

Study on Venture Capital Investments and its ability to stimulate Innovation and Spur Economic Growth in India

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ABSTRACT

Objective: This paper examines the impact of Venture Capital Investments (VCI) on Innovation and Economic Growth in India. Venture Capital has emerged as a critical source of funding for startups, enabling them to develop innovative ideas, scale their operations, and contribute to economic growth. India, with its vibrant entrepreneurial ecosystem, has witnessed a significant increase in venture capital investments over the past decade.

Research Design and Methods used: This paper gathers key information from the market, varying from various reports and relevant data published by private players like E&Y, Bain & Company, Hurun, Venture Intelligence, Indian Venture Capital Association (IVCA); besides, governmental reports of SIDBI, SEBI, Economic Surveys, MSME Annual Reports and 'Intellectual Property India' report published by the Controller General of Patents, Design, Trademarks and Geographical Indications, Ministry of Commerce, Government of India. This is qualitative research. For the purpose of this research, the data pertains to last ten years. Using Python language, data analysis has been done by finding Correlation and Regression Analysis. The model has been run on Jupyter Notebook for Python.

Findings: There is, visible upsurge in the VC investments in the last few years, much credited to the pro-active approach of the Government in creating the right ambience and the infrastructure. The flagship programs of the Government, like, Startup Mission and Make in India have yielded positive results. Pandemic did its own damage, but, post Covid-19 pandemic, there has been a considerable upward shift in the VC investments as they venture into new terrains, seeding new technologies and nurturing Startups. AS a result of this, there has been a significant jump in the number of Unicorns. There has been a quantum jump in number of VCs that have invested in India and also the deal size is consistently on the rise.

Implications and Recommendations: By studying the existing research and data available, it is observed that there is asymmetry between the literature and the industry. The venture capital industry is inward cautious and there is dearth of exact deal data because of the secrecy and privacy issue, coupled with demographic and geographical shortcoming to collect the data. The role played by IVCA and other private players is, undoubtedly, worth a praise. It is recommended that further research should alienate with industry and be more methodical.

Contribution and Value Added: This study will benefit, immensely, to both researchers, intending to do further research in this area, and, also to the industry in building a nexus with academia. This research has taken one step forward in building the bridge between the two. This paper fills the gap by identifying the relationship between key variables and apply statistical tools like Correlation and Regression analysis to assess the trends and contribution of venture capital investments in terms of key variables innovation and economic growth. The outcomes of this study will offer a comprehensive understanding of the fundamental elements of venture capital investments (VCI) and their influence on both innovation and the growth of the Indian economy.

Keywords: Venture Capital, Unicorns, Innovation, Research &Development, Patents

1.0 INTRODUCTION

Though, in numerous publications of research data, whether domestic or international, the findings depict relatively insignificant amount of Venture Capital Investment, nonetheless, this has never discouraged researchers and the governments, the world over, to take this to obscurity. Is there any relationship between Venture Capital Investments (VCI) and innovation and eventually, to Economic Growth?

Research, in its obliqueness, is quintessentially a process of seeking intangible knowledge, which may or may not be much interest to the consumer per se, but acts as an intermediary in producing Innovation, which of course, is predominantly important for the final consumer (**Clancy and Moschini, 2013**).

Disruptions and innovations are taking on established businesses globally, creating a new wave of entrepreneurs and startups. Economists, the world over, are attributing the upsurge in number of innovations and growth of enterprises primarily to the rise of Venture Capitalists. VC investments in startups have really helped the investee firms to innovate. The quantum of capital going into Research and Development is helping these startups to grow organically, much to the fact that the VCs bring to the table, much needed experience and expertise to the investee firms.

Venture Capital investments play a vital role in financing innovation. These investor firms specialize in investing in the new ingenious companies with cutting edge technology (**Faiza Elloumi 2022**). In another study, Popov and Roosenboom provided the evidence of venture capital investments on potential inventions using a panel of 21 European Countries and 16 manufacturing industries by studying the effect of VC, relative to R&D on number of patents granted (**Popov and Roosenboom, 2012**). Venture Capital Investments contribute substantially to grow those entrepreneurial firms that propel innovation by both value-added and selectivity effects (**Da Rin, 2016**). **Hirukawa and Ueda, 2008** presented a paper titled "Venture Capital and Industrial Innovation" in which they further strengthened the results of (**Kortum and Lerner, 2000**), by extending the period originally taken by, from 1965-1992 and stretching it further to 2001 in order to study the impact during the NASDAQ bubble during which the VC industry experienced an explosive growth.

The quantum of VC investments in startups in India is just phenomenal. There has been a considerable jump in the number of startups in the recent years. Many of the startups who received VC investments have become Unicorns. Going by the NASSCOM report, India has the world's third largest startup kitty. The meteoric rise of startups in India has a significant impact on the Economy, demonstrating the ability to contribute nearly 4-5% of India's Gross Domestic Product (GDP). India is one of the fastest growing economies in the world in terms of number of startups and aims at taking the number of unicorns to 250 by 2025 (**Dr. Mallikarjun M. Maradi, 2023**).

2.0 LITERATURE AND CONTRIBUTIONS

Venture capital industry has evolved as an alternative source of financing the new entrepreneurs who do not get capital from the banking sector because of lack of asset base, nature of the risk, and absence of collateral security. Worldwide, it has been observed that many startups went on to become big giants because of early-stage financing by the venture capital firms. Venture capital firms infuse funds in the Startup in exchange of equity participation. These firms also provide valuable mentorship to the investee firms because of the vastness of the experience that they carry with them from their previous ventures. Such experience guides the new entrepreneurs in setting up policies, procedures and envisage innovative ideas with the help of their coaches. In India, though the industry is comparatively new, but it has significant contribution to the development of the new startups. The journey, so far, of Venture investors in India, has witnessed a bumpy ride with detours and roller-coaster rides. Venture Capital Investments have helped Startups to innovate. Their contribution to the economic growth has been small but significant.

