THE EFFECTS OF CORPORATE VENTURE CAPITAL ON VALUE CREATION AND INNOVATION OF EUROPEAN PUBLIC OWNED FIRMS

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Abstract

The practice of corporate venture capital (CVC) has been widely adopted by corporations that invest in highly disruptive start-ups with the aim of fueling innovation and gain strategic advantages. Even if a wide consensus exists on the strategic benefits and performance of CVC investors in the North American venture capital industry, scarce information is available on the European CVC ecosystem. Therefore, the scope of this research is to investigate whether CVC activity, measured as the number of investments, deal size, and the number of realized exits is beneficial for value creation and innovation for European listed companies. Using a panel of CVC investors linked to European listed firms, it is found evidence that CVC activity creates firm value in the period under consideration (2008–2019), confirming North American's past evidence. Surprisingly, exits convey a negative effect on firm value, suggesting that CVC performance may not be satisfactory enough. Moreover, when considering innovation, evidence is presented that investing in rounds with a higher deal size positively affects investor's patenting levels, indicating that the later the start-up's stage in its life cycle, the higher the possibility for the CVC investor to effectively absorb its technology. The relationship is true also for lagged CVC activity, confirming deferred effects on innovation demonstrated on US companies. The findings shed light on the European CVC ecosystem and give room for additional research on CVC investors' exit performance and co-investors' benefits on patenting levels.

Keywords: Corporate Venture Capital, Innovation, Start-Up, Europe, R&D, Patents Brands and Trademarks, Tobin's q, Publicly Owned Firms, Value Creation, Ownership Structure, Organizational Design, M&As

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1. INTRODUCTION

Innovation is a key aspect in firms' ability to satisfy the market demand for new products and services. Firms are compelled to put in place different kinds of innovation strategies to defend their competitive predominance and to increase their competitive advantage (Drover et al., 2017). Investments in internal R&D, partnerships, alliances (Pisano, 2015), and corporate venture capital (CVC) are certainly the most common strategies to pursue innovation. In particular, corporate venture capital refers to minority equity investments made by established, publicly-traded firms in privately-held entrepreneurial ventures (Gompers & Lerner, 2000) and it has been at the center of fervent research activity throughout the years, especially regarding the befits arising from this investment practice. Firstly, CVC parent companies have a technological interest in innovative start-ups operating in their same industry because they can get a "window" on new technologies (Benson & Ziedonis, 2009) by tracking the latest innovations put in place by new ventures. Also, the innovation performance of corporate investors increases with the diversity of their start-up portfolio, at least until the achievement of an optimum level (Wadhwa, Phelps, & Kotha, 2016). Another reason is linked to the effectiveness of internal R&D, since companies may sponsor start-ups that can develop unexploited patents in the company's portfolio via licensing agreements (Lantz, Sahut, & Teulon, 2011). Moreover, investing in start-ups in different sectors allows investors to test new products and business models while approaching different types of consumers. This represents a flexible way to assess the attractiveness of a new business opportunity and the feasibility of entering a new market, with lower risks and irreversibility compared to M&A strategies, particularly when market uncertainty is high (Tong & Li, 2011).

However, academic efforts have been mainly focused on North American companies, leaving the European corporate venture capital industry unexplored. The imbalance may be due to the fact that the US corporate venture capital ecosystem has been historically and currently bigger than the European one, which started to develop only in recent years.

As a result, this research attempts to expand current literature by testing consolidated hypotheses and results valid on North American companies and tested on older time frames for the first time on European corporate venture capital investors during a recent time period.

In particular, it is proposed and demonstrated that CVC creates firm value for investors, measured as Tobin's q (enterprise value over total assets) and is associated with a higher level of patents, brands, and trademarks, confirming North American past evidence. In addition, it is shown that patenting levels increase with the round size in which investors participate, while negative effects of exit performance on firm value build on contradictory past evidence regarding CVC investment performance.

The remainder of the paper is structured as follows. Section 2 gives an overview of existing literature on CVC. In Section 3, the methodology used for this study is outlined. Section 4 depicts and Section 5 discusses the research results. Finally, the conclusions and limitations of the paper are presented in Section 6.

2. LITERATURE REVIEW

2.1. Antecedents

Dushnitsky and Lenox (2005a) find that industry factors that positively affect CVC investments are high technological opportunities (in terms of the number of patents applied for in a given industry), weak intellectual property protection, and the importance of complementary capabilities, like manufacturing or distribution, in the implementation of innovation. Moreover, they suggest that firm-level characteristics that stimulate the engagement of CVC are a high level of cash flows and absorptive capacity, defined as the "ability to recognize the value of new information, assimilate it, and apply it to commercial ends" (Cohen & Levinthal, 1990, p. 128). The results regarding industry-level factors have been later confirmed with a study made by Basu, Phelps, and Kotha (2011) on a sample of US Fortune 500 firms between 1990 and 2000, which also added the competitive intensiveness as a driver for CVC activity. Moreover, Tong and Li (2011) have used a comparative approach to demonstrate that in markets with high uncertainty firms prefer CVC investments with respect to M&A activity. Additionally, Sahaym, Steensma, and Barden (2010) build on the aforementioned results by finding that not only firms with high R&D levels are more prone to invest in start-ups, but also that, for a sample of US manufacturing firms, CVC activity increases in R&D intensive industries, mainly because firms in such industries are proficient at constantly looking at new technologies and innovative trends in the market. In conclusion, other explanations that drive the decision to invest in start-ups are preventing other players from appropriating innovative technologies in the market, together with the increase in the success rate of internal R&D projects (Fulghieri & Sevilir, 2009).

2.2. Organization

When looking at how companies organize their CVC efforts (Gianfrate & Zanetti, 2008), it is possible to isolate three domains of research: objective, structure, and human resources policies adopted by CVC companies.

Firstly, considering the objectives set by corporations when approaching CVC, there is a wide consensus regarding the work done by Chesbrough (2002). His framework suggests that investment objectives can be either strategic or financial. The former is aimed at creating future synergies, accepting low or negative returns that will be more than offset by higher sales in the long run. The latter involves focusing on financial returns only, by betting on superior industry knowledge longer investment windows.

