

The Interrelation of Venture Capital Investments and Innovation – The Fintech Market

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Abstract: The interrelationship between venture capital investments and innovation within the European FinTech market was investigated over the period from January 2015 to July 2022. In the study period, the monthly granted patents by the European Patent Office were employed as the quantification of innovation. The stock, as well as the number, of venture capital investments across the member states of the European Patent Office were collected.

The results demonstrate a strong positive correlation between the aggregate volume of venture capital investments and innovation, and a slightly weaker correlation between the number of venture capital investments and innovation. The potential causal effect of venture capital availability on innovation output, as measured by patents, is highly likely to account for more than 40% (investment volume) or more than 20% (number of investments) of the dispersion in patent grants. Furthermore, the study's results suggest the existence of a reverse relationship, where a high patent output attracts new capital investments.

Keywords: Fin Tech, patent, Europe, venture, capital, seed, grants, investment, innovation, volume

JEL: G24, O31

1. INTRODUCTION

The emergence of Fintech companies has been a disruptive development within financial markets (Rau *et al.*, 2021). This transformative impact on the economy

is primarily driven by entrepreneurial and pioneering behavior, which ultimately culminates in innovations, frequently originating from start-ups (Cumming & Schwienbacher, 2021; Lerner & Nanda, 2023). Generally, the Fintech market is segmented into four principal categories (digital payments, personal finance, alternative lending, and alternative financing), each with two respective sub-categories (Fenwick *et al.*, 2018; Leong & Sung, 2018). In 2020, the aggregate transaction volume across these four categories culminated at US\$ 6,577 billion. Projections anticipated growth in every category, with the largest projected compound annual growth rate (CAGR) of 22.8% for the period 2020–2025. This anticipated development has since been surpassed by the actual market performance (Fast *et al.*, 2024).

Given that innovation is a primary driver of economic activity and growth, governments maintain a keen interest in supporting innovative behaviour (Yu *et al.*, 2024). Alongside official institutions striving for macroeconomic benefits, private investors, such as venture capital (VC) firms or angel investors, also demonstrate a strong interest in start-ups (Li *et al.*, 2023; Vallée & Zeng, 2019).

Kortum and Lerner (1998) early on examined the interrelationship between innovation and VC investments within the US. Equating innovations with patented inventions, they found significant evidence that the amount of VC investments increases concurrently with the rate of patenting, thereby displaying a general correlation between VC investments and innovation quantified as patents. Furthermore, their analysis demonstrated “that venture capital accounts for 15% of industrial innovations”.

Building upon this framework, Popov and Roosenboom (2012) investigated the interrelation between VC investments and innovation across Europe, utilizing a sample of 21 European countries. Analogous to the methodology of Kortum and Lerner (1998), they elaborated the interrelation in a cross-industry research encompassing ten distinct industries. They concluded that a general interrelation exists but is “weak at best”. Overall, they determined “that venture capital investment has accounted for about 10.2% of industrial innovation in 15 European countries since the early 1990s”. This finding lends support to the suggestion by Kortum and Lerner (1998), who questioned the transferability of their results to other industries, stating that “Different employment practices, regulatory policies, or public market conditions might limit the formation of these funds” (p. 37). However, Cailou and DeHai (2022) find effects for the Chinese energy sector.

Popov and Roosenboom (2012) provided the first cross-country analysis of the effect of VC investments on innovation within Europe. They observed an interrelation that “is weak at best”. More recently, but with similar results, Xiao *et al.* (2023) demonstrated that the availability of VC primarily fosters process innovation rather than product innovation, the former of which is not necessarily covered comprehensively by patent data. A comparison of the share of innovation driven by VC investments in the United States and Europe suggests a comparably less efficient VC market in Europe in terms of innovative output. A current comprehensive overview of the literature concerning the relationship between VC financing and innovation is provided by Lerner and Nanda (2023). Even though this topic has been studied for more than three decades, a substantial amount of research potential still exists, and the topic remains of primary interest (Alaasar *et al.*, 2023; Du *et al.*, 2024).

With the emergence of the Fintech market in 2015, numerous scientific studies on the sector have been conducted (Giglio, 2021); however, the interrelation of VC investments and innovation within the Fintech market remains largely unexplored, with studies such as Olayiwola *et al.* (2024) constituting rare exceptions.

