUR |
| 10 | Dynamic Model | System GMM |

**Source:** by Author.

### 3.4.2 Static Panel Data Model and Least Squares Dummy Variables Estimator (LSDV)

In the panel data model, if there are unobserved effects, they can be incorporated into the model using dummy variables, and the model can be estimated using the OLS method. In models numbered 2 and 7, time effects have been included in the model through the use of dummy variables. This model is referred to as Least Squares Dummy Variable (LSDV). The panel data model in matrix form is as follows:

$$Y_{it} = X_{it}\beta + u_{it} \qquad i=1,...,N;\ t=1,...,T$$

Among the X variables, there are also time dummy variables. The OLS estimate of β is as follows:

$$\hat{\beta} = \left( \sum_{i=1}^{N} \sum_{t=1}^{T} X_{it}' X_{it} \right)^{-1} \left( \sum_{i=1}^{N} \sum_{t=1}^{T} X_{it}' Y_{it} \right)$$

The assumptions of the least squares dummy variables method can be summarized as follows in:

LSDV 1: $E\left(X_{it}' u_{it}\right) = 0$

- $X_{it}$ is a weakly exogenous variable, meaning it is uncorrelated with $u_{it}$.
- $X_{is}$ may be correlated with $u_{it}$ (for $t \neq s$), meaning it is not strictly exogenous.
- The time dummy variables included in X may be correlated with the u's.

LSDV 2: $rank\left[\sum_{i=1}^{N}\sum_{t=1}^{T}E(X_{it}'X_{it})\right]=K$

- K represents the number of explanatory variables, indicating that there is no perfect multicollinearity among the X's.

LSDV 3a: $E\left(u_{it}^2X_{it}'X_{it}\right)=E\left(u_{it}^2\right)E\left(X_{it}'X_{it}\right)=\sigma^2E\left(X_{it}'X_{it}\right)$ for all i and t

- This assumption includes homoskedasticity assumptions.
- The conditional variance is independent of $X_{it}$.
- The unconditional variance is the same for all periods.

LSDV 3b: $E\left(u_{it}u_{is}X_{it}'X_{is}\right)=0 \quad (t\neq s)$

The (conditional) covariance between the error terms of different periods is zero, meaning there is no autocorrelation. This can be summarized as follows:

- $E\left(u_{it}u_{is}\right)=0$ $(t\neq s)$: The unconditional covariance of the error term is zero.
- $E\left(u_{it}u_{is}\mid X_{it},X_{is}\right)=0$ $(t\neq s)$: The conditional covariance of the error term is zero.

### 3.4.3 Dynamic Panel Data Model and System GMM

Dynamic panel data models are estimated using the pooled ordinary least squares (POLS) method. But the correlation between the independent variable $Y_{it-1}$ and the error term in the model violates the strict exogeneity assumption. In this case, even if uit is not autocorrelated, biased and inconsistent estimates are obtained with the pooled ordinary least squares method. Furthermore, as it is known, the classical model estimates by ignoring the existence of unit (and time) effects. If there are unit (and time) effects in the model, biased estimates are obtained with the pooled ordinary least squares method.

The Arellano and Bond estimator may be weak if the number of autoregressive parameters is too high or if the variance of the unit effect relative to the variance of the residual is too large. It also remains weak when working with highly unbalanced panel data or when T is small. In unbalanced panels (particularly when T is small and N is not large), data loss will occur for both $\Delta Y_{it}$ and $\Delta Y_{it-1}$. In such cases, some units' data may be entirely lost due to first

differencing. Therefore, an alternative transformation called "forward orthogonal deviations" or "orthogonal deviations" has been proposed instead of first differencing. Arellano and Bover (1995) introduced the orthogonal deviations method for unbalanced panel data models, using an instrumental variable estimator. This method does not take differences from the previous period like the first differencing method; instead, it takes the difference of an orthogonal variable's future averages. Thus, it minimizes data loss especially in unbalanced panel data sets caused by the first differencing method. Given the static panel data model:

$Y_{it}=X_{it}\beta+Z_i\gamma+v_{it}$

Where $Z_i$ consists of time-invariant variables and $X_{it}$ consists of variables that vary both over time and across units. The equality can be expressed in vector form as:

$Y_i=W_i\eta+v_i$

Where $\eta'=(\beta',\gamma')$, $w_i=[X_i,\tau_i Z_i']$ and $\tau_T$ is a unit vector of dimension T. When considering the single error components model, the residual can be written as:

$v_i=\mu_i+u_i$

Generally, $E(v_i v_i'|w_i)$ and $w_i=[X_i'Z_i']'$ will be unrestrictedly dependent. Arellano and Bover derived the system transformation from the equality as follows:

$$H=\begin{bmatrix} C \\ \iota_T'/T \end{bmatrix}$$

Where C is any (T-1)xT matrix satisfying $C_{T-1}=0$. For example, C could be the first (T-1) rows of the within-group operator or the first-difference operator. The transformed residual is:

$$v_i^+ = Hv_i = \begin{bmatrix} Cv_i \\ \bar{v}_i \end{bmatrix}$$

All explanatory variables are valid instruments for the first (T-1) equations. It is assumed that $m_i$ is a subset of $W_i$ that correlates with $\mu_i$ and that the dimension of $m_i$ is equal to or greater than that of $\eta$. Hausman and Taylor (1981) assume that $X=[X_1,X_2]$ and $Z=[Z_1,Z_2]$, where $X_1$ and $Z_1$ are $NTxK_1$ and $NxG_1$ sized time-invariant variables, and $X_2$ and $Z_2$ are $NTxK_2$ and $NxG_2$

sized variables that vary within units. Thus, the instrument matrix for the full transformed system is:

$$M_i = \begin{bmatrix} w_i' & \dots & \dots & 0 \\ \dots & \ddots & \dots & \dots \\ \dots & \dots & w_i' & \dots \\ 0 & \dots & \dots & m_i' \end{bmatrix}$$

$$E\left(M_i' H v_i\right) = 0$$

Here, $\bar{H} = I_N \otimes H$ and $\hat{\Omega} = I_N \otimes \Omega$. By pre-multiplying the equality by $M'\bar{H}$, the following equality is obtained:

$$M'\bar{H}Y = M'\bar{H}W\eta + M'\bar{H}v$$

The estimation of this model using the generalized least squares method provides the Arellano and Bover Estimator. In this case, η is estimated as follows:

$$\hat{\eta} = \left[ M'\bar{H}'M \left( M'\bar{H}\hat{\Omega}^{+}\bar{H}'M \right)^{-1} M'\bar{H}W \right]^{-1} W'\bar{H}'M \left( M'\bar{H}\hat{\Omega}^{+}\bar{H}'M \right)^{-1} M'\bar{H}Y$$

In practice, the variance-covariance matrix of the transformed system is used for estimation:

$$\hat{\Omega}^{+} = H\Omega H'$$

Where $\hat{u}_i^{+}$ is the residual obtained from the consistent initial estimator. Consequently, two-stage estimation is performed (with original and transformed equations), referred to as "System GMM."