Secondly, the way in which the CVC arm of a company is structured may vary widely. In general, it is possible to distinguish between two main organizational structures: internal and external CVC programs. Internal CVC programs are characterized by direct investments from the company's balance sheet subject to the dedicated investment committee's approval, with personnel staffed in *ad-hoc* company units. Conversely, external CVC programs are legally separated entities taking the form of venture capital funds in which the parent company transfers capital dedicated to CVC. They typically have higher independence regarding investment decisions and are formed by personnel with a VC background (Gaba & Meyer, 2008).

Indeed, scholars attempted to describe the benefits and drawbacks of these two types of organizational structures. A recent study conducted by Asel, Park, and Velamuri (2015) suggested that internal CVC units are better at achieving strategic goals, especially when the aim is to consolidate knowledge in the core business and due to greater involvement in the day-to-day operations. Also, internal CVCs are more likely to invest in late-stage companies that have already shown results in the industry. However, internal CVCs show slower decision-making and higher possibilities of conflicts of interest arising from the business unit during the investment due diligence. Moreover, internal CVC programs are usually more prone to economic cycles by being directly affected by the company's financial health. On the contrary, external CVC programs are more dynamic and flexible, being autonomous from the parent company decision-making, and set up when the main goal is to achieve financial returns (Dushnitsky & Shaver, 2009). Coherently, the independence of external funds is reflected both by their portfolios, which are made up by companies operating also in non-core industries, as well as by targeting companies at an earlier stage life-cycle, indicating a higher risk-taking investment behavior. This suggests that it is more suitable to adopt external CVCs when the aim is to catch disruptive innovation or to explore non-core business areas.

2.3. Outcomes and performance

The study on the outcomes of CVC from the perspective of the investing company plays a central role in the CVC literature. This stream of research conveys the challenge of measuring performance which, in most cases, is not purely financial but rather strategic and, by definition, more difficult to capture. Nonetheless, Dushnitsky and Lenox (2006) had been able to demonstrate that CVC creates value, measured as Tobins' q, to the parent company, at least when CVC programs are explicitly oriented towards pursuing innovation and discovering new technologies. The study had been conducted between 1990 and 2000 over a sample of more than 1,000 US firms, among which 171 were CVC investors, finding strong evidence, in particular, on the computer, semiconductors, and device sectors. However, in open contrast with previous studies, Benson and Ziedonis (2010) found out that acquisitions of start-ups that have been previously funded by the same CVC-investing companies tend to destroy value for the parent company's shareholders. The study considered parent companies' abnormal returns at acquisition announcement date for a sample of US firms. Interestingly, the same methodology had been used by Higgins and Rodriguez (2006) by looking at abnormal returns of companies that acquired targets that were previously alliance partners in the pharmaceutical industry. The study showed that acquiring companies generated more value by purchasing former alliance partners, compared to targets with no previous strategic link.

When considering patenting performance, it is shown that CVC-investing companies outpaced their non-CVC peers in the context of innovation rates (Dushnitsky & Lenox, 2005a). The same result was confirmed later by Keil, Maula, and Wilson (2010) on a broader analysis comprising innovation contribution of strategic alliances, joint ventures, and CVC. Moreover, patenting performance is also affected by CVC portfolio diversity (Wadhwa et al., 2016). Interestingly, the negative effects of a higher portfolio diversity are mitigated when the number of alliance partners of portfolio ventures is high, due to higher collaborative experience and knowledge transfers. Indeed, strategic alliances play an important role in the way in which companies can pursue innovation. Moreover, they are linked to CVC due to the fact that, when a technology within a CVC invested start-up becomes less risky, the formation of a strategic alliance between the parent company and the start-up is a logical evolution of the initial CVC investment. In fact, the creation of strategic alliances is more likely to emerge when a previous CVC relationship between the two companies exists (Van de Vrande & Vanhaverbeke, 2013).

In conclusion, the analysis of the pure financial performance of CVC programs is another important field in the CVC literature. However, research in this field has been penalized by the fact that disclosure from CVC sponsoring companies about financial returns of their venture investments is always scarce or not available (Allen & Hevert, 2007). Nonetheless, some authors have attempted to overcome this issue by considering IPO rates as a proxy of portfolio performance (Gompers & Lerner, 2000), concluding that CVC investments performed better than independent VCs only when the investor and the investee operated in the same industry. In all other cases, returns from CVC activity were comparable to the ones of independent VC funds. Alternatively, post-IPO valuations of invested start-ups were used as a proxy of CVC performance, suggesting that when start-ups were backed by both CVC investors and independent VCs they showed higher valuations compared to start-ups backed only by independent VCs, at least when looking at investments made by Fortune 500 companies (Maula & Murray, 2000). However, in a study undergone by Allen and Hevert (2007), the authors had been able to directly calculate returns from CVC activity by using parent companies' 10-K filings from a sample of US technology companies between 1988 and 2002. The performance metrics used were IRR, program cumulative net cash flow, and net cash flow over EBITDA. The results indicate that the financial performances of CVC varied widely among investors.

3. RESEARCH METHODOLOGY

3.1. Data collection

Data on CVC activity in Europe has been collected using the PitchBook[1] database. Firstly, it has been downloaded the full list of venture capital deals with the participation of CVC investors in Europe between 2008 and 2019. Subsequently, the total number of CVC investors (292) has been obtained. From the full list of CVC investors, a meticulous

[1] PitchBook is a subscription database of PitchBook Data, Inc. covering private capital market. In particular, information regarding companies, investors, advisors involved in venture capital, private equity and M&A transactions is disclosed.

check has been made in order to confirm whether the investor was actually a CVC investor or it represented another type of investor wrongfully labelled by PitchBook. For the scope of this research, both internal and external CVC funds were comprised in the sample. Later, private companies and listed companies headquartered outside the 27 EU member states and UK have been excluded. The final sample was made up of 94 European listed companies that engaged in CVC activity between 2008 and 2019. The full list of CVC investors is reported in Appendix A, Tables A.1 and A.2.