Kortum and Lerner are considered as the pioneers in studying VCs impact on innovative behavior of the investee firms. Their paper 'Assessing the contribution of venture capital to innovation' has been cited extensively by all the researchers who worked on studying the impact of VCs on innovation in the subsequent years. The authors' primary focus was to examine the effects of a policy change in 1979, which allowed pension funds to invest in venture capital (VC) firms. This policy shift had a significant impact on VCs as it resulted in a substantial increase in the availability of capital, enabling them to make more investments. The authors conducted research on US companies spanning from 1965 to 1992, utilizing the number of patent registrations as a quantitative measure of innovation. They concluded that VC investments have a positive correlation with innovation. During the period of 1983-1992, while Research and Development accounted for an average of 3%, industrial innovations reached nearly 8%, as observed in their study. (**Kortum and Lerner 2000**).

Anirudh Agarwal, 2017, has published paper titled 'Venture Capitalist Enabled Entrepreneurial Mentoring: An Exploratory Study,' in which he has emphasized on the importance of examining the relationship between investors and investees and its influence on the performance of startups and VC funds. The study specifically focused on the extent of

guidance and support provided by venture capital firms, which is commonly observed in the Indian context. In yet another study, the author stated that higher interest rates by banks and other financial institutions and depressed equity market encouraged VC investments in India (Joshi, 2018). These VCs not only provide necessary seed money but also do the handholding by providing their vast experience. A study by Hellmann emphasized on the mentorship function performed by the venture capitals to provide their own immensely useful experience to the investee firms and they coach the startups and provide them access to their existing network and business infrastructure. This stance has also been strongly put forward by many researchers. They believe that expertise and vast experience of venture capital firms and angel investors does help significantly in providing mentorship and coaching to new startups (Kortum and Lerner, 2000; Popov and Roosenboom, 2012). They build new entrepreneurs to become tech giants in future. Venture Capital firms look for areas and startups having prospects of high growth but with high risk, who otherwise would find difficulty in finding the capital infusion (Da Rin et al, 2013); (Jain, 2011); (Wonglimpiyarat, 2012). The VC firms invest in such companies and as an exit policy, takes stake in the equity of the company.

VC firms eventually create many positive outcomes. They contribute immensely in creating new jobs, encourages innovation, raise the standard of living of the people, invest heavily in creating infrastructure and provide business support to tertiary sector (Pradhan et al, 2016; Hellmann and Puri, 2002). VC investing firms provide both managerial skills and competencies. Since the beginning of this century, it is notable that declarations about venture investment's contribution to 'technological breakthrough' or 'instant modernization' are becoming increasingly prevalent (Kolmakov et al., 2015). This raises questions as to whether these declarations are admissible, whether such form of investing is really that important, and if the effect of relatively small venture investment is significant (Pradhan et al. 2018). India is on the cusp of becoming a hub for innovation as new firms have come into existence in the last five years with the investments made by Venture Capital firms. B. Raghupathy, A. Thillairajan 2015 investigate the success of venture capital- and non-venture capital backed initial public offerings (IPO) in India. According to the findings, the average performance of an initial public offering (IPO) supported by venture capital was better in terms of profitability, size, and growth rates. The outcomes support the choice of private equity as being of the highest caliber. A study by Kishan Kumar Shetty, 2017 on the comparison of the effects of venture capital financing on the growth of startups, they observed that in the United States and China the influence appeared to be considerably more as compared to India. However, the momentous growth is evident in consumer technology sector in India, where VC seems to be bullish. The strengths of venture capital investing include a larger network, positive cash flows from potential firms, and raising innovations. Advent of new entrepreneurial firms in developing new products and doing contract research in collaboration with the international firms has really picked up.

A contrasting study conducted by Lahr and Mina suggests that venture capitalists (VCs) might have a detrimental impact on the innovative behaviour of firms. The researchers examined the effect of VCs on firms' patenting activities using survey data collected from 940 UK and US firms between 2004 and 2005. They employed Probit Regression models to estimate the likelihood of VC-backed firms applying for or being granted patents compared to their counterparts. Surprisingly, the study found that VCs do not increase the probability of firms applying for or being granted more patents. In fact, the opposite effect was observed, as patenting activities decreased following a VC investment. Their findings support the notion that VCs excel in identifying innovative firms and focusing on commercializing their innovations rather than stimulating future innovation. The study emphasized the importance of the expertise and extensive experience of venture capital firms and angel investors in providing mentorship and coaching to new startups, ultimately shaping them to become future tech giants (Lahr and Mina, 2016).

3.0 OBJECTIVES OF THE STUDY AND RESEARCH GAP

The purpose of this study is to correlate Venture Capital Investment with Innovation and Economic Growth. While the trends of VC investments have picked up pace considerably in the last few years, there has not been any substantial research in Indian context to interlink the three.

The objectives of the study are as follows:

1. To study the trends of Venture Capital Investment (VCI) in India
2. To study the impact of VCI on innovation in India
3. To study the impact of VCI on Economic Growth in India

While ample research has been done in developed economies such as US, Russia and European Countries, showing the relationship amongst VCI, Innovation and Economic Growth; there is dearth of research in Indian context. The venture capital industry is comparatively new and still at its infancy stage in India. The key initiatives taken by the Government in the last few years have witnessed flux of venture capital investments coming to India. 'Startup India Mission', 'Make in India' coupled with ease of doing business have yielded encouraging results. These results need to be corroborated with statistical tools and trends for both researchers and the corporate world. This paper fills the gap by applying the correlation and regression analysis using Python, to assess the trends and contribution of venture capital investments in terms of key variables innovation and economic growth. The results in this study shall provide deep insight into the key aspects of VCI and its impact on innovation and economic growth in India growth story. The study utilizes a comprehensive dataset of venture capital investments in India and employs various econometric techniques to assess the relationship between venture capital investments, innovation, and economic growth. The analysis focuses on multiple dimensions of innovation, including research and development (R&D) expenditures, patent filings, and technology adoption.