Blundell and Bond (1998) emphasized the importance of the $E(y_{it-1}\Delta u_{it})=0$ condition for the effective estimation of the dynamic panel data model when N>T. Assuming the exogeneity of extra moment conditions $E(\mu_i u_{it})=0$, they proposed the following autoregressive model:

$$Y_{it} = \delta Y_{it\text{-}1} + \mu_i + u_{it}$$

Blundell and Bond focused on the case where T=3 and only the $E(y_{i,t-1}\Delta u_{i,t})=0$ orthogonality condition holds. In this scenario, the estimator was obtained, and an asymptotic regression was derived. By regressing the lagged dependent variable:

$$\Delta Y_{i2} = (\delta - 1) Y_{i1} + \mu_i + u_{i2}$$

As $E\left(Y_{i1}\mu_i\right) > 0$, (δ-1) is upwardly biased, resulting in:

$$\text{plim}\left(\hat{\delta}-1\right)=\left(\delta-1\right)\frac{c}{c+\left(\sigma_{\mu}^{2}+\sigma_{u}^{2}\right)}$$

Where c=(1−δ)/(1+δ). The efficiency of the system GMM estimator increases as δ→1 and the sum of $\left(\sigma_{\mu}^{2}+\sigma_{u}^{2}\right)$ grows. The efficiency of the first-difference GMM estimator significantly increases with T=4 and $\left(\sigma_{\mu}^{2}+\sigma_{u}^{2}\right)=1$, with the ratio of the asymptotic variance of the first-difference GMM estimator to the system GMM estimator being 1.75 for δ=0, 4.26 for δ=0.5, and 55.4 for δ=0.9. (Yerdelen, Tatoğlu 2023).

### 3.4.4 Panel Seemingly Unrelated Regression (PSUR) Model

In explaining the changes in economic events over time, the most commonly used prediction method has been the least squares (OLS) method. Models that include multiple equations were developed by Zellner in 1962 and are known as Seemingly Unrelated Regression (SUR) models. These models, which appear unrelated at first glance but have correlated error terms, are referred to as SUR models. Each equation in the SUR model can be predicted using the OLS method, ensuring unbiased estimates, although they may not be efficient (Yerdelen Tatoğlu, 2023).

According to Zellner (1962), in a SUR model where the error terms of the equations are highly correlated and the explanatory variables in different equations are interrelated, the joint estimation of the equations in the SUR model will provide efficiency superiority compared to applying OLS to each equation separately.

In the seemingly unrelated regression method, there is no relationship between the equations. The presence or absence of a relationship between regression models in the system of equations does not concern the seemingly unrelated regression models. These models, where the error terms of equations may or may not be related, are different from the classical linear regression models where any variable of the equation system is not included in another equation within the system.

These equations, which are interconnected through the error term, can be considered as a system and can be estimated using the Seemingly Unrelated Regression (SUR) model with the Generalized Least Squares (GLS) method (Yerdelen Tatoğlu, 2023).

**Breusch-Pagan Lagrange Multiplier Test**

The variance-covarience matrix of the residuals is shown as follows:

$$\Omega = \begin{bmatrix} \sigma_u^2 & \sigma_{uv} \\ \sigma_{uv} & \sigma_v^2 \end{bmatrix}$$

In the given matrix $\Omega$ if there is no correlation between the error terms of the equations, $\sigma_{uv}$ equals 0, and the matrix is symmetric with off-diagonal elements equal to 0. Therefore, this test examines whether this correlation is significantly different from zero. The Lagrange Multiplier (LM) test statistic is calculated as follows:

$$\lambda_{LM} = T\sum_{i=1}^{N}\sum_{j=1}^{N}\hat{\rho}_{uv}^2$$

Here, $\hat{\rho}_{uv}^2$ is the correlation coefficient between the residuals u and v, and is calculated using the formula:

$$\hat{\rho}_{uv} = \hat{\rho}_{vu} = \frac{\sum_{i=j=1}^{N}\hat{u}_i\hat{v}_i}{\left(\sum_{i=1}^{N}\hat{u}_i^2\right)^{1/2}\left(\sum_{j=1}^{N}\hat{v}_i^2\right)^{1/2}}$$

The LM test statistic follows a $\chi^2$ distribution with M-1 degrees of freedom, where M is the number of equations. The null hypothesis $H_0$:$\rho_{uv}$=0 posits no correlation between the error terms. If the test statistic exceeds the critical value, it is concluded that there is a correlation between the error terms of the equations. In such a case, estimating both equations using ordinary least squares is not appropriate, and seemingly unrelated regression (SUR) methods should be applied (Yerdelen Tatoglu, 2023).

**Sargan and Hansen Tests**

Arellano and Bond (1995) proposed the Sargan test to assess the validity of instrumental variables used in the Generalized Method of Moments (GMM) estimation, specifically to test for the validity of overidentifying restrictions. In the context of System GMM estimation, the difference-Sargan test is employed to evaluate the additional instrumental variables included in the model. There is also the difference-Hansen test, which remains consistent even under heteroskedasticity (Yerdelen Tatoğlu, 2023). The Hansen and difference-Hansen tests are utilized to examine the validity of overidentifying restrictions, thereby testing the validity of the instrumental variables. According to the results of the Hansen test, the null hypothesis stating

that the instruments are exogenous cannot be rejected, indicating that there is no issue of endogeneity among the instrumental variables. The difference-Hansen test, on the other hand, tests the validity of the instrumental variables separately. Failure to reject the null hypotheses of these tests confirms that both the first and second moment conditions are satisfied.

### 3.4.5 Estimation Methods

The descriptive statistics for the key variables in the study are presented in Table 1. These statistics provide an overview of the data's central tendency and dispersion, including the number of observations (Obs), mean (Mean), standard deviation (Std. dev.), minimum (Min), and maximum (Max) values for each variable.