Since testing the hypothesis of the effects of CVC only on the sample of the 94 CVC investors may cause gross misinterpretation of the results, the sample was augmented using the companies that make up the STOXX Europe 600 Index, taking the total number of companies in the sample to 602. The STOXX Europe 600 Index is a stock index representing the large, mid and small capitalization companies headquartered in the Eurozone (Qontigo, 2021). The choice of this index has been driven by the fact that nearly all of the 92 CVC investors (81%) were already part of it, meaning that the market fluctuations suffered by the CVC sample are embedded in the fluctuations of the index. Moreover, this is coherent with the aim of taking into account the same industry-wide effects and macroeconomic downturns and trends that the remaining European non-CVC investors experienced throughout the selected time frame. All the CVC variables pertaining to the newly added non-CVC firms were labelled with 0. Descriptive analysis is available in Appendix B, Tables B.1, B.2, B.3, and B.4.

3.2. Dependent variables

3.2.1. Log of Tobin's q

Tobin's q is measured as enterprise value over total assets and represents an indicator of the company's competitive advantage (Wernerfelt & Montgomery, 1988). A value of *Tobin's q* greater than one indicates that the market recognizes a positive outlook of the future performance of the company. Because of its forward-looking attributes, *Tobin's q* is ideal to capture the future benefits and drawbacks that current CVC activities may generate on the firm. In the models used to demonstrate *research question 1* (*RQ 1*), the *log of Tobin's q* has been used as a main dependent variable. First, the *log of Tobin's q* is useful to address normality issues in the sample that have been solved thanks to the log transformation. Secondly, the preference of the log form of Tobin's q over the linear form has also been confirmed in prior studies (Hirsch & Seaks, 1993).

3.2.2. Log of gross value of patents, trademarks, and brands

The gross value of patents, brands, and trademarks has been used to test the level of innovation of CVC-investing firms. It is noted that the use of this indicator conveys a less granular level of precision compared to the citation-weighted number of patents, a variable extensively used in previous studies (Dushnitsky & Lenox, 2005b). On the other hand, it is believed that the use of this indicator may still represent a reasonable proxy on the effects of CVC investments on a firm's patenting activity, where the gross value of patents will increase if the invested start-ups provide knowledge of new technologies to the parent company, that will ultimately translate it into new valuable patents, brands, and trademarks. As for Tobin's q, in order to address normality issues concerning the dataset, a log transformation of the dataset has been performed.

3.2.3. Log of research & development intensity

Research & development intensity has been defined as the ratio of research & development costs over sales (Moncada-Paternò-Castello, Amoroso, & Cincerca, 2020). The ratio scales the costs sustained by a company to develop an asset to its annual sales, representing a useful comparability tool that can be used to relate companies with considerable differences in R&D expenditures as well as in size that would have ultimately biased the results of the analysis.

3.3. Main independent variables

The main independent variables are as follows:

1) the *CVC* dummy variable was filled with 1 if the investor has made at least one investment in a year or 0 otherwise;

2) the *CVC DEALS* variable indicates the total number of investments made in the year (i.e., the number of invested start-ups);

3) The *CVC AMOUNTS* variable represents the cumulated transaction amount of every deal (can represent either capital increase or acquisition) in the year. It is noted that this information does not indicate the amount that every single company invested in start-ups every year, since it represents the total deal size of every transaction. Information regarding single investments is not disclosed on PitchBook, as a result, the *CVC AMOUNTS* variable is used to represent a good proxy of the money committed on CVC programs by CVC parent companies. Intuitively, the higher the total deal size, the higher the money invested in start-ups, the higher the commitments from the parent company in investing in external innovation through CVC.

4) The *CVC EXIT* variable indicates the number of exits the parent company made in the year.

Data on *enterprise value, total assets, EBITDA, sales, sales growth YoY, CapEx, R&D expenditure, gross value of brands, patents and trademarks* and *total debt* has been downloaded from the Refinitiv Workspace[2] database and using Worldscope and Eikon resources. The description of each variable is available in Appendix C, Table C.1.

[2] Refinitiv provides data relating to public financial markets. The company offers a wide array of software and solutions, among which Eikon and Worldscope. The Eikon platform has been used to retrieve real time market data on the sample of European listed CVC investors. However, the platform covers real time market data and analysis on a wide range of asset classes. The Worldscope platform, instead, has been used to retrieve financial statement.

4. RESEARCH RESULTS

4.1. Research question 1 (RQ 1): Value creation

Following the approach pointed out by Dushnitsky and Lenox (2006) a first "Base" model is created for comparison. In the Base Model (Model 1) the *log of Tobin's* is the dependent variable, while *leverage, sales growth, the log of EBITDA, total assets, R&D and CapEx* are the regressors.

Every model includes a fixed-effects specification in order to control for the unobservable heterogeneity related to macroeconomic trends or economic downturns that may affect the level of the dependent variables. The fixed-effects model has been preferred over the generalized least squares (GLS) random effects model after performing the Hausman specification test, which reported a p-value small enough (below the 0.1 significance level) to reject the null hypothesis that individual effects are uncorrelated with the other regressors. The results of the Hausman test are reported in Table 1 below.

Table 1. Model 1 — Random effects (GLS)

Breusch-Pagan test	*Hausman test*
Null hypothesis: Variance of the unit-specific error = 0	Null hypothesis: GLS estimates are consistent
Asymptotic test statistic: Chi-square(1) = 6465.24	Asymptotic test statistic: Chi-square(6) = 144.268
with p-value = 0	with p-value = 1.25858e-028

Conversely, the results of the fixed-effects panel regression are outlined in Table 2. The selected coefficients, except for *CapEx*, are significant at a 1% level, implying that growing firms with greater *EBITDA* and higher levels of *leverage* and investments in *R&D* show higher *Tobin's q*. Conversely, the size of the company (i.e., *log of total assets*) has a negative effect on Tobin's q. The results for European listed firms are consistent with the results arising from the study of US listed firms active in CVC conducted by Dushnitsky and Lenox (2006), in particular, the same effects on *Tobin's q* (used as dependent variable) have been registered for company size, sales growth and R&D expenses (used as regressors) in their study (see Model 1, Table 2, p. 763). On the other hand, the capital expenditures and leverage regressors show opposite signs and significance.