Focusing on the Fintech sector, the study by Baartmans (2020) addresses a question similar in nature to the present study: to what extent the availability of VC to Fintech companies allowed for greater innovativeness within the companies. Due to the study's time frame extending only until 2016, all subsequent and current developments are not inherently considered. Chemmanur *et al.* (2020) also investigated the interrelation of innovation in the Fintech market and the availability of VC. Their study placed an additional focus on sector-specific regulations, an issue previously foreshadowed by Philippon (2016). Gomber *et al.* (2018) offered a more general overview of the drivers and impact factors of innovation in the Fintech sector, without focusing exclusively on capital availability.

Aside from the impact of VC availability on Fintech companies, the reverse causality can also be considered: an innovative Fintech market, characterized by increasing patent output, may become more attractive to investors, thereby drawing in capital and investments, as demonstrated for China by Zhao *et al.* (2022).

Currently, neither the direction considered by Chemmanur *et al.* (2020) nor the one considered by Zhao *et al.* (2022) has been investigated for the European markets over an extended time horizon. Only Kolokas *et al.* (2020) indirectly included a portion of the European market, making it the study most closely linked to the

proposed article, which focuses studies like Perret (2014) and Leogrande *et al.* (2021) on the Fintech market. In contrast to studies such as Li *et al.* (2023), which consider the perspective of banks as investors (a business perspective), this study adopts an economics perspective.

Consequently, the two main research questions (RQs) of this article are formulated as follows:

- RQ 1: Do VC investments and innovation correlate across the European Fintech market?
- RQ 2: How strong is this relation?

To address these questions, the second section will formulate two research hypotheses based on the theoretical background, and will discuss the data sources as well as the overall research design. Subsequently, the third section will cover a descriptive analysis of the data set and the testing of the hypotheses. These results will be interpreted thereafter. The thesis will be concluded in the fourth section, which will display the limitations of the thesis and provide recommendations for implications.

2. METHODOLOGY

2.1. Research Hypotheses

Within the European Fintech market, studies investigating the correlation between venture capital (VC) investments and innovation have not yet been established. Based on cross-industry findings from prior research, a positive correlation can be reasonably assumed between VC investment amounts and innovation, as quantified by patents, within the European Fintech market. This leads to the formulation of the first hypothesis:

- H1: The aggregate volume of venture capital investments is positively correlated with the level of innovation within the European Fintech market.

These foundational studies, however, have focused exclusively on the *amounts* of VC invested, rather than the *number* of investments. Analyzing the investment count provides additional insight into the market behaviour of venture capitalists, thereby prompting the second hypothesis:

- H2: The number of venture capital investments is positively correlated with the level of innovation within the European Fintech market.

2.2. Data Sources

The measurement of innovation via patent grants or applications is subject to considerable debate within the scientific literature, with patents frequently being considered a noisy measure (Verspagen & Schoenmakers, 2004). Nonetheless, the majority of studies employ patents due to the lack of a superior alternative proxy for innovation (Perret, 2014). Given the focus on the European market, patent grants were collected from the European Patent Office (EPO), the official patenting administration for the region.

To accurately assess innovation and the impact of VC within the European Fintech market, the scope requires demarcation regarding the relevant patent classes. This task is complicated by the absence of an agreed-upon Fintech classification system. Consequently, a general patent class approach is not implemented. Instead, the analysis is restricted to patents that explicitly report the term “Fintech” in either the title or the description. January 2015 was determined as the start of the relevant time frame, as the Fintech market emerged at the beginning of 2015. The end is the latest possible month available (July 2022).

The requisite data were sourced from two distinct entities: the European Patent Register and Dealroom.co B.V. (Dealroom.co, 2022a). The European Patent Register, in concert with other global administrative institutions, tracks every patent throughout the entire process, from initial registration to final publication within Europe. Dealroom.co, a prominent data provider specializing in start-ups, growth companies, and technology ecosystems, was utilized for the VC investment data due to its provision of the most extensive dataset on VC investments within the European Fintech market (Dealroom.co, 2022b).