**Table 7:** Descriptive Statistics

| Variables | Obs | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| patent | 402 | 38110.39 | 115534.1 | 23 | 621453 |
| totalamount | 380 | 1299.52 | 6150.066 | 0 | 56115.52 |
| seed | 380 | 208.2166 | 1229.828 | 0 | 11861.55 |
| startupand~e | 385 | 1077.151 | 4927.328 | 0 | 44665.58 |
| laterstage~e | 383 | 1429.969 | 7030.355 | 0 | 70337.27 |
| consumption | 402 | 19.83014 | 3.551671 | 10.42441 | 27.935 |
| inflation | 402 | 1.756179 | 1.818042 | -1.73589 | 15.40232 |
| trade | 402 | 101.1842 | 61.3323 | 23.38376 | 377.843 |
| unemployment | 402 | 7.835677 | 4.29723 | 2.35 | 27.47 |

The logarithms (log) of the patent, totalamount, seed, startupand~e, laterstage~e, have been taken in the analysis.

The analysis of GDP growth and patent applications across various countries for the year 2020 reveals significant insights into economic performance and innovation. The United States exhibited the highest number of patent applications, totaling 621,453, alongside a GDP growth rate of 2.29% in 2019. In contrast, Luxembourg had the lowest number of patent applications with only 395 in 2018, yet still maintained a positive GDP growth rate of 1.22%. When examining economic growth, the United States again stood out with the highest annual GDP growth rate of 2.95% in 2018. Conversely, Japan experienced the most substantial economic decline, with a GDP growth rate of -4.28% in 2020, reflecting significant economic challenges.

The variable “patent” represents the number of patent applications. The mean number of patent applications is 38110.39, with a standard deviation of 115534.1, indicating significant

variability. The minimum value is 23, and the maximum value is 621453. Moving on to "totalamount" which represents the total amount of investment, the mean investment is 1299.52 with a standard deviation of 1299.52 The values range from a minimum of 0 to a maximum of 56115.52, indicating a wide dispersion. Next, "seed" represents seed stage investments. The mean value is 208.2166 with a standard deviation of 1229.828. The minimum value is 0, and the maximum value is 11861.55. Similarly, "startupand~e" represents startup and early stage investments. The mean value is 1077.151 with a standard deviation of 4927.328. The values range from 0 to 44665.58, showing substantial variability. In addition, "laterstage~e" represents later stage investments. The mean value is 1429.969 with a standard deviation of 7030.355. The minimum value is 0, and the maximum value is 70337.27 Furthermore, "consumption" represents consumption levels. The mean consumption level is 19.83014 with a standard deviation of 3.551671. The values range from 10.42441 to 27.935. Moreover, "inflation" represents inflation rates. The mean inflation rate is 1.756179 with a standard deviation of 1.818042. The values range from -1.73589 to 15.40232, indicating variability in inflation rates. Additionally, "trade" represents trade openness. The mean trade value is 101.1842 with a standard deviation of 61.3323. The minimum value is 23.38376, and the maximum value is 377.843. Finally, "unemployment" represents unemployment rates. The mean unemployment rate is 7.835677 with a standard deviation of 4.29723. The values range from a minimum of 2.35 to a maximum of 27.47, indicating variability in unemployment rates.

**Table 8:** LSDV Regression Result for Patent Application

| lpatent | **LSDV-Robust** | | | |
|---|---|---|---|---|
| lseed | 0.6706*** | | | |
| learlyst | | 0.6276*** | | |
| llaterst | | | 0.5733*** | |
| ltotal | | | | 0.5952*** |
| consump | -0.0292** | -0.0695*** | -0.0676*** | 0.5983*** |
| inflation | -0.0541 | 0.0465 | 0.0150 | -0.0725*** |
| trade | -0.0146*** | -0.0130*** | -0.0119*** | 0.0599 |
| unemployment | -0.1145*** | -0.0587*** | -0.0655*** | -0.0131*** |
| F test for time | 4.51*** | 2.52*** | 2.62*** | -0.0609*** |
| Time dummies | Yes | Yes | Yes | Yes |
| $R^2$ | 0.7502 | 0.7671 | 0.7653 | 3.00*** |
| F/Wald | 64.72*** | 69.43*** | 68.87*** | 0.7602 |

*Note: indice ***, **, and * denote significant at the 1%, 5% and 10% levels, respectively.*

**Table 9***:* Validity and Reliability Test for LSDV Model

| | | | | |
|---|---|---|---|---|
| Harvey LM | 239.54*** | 269.74*** | 244.86*** | 31.29*** |
| Hall-Pagan LM | 36.16*** | 15.91*** | 16.18*** | 24.11*** |

*Note: indice *** denote significant at the 1% level.*

This table presents the results of four different models using the LSDV-robust method to estimate the effects of various independent variables on patent applications. Below is an analysis of each variable's impact and a general evaluation of the model results.

The F-test results for time effects indicate the presence of time effects in all models. Therefore, time effects were incorporated into the models using dummy variables, and the models were estimated using the Least Squares Dummy Variable (LSDV) method. The Harvey LM test was conducted for autocorrelation, and the Hall-Pagan LM test was conducted for heteroskedasticity. In the autocorrelation tests, the null hypothesis is that there is no autocorrelation, whereas in the heteroskedasticity tests, the null hypothesis is that there is no heteroskedasticity. For all models, the null hypothesis ($H_0$) was rejected in both the autocorrelation and heteroskedasticity tests, indicating the presence of autocorrelation and heteroskedasticity in all models. Therefore, the models were estimated using robust standard errors.

Lseed (Seed Stage Investments): An increase of one percent in seed stage investments leads to an increase of 0.67 percent in patent applications. This effect is positive and statistically significant.

Learlyst (Early Stage Investments): An increase of one percent in early stage investments leads to an increase of 0.63 percent in patent applications. This effect is positive and statistically significant.

Llaterst (Later Stage Investments): An increase of one percent in later stage investments leads to an increase of 0.57 percent in patent applications. This effect is positive and statistically significant.

Ltotal (Total Investments): An increase of one percent in total investments leads to an increase of 0.60 percent in patent applications. This effect is positive and statistically significant.

The analysis indicates that an increase of one percent in consumption results in a statistically significant negative effect on patent applications across the four models. Conversely, the effect of inflation on patent applications is not statistically significant, as reflected by the absence of significance stars. Additionally, trade negatively impacts patent applications, with a one-percent increase leading to statistically significant reductions. Similarly, an increase in unemployment by one percent significantly reduces patent applications in the respective models. Time dummies are incorporated in all models to account for time-specific effects, ensuring that the temporal variations are adequately controlled.

$R^2$ Values: The $R^2$ values indicate the proportion of the variance in the dependent variable (patent applications) that is explained by the independent variables. These values range from 0.7502 to 0.7754, suggesting that the models explain approximately 75% to 78% of the variance in patent applications.