Table 2. Model 1 — Dependent variable: *l–TOBIN'SQ*

Variable	*Coefficient*	*Std. Error*	*t-ratio*	*p-value*
Const	1.63886	0.27832	5.888	< 0.0001***
l_EBITDA	0.08451	0.02137	3.954	< 0.0001***
l_TOTAL ASSETS	-0.46548	0.03729	-12.48	< 0.0001***
l_R&D	0.42084	0.02010	20.93	< 0.0001***
l_CAPEX	-0.01462	0.01754	-0.833	0.4048
SALES GROWTH	0.00113	0.00014	7.643	< 0.0001***
LEVERAGE	0.03753	0.00543	6.911	< 0.0001***
Mean dependent variable	-0.28881		**S.D. dependent variable**	1.75335
Sum squared resid	502.9502		S.E. of regression	0.46390
LSDV R-squared	0.93760		Within R-squared	0.23607
LSDV F(285, 2337)	123.2197		p-value(F)	0
Joint test on named regressors			Time-series length: minimum 1, maximum 12	
Test statistic: F(6, 2337) = 120.368			Included 280 cross-sectional units	
with p-value = P(F(6, 2337) > 120.368) = 8.45504e-133			Fixed-effects, using 2623 observations	

*Note: * p-value < 0.05, ** p-value < 0.01, *** p-value < 0.001.*

In Model 2 the CVC activity dummy is added among the independent variables. The results in Table 3 show a positive and significant coefficient for CVC activity, indicating that firms that engage in CVC benefit from higher Tobin's q relative to firms that do not invest in innovative firms.

In Model 3 the other CVC independent variables are included (Table 4). The newly added variables do not influence the significance and sign of the regressors already present in the Base Model 1 and Model 2. However, only the variable *CVC Exit* is significant at 10% level, indicating that the greater the number of exits from venture capital investments in a year, the lower Tobin's q.

Table 3. Model 2 — Dependent variable: *l_TOBIN'SQ* — Fixed effects

Variable	*Coefficient*	*Std. Error*	*t-ratio*	*p-value*
Const	1.69268	0.279392	6.058	< 0.0001***
l_EBITDA	0.08344	0.021365	3.906	< 0.0001***
l_TOTAL ASSETS	-0.47227	0.037423	-12.62	< 0.0001***
l_R&D	0.42061	0.020093	20.93	< 0.0001***
l_CAPEX	-0.01416	0.017536	-0.807	0.4192
SALES GROWTH	0.00113	0.000148	7.691	< 0.0001***
LEVERAGE	0.03735	0.005428	6.881	< 0.0001***
CVC	0.12384	0.060846	2.035	0.0419**
Mean dependent variable	-0.28881		**S.D. dependent variable**	1.75335
Sum squared resid	502.0597		S.E. of regression	0.46359
LSDV R-squared	0.93771		Within R-squared	0.23743
LSDV F(286, 2336)	122.9684		p-value(F)	0
Joint test on named regressors			Time-series length: minimum 1, maximum 12	
Test statistic: F(7, 2336) = 103.903			Model 4: Fixed-effects, using 2623 observations	
with p-value = P(F(7, 2336) > 103.903) = 1.23984e-132			Included 280 cross-sectional units	

*Note: * p-value < 0.05, ** p-value < 0.01, *** p-value < 0.001.*

Table 4. Model 3 — Dependent variable: *l_TOBIN'SQ* — Fixed effects

Variable	*Coefficient*	*Std. Error*	*t-ratio*	*p-value*
Const	1.66789	0.28053	5.945	< 0.0001***
l_EBITDA	0.08534	0.02139	3.989	< 0.0001***
l_TOTAL ASSETS	-0.47131	0.03752	-12.56	< 0.0001***
l_R&D	0.42172	0.02010	20.97	< 0.0001***
l_CAPEX	-0.01414	0.01754	-0.806	0.420
SALES GROWTH	0.00114	0.00014	7.699	< 0.0001***
LEVERAGE	0.03738	0.00543	6.884	< 0.0001***
CVC	0.13123	0.06250	2.1	0.035**
CVC DEALS	0.00038	0.00244	0.159	0.873
CVC AMOUNTS	-9.455e-06	9.84e-05	-0.096	0.923
CVC EXIT	-0.01143	0.00672	-1.701	0.089*
Mean dependent variable	-0.28881		**S.D. dependent variable**	1.75335
Sum squared resid	501.3923		S.E. of regression	0.46358
LSDV R-squared	0.93779		Within R-squared	0.23844
LSDV F(289, 2333)	121.7082		p-value(F)	0
Joint test on named regressors			Fixed-effects, using 2623 observations	
Test statistic: F(10, 2333) = 73.0462			Included 280 cross-sectional units	
with p-value = P(F(10, 2333) > 73.0462) = 2.57596e-130			Time-series length: minimum 1, maximum 12	

*Note: * p-value < 0.05, ** p-value < 0.01, *** p-value < 0.001.*

4.2. Research question 2 (RQ 2): Innovation

In order to tackle *research question 2* (*RQ 2*), a series of fixed-effects panel regression models with the *log of the gross value of patents, brands, and trademarks* ("*patents*") as dependent variable is used as a proxy of a firm's absorptive capacity of the knowledge and innovation of the start-ups that firms decide to invest in. Also, in this case, the Hausman test of the random effects panel regression run for the first model (Model 4) reported a p-value low enough to reject the hypothesis that generalized least squares estimates are consistent. The results are shown in Table 5 below.

Table 5. Model 4 — Dependent variable: *l_PATENTS* — Random effects (GLS)

Hausman test
Null hypothesis: GLS estimates are consistent
Asymptotic test statistic: Chi-square(1) = 20.4253
with p-value = 6.20055e-006

Firstly, the relationship between *patents* and CVC activity is studied for one CVC variable as a regressor at a time. Additional lagged models are presented to investigate the effects of prior CVC activity on a firm's level of patents, brands, and trademarks. The rationale in the use of lagged models entails the fact that investments in innovative ventures may not immediately translate into patenting activity. On the other hand, it is more reasonable to assume that strategic benefits in the form of patenting activity will take place only after a period of time during which the investor has the possibility to acknowledge and absorb the investee's technology and know-how. In the following models, the number of three lagged years is used to test the relationship between patenting activity and lagged CVC activity. As a reference point, it has been demonstrated that a strong correlation between 1 year lagged R&D expense and patenting activity exists (Hall & Ziedonis, 2001), while studies on the impact of CVC amount invested on a firm's patent citation levels indicate the strongest relationships between 2 and 3 years CVC amounts lag (Dushnitsky & Lenox, 2005b).