3. EMPIRICAL ANALYSIS

3.1. Description of the Data Set

After not a single granted patent in 2015, the first official Fintech patents were granted in September 2016, as illustrated in Table 1. Considering the processing time of patents at the EPO of one and a half years, this outcome is consistent with expectations. The last three months of the considered time horizon marked an all-time high, specifically, 27 granted patents in May, 28 in June, and 24 in July 2022. This demonstrates the increasing innovative spirit and growth of entrepreneurial activity within the Fintech market.

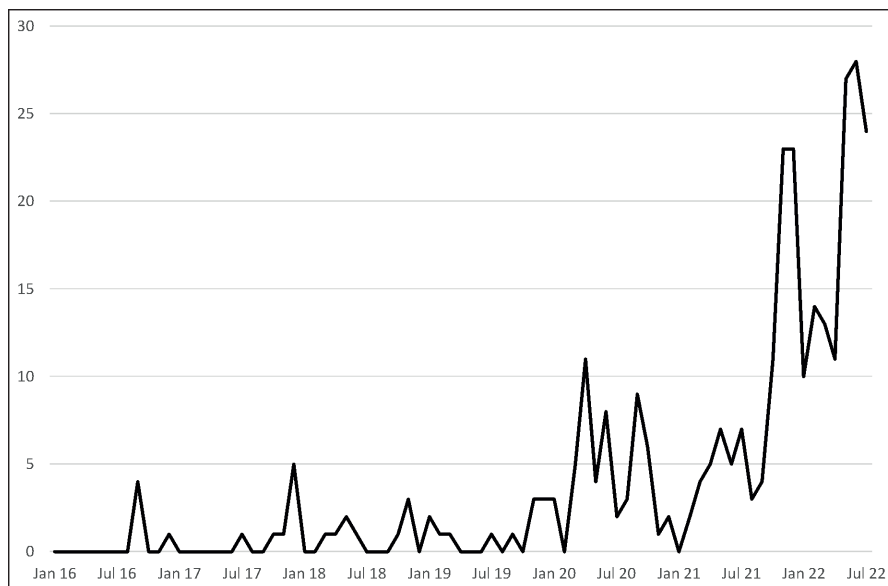


Figure 1: Development of European Fintech Patents at the EPO

To analyse the market, the sum of VC investment across the EPO member states was collected for Fintech companies. With an initial three-digit million-euro investment figure in January 2015, the VC investments subsequently reached one billion euros in May 2019. Marking the highest average across the years so far, 2022 exhibited an average investment of two billion euros per month. For the analysis of the amounts of VC investments, the numbers were examined for the same time frame as well. Notably, the amounts of VC investments exhibit significant volatility in contrast to the cumulative sum (cf. Figure 2). Furthermore, with an average of 86.24 VC investments per month, 2021 marks the highest amount thus far.

A detailed examination of the VC investments reveals that only two countries (the United Kingdom and Germany) have invested throughout the entire time into the Fintech market. Nearly half of the investments originate from the UK (3,073), followed by approximately one sixth from Germany (889), and slightly more than one fifth from France (646). Collectively, these three countries cover approximately 75% of all VC investments in the Fintech market. Monaco and North Macedonia are the only countries that had not invested at all until July 2022. Looking at the total VC investments within the European Fintech market, a total investment volume across the EPO countries of €67,347,384,990 has been invested throughout the observed timeframe. Hereby, a mean of €740,081,154 and