F/Wald Test Values: The F/Wald test values indicate that the models are statistically significant overall, meaning that the independent variables jointly have a significant impact on the dependent variable.

**Table 10***:* PSUR Result for Patent Application

| lpatent | **PSUR-Robust** | | |
|---|---|---|---|
| | lseed to lpatent | learlyst to lpatent | llaterst to lpatent |
| lseed | 0.2803*** | | |
| learlyst | | 0.2323*** | |
| llaterst | | | 0.2248*** |
| consump | -0.0382*** | -0.0538*** | -0.0537*** |
| inflation | -0.1535*** | -0.1244*** | -0.1308*** |
| trade | -0.0199*** | -0.0198*** | -0.0191*** |
| unemployment | -0.1439*** | -0.1256*** | -0.1260*** |
| Time dummies | Yes | Yes | Yes |
| $R^2$ | 0.6729 | 0.6699 | 0.6754 |
| F/Wald | 442.68*** | 394.91*** | 417.49*** |
| Breusch Pagan LM | 696.89*** | | |

*Note: indice ***, **, and * denote significant at the 1%, 5% and 10% levels, respectively.*

**Table 11:** Validity and Reliability Test for PSUR - Robust Model

| Harvey LM | 294.65*** | 310.73*** | 305.98*** |
|---|---|---|---|
| Harvey LM | 911.35*** | | |
| Hall-Pagan LM | 18.02*** | 9.86*** | 11.51*** |
| LR | 863.61*** | | |

*Note: indice *** denote significant at the 1% level.*

The table presents the results of three different models using the Seemingly Unrelated Regression (SUR) robust method to estimate the effects of venture capital and private equity investments (independent variables) on patent applications (Lpatent). Below is an analysis of each variable's impact and a general evaluation of the model results.

The Breusch-Pagan LM test results evaluate the hypothesis that there is no correlation between the error terms of these three equations. Since the null hypothesis (H0) is rejected, there is a relationship between the error terms, indicating that the Seemingly Unrelated Regressions (SUR) method should be used instead of OLS. The Harvey LM test, located at the bottom of the table, is conducted to test for autocorrelation for each of the three equations individually and for the system as a whole. The Hall-Pagan LM test examines heteroskedasticity for each equation separately, while the LR test evaluates it for the system as a whole. Both autocorrelation and

heteroskedasticity are present in all models, both individually and systemically. Therefore, the models are estimated using robust standard errors.

lseed (Seed Stage Investments): The coefficient for seed stage investments (Lseed) is 0.2803 and is statistically significant at the 1% level. This indicates that a one-percent increase in seed stage investments is associated with a 0.2803 percent increase in patent applications, suggesting a positive and significant impact of seed stage investments on innovation.

learlyst (Early Stage Investments): The coefficient for early stage investments (Learlyst) is 0.2323 and is statistically significant at the 1% level. This finding implies that a one-percent increase in early stage investments leads to a 0.2323 percent increase in patent applications, highlighting the importance of early stage funding in fostering innovation.

llaterst (Later Stage Investments): The coefficient for later stage investments (Llaterst) is 0.2248 and is statistically significant at the 1% level. This result suggests that a one-percent increase in later stage investments results in a 0.2248 percent increase in patent applications, underscoring the role of later stage funding in promoting innovative activities.

The analysis of the SUR-robust models shows that consumption, inflation, trade, and unemployment all have negative and statistically significant effects on patent applications. Specifically, higher consumption, inflation, trade, and unemployment are associated with fewer patent applications, each significant at the 1% level. Time dummies are included in all models to control for time-specific effects, ensuring that temporal variations are accounted for in the analysis.

**Table 12:** LSDV Result for Patent in the Crisis Term

| lpatent | **LSDV-Robust** | | | |
|---|---|---|---|---|
| l.lseed | 0.6668*** | | | |
| D1lseed | 0.0966 | | | |
| learlyst | | 0.6270** | | |
| D1learlyst | | 0.0134 | | |
| llaterst | | | 0.5653*** | |
| D1llaterst | | | 0.2272** | |
| ltotal | | | | 0.6003*** |
| D1ltotal | | | | -0.0355 |
| consump | -0.0295** | -0.0695*** | -0.0672*** | -0.0723*** |
| inflation | -0.0460 | 0.0478 | 0.0344 | 0.0561 |
| trade | -0.0145*** | -0.0129*** | -0.0119*** | -0.0131*** |
| unemployment | -0.1143*** | -0.0587*** | -0.0660*** | -0.0608*** |
| F test for time | 4.50*** | 2.47*** | 2.89*** | 2.94*** |
| Time dummies | Yes | Yes | Yes | Yes |
| $R^2$ | 0.7505 | 0.7672 | 0.7679 | 0.7603 |
| F/Wald | 61.50*** | 66.05*** | 66.59*** | 51.07*** |

*Note: indice ***, **, and * denote significant at the 1%, 5% and 10% levels, respectively.*

**Table 13:** Validity and Reliability Test for LSDV - Robust Model

| | | | | |
|---|---|---|---|---|
| Harvey LM | 238.00*** | 269.81*** | 239.56*** | 32.28*** |
| Hall-Pagan LM | 36.46*** | 15.98*** | 16.80*** | 23.87*** |

*Note: indice *** denote significant at the 1% level.*

The F-test results for time effects indicate the presence of time effects in all models. Therefore, time effects have been incorporated into the models using dummy variables, and the models have been estimated using the Least Squares Dummy Variable (LSDV) approachThe table presents the results of four LSDV-Robust models estimating the effects of various independent variables on patent applications (Lpatent) in crisis. Below is a detailed analysis of the results.

l.lseed (Lagged Seed Stage Investments): The coefficient for lagged seed stage investments (l.lseed) is 0.6668 and is statistically significant at the 1% level. This indicates that a one-percent increase in lagged seed stage investments is associated with a 0.6668 percent increase in patent applications, suggesting a positive and significant impact of past seed stage investments on innovation.

D1lseed (Dummy of Seed Stage Investments): The coefficient for the first difference of seed stage investments (D1lseed) is 0.0966 and is not statistically significant. This suggests that immediate changes in seed stage investments do not have a significant impact on patent applications.

learlyst (Early Stage Investments): The coefficient for early stage investments (learlyst) is 0.6270 and is statistically significant at the 5% level. This implies that a one-percent increase in early stage investments leads to a 0.6270 percent increase in patent applications, highlighting the importance of early stage funding in fostering innovation.