Subsequently, a model with the full set of the CVC variables that demonstrated a certain degree of significance has been run to verify the joint effects of the regressors on the dependent variable.

Model 4 uses the CVC dummy variable as the sole regressor for the firm level of patents. The coefficient is positive and significant at the 0,5% level, indicating that firms engaging in CVC activities have a higher level of gross patents with respect to firms that do not invest in CVC. The level of the F-test is high enough to reject the null hypothesis that the CVC coefficient is zero, confirming the solidity of the model (see Table 6).

Table 6. Model 4 — Dependent variable: *l_PATENTS* — Fixed effects

Variable	*Coefficient*	*Std. Error*	*t-ratio*	*p-value*
Const	5.03534	0.01535	328	< 0.0001***
CVC	0.23504	0.08356	2.813	0.005***
Mean dependent variable	5.05638		**S.D. dependent variable**	2.33257
Sum squared resid	1283.89		S.E. of regression	0.71519
LSDV R-squared	0.91708		Within R-squared	0.00314
LSDV F(336, 2510)	82.6271		p-value(F)	0
Joint test on named regressors			Fixed-effects, using 2847 observations	
Test statistic: F(1, 2510) = 7.91117			Included 336 cross-sectional units	
with p-value = P(F(1, 2510) > 7.91117) = 0.00495			Time-series length: minimum 1, maximum 12	

*Note: * p-value < 0.05, ** p-value < 0.01, *** p-value < 0.001.*

Model 4 lagged (see Table 7) adds the 1, 2 and 3-years lagged CVC dummy variables as regressors. The results indicate that 1-year and 3-year lagged CVC activity positively affects the patenting level of a firm with a moderate significance level (both the p-values show a value below the 10% confidence level). Again, a low p-value for the F-test allows to rejects the null hypothesis, confirming that at least one of the lagged variables provides useful information to explain the patenting level of a company. On the other hand, the current CVC dummy lost its significance, compared to Model 4.

Table 7. Model 4 lagged — Dependent variable: *l_PATENTS* — Fixed effects

Variable	*Coefficient*	*Std. Error*	*t-ratio*	*p-value*
Const	5.12043	0.01791	285.9	< 0.0001***
CVC	0.03615	0.09773	0.3699	0.7115
CVC_1	0.19440	0.10473	1.856	0.0636*
CVC_2	0.15811	0.10748	1.471	0.1414
CVC_3	0.20354	0.10999	1.85	0.0644*
Mean dependent variable	5.169365		**S.D. dependent variable**	2.287262
Sum squared resid	761.7484		S.E. of regression	0.635866
LSDV R-squared	0.934174		Within R-squared	0.010829
LSDV F(328, 1884)	81.51551		p-value(F)	0
Joint test on named regressors -			Fixed-effects, using 2213 observations	
Test statistic: F(4, 1884) = 5.15606			Included 325 cross-sectional units	
with p-value = P(F(4, 1884) > 5.15606) = 0.00039362			Time-series length: minimum 1, maximum 9	

*Note: * p-value < 0.05, ** p-value < 0.01, *** p-value < 0.001.*

Model 5 takes into consideration the effect of the total deal size of CVC investments in a given year. The results are shown in Table 8. The predictor is positive and highly significant, indicating that the higher the deal size of CVC investments, the higher the gross value of patents of the investing company.

Table 8. Model 5 — Dependent variable: *l_PATENTS* — Fixed effects

Variable	*Coefficient*	*Std. Error*	*t-ratio*	*p-value*
Const	5.0357	0.01403	358.8	< 0.0001***
CVC AMOUNTS	0.0031	0.00066	4.827	< 0.0001***
Mean dependent variable	5.05638		**S.D. dependent variable**	2.33257
Sum squared resid	1276.089		S.E. of regression	0.71302
LSDV R-squared	0.91759		Within R-squared	0.00919
LSDV F(336, 2510)	83.17789		p-value(F)	0
Joint test on named regressors			Fixed-effects, using 2847 observations	
Test statistic: F(1, 2510) = 23.3038			Included 336 cross-sectional units	
with p-value = P(F(1, 2510) > 23.3038) = 1.46628e-006			Time-series length: minimum 1, maximum 12	

*Note: * p-value < 0.05, ** p-value < 0.01, *** p-value < 0.001.*

Model 5 lagged (see Table 9) contains the 1, 2 and 3-years lagged *CVC AMOUNTS* variables. The model shows that the 1-year lagged total deal size, together with the current total deal size, positively affects the dependent variable taken into consideration.

Table 9. Model 5 lagged — Dependent variable: *l_PATENTS* — Fixed effects

Variable	*Coefficient*	*Std. Error*	*t-ratio*	*p-value*
Const	5.13944	0.01498	343	< 0.0001***
CVC AMOUNTS	0.00175	0.00071	2.438	0.0149**
CVC AMOUNTS_1	0.00174	0.00082	2.12	0.0341**
CVC AMOUNTS_2	0.00085	0.00088	0.9633	0.3355
CVC AMOUNTS_3	0.00016	0.00088	0.1927	0.8472
Mean dependent variable	5.16936		**S.D. dependent variable**	2.28726
Sum squared resid	760.993		S.E. of regression	0.63555
LSDV R-squared	0.93424		Within R-squared	0.01181
LSDV F(328, 1884)	81.60214		p-value(F)	0
Joint test on named regressors			Fixed-effects, using 2213 observations	
Test statistic: F(4, 1884) = 5.62875			Included 325 cross-sectional units	
with p-value = P(F(4, 1884) > 5.62875) = 0.00016			Time-series length: minimum 1, maximum 9	

*Note: * p-value < 0.05, ** p-value < 0.01, *** p-value < 0.001.*

Model 6 and Model 6 lagged take into consideration the number of invested start-ups in the same year and with a 1, 2, and 3-year lag, respectively. However, the models reported no significance in the predictors, with a low value of F-test and a correspondingly high value of p-value, which does not allow us to rule out the possibility that all the predictors' coefficients are equal to zero. The respective outputs are exhibited in Tables 10 and 11.