The findings reveal a positive and significant association between venture capital investments and innovation indicators. The infusion of venture capital funding facilitates increased R&D expenditures by startups, fostering technological advancements and the creation of intellectual property. Moreover, venture capital-backed firms demonstrate a higher propensity to file patents, suggesting a greater emphasis on protecting innovative ideas.

4.0 RESEARCH METHODOLOGY AND HYPOTHESIS

For the purpose of this study, the data has been sourced from following:

- GDP and Per Capita Income from National Statistical Organization, Government of India
- Venture Capital Data from 'India Venture Capital Reports (2016-2023) by Bain & Company
- DPIIT, Ministry of Commerce and Industry, Government of India, Annual Reports (2018-2023)
- Economic Survey and Niti Ayog Reports, Government of India
- MSME Annual Reports, Government of India
- India Unicorn Index by Hurun India
- Patents and Intellectual Property Rights (IPR) from Controller General of Patents, Designs, Copyright and Geographical Indications, Government of India

For the purpose of this research, the data pertains to ten years. Using Python language, data analysis has been done by finding Correlation, Line Diagram and Regression Analysis. The model has been run on Jupyter Notebook for Python.

The present study intends to test the following hypotheses:

H₁: VCI are showing upward trend in India

H₂: There is relationship between VCI and Innovation

H₃: There is relationship between VCI and GDP

5.0 RESULTS AND EXPLANATION

There are ample evidences found during this research which suggest that VC investments does play a key role in innovation and economic growth. In India, VC investments in Startups have yielded encouraging results. Many VC investments made few years back in Startups are the Unicorns of today.

5.1 Trends in Venture Capital Investments in India

India, with its vibrant entrepreneurial ecosystem and burgeoning startup landscape, presents a compelling case for studying the relationship between venture capital investments, innovation, and economic growth. Over the past decade, India has witnessed a remarkable growth in venture capital investments, with startups spanning diverse sectors such as technology, e-commerce, fintech, and healthcare attracting significant funding. However, to date, limited research has been conducted

to comprehensively analyse the specific impact of venture capital investments on innovation and economic growth in the Indian context.

Table 1 below contains data from 2012-2022 on two important parameters namely number of deals in each year and annual VC Investments in India. As observed from the data in the table, it is clearly visible that over the past decade, the venture capital (VC) landscape in India has witnessed a remarkable growth in both the number of deals and the size of investments. This trend highlights the increasing interest and confidence of investors in the Indian startup ecosystem. The combination of the growing number of deals and increasing deal sizes has resulted in a surge in overall VC investments in India. This has played a crucial role in fuelling the growth of startups, fostering innovation, and contributing to the overall economic development of the country. The influx of capital has enabled startups to scale their operations, expand into new markets, hire talent, invest in research and development, and develop disruptive technologies. Consequently, this has created job opportunities, spurred entrepreneurship, and contributed to the GDP growth of India.

Table 1: Venture Capital Investments in India

Year	Number of deals	Annual VC investments in India(\$B)
2012	458	3.1
2013	593	2.9
2014	684	4.6
2015	987	6.3
2016	854	4.8
2017	589	4.7
2018	571	6.6
2019	756	11.1
2020	809	10.0
2021	1545	38.5
2022	1611	25.7

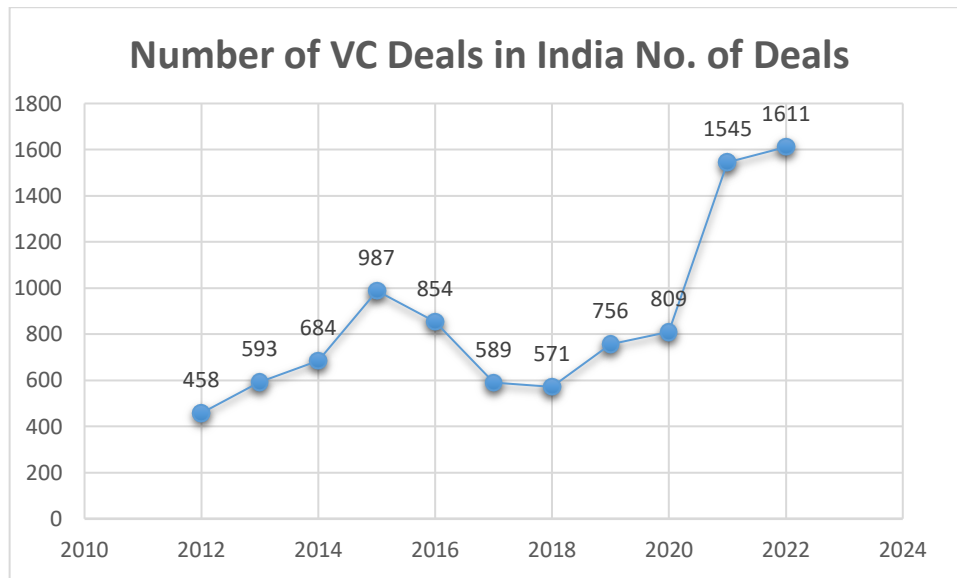
Source: India Venture Capital Report 2023, Bain & Company

The number of venture capital deals in India has been steadily increasing over the years. From 458 deals in 2012, it rose to 1,545 deals in 2021, representing a significant growth of over threefold. This trend indicates a vibrant startup ecosystem and a growing interest from investors in Indian startups. Fluctuating Annual VC Investments: The annual VC investments in India have shown some fluctuations throughout the period. There were peaks and valleys in investment amounts, reflecting the dynamics of the investment landscape and market conditions. Although the number of deals increased from 2012 to 2013, the total VC investments saw a slight decline from \$3.1 billion to \$2.9 billion. This decline could be attributed to factors like economic uncertainty and investor caution. From 2014 to 2016, there was a consistent growth in annual VC investments, reaching a peak of \$6.3 billion in 2015. The number of deals also showed a positive trend during this phase, indicating increased investor confidence and a maturing startup ecosystem. In 2017, there was a decline in both the number of deals and total VC investments. However, the investment amount rebounded in 2018, reaching \$6.6 billion. The dip in 2017 could be attributed to factors like regulatory changes, market corrections, or investor sentiment. The period from 2019 to 2021 witnessed substantial growth in annual VC investments. The investments more than doubled from \$11.1 billion in 2019 to \$38.5 billion in 2021, which can be attributed to increased investor interest, the rise of unicorns, and favourable market conditions. In 2022, the number of deals remained relatively stable compared to the previous year, while the total VC investments decreased to \$25.7 billion. This could indicate a phase of consolidation and a more balanced investment landscape.