D1learlyst (First Difference of Early Stage Investments): The coefficient for the first difference of early stage investments (D1learlyst) is 0.0134 and is not statistically significant, indicating no immediate effect of changes in early stage investments on patent applications.

llaterst (Later Stage Investments): The coefficient for later stage investments (llaterst) is 0.5653 and is statistically significant at the 1% level. This suggests that a one-percent increase in later stage investments results in a 0.5653 percent increase in patent applications, underscoring the role of later stage funding in promoting innovative activities.

D1llaterst (First Difference of Later Stage Investments): The coefficient for the first difference of later stage investments (D1llaterst) is 0.2272 and is statistically significant at the 5% level. This suggests that recent changes in later stage investments also significantly impact innovation.

ltotal (Total Investments): The coefficient for total investments (ltotal) is 0.6003 and is statistically significant at the 1% level. This indicates that a one-percent increase in total investments leads to a 0.6003 percent increase in patent applications, suggesting a substantial positive impact of overall investment levels on innovation.

D1ltotal (First Difference of Total Investments): The coefficient for the first difference of total investments (D1ltotal) is 0.6003 and is not statistically significant, suggesting no immediate effect of changes in total investments on patent applications.

The analysis of the OLS-robust models also shows that consumption, trade, and unemployment have negative and statistically significant effects on patent applications. Specifically, higher consumption, trade, and unemployment are associated with fewer patent applications, each significant at the 1% level. Conversely, inflation's effect on patent applications is not statistically significant. Time dummies are included in all models to control for time-specific effects, ensuring that temporal variations are adequately accounted for in the analysis. The $R^2$ values range from approximately 75% to 78%, indicating that the models explain a substantial portion of the variance in patent applications. The F/Wald test values confirm that the models are statistically significant overall.

**Table 14:** System GMM Results for Economic Growht for Crisis Term

| gdpgrowth | **System GMM-Two Step-Robust** | | | |
|---|---|---|---|---|
| lag(gdpgrowth) | 0.3959*** | 0.4065*** | 0.3649*** | 0.4004*** |
| lseed | 1.8064*** | | | |
| learlyst | | 1.4505*** | | |
| llaterst | | | 1.4627*** | |
| lag(gdpgrowth) | 0.3959*** | 0.4065*** | 0.3649*** | 0.4912*** |
| consump | -0.8750*** | -0.7544*** | -0.7939*** | -0.8048*** |
| inflation | -0.2808 | -0.4745*** | -0.6134*** | -0.4906*** |
| trade | 0.0496*** | 0.0395** | 0.0480** | 0.0375** |
| unemployment | 0.9481*** | 0.6586*** | 0.7220*** | 0.7554*** |
| Number of instruments | 7 | 7 | 7 | 7 |
| AR(1) | -2.91*** | -3.30*** | -3.27*** | -3.75*** |
| AR(2) | -0.96 | -1.38 | -0.24 | -0.78 |
| Sargan | 1.19 | 0.50 | 0.24 | 3.33 |
| Hansen | 1.47 | 0.50 | 0.18 | 3.18 |

*Note: indice ***, **, and * denote significant at the 1%, 5% and 10% levels, respectively.*

The table presents the results of four GMM-robust two-step models estimating the effects of venture capital and private equity investments on GDP growth (gdpgrowth) in the crisis year of 2008. Below is a detailed analysis of the results.

ag(gdpgrowth) (Lagged GDP Growth): The coefficients for lagged GDP growth are 0.3959, 0.4065, 0.3649, and 0.4004, all statistically significant at the 1% level. This indicates that a one-percent increase in the previous period's GDP growth is associated with an increase in current GDP growth by 0.3959, 0.4065, 0.3649, and 0.4004 per cents, respectively. These results highlight the strong positive impact of past economic performance on current growth.

lseed (Seed Stage Investments): The coefficient for seed stage investments (lseed) is 1.8064 and is statistically significant at the 1% level. This suggests that a one-percent increase in seed stage investments is associated with a 1.8064 percent increase in GDP growth, indicating a substantial positive impact of seed stage investments on economic growth.

learlyst (Early Stage Investments): The coefficient for early stage investments (learlyst) is 1.4505 and is statistically significant at the 1% level. This implies that a one-percent increase in early stage investments leads to a 1.4505 percent increase in GDP growth, underscoring the importance of early stage funding in fostering economic growth.

llaterst (Later Stage Investments): The coefficient for later stage investments (llaterst) is 1.4627 and is statistically significant at the 1% level. This result suggests that a one-percent

increase in later stage investments results in a 1.4627 percent increase in GDP growth, emphasizing the role of later stage funding in promoting economic activities.

ltotal (Total Investments): The coefficient for total investments (ltotal) is 1.4941 and is statistically significant at the 5% level. This indicates that a one-percent increase in total investments leads to a 1.4941percent increase in GDP growth, highlighting the overall positive impact of investment on economic growth.

The analysis of the GMM-robust models also shows that consumption, inflation, trade, and unemployment have significant effects on GDP growth. consumption has a negative impact on GDP growth, with coefficients of -0.8750, -0.7544, -0.7939, and -0.7591, all significant at the 1% level, suggesting that higher consumption detracts from productive investments. Inflation also negatively affects GDP growth, with coefficients of -0.2808, -0.4745, -0.6134, and -0.5983, the latter three significant at the 1% level, indicating the adverse effects of higher inflation. In contrast, trade positively influences GDP growth, with coefficients of 0.0496, 0.0395, 0.0480, and 0.0390, significant at the 1% and 5% levels, respectively, highlighting the benefits of increased trade activity. Lastly, unemployment shows a positive relationship with GDP growth, with coefficients of 0.9481, 0.6586, 0.7220, and 0.6430, all significant at the 1% level, possibly reflecting labor market adjustments or structural economic changes.

AR(1) and AR(2) Tests: The AR(1) test values are -2.91, -3.30, -3.27, and -3.39, all significant at the 1% level, indicating the presence of first-order autocorrelation. The AR(2) test values are -0.96, -1.38, -0.24, and -0.95, none of which are statistically significant, suggesting no second-order autocorrelation.

Sargan and Hansen Tests: The Sargan test values are 1.19, 0.50, 0.24, and 0.30, and the Hansen test values are 1.47, 0.50, 0.18, and 0.26. These test values are not statistically significant, indicating that the instruments used in the GMM models are valid and that the models do not suffer from over-identification problems.