Table 10. Model 6 — Dependent variable: *l_PATENTS* — Fixed effects

Variable	*Coefficient*	*Std. Error*	*t-ratio*	*p-value*
Const	5.05346	0.01373	368	< 0.0001***
Mean dependent variable	5.05639		**S.D. dependent variable**	2.33257
Sum squared resid	1287.41100		S.E. of regression	0.71618
LSDV R-squared	0.91686		Within R-squared	0.00041
LSDV F(336, 2510)	82.38070		p-value(F)	0
Joint test on named regressors -			Fixed-effects, using 2847 observations	
Test statistic: F(1, 2510) = 1.02519			Included 336 cross-sectional units	
with p-value = P(F(1, 2510) > 1.02519) = 0.311389			Time-series length: minimum 1, maximum 12	

*Note: * p-value < 0.05, ** p-value < 0.01, *** p-value < 0.001.*

Table 11. Model 6 lagged — Dependent variable: *l_PATENTS* — Fixed effects

Variable	*Coefficient*	*Std. Error*	*t-ratio*	*p-value*
Const	5.15835	0.01517	340.1	< 0.0001***
CVC_DEALS	0.00373	0.01100	0.3388	0.7348
CVC_DEALS_1	0.01146	0.01641	0.6987	0.4848
CVC_DEALS_2	-0.01025	0.01438	-0.7127	0.4761
CVC_DEALS_3	0.01224	0.01009	1.213	0.2253
Mean dependent variable	5.16937		**S.D. dependent variable**	2.28726
Sum squared resid	768.85040		S.E. of regression	0.63882
LSDV R-squared	0.93356		Within R-squared	0.00161
LSDV F(328, 1884)	80.70949		p-value(F)	0
Joint test on named regressors			Fixed-effects, using 2213 observations	
Test statistic: F(4, 1884) = 0.757746			Included 325 cross-sectional units	
with p-value = P(F(4, 1884) > 0.757746) = 0.552792			Time-series length: minimum 1, maximum 9	

*Note: * p-value < 0.05, ** p-value < 0.01, *** p-value < 0.001.*

Model 7 full has been designed with the aim of testing the joint effects of all the CVC variables on a firm's value of gross patents that in previous models showed some degree of significance. In Model 7, the coefficients of the CVC dummy variable with a 1-year and 3-year lag are positive and moderately significant (i.e., taking into consideration a confidence level of 10%), while the *CVC AMOUNTS* current and lagged by 1 year are positive and significant. Only the current CVC dummy variable did not confirm the positive significance shown in previous models. Overall, the model is significant with an F-statistic high enough to reject the null hypothesis. The results of Model 7 Full are available in Table 12 below.

Table 12. Model 7 full — Dependent variable *l_PATENTS* — Fixed effects

Variable	*Coefficient*	*Std. Error*	*t-ratio*	*p-value*
Const	511.283	0.01793	285.0	< 0.0001***
CVC	0.03500	0.09675	0.3618	0.7175
CVC_1	0.17634	0.10312	1.710	0.0874*
CVC_3	0.20259	0.10657	1.901	0.0574*
CVC_AMOUNTS	0.00146	0.00072	2.033	0.0422**
CVC_AMOUNTS_1	0.00174	0.00076	2.279	0.0228**
Mean dependent variable	5.16936		**S.D. dependent variable**	2.287262
Sum squared resid	757.1881		S.E. of regression	0.634128
LSDV R-squared	0.93456		Within R-squared	0.016750
LSDV F(329, 1883)	81.74827		p-value(F)	0.000000
Joint test on named regressors -			Fixed-effects, using 2213 observations	
Test statistic: F(5, 1883) = 6.41562			Included 325 cross-sectional units	
with p-value = P(F(5, 1883) > 6.41562) = 6.4106e-6			Time-series length: minimum 1, maximum 9	

*Note: * p-value < 0.05, ** p-value < 0.01, *** p-value < 0.001.*

4.3. Research question 3 (RQ 3): Innovation

In order to investigate the relationship between CVC activity and R&D intensity on the selected sample of European listed firms, the *log of R&D intensity* has been used as a main dependent variable in the panel regression models. Furthermore, following the rationale explained in *RQ 2*, also lagged models were run in order to tackle the possible "lagged" effect of CVC activity.

Regarding the type of panel regression used, as for the previous set of models, the Hausman test has been performed. The random-effects model reported a p-value small enough (below the 0.1 significance level) to reject the null hypothesis that GLS estimates are consistent. Furthermore, the F-statistic for the fixed effect model used to test the relationship between the dependent variable and the CVC dummy variable was high enough to reject the null hypothesis that the CVC dummy coefficient is equal to zero, ultimately confirming that the fixed effect model is useful to explain the relationship. The results of the Hausman test and the F-test for the fixed model are reported in Tables 13 and 14 below.

Table 13. Model 8 — Dependent variable: *l_R&D INTENSITY* — Random effects (GLS)

Hausman test
Null hypothesis: GLS estimates are consistent
Asymptotic test statistic: Chi-square (1) = 8.60262
with p-value = 0.0033569

Table 14. Model 8 — Dependent variable: *l_R&D INTENSITY* — Fixed effects

Variable	*Coefficient*	*Std. Error*	*t-ratio*	*p-value*
Const	-4.13130	0.01416	-291.7	< 0.0001***
CVC	-0.12227	0.07072	-1.729	0.0840*
Mean dependent variable	-4.14676		**S.D. dependent variable**	2.23658
Sum squared resid	876.0854		S.E. of regression	0.58545
LSDV R-squared	0.93852		Within R-squared	0.00116
LSDV F(293, 2556)	133.1857		p-value(F)	0.00000
Joint test on named regressors			Fixed-effects, using 2850 observations	
Test statistic: F(1, 2556) = 2.989			Included 293 cross-sectional units	
with p-value = P(F(1, 2556) > 2.989) = 0.08395			Time-series length: minimum 1, maximum 12	

*Note: * p-value < 0.05, ** p-value < 0.01, *** p-value < 0.001.*

Model 8 and Model 8 lagged use the CVC dummy as a predictor to capture the current and lagged effect of CVC activity on R&D intensity. In Model 8, the CVC dummy has a negative coefficient that shows moderate significance (p-value equal to 0.08, below the 10% confidence level). However, when considering the effects of the lagged predictors in Model 8 lagged (Table 15), none of the coefficients reports a low p-value, while the F-test suggests that the model is not significant in explaining the variability of R&D intensity (available in Appendix C, Table C.1).