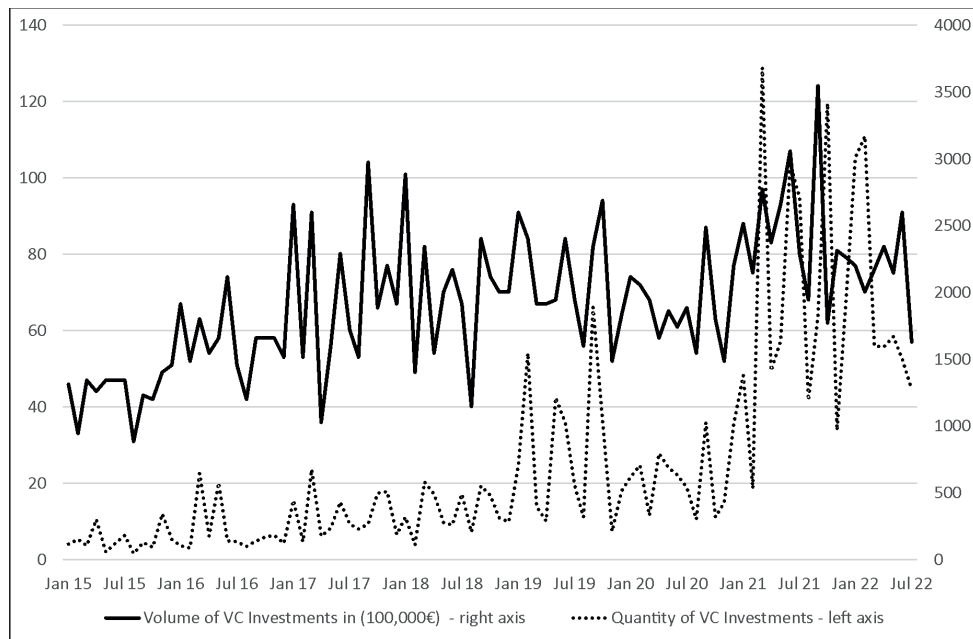


Figure 2: Venture Capital Investments in the European Fintech Sector

a standard deviation of €815,838,858 illustrate the wide spread across months. This can be attributed to the different development stages of the Fintech market within the respective country. Additionally, the market only commenced in January 2015 and developed over time, which increases its attractiveness for venture capitalists at a later stage as initial investigation into the market and its developments is required. As the potential of the market was observed, the investment started to increase significantly over time, with the highest amounts in more recent months. Thus, it comes as no surprise that the volatility in the market, specifically fluctuations of the volume of average investments across months, significantly increased in the later periods.

3.2. The Interrelation of Venture Capital and Innovations

The number of patents and the sum of VC investments are treated as scale variables. Therefore, for the analyses of H1 and H2, the bivariate Pearson correlation test was initially considered. However, the application of a Shapiro-Wilk test to the three involved variables revealed that only the number of VC investments exhibits a normal distribution; consequently, Spearman's rank correlation coefficient is utilized and presented.

Given that neither venture capital (VC) leads to an immediate invention nor is a patent application at the European Patent Office (EPO) granted instantly, a total of four alternative scenarios were considered. In addition to the correlation considering simultaneous VC investments and patents, a test was conducted using the VC variable lagged by 12 months, 18 months, and 24 months, respectively. The results for hypotheses H1 and H2 are summarized in Table 1 below.

Table 1: Correlation Results for Hypothesis H₁ and H₂

Hypothesis	Lag 0 Months	Lag 12 Months	Lag 18 Months	Lag 24 Months
H ₁	0.639*** (0.000)	0.602*** (0.000)	0.464*** (0.000)	0.644*** (0.000)
H ₂	0.392*** (0.000)	0.438*** (0.000)	0.405*** (0.000)	0.463*** (0.000)
N	91	79	73	67

Asterisks indicate the significance level of the test result. *** indicate a significance with $p < 0.001$.

The results presented in Table 1 offer a relatively unambiguous finding. All reported results are highly statistically significant, and the correlation coefficients are categorized as strong (Gignac & Szodorai, 2016). As all coefficients are positive, both hypotheses are retained, establishing a positive correlation. Across the three lagged models, the strongest correlations were observed with a lag of 24 months. For H1, approximately 41.5% of the variance in innovation output can be explained solely by the availability of VC; for H2, this figure remains substantial at 21.2%, accounting for over one-fifth of the variance. Given a maximum EPO patent processing time of up to 18 months (Perret, 2014) and the prerequisite that VC inputs must first generate the underlying invention, these results are theoretically consistent⁶⁷. While the results do not conclusively prove the causality of VC investments driving FinTech innovations via patents, they provide strong supporting evidence. The decrease observed at the 18-month lag can be attributed to seasonal patterns within the data, resulting in a poorer fit due to the non-alignment of seasonal peaks.