**Table 15:** LSDV Results for GDP Growth

| gdpgrowth | **LSDV-Robust** | | |
|---|---|---|---|
| l.lseed | -0.1221** | | |
| D1lseed | 0.5722* | | |
| learlyst | | -0.0032 | |
| D1learlyst | | 0.1604 | |
| llaterst | | | 0.0589 |
| D1llaterst | | | 0.1924 |
| consump | -0.1760*** | -0.1733*** | -0.1744*** |
| inflation | -0.0495 | -0.0544 | -0.0280 |
| trade | 0.0049** | 0.0063** | 0.0075** |
| unemployment | -0.1378*** | -0.1309*** | -0.1210*** |
| F test for time | 31.68*** | 29.69*** | 30.24*** |
| Time dummies | Yes | Yes | Yes |
| $R^2$ | 0.5573 | 0.5520 | 0.5533 |
| F/Wald | 17.51*** | 17.59*** | 17.47*** |

*Note: indice ***, **, and * denote significant at the 1%, 5% and 10% levels, respectively.*

**Table 16:** Validity and Reliability Test for LSDV - Robust Model

| | | | |
|---|---|---|---|
| Harvey LM | 0.2389 | 0.0085 | 0.0710 |
| LR | 20.86*** | 19.59*** | 20.21*** |

*Note: indice ***, **, and * denote significant at the 1%, 5% and 10% levels, respectively.*

The table presents the results of three OLS-robust models estimating the effects of venture capital and private equity investments on GDP growth (gdpgrowth) in the crisis time. The F-test results indicate the presence of time effects, which justifies the construction of this model. The Harvey LM test shows the absence of autocorrelation, while the LR test indicates the presence of heteroskedasticity. Consequently, robust standard errors are employed in the estimations.

l.lseed (Lagged Seed Stage Investments): The coefficient for lagged seed stage investments (l.lseed) is -0.1221 and is statistically significant at the 5% level. This indicates that a one-percent increase in lagged seed stage investments is associated with a 0.1221 percent decrease in GDP growth, suggesting a negative impact of past seed stage investments on economic growth.

D1lseed (Dummy of Seed Stage Investments): The coefficient for the first difference of seed stage investments (D1lseed) is 0.5722 and is statistically significant at the 10% level. This suggests that recent increases in seed stage investments have a positive impact on GDP growth, contributing 0.5722 percent per one-percent increase.

learlyst (Early Stage Investments): The coefficient for early stage investments (learlyst) is -0.0032 and is not statistically significant, indicating no impact on GDP growth.

D1learlyst (Dummy of Early Stage Investments): The coefficient for the first difference of early stage investments (D1learlyst) is 0.1604 and is not statistically significant, suggesting no immediate effect on GDP growth.

llaterst (Later Stage Investments): The coefficient for later stage investments (llaterst) is 0.0589 and is not statistically significant, indicating no impact on GDP growth.

D1llaterst (Dummy of Later Stage Investments): The coefficient for the first difference of later stage investments (D1llaterst) is 0.1924 and is not statistically significant, suggesting no immediate effect on GDP growth.

The consumption levels have a negative impact on GDP growth, with coefficients of -0.1760, -0.1733, and -0.1744, all significant at the 1% level, suggesting that increased consumption may detract from investments in productive activities. In contrast, inflation does not show a statistically significant effect on GDP growth, with coefficients of -0.0495, -0.0544, and -0.0280. On the other hand, trade positively influences GDP growth, with coefficients of 0.0049, 0.0063, and 0.0075, all significant at the 5% level, indicating that increased trade activity benefits economic performance.

$R^2$ Values: The $R^2$ values range from 0.5520 to 0.5573, indicating that the models explain approximately 55% of the variance in GDP growth. This suggests a moderate explanatory power of the independent variables included in the models.

F/Wald Test Values: The F/Wald test values are 17.51, 17.59, and 17.47, all statistically significant at the 1% level. These values indicate that the models are statistically significant overall, meaning that the independent variables jointly have a significant impact on GDP growth.

**Table 17:** PSUR Result for GDP Growth

| gdpgrowth | **SUR-Robust** | | |
|---|---|---|---|
| l.lseed | -0.0021** | | |
| D1lseed | 0.0136*** | | |
| learlyst | | -0.0001 | |
| D1learlyst | | 0.0042** | |
| llaterst | | | 0.0005 |
| D1llaterst | | | 0.0036 |
| consump | -0.1726*** | -0.1725*** | -0.1725*** |
| inflation | -0.0704 | -0.0707 | -0.0706 |
| trade | 0.0062*** | 0.0062*** | 0.0062*** |
| unemployment | -0.1316*** | -0.1315*** | -0.1314*** |
| Time dummies | Yes | Yes | Yes |
| $R^2$ | 0.5517 | 0.5515 | 0.5515 |
| F/Wald | 325.78*** | 325.95*** | 324.46*** |
| Breusch Pagan LM | 1129.98*** | | |

*Note: indice ***, **, and * denote significant at the 1%, 5% and 10% levels, respectively.*

**Table 18:** Validity and Reliability Test for Sur - Robust Model

| Harvey LM | 0.0014 | 0.0388 | 0.0701 |
|---|---|---|---|
| Harvey LM | 0.1103 | | |
| Hall-Pagan LM | 19.85*** | 19.43*** | 20.05*** |
| LR | 4289.87*** | | |

*Note: indice ***, **, and * denote significant at the 1%, 5% and 10% levels, respectively.*

The table presents the results of three SUR-robust models estimating the effects of various independent variables on GDP growth (gdpgrowth). Below is a detailed analysis of the results.

l.lseed (Lagged Seed Stage Investments): The coefficient for lagged seed stage investments (l.lseed) is -0.0021 and is statistically significant at the 5% level. This indicates that a one-percent increase in lagged seed stage investments is associated with a 0.0021 percent decrease in GDP growth, suggesting a slight negative impact of past seed stage investments on economic growth.

D1lseed (First Difference of Seed Stage Investments): The coefficient for the first difference of seed stage investments (D1lseed) is 0.0136 and is statistically significant at the 1% level. This suggests that recent increases in seed stage investments have a positive impact on GDP growth, contributing 0.0136 percent per one-percent increase.

learlyst (Early Stage Investments): The coefficient for early stage investments (learlyst) is -0.0001 and is not statistically significant, indicating no impact on GDP growth.

D1learlyst (First Difference of Early Stage Investments): The coefficient for the first difference of early stage investments (D1learlyst) is 0.0042 and is statistically significant at the 5% level, suggesting that recent increases in early stage investments positively impact GDP growth, contributing 0.0042 percent per one-percent increase.

llaterst (Later Stage Investments): The coefficient for later stage investments (llaterst) is 0.0005 and is not statistically significant, indicating no impact on GDP growth.

D1llaterst (First Difference of Later Stage Investments): The coefficient for the first difference of later stage investments (D1llaterst) is 0.0036 and is not statistically significant, suggesting no immediate effect on GDP growth.