Table 15. Model 8 lagged — Dependent variable: *l_R&D INTENSITY* — Fixed effects

Variable	*Coefficient*	*Std. Error*	*t-ratio*	*p-value*
Const	-4.07050	0.0201564	-201.9	< 0.0001***
CVC	-0.0657198	0.0884632	-0.7429	0.4576
CVC_1	-0.0233950	0.0905078	-0.2585	0.7961
CVC_2	-0.0656653	0.0888119	-0.7394	0.4598
CVC_3	-0.0938927	0.0877319	-1.070	0.2847
Mean dependent variable	-4.100335		**S.D. dependent variable**	2.210193
Sum squared resid	597.6421		S.E. of regression	0.561142
LSDV R-squared	0.944212		Within R-squared	0.001974
LSDV F(295, 1898)	108.8933		p-value(F)	0.000000
Joint test on named regressors			Fixed-effects, using 2194 observations	
Test statistic: F(4, 1898) = 0.938578			Included 292 cross-sectional units	
with p-value = P(F(4, 1898) > 0.938578) = 0.440525			Time-series length: minimum 1, maximum 9	

*Note: * p-value < 0.05, ** p-value < 0.01, *** p-value < 0.001.*

Subsequently, the number of CVC investments in the year *t* (*CVC DEALS*) and *t-1, t-2,* and *t-3* were used as regressors for Model 9 and Model 9 lagged respectively. In Model 9 (Table 16) the coefficient for the sole regressor *CVC DEALS* is negative and has a moderate significance, with a p-value lower than the 10% confidence level. On the other hand, when considering Model 9 lagged (Table 17), it is possible to notice that the coefficient for the number of deals became strongly significant, with a p-value of 0.003, indicating that participating in more rounds seems to have a negative effect on the level of R&D intensity of the CVC-investing firm in the same year (*t*). However, the coefficient for the year *t-1* number of investments is positive and significant, suggesting an opposite effect on the dependent variable. Furthermore, the analysis on the confidence interval of the coefficients (using a 95% confidence level) confirmed that the coefficient is not equal to zero as well as the positive sign for the 1-year lagged regressor and the negative sign on the current year regressor.

Table 16. Model 9 — Dependent variable: *l_R&D INTENSITY* — Fixed effects

Variable	*Coefficient*	*Std. Error*	*t-ratio*	*p-value*
Const	-4.14140	0.01133	-365.4	< 0.0001***
CVC DEALS	-0.00522	0.00277	-1.884	0.0597*
Mean dependent variable	-4.14678		**S.D. dependent variable**	2.23658
Sum squared resid	875.8935		S.E. of regression	0.58539
LSDV R-squared	0.93854		Within R-squared	0.00138
LSDV F(293, 2556)	133.2168		p-value(F)	0.00000
Joint test on named regressors -			Fixed-effects, using 2850 observations	
Test statistic: F(1, 2556) = 3.5497			Included 293 cross-sectional units	
with p-value = P(F(1, 2556) > 3.5497) = 0.05966			Time-series length: minimum 1, maximum 12	

*Note: * p-value < 0.05, ** p-value < 0.01, *** p-value < 0.001.*

Table 17. Model 9 lagged — Dependent variable: *l_R&D INTENSITY* — Fixed effects

Variable	*Coefficient*	*Std. Error*	*t-ratio*	*p-value*
Const	-4.09397	0.01329	-307.9	< 0.0001***
CVC DEALS	-0.01556	0.00525	-2.962	0.0031***
CVC DEALS_1	0.01793	0.00701	2.557	0.0106**
CVC DEALS_2	-0.00650	0.00805	-0.8078	0.4193
CVC DEALS_3	-0.00060	0.00607	-0.09944	0.9208
Mean dependent variable	-4.10033		**S.D. dependent variable**	2.21019
Sum squared resid	595.3656		S.E. of regression	0.56007
LSDV R-squared	0.94442		Within R-squared	0.00577
LSDV F(295, 1898)	109.3343		p-value(F)	0.00000
Joint test on named regressors -			Fixed-effects, using 2194 observations	
Test statistic: F(4, 1898) = 2.75652			Included 292 cross-sectional units	
with p-value = P(F(4, 1898) > 2.75652) = 0.02656			Time-series length: minimum 1, maximum 9	

*Note: * p-value < 0.05, ** p-value < 0.01, *** p-value < 0.001.*

Consequently, the total amount of deal size in the current year *t* and years *t-1, t-2,* and *t-3* (*CVC AMOUNTS*) was tested in Model 10 and Model 10 lagged. However, in both cases, none of the regressors were significant, while the F-statistic was not high enough to reject the null hypothesis that all the regressors have a coefficient equal to zero (Table 18 and 19).

Table 18. Model 10 — Dependent variable: *l_R&D INTENSITY* — Fixed effects

Variable	*Coefficient*	*Std. Error*	*t-ratio*	*p-value*
Const	-4.14608	0.01110	-373.5	< 0.0001***
CVC AMOUNTS	-5.10866e-05	0.00012	-0.4205	0.6742
Mean dependent variable	-4.14676		**S.D. dependent variable**	2.23658
Sum squared resid	877.0492		S.E. of regression	0.58577
LSDV R-squared	0.93846		Within R-squared	0.00006
LSDV F(293, 2556)	133.0297		p-value(F)	0.00000
Joint test on named regressors			Included 293 cross-sectional units	
Test statistic: F(1, 2556) = 0.176813			Time-series length: minimum 1, maximum 12	
with p-value = P(F(1, 2556) > 0.176813) = 0.67416				

*Note: * p-value < 0.05, ** p-value < 0.01, *** p-value < 0.001.*

Table 19. Model 10 lagged — Dependent variable: *l_R&D INTENSITY* — Fixed effects