The trends in both the number of deals and annual VC investments indicate a positive growth trajectory. The increasing number of deals reflects the growing interest from investors, highlighting the renewed interest of investors in the Indian startup eco-system and the country's growing reputation as a favourable destination for venture capital and also imposing

the faith in initiatives taken by the Government. On the other hand, the occasional fluctuations in investment amounts highlight the evolving nature of the market showing maturity.

Graph 1: Showing Number of VC deals in India between 2010-2022



Source: Data from India Venture Capital Report 2023, Bain & Co.

The line chart represents the number of venture capital deals in India from 2012 to 2022. It can be clearly observed that there is an increasing trend in the number of deals over the years, with some fluctuations in the middle showing a maturing market doing consolidation for a leap further. Notably, there has been a significant rise in the number of deals in recent years.

Descriptive statistics

From the data above, the following measures of central tendency are calculated.

Table 2: Showing Measures of Central Tendency

Measure	No. of Deals
count	11.000000
mean	882.454545
std	460.914854
min	458.000000
25%	601.500000
50%	756.000000
75%	930.000000
max	1611.000000

Source: Author’s own calculations

The dataset consists of 11 observations or data points, representing the number of deals in each respective year. Average number of deals over the 11-year period is approximately 882.45. This provides an indication of the typical or average number of venture capital deals that took place annually in India during the period under consideration. The standard deviation, which measures the dispersion or variability of the data, is approximately 460.91. This indicates that the number of deals in each year varied significantly from the average. The minimum value recorded for the number of deals is 458, representing the lowest number of deals observed in a given year during the analysed period. The 25th percentile, or the lower quartile, is 601.5. This means that 25% of the data points fall below this value, indicating that in 25% of the years, the number of deals was less than or equal to 601.5. The median, or the middle value when the data is arranged in ascending order, is 756. This suggests that 50% of the years had a number of deals equal to or less than 756. The 75th percentile, or the upper quartile, is 930. This means that 75% of the data points fall below this value, indicating that in 75% of the years, the number of deals was less than or equal to 930. The maximum value recorded for the number of deals is 1611, representing the highest number of deals observed in a given year during the analysed period.

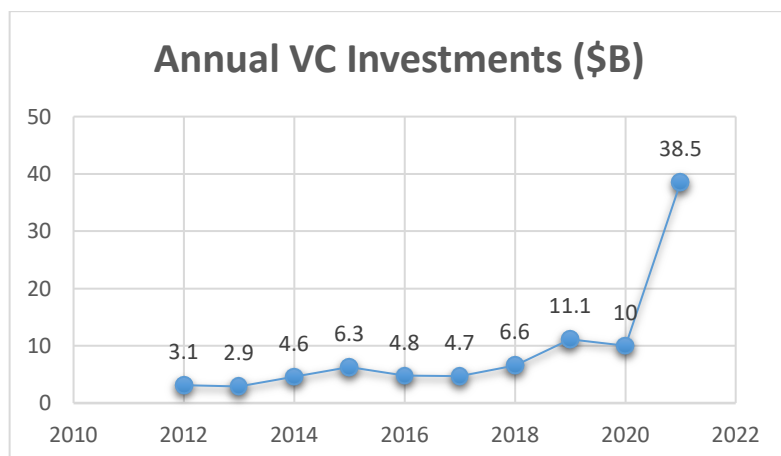
These summary statistics provide insights into the distribution and range of the number of venture capital deals in India over the specified period. The mean, median, and quartiles indicate the central tendency and spread of the data, while the minimum and maximum values give an understanding of the range of values observed. These statistics help to contextualize the average, typical, and extreme values of venture capital deal activity in India during the analysed period.

To analyse the trend more precisely, calculate the compound annual growth rate (CAGR) of the number of deals over the period.

$$\text{CAGR} = (\text{Ending balance}/\text{beginning balance})^{1/n} - 1$$

Using the formula, the CAGR of the number of venture capital deals in India is approximately 16.2%. This indicates that, on average, the number of deals has been growing at a rate of 16.2% annually over the given period. Overall, the data shows a positive trend in the number of venture capital deals in India from 2012 to 2022. This suggests a growing interest in venture capital investments and startup activity in India during the analysed period.

Graph 2: Line graph showing Annual VC Investments



Source: Graph from data obtained from India Venture Capital Report 2023

The line graph above depicts important stages of venture capital investments in India in last ten years. From initial rise from 2012 till 2015, the graph shows static and consistent rise, describing the growing faith of VC investors in the India growth story. From 2015 the investments grow at a constant rate showing consolidation and maturing market. During this period, the VC investors reposed faith in India but they were reluctant to pump more money due to global liquidity issues and inflationary conditions. As displayed by the graph, once the consolidation phase was over, there was a tremendous jump in the investments made by such investors. The jump has been significant and the growth has been phenomenal.