The potential existence of a feedback relation between the variables is motivated by the findings of Zhao *et al.* (2022). In the case of the number of VC investments, the continuously increasing coefficients (at 0, 12, and 24 months) suggest a one-sided relationship. Conversely, the results for hypothesis H1 concerning the volume of VC investments are less definitive. The coefficient decreases when switching from no lag to a one-year lag, and then increases again when switching to a 24-month

lag. Thus, the observed increase may stem from the impact of VC investments on FinTech patenting, while the initial decrease may suggest an opposite effect, wherein strong patenting within a sector serves as an attractor for investors. It is important to acknowledge that in the scenario without a lag, the investments leading to the patents must have occurred prior to the patent date; as detailed previously, patents do not have an immediate effect on investments. Correlation results considering a 12-month lead time for VC investments yielded slightly weaker outcomes. Therefore, any attracting effect of patents on VC investments would likely only incorporate recent patenting results. Given the relative youth of the FinTech market, this is highly logical, as extensive historical data series are unavailable for investor analysis, and VC investment decisions are frequently based on the current market situation and perceived future potential, rather than solely on past development.

Comparison of the two preceding results suggests that innovation is attracting a significant volume of VC investments, rather than a large number of individual investors. This is likely driven by the cost-intensive trajectory entrepreneurs must follow when conceiving an innovation. When applying for patents, entrepreneurs and start-ups face substantial bureaucratic and cost-intensive hurdles until final patent granting.

4. CONCLUSIONS

4.1. Insights Gained

With the emergence of the Fintech market in 2015, a new economic domain with its distinct market structure and behavior became established. Cross-industry studies have previously established the interrelationship between venture capital (VC) investments and innovation (Kortum & Lerner, 1998; Popov & Roosenboom, 2012). The primary objective of this study was to detail these interrelationships specifically within the Fintech market.

For the observed timeframe from January 2015 until July 2022, the European Patent Office (EPO) granted 91 patents that include the term “Fintech” in either the title or the text. Overall, 6,127 VC investments were executed within the EPO member states. These investments represented an aggregate volume of €67,347,384,990 across 3,073 distinct VC transactions.

The study results demonstrate a substantial positive correlation between the volume of VC investments and patent grants, and a weaker, yet statistically significant, correlation between the number of VC investments and patent grants.

Furthermore, the results indicate a two-year lag before the investments fully translate into measurable effects. A feedback relation, wherein patents attract VC investments into the Fintech market, could not be definitively established, although the results provide strong suggestive evidence of its likelihood.

4.2. Practical Implications and Policy Options

For practitioners, specifically VC investors or agencies, the results of this study suggest that investments in the Fintech market will stimulate innovation, thereby indicating significant potential for future returns. However, these returns are only expected to materialize over an extended period. A significant finding resulting from this study is that the investment volume plays a more pronounced role than the number of investments. Consequently, a VC investor should prioritize selective targets and higher funding concentration over distributing capital across a broader group of targets. It is noted that this focused strategy inherently introduces a higher degree of portfolio risk due to reduced diversification.

While the Fintech market has demonstrated increasing innovativeness recently, it still accounts for a marginal share of the overall patent output. Nevertheless, it performs an important disruptive function with respect to the broader financial markets. Thus, from the perspective of national or supranational government bodies, a growing Fintech market is poised to introduce new impetus into the comparatively rigid European financial markets through increased competition and diversity (Caragea *et al.*, 2024). In the long term, this development is expected to strengthen the European financial markets and enhance their resilience against foreign competition, external shocks, and crises. Therefore, governmental intervention, whether through direct public VC funding of Fintech companies or by creating a more favorable environment for private VC funds and investors, is projected to yield multifaceted positive outcomes in the long run.

4.3. Limitations and Outlook

This study focuses on the European Fintech market; hence, the generalizability of its results to other markets, particularly the United States, which operates under a substantially different investment and VC market framework, may be limited. Comparative research encompassing other Fintech markets outside Europe, especially in larger domains like the United States or China, would offer valuable insights.

To quantify innovation, patent grants by the EPO that include the term “Fintech” were utilized. Some researchers posit that patent applications should instead be considered, as they are argued to more closely represent innovative behavior within a market. Patent applications were not considered in this study, as the focus was on realized innovation rather than innovative behavior. Beyond patents, copyrights offer an alternative mechanism for the assurance of intellectual property rights. Despite their potential, copyrights remain understudied by economists, with exceptions such as Oberholzer-Gee and Strumpf (2007) and Waldfogel (2012). Nevertheless, copyrights could provide additional data on the interrelationship between VC investments and innovation by serving as another metric for innovation quantification. This is particularly relevant given that the Fintech market is a technology-based environment where copyrights are a common means of intellectual property protection.

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