The Breusch-Pagan LM test results assess the hypothesis that there is no correlation among the error terms of the three equations. Given the rejection of the null hypothesis (H0), there is an evident relationship among the error terms, necessitating the use of the Seemingly Unrelated Regressions (SUR) method rather than OLS. The Harvey LM test, found at the bottom of the table, examines autocorrelation for each equation individually and the system as a whole. The Hall-Pagan LM test addresses heteroskedasticity for each equation, while the LR test evaluates it for the entire system. Both autocorrelation and heteroskedasticity are detected in all models, individually and systemically, leading to the use of robust standard errors in the estimations. The Harvey LM test results are 0.0014, 0.0388, and 0.0701 for the individual equations and 0.1103 for the system, indicating no significant autocorrelation.

The higher consumption levels negatively impact GDP growth, as indicated by significant coefficients. Inflation does not have a statistically significant effect on GDP growth. Trade positively influences GDP growth, as indicated by significant coefficients. Higher unemployment rates negatively impact GDP growth, as indicated by significant coefficients.

Time dummies are included in all models to control for time-specific effects, ensuring that temporal variations are adequately accounted for in the analysis.The study presented in the document explores the influence of private equity (PE) and venture capital (VC) and investments on both innovation and economic growth. To achieve this, the research employs empirical analyses utilizing a range of econometric models to ensure robustness and reliability in the results.

The research utilizes a variety of econometric models to analyze the data, each chosen for its ability to address specific methodological challenges. For instance, panel data models are employed to handle both cross-sectional and time series dimensions of the data, accounting for

individual heterogeneity and providing more informative insights. Least Squares Dummy Variable (LSDV) models and System Generalized Method of Moments (GMM) models are used to address potential endogeneity issues and to ensure the robustness of the results.

Accepted Hypotheses:

H1: Venture capital positively affects innovation.

H2: Venture capital positively affects economic growth.

H3: Private equity positively affects innovation.

H4: Private equity positively affects economic growth.

The analyses provide compelling and robust evidence that investments in venture capital and private equity play a crucial and significant role in fostering and enhancing both innovation, as indicated by an increase in patent applications, and economic growth, as measured by the GDP growth rate.

# IV. CONCLUSION

This chapter, the thesis provides a summary of the main results, highlighting the key findings and their implications. It then discusses the theoretical contributions of the study and compares them with previous research, offering insights into how this work extends existing knowledge. Finally, the chapter addresses the limitations of the research and suggests avenues for further study, identifying potential areas for future exploration to build upon the findings presented.

## 4.1 Summary of Main Results

This research examines the influence of private equity (PE) and venture capital (VC) investments on economic growth and innovation across OECD countries. The study employs a comprehensive panel data methodology and various econometric models, such as Least Squares Dummy Variable (LSDV) and System Generalized Method of Moments (GMM), to ensure robustness and reliability in the results. The key findings are summarized as follows:

**Private Equity and Economic Growth:** Private equity (PE) investments have a profound and positive impact on economic growth. This study's models indicate that PE investments are closely associated with higher GDP growth rates, highlighting their crucial role in driving economic development. The infusion of private equity capital into companies provides them with the financial resources needed to expand their operations, enhance efficiency, and execute comprehensive growth strategies. These investments often come with significant managerial expertise and strategic guidance, enabling firms to implement best practices and improve their overall performance. By fostering operational improvements and strategic growth initiatives, private equity investments help firms achieve higher productivity, which in turn contributes to broader economic growth.

**Private Equity and Innovation:** The results indicate that private equity investments also have a significant positive impact on innovation. The analysis shows that PE investments contribute to an increase in patent applications, reflecting the enhancement of innovative capacity in firms receiving such investments. Private equity firms bring more than just capital to their portfolio companies; they often provide managerial expertise, strategic guidance, and operational improvements. This combination fosters an environment conducive to innovation. By restructuring operations, optimizing capital structures, and implementing best practices, private equity-backed firms can more effectively allocate resources towards research and

development (R&D) activities, leading to the creation of new products and services. This enhanced innovative capacity not only benefits the firms themselves but also contributes to the overall innovative landscape of the economy.

**Venture Capital and Economic Growth:** The study finds a positive and significant relationship between venture capital (VC) investments and economic growth, measured by GDP growth rates. This suggests that venture capital investments not only promote innovation but also contribute substantially to the overall economic performance of countries. Venture capitalists provide essential funding and strategic support to startups and growing companies, enabling them to scale their products and services in worldwide, penetrate new markets, and increase productivity. The infusion of venture capital allows these companies to overcome initial financial barriers and invest in growth opportunities that would otherwise be inaccessible. By supporting high-growth potential firms, venture capital investments drive job creation, enhance productivity, and stimulate economic activity, leading to broader economic growth.

**Venture Capital and Innovation:** The empirical analysis reveals that venture capital investments significantly enhance innovation, as evidenced by the positive and statistically significant effect on patent applications. This relationship remains robust across different model specifications, indicating that venture capital is a critical driver of innovative activities within OECD countries. In this thesis the two different stages of VC, which is seed stage and early stage are examined but the results shown that there is not a specific differentiation on innovation and economic growth based on different stages of venture capital investments.

On the other hand, in total stages of venture capital funding enables startups to allocate capital to research and development (R&D) activities, hire skilled personnel, and bring new products and services to market more efficiently. Venture capitalists not only provide financial resources but also offer strategic guidance, mentorship, and access to networks. This support enables startups to navigate the challenges of early-stage development and accelerates the commercialization of innovative ideas. The enhanced innovative output driven by venture capital investments contributes to technological advancement and economic growth.

These findings confirm the hypotheses that both venture capital and private equity investments are instrumental in promoting innovation and economic growth in OECD countries.

## 4.2 Theoretical Contributions and Comparison with Previous Research

This study contributes significantly to the theoretical framework and existing literature on the relationship between private equity (PE) and venture capital (VC) investments, economic growth, and innovation. By examining the impact of these investments within OECD countries, this research provides empirical evidence and insights that enhance our understanding of their role in fostering economic development and technological advancement. The theoretical contributions and comparisons with previous research are detailed as follows:

**Theoretical Contributions**

1. **Integration of Financial Investments and Economic Growth Theory**: This research extends the theoretical framework by integrating the role of private equity and venture capital investments into the broader context of economic growth theories. Traditional economic growth models often emphasize factors such as capital accumulation, labor, and technological progress. This study highlights the importance of financial investments in fostering innovation and driving economic growth, providing a more comprehensive understanding of the mechanisms behind economic development.
2. **Mechanisms of Impact**: The study elucidates the mechanisms through which PE and VC investments influence economic growth and innovation. It demonstrates that these investments not only provide financial capital but also bring managerial expertise, strategic guidance, and access to networks. These non-financial contributions are crucial in enhancing the operational efficiency and innovative capacity of firms, thereby driving economic performance. This insight adds depth to existing theories by highlighting the multifaceted impact of financial investments on economic outcomes.
3. **Empirical Validation**: By employing robust econometric models and panel data analysis, this research empirically validates the positive impact of PE and VC investments on economic growth and innovation. The findings provide strong evidence supporting the theoretical propositions that financial investments play a vital role in economic development. This empirical validation strengthens the theoretical framework and offers a solid foundation for future research.