On analyzing the above data, it is observed that there is a consistent rise in the annual VC investments in India. The important measures of central tendency are as follows:

Table 3: Measures of Central Tendency

Mean	6.26
Median	5.55
Range	35.6
Variance	83.47
Standard Deviation	9.13

Source: Author's own calculations

Based on the above calculations, there are significant evidences to portray that there has been a consistent rise in both number of deals and deal size. At some point of time, the investments do take a breather but only to come back sharply. The following observations are made:

1. **Number of Deals:** The number of venture capital deals in India has been steadily increasing over the years. There is significant growth from 2012 to 2022, with a peak of 1611 deals in 2022 compared to 458 deals in 2012.
2. **Annual VC Investments:** The annual venture capital investments in India have shown substantial growth, particularly in recent years. There is a significant increase from 2012 to 2021, reaching a peak of \$38.5 billion in 2021 compared to \$3.1 billion in 2012.
3. **Average Deal Size:** The average deal size has varied over the years. It initially showed some fluctuations but started to increase consistently from 2017 onwards. The average deal size reached its peak in 2021 at \$24.9 million compared to \$6.7 million in 2012.

5.2 Impact of VCI on Innovation in India

Venture capital (VC) investments foster research and development (R&D), which in turn lead to innovation. Venture capitalists provide funding to early-stage, high-potential companies with innovative ideas and growth potential. This financial support enables these companies to conduct R&D activities, which often play a critical role in driving innovation.

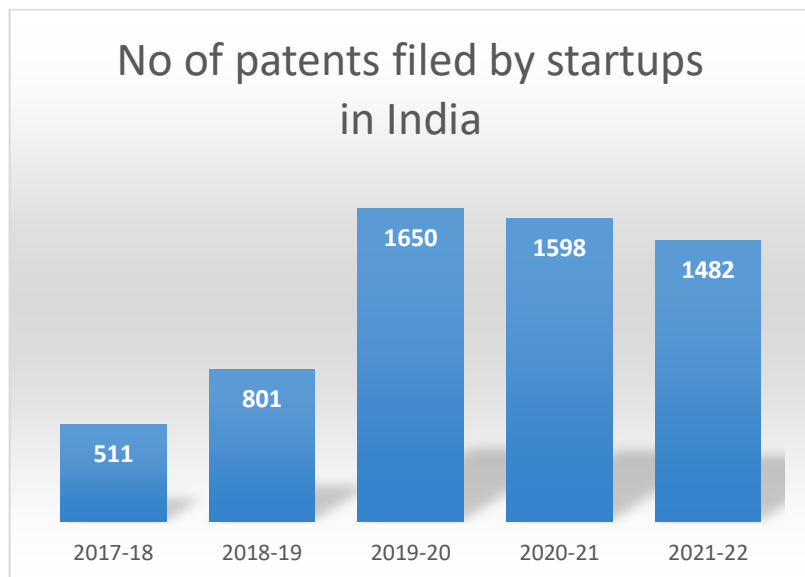
However, it's important to note that not all venture capital investments directly lead to successful R&D and innovation. The outcomes can vary, and there are risks involved, as not all R&D projects result in successful innovations. Venture capitalists carefully evaluate investment opportunities and make decisions based on various factors, including the company's potential for growth, market demand, and the strength of its R&D capabilities. Overall, venture capital investments can play a crucial role in fostering R&D and promoting innovation by providing the necessary financial resources, expertise, guidance, and long-term support to early-stage companies with high-growth potential.

Since there is not authentic data available on research and development spendings by VC backed firms, the present study takes into consideration the patents filed for the purpose of analysing the Innovation pattern of these investee firms.

Patents – A precursor for Innovation

Patents serve as a crucial precursor for innovation, driving technological advancements, economic growth, and social development. By incentivizing inventive activities, promoting knowledge sharing, and protecting intellectual property rights, the patent system encourages individuals, businesses, and research institutions to invest in R&D and create groundbreaking solutions. As India strives to become a global hub for innovation, the significance of patents cannot be overstated, as they continue to fuel progress, attract investments, and protect the nation's intellectual capital.

Graph 3: Number of Patents filed by Startups in India



Source: Intellectual Property India, 2021-22, Government of India

India has seen a significant increase in patent filings over the years due to various government initiatives and a growing emphasis on innovation and intellectual property rights. There has been a consistent rise in the in the patent filing by Startups. This data shows that VC investment firms are also investing in the startups who are keen to go for patents and innovation. The data shows a consistent increase in the number of patents filed by startups in India from 2017-18 to 2019-20. The number of patents filed grew significantly during this period, indicating a positive environment for innovation and entrepreneurial activity among startups. From 2019-20 to 2021-22, there is a slight decline in the number of patents filed by startups. While the decline is relatively small, it suggests a possible stabilization or pause of patent filings by startups during this period. The number of patents filed by startups experienced substantial growth, almost doubling from 511 in 2017-18 to 1650 in 2019-20. This indicates an increasing focus on research and development activities, as well as a higher level of innovation among startups in India.

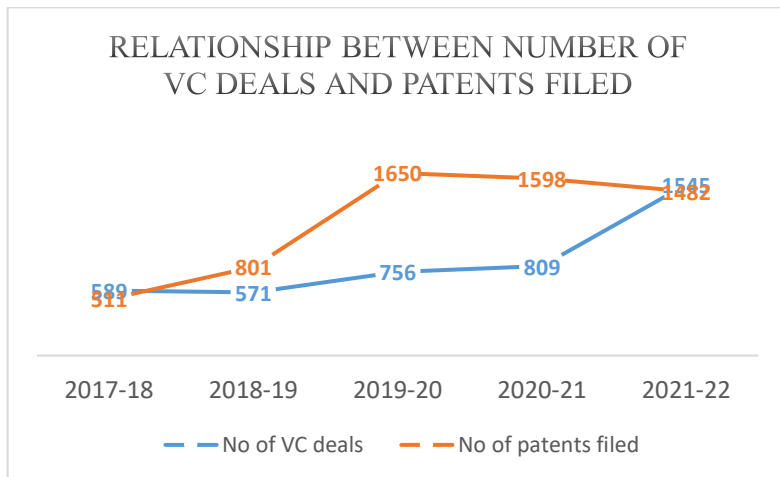
The table below shows the number of deals that VC investors have done in India and the other column shows number of patents filed by the startups. The data shows that number of patents have completely outnumbered the number of VC deals in some years, which shows that startups are filing more than one patent. Also, when the Government made some sweeping changes including reduction in the fee for filing patents by the startups, it encouraged more startups to file for patents.