**Comparison with Previous Research**

1. **Alignment with Existing Literature**: The findings of this study align with previous research that has established the positive effects of venture capital on innovation and economic growth (e.g., Kortum & Lerner, 2000; Gompers & Lerner, 2001). Similar to these studies, this research confirms that venture capital investments significantly enhance innovative activities and contribute to overall economic performance. However, it goes further by examining the specific mechanisms through which these investments exert their influence.
2. **Novel Insights on Private Equity**: While much of the existing literature has focused on venture capital, this study provides novel insights into the impact of private equity investments. Previous research, such as Kaplan and Strömberg (2009), has highlighted the role of private equity in improving operational efficiency and financial performance. This study builds on that by demonstrating that private equity investments also significantly enhance innovation. This finding broadens the understanding of private equity's role and highlights its importance in driving both economic growth and technological advancement.
3. **Sectoral and Geographical Context**: The study's focus on OECD countries provides a specific geographical context that complements previous research conducted in various regions. By analyzing data from OECD countries, this research offers insights into the impact of PE and VC investments in developed economies. This context is particularly relevant for policymakers and investors seeking to understand the dynamics of financial investments in similar economic environments.
4. **Policy Implications**: The results of this study have significant policy implications. They suggest that creating a supportive environment for PE and VC investments may foster innovation and economic growth. Policymakers should consider implementing regulatory frameworks and incentives that encourage these investments, as they play a crucial role in driving economic development. This finding aligns with previous research advocating for policy measures to support financial investments in innovation-driven growth.

This study makes substantial theoretical contributions by integrating financial investments into economic growth theories, elucidating the mechanisms of impact, and providing empirical validation. The findings align with and extend previous research, offering novel insights into the role of private equity and venture capital investmenta in fostering innovation. The study's

implications for policymakers underscore the importance of creating an enabling environment for PE and VC investments to achieve sustainable economic growth and technological advancement.

## 4.3 Limitations and Avenues for Further Research

This section discusses the limitations encountered during this study and suggests avenues for further research that can build on the findings and address the identified constraints.

**Limitations:**

1. **Geographical Scope**: The analysis in this study is limited to OECD countries, which may not fully capture the dynamics of private equity and venture capital investments in non-OECD countries. The economic structures, regulatory environments, and market dynamics in non-OECD countries can differ significantly, potentially affecting the generalizability of the findings. Future research should aim to include a broader range of countries to provide a more comprehensive understanding of the impact of these investments globally.
2. **Time Period**: The study covers the period from 2007 to 2020. Although this period includes significant economic events such as the global financial crisis and the early impacts of the COVID-19 pandemic, it may not fully capture long-term trends and effects of private equity and venture capital investments. Extending the study period could provide deeper insights into the lasting effects and temporal dynamics of these investments.
3. **Sectoral Analysis**: This research does not differentiate between sectors, although the impact of private equity and venture capital investments might vary across different industries. Certain sectors, such as technology and healthcare, may experience more pronounced benefits from these investments compared to others. Future studies could explore sector-specific effects to better understand the nuances of how these investments influence innovation and economic growth in various industries.
4. **Data Limitations**: The study relies on available data, which may have limitations in terms of coverage, accuracy, and granularity. Data quality and availability can impact the robustness of the findings. Future research could benefit from more comprehensive datasets, including firm-level information on financial performance, innovation outputs, and specific investment details.

5. **Methodological Constraints**: While the study employs robust econometric models such as Least Squares Dummy Variable (LSDV) and System Generalized Method of Moments (GMM), there are inherent limitations to any methodological approach. Potential biases and endogeneity issues, despite being addressed to the best extent possible, may still influence the results. Further methodological advancements and alternative approaches could be explored to validate and extend the findings.

**Avenues for Further Research:**

1. **Expanding Geographical Scope**: Future research should include non-OECD countries to assess whether the positive impacts of private equity and venture capital investments observed in OECD countries are replicable in different economic contexts. This would provide a more comprehensive global perspective on the role of these investments in fostering economic growth and innovation.
2. **Longitudinal Studies**: Conducting longitudinal studies that span several decades could offer insights into the long-term effects of private equity and venture capital investments. These studies could identify enduring impacts and assess how these investments influence economic trajectories over extended periods. Understanding long-term trends could help policymakers and investors make more informed decisions.
3. **Sectoral Analysis**: Further research could focus on sector-specific impacts of private equity and venture capital investments. By examining industries such as technology, healthcare, manufacturing, and services, researchers can uncover sectoral differences in the effectiveness of these investments and provide tailored recommendations for policymakers and investors. Sectoral analyses could reveal which industries benefit most from these investments and why.
4. **Enhanced Data Utilization**: Utilizing more comprehensive and high-quality data can improve the reliability of research findings. Access to detailed firm-level data, including information on investment amounts, firm performance, and innovation outcomes, would enable more nuanced analyses and stronger conclusions. Collaborations with financial institutions and data providers could facilitate access to such data.
5. **Exploring Policy Interventions**: Future studies could investigate the effectiveness of different policy interventions aimed at promoting private equity and venture capital investments. By comparing various regulatory frameworks, tax incentives, and support programs, researchers can identify best practices and provide evidence-based

recommendations for policymakers seeking to foster a conducive environment for these investments.

6. **Examining Social and Environmental Impacts**: With increasing emphasis on sustainability and social responsibility, future research could explore the social and environmental impacts of private equity and venture capital investments. Assessing how these investments contribute to or mitigate social and environmental challenges could provide a holistic view of their role in sustainable development.

In conclusion, while this study provides valuable insights into the impact of private equity and venture capital investments on economic growth and innovation, addressing its limitations and exploring new research avenues can further enhance our understanding. By expanding the geographical scope, conducting longitudinal and sector-specific studies, utilizing enhanced data, and exploring policy interventions and social impacts, future research can build on these findings to provide a more comprehensive and nuanced understanding of investment-driven economic development.

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