Table 4: Data for Number of VC deals and Number of Patents

Year	No of VC deals	No of patents filed
2017-18	589	511
2018-19	571	801
2019-20	756	1650
2020-21	809	1598
2021-22	1545	1482

Source: Intellectual Property Report and Venture Capital Report

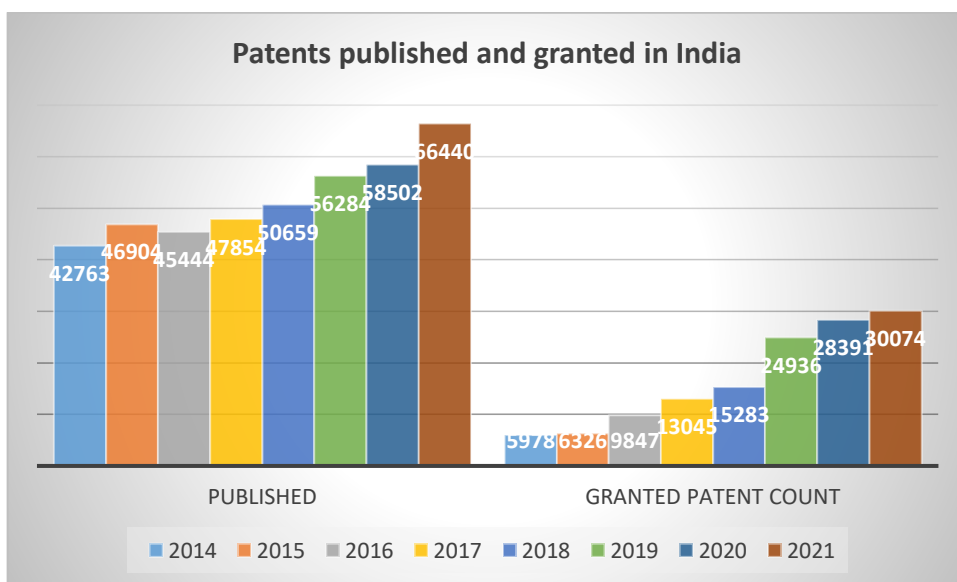
Graph 4: Line Graph showing relationship between number of VC deals and Patent filed



The graph above shows variability in the data and the correlation is almost negligible which indicates that number of patent filing is much higher as compared to the number of VC deals in India. It exhibits the exuberance in the startup community to go for the innovation. This is a healthy sign for India as more patents mean new products and designs are being envisaged in different sectors of the economy,

Graph 5 shows the total number of patents published and granted in India. While there has been a consistent improvement in the number of patents published, on the other hand there is considerable rise in the number of patents granted. This is primarily due to the ease in the patents granting process which has resulted in less lag time for granting the patent. These measures have led to the marked improvement in the global Innovation Index for India.

Graph 5: Bar Chart showing Patents published and granted in India



Source <https://pib.gov.in/PressReleasePage.aspx?PRID=1815852>

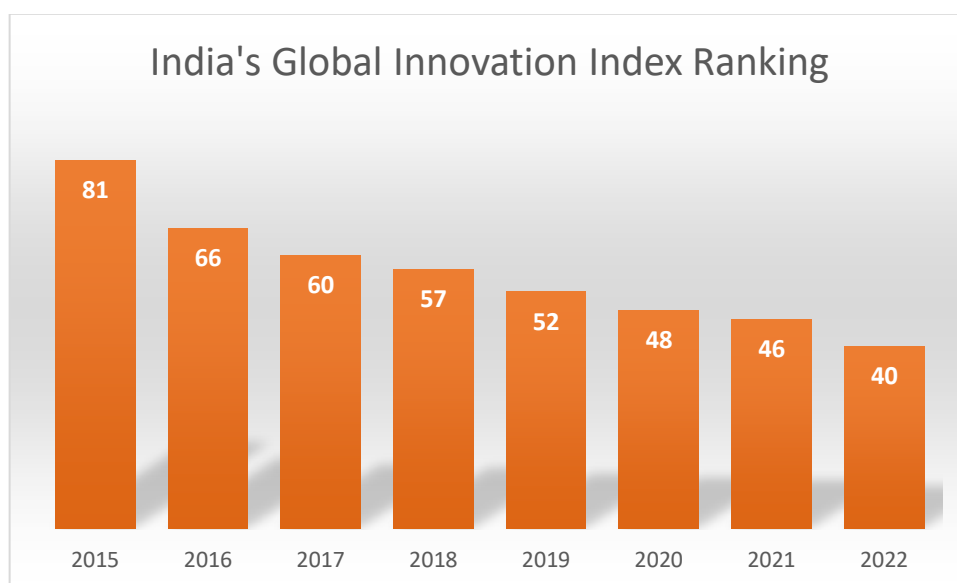
The Economic survey 2021-2022, published by the Ministry of Finance, Government of India, highlights the significance of intellectual property rights, particularly patents, for startups in India, which are predominantly from the IT/Knowledge sector. The report reveals a consistent growth in the filing and granting of patents in India over the years. The number of patent filings has increased from 39,400 in 2010-11 to 45,444 in 2016-17 and further to 58,502 in 2020-21. Similarly, the number of patents granted has risen from 7,509 to 9,847 to 28,391 during the same period. Furthermore, the report indicates

a shift in patent applications, with an increasing number originating from Indian residents rather than multinational corporations (MNCs). The proportion of Indian residents' applications in the total has seen a rise from 20% in 2010-11 to approximately 30% in 2016-17 and further to 40% in 2020-21.

Global Innovation Rankings

The GII ranking allows countries to benchmark their performance against other nations and learn from successful innovation models. It facilitates knowledge sharing, collaboration, and best practices exchange among countries to foster innovation-driven development. A higher GII ranking enhances a country's appeal to foreign investors and innovators. It signals a supportive environment for research, development, and commercialization of new technologies, attracting investments and skilled talent from around the world. In conclusion, the Global Innovation Index ranking serves as a comprehensive assessment of a country's innovation capabilities and outcomes. India's improved ranking reflects its commitment to nurturing innovation and highlights its potential as an innovation-driven economy. The ranking holds significance in terms of recognition, competitiveness, policy formulation, benchmarking, and attracting investments and talent.

Graph 6: Histogram showing Global Innovation Index Ranking for India



Source: Department for Promotion of Industry and Internal Trade, Ministry of Commerce and Industry, Government of India, Annual Report 2022-2023

Remember, the lower the number, the better position in the ranking. The Global Innovation Index (GII) ranking for India has shown improvement in recent years. The GII is an annual report published by the World Intellectual Property Organization (WIPO), in collaboration with other institutions, that measures and ranks countries based on their innovation capabilities and outcomes. The ranking takes into account various indicators such as research and development investments, human capital, infrastructure, market sophistication, business environment, and intellectual property rights protection. In the last few years, India's GII ranking has witnessed a positive trend. Specifically, India's ranking has climbed 35 positions, moving from 81 in 2015-16 to 46 in 2021. It has further improved to 40 in 2022. This improvement indicates the country's growing emphasis on fostering innovation and its efforts to create an ecosystem conducive to innovation-driven growth.

The GII ranking holds significant importance for India for several reasons. A higher GII ranking signifies that India is making notable progress in terms of innovation. It enhances the India's image and perception on the global stage, showcasing its potential and attractiveness for investments, collaborations, and partnerships. Innovation plays a vital role in enhancing a country's competitiveness and driving economic growth. A higher GII ranking suggests that India is actively fostering innovation, which can lead to increased productivity, job creation, and sustainable development. The GII provides policymakers with valuable insights into the strengths and weaknesses of a country's innovation ecosystem. It helps identify

areas that require attention and improvement, enabling policymakers to formulate targeted strategies and policies to nurture innovation and technological advancements.

All the abovementioned discussion on innovation scenario in India indicate towards great appetite for innovative ideas and VC investments hovering around this idea.

5.3 IMPACT OF VENTURE CAPITAL ON ECONOMIC GROWTH

5.3.1 Relationship between VCI and GDP

Numerous studies have shown relationship between VCI and GDP in developed nations where VC investments have a long track record. In India, on the contrary, the Venture Capital culture is relatively new. Through this study, an effort has been made to establish the relationship between the two. The study aims to explore the relationship between venture capital investments (VCI) and Gross Domestic Product (GDP) in India over the past decade. By analysing the impact of VCI on economic growth, the study seeks to provide insights into the role of venture capital in driving India's economic development.

The study highlights the importance of supportive policies and a favourable regulatory environment in promoting venture capital investments and their positive impact on GDP. It emphasizes the need for policymakers to continue developing frameworks that encourage entrepreneurship, innovation, and access to capital. Ensuring ease of doing business, protecting intellectual property rights, and fostering collaboration between startups, investors, and research institutions are crucial for sustaining the positive relationship between VCI and GDP.

Startups supported by venture capital investments have played a significant role in contributing to India's GDP growth. These startups have not only created employment opportunities but have also driven innovation, technological advancements, and disruption in traditional industries. The findings suggest that nurturing a vibrant startup ecosystem through venture capital investments can act as a catalyst for economic growth and transformation.

Table 5: Showing GDP, Average VC deal Size and Annual VC Investments in India

Year	GDP (\$B)	Average VC deal Size (\$M)	Annual VC Investments (\$B)
2021	3,176.30	24.9	38.5
2020	2,667.69	12.4	10
2019	2,831.55	14.7	11.1
2018	2,702.93	11.5	6.6
2017	2,651.47	8.1	4.7
2016	2,294.80	5.6	4.8
2015	2,103.59	6.4	6.3
2014	2,039.13	6.8	4.6
2013	1,856.72	4.9	2.9
2012	1,827.64	6.7	3.1

Source: Indian Statistical Organisation Report 2021, India Venture Capital Report 2021, Bain & Co.

For the purpose of establishing relationship between VCI and GDP, this study uses statistical tools of Correlation and Regression Analysis. Though, the author would have liked to use Time Series Analysis for the same but since the period of study is small, using Correlation and Regression is apt and more meaningful. In order to perform correlation and regression analysis to determine the relationship between GDP and Annual VC deal, Python libraries such as Pandas, NumPy, and SciPy have been deployed to generate the correlation matrix and perform linear regression. The Python code calculates the correlation matrix and performs linear regression between GDP and Annual VC Investments. Here is the output:

Table 6: Correlation and Regression Analysis

Correlation	0.90560015
Linear Regression Parameters	
Slope	0.010303991078045848
Intercept	-5.710794384102335
R-Value	0.9056001473146688
P-Value	0.00045276377076883185
Standard Error	0.0017915265682850032

Source: Author's own calculations using Python

The correlation matrix shows that there is a strong positive correlation between GDP and Annual VC Investments, with a correlation coefficient of 0.9056. This indicates that as GDP increases, the VC Investments also tends to increase. This value indicates a strong positive correlation between the two variables. It suggests that there is a significant and consistent relationship between GDP and Annual VC Investment in India over the given time period. The linear regression analysis shows that the slope of the regression line is 0.0103, indicating that for every \$1 billion increase in GDP, there is a \$10.3 million increase in Annual VC Investment. The vice-a-versa is also true. The more the VC investments, the more will be the GDP. The intercept of the regression line is -5.71, indicating that when GDP is zero, the expected value of VC Investment is negative \$5.71 million, which in practicality is impossible as GDP can't fall to zero. The R-value of 0.906 indicates that the regression line explains about 90.56% of the variability in the Annual VC Investments. The P-value is 0.00045, which is less than the significance level of 0.05, suggesting that the relationship between GDP and VC Investments is statistically significant. The standard error represents the average distance between the observed VC Annual Investment values and the values predicted by the regression line.

In conclusion, the analysis indicates a strong positive correlation and a statistically significant relationship between GDP and Annual VC Investment in India. The linear regression parameters provide insights into the direction and magnitude of this relationship, suggesting that an increase in GDP is associated with a corresponding increase in Annual VC Investment. However, it's important to note that correlation and regression analyses do not establish causation, and other factors may also influence the relationship between GDP and Annual VC Investment.

6.0 DISCUSSION

Over the last ten years, Venture Capital Investments have shown various stages of Indian market. From maturing market to growing optimism, and then pandemic stage and finally the recalibration stage; the VCI in India has evolved over the last ten years. Rapidly evolving startup environment coupled with increasing investor sentiment has led to scaling of first-generation startups in India. Marquee exits renew investors' confidence. Emerging sectors demonstrating traction in areas such as fintech and SaaS.

In the last few years, the momentum of the whole eco-system of Venture Capital Investments and building a robust growth model. The year 2021 witnessed a record growth year for VC funding which reached \$38.5 billion growing 3.8x over 2020 and faster than that of China (1.3x) **India Venture Capital Report Bain & Company, (2022-2023)**. The report stated that 44 unicorns were minted in India surpassing China where this number is 42. Momentum in VC investments in India in the last few years have upscaled due to ground work done in the previous years. The present-day growth is the effort of the several past years. Maturing infrastructure of UPI (Unified Payment Interface) led to many payment gateways, eKYC linked to Aadhar electronic data access, increasing depth in the eco-system of startups and repositioned faith of the investor because of the various investors friendly initiatives of the Government have bolstered the long-term capital inflow. The number of Active VC funds in India has shown a steady growth in the last few years with some micro-VCs and family offices coming forward with investments for early-stage investments in sunrise sectors. There has been a consistent rise in

both deal volumes and average deal size over the last decade and India has witnessed a phenomenal growth in both these areas.

The diverse demographic profile of India continues to play key role in strategizing investment; the VC investments have been concentrated to IT centered hubs in different metros across the country. Within Asia-Pacific, the kitty of the India centered investments reached 20% for the very first time and India continued its dominance to account for 5% of global VC funding, in line with previous years. India had another feather in the cap when in 2022 it became the third country in the world to cross triple digit mark for number of Unicorns created. The present tally of Indian Unicorns created stands at 108. Recalibrating the stupendous inflow of the funds as VC investments, 2022 witnessed a softening of funding momentum, in tandem with, increasing macroeconomic uncertainty and wider apprehension of global recession, broadly triggered by (1) tightening of monetary policy by all central banks across the world; (2) Intensifying geo-political tension due to Russia-Ukraine conflict; (3) trade sanctions by NATO countries led by US and France, leading to severe shockwaves in global supply chain. While, global macroeconomic factors led to a considerable slowdown; India, on the contrary, continued to be a go-to-destination for investors, given the strong fundamentals, infrastructure, favorable demographic positions and tech savvy environment.

Since the study of the process from VC Investment to Startups, Innovation and Unicorns is outside the purview of the present study, the author intends to undertake a separate study in a separate paper in the near future.

7.0 Concluding Remarks

The present study explored the relationship between venture capital investments (VCI), innovation, and economic development in India over the last decade. Through correlation and regression analysis and detailed interpretation of the data sourced, the study aimed to provide insights into the role of venture capital in fostering innovation and driving economic growth in the Indian context.

The findings of the research indicate a positive and significant relationship between VCI, innovation, and economic development in India. The analysis revealed that increased venture capital investments have been associated with higher levels of innovation and subsequent economic growth. This correlation suggests that venture capital plays a vital role in nurturing startups, encouraging entrepreneurial activities, and supporting innovation-driven industries.

The study observed a notable increase in venture capital investments in India over the last ten years, reflecting the growing interest and confidence of investors in the Indian startup ecosystem. This surge in investments has contributed to the development of technology-driven sectors such as IT/Knowledge, e-commerce, fintech, and health-tech. These sectors have been instrumental in driving economic growth, generating employment opportunities, and fostering disruptive innovations in traditional industries. Moreover, the research highlights the importance of supportive policies and a conducive regulatory environment in facilitating venture capital investments and their positive impact on innovation and economic growth. Policy interventions that promote ease of doing business, protect intellectual property rights, encourage research and development, and provide access to capital are crucial for sustaining and enhancing the relationship between venture capital, innovation, and economic development in India.

The findings of this study have significant implications for various stakeholders. Policymakers can leverage these insights to formulate targeted policies that foster a favourable environment for venture capital investments, entrepreneurship, and innovation. Investors can gain valuable information about the potential returns and opportunities associated with venture capital investments in India. Entrepreneurs can use these findings to understand the role of venture capital in their business growth strategies and seek appropriate funding sources. While this research provides valuable insights into the relationship between venture capital, innovation, and economic growth in India, there are certain limitations to consider. The study relies on aggregated data and does not capture the nuanced dynamics of individual startup cases. External factors, such as global economic conditions and geopolitical events, may also influence the observed relationship. Due to paucity of the data on research and development and patents granted by venture capital invested startups, the same has not been integrated in this study and left for future research.

Future research can further explore the specific mechanisms through which venture capital investments drive innovation and economic development in India. This includes studying the impact of venture capital on job creation, technological

advancements, industry-specific growth, and regional disparities. Additionally, research can focus on the effectiveness of different policy interventions and their impact on venture capital investments and economic outcomes.

In conclusion, this research underscores the significant role of venture capital in stimulating innovation and spurring economic growth in India. The findings highlight the importance of fostering a supportive ecosystem that attracts venture capital investments, nurtures startups, and promotes entrepreneurship and innovation. By understanding the dynamics of venture capital investments and their impact on innovation and economic development, stakeholders can collaborate to create a vibrant and sustainable entrepreneurial ecosystem that drives India's economic growth in the years to come.

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