Variable	*Coefficient*	*Std. Error*	*t-ratio*	*p-value*
Const	-4.09880	0.01304	-314.2	< 0.0001***
CVC AMOUNTS	-3.37260e-05	0.00013	-0.2594	0.7953
CVC AMOUNTS_1	0.00026	0.00033	0.7779	0.4367
CVC AMOUNTS_2	-4.89619e-05	0.00049	-0.0989	0.9212
CVC AMOUNTS_3	-0.00047	0.00059	-0.8037	0.4217
Mean dependent variable	-4.10033		**S.D. dependent variable**	2.21019
Sum squared resid	598.4700		S.E. of regression	0.56153
LSDV R-squared	0.94413		Within R-squared	0.00059
LSDV F(295, 1898)	108.7338		p-value(F)	0.00000
Joint test on named regressors -			Fixed-effects, using 2194 observations	
Test statistic: F(4, 1898) = 0.280873			Included 292 cross-sectional units	
with p-value = P(F(4, 1898) > 0.280873) = 0.89048			Time-series length: minimum 1, maximum 9	

*Note: * p-value < 0.05, ** p-value < 0.01, *** p-value < 0.001.*

Finally, the full CVC Model 11 has been designed using all the variables that reported significant coefficients in previous models as regressors for the dependent variable *log of R&D intensity*. The output of Model 11 is reported in Table 20. The results confirmed what was previously demonstrated in Models 8, 9, and 9 lagged, with the CVC dummy for the current year that loses significance when paired with other regressors, together with the opposite signs of the coefficients for the number of investments in the current year and 1-year lag (both statistically significant). Overall, the F-test reports a p-value low enough to confirm the significance of the regressors.

Table 20. Model 11 full — Dependent variable: *l_R&D INTENSITY* — Fixed effects

Variable	*Coefficient*	*Std. Error*	*t-ratio*	*p-value*
Const	-4.11676	0.01492	-275.8	< 0.0001***
CVC DEALS	-0.01173	0.00408	-2.873	0.0041***
CVC DEALS_1	0.00997	0.00407	2.447	0.0145**
CVC	-0.07227	0.07623	-0.9482	0.3431
Mean dependent variable	-4.12942		**S.D. dependent variable**	2.23183
Sum squared resid	786.4818		S.E. of regression	0.57933
LSDV R-squared	0.94012		Within R-squared	0.00441
LSDV F(294, 2343)	125.1279		p-value(F)	0.00000
Joint test on named regressors -			Model 29: Fixed-effects, using 2638 observations	
Test statistic: F(3, 2343) = 3.46466			Included 292 cross-sectional units	
with p-value = P(F(3, 2343) > 3.46466) = 0.015646			Time-series length: minimum 1, maximum 11	

*Note: * p-value < 0.05, ** p-value < 0.01, *** p-value < 0.001.*

5. DISCUSSION OF THE RESULTS

The empirical analysis provided evidence that corporate venture capital is associated with value creation for European listed firms, confirming *RQ1*. In the first place, companies that made at least one investment in CVC showed a higher level of Tobin's q with respect to companies that did not during the time frame taken into consideration. The research findings are consistent with previous studies undergone on North American firms as well as in older time frames. For instance, Dushnitsky and Lenox (2006) demonstrated that US listed firms investing in CVC showed higher Tobin's q. The fact that the evidence of benefits arising from CVC for corporate investors is considered a baseline for a great number of studies on venture capital has been confirmed by the numerous academic papers citing their study (Chemmanur, Loutskina, & Tian, 2014; Drover et al., 2017; Narayanan, Yang, & Zahra, 2009; Yang, Narayanan, & De Carolis, 2014). The reasons because CVC is beneficial for companies that pursue it may be different. For instance, the investment into innovative start-ups conveys a positive signal to the market because investors may highly value the possibility to acquire resources and capabilities from innovative companies. Moreover, it is possible that shareholders may require companies to allocate funds to start-up investments because of the exceptionally hyped period regarding CVC. On the other hand, moderate evidence was found that a higher number of exits in CVC investments is associated with a lower value of Tobin's q. This result may indicate that investors react negatively in case of CVC exits either because the proceeds from the exit may not be satisfactory or that the exit may indicate a failure in the creation of a strategic fit between investee and investor that it should have ended up in an acquisition, instead of a divestiture. However, this reasoning may not be consistent with the findings of Benson and Ziedonis (2010) that acquisition of start-ups that were previously funded by the same CVC tends to destroy value for the parent company. The fact that both acquisitions and exits destroy value may indicate that the performance of CVC investments teams is not satisfactory and a more comprehensive study on CVC funds' returns may be more useful to explain this relationship. Moreover, the results achieved by this research may fuel additional studies that can investigate whether the division between the strategic and financial orientation of CVC funds may be able to further explain the value generated for the parent company's shareholders and the relations with exit performance.

After having provided an overview of CVC in geographical and historical terms, a thorough literature review pointed out the gaps that this research aims to partially answer. In particular, the scope of this research is to investigate whether CVC activity, measured in number and size of investments made and the number of realized exits, is beneficial for value creation and innovation for European listed companies, as already confirmed in the North American industry in terms of value creation (Dushnitsky & Lenox, 2006), corporate financial performance (at least until reaching an optimum level of investment) (Yang et al., 2014), innovation rates (Keil et al., 2010; Dushnitsky & Lenox, 2005a) and patenting performance (Wadhwa et al., 2016). Indeed, the choice of the research topic has been driven by the fact that, at first, when considering geography, existing literature has been relatively more focused on the US CVC ecosystem. Therefore, a pool of European listed CVC-active firms has been merged with the STOXX 600 non-CVC active firms in order to set up the sample that has been used to test the following research questions over a period of 12 years, ranging from 2008 to 2019.

When considering *RQ 2*, it is found evidence that CVC activity is associated with a higher level of patent stock, in coherence with existing literature (Dushnitsky & Lenox, 2005b). In particular, there is strong evidence that the higher the deal size in which companies participate, the higher the effects on patenting activity. The effects are mainly contemporary rather than lagged, indicating that CVC investors are relatively nimble in absorbing innovation and know-how from invested start-ups. Moreover, the results suggest that companies may believe that participating in bigger rounds can be strategically more useful if compared to rounds characterized by a smaller size. The reason may be twofold. Firstly, because the bigger the financing round, the later the stage in the life cycle of the invested star-tup and the higher the possibility that the start-up may own technology or know-how with a demonstrated validity and that can be more easily translatable into patents. Moreover, the bigger the round, the higher the possibility that a co-investor is present in the transaction. This may be linked with the fact that additional strategic benefits that co-investors can bring to the invested start-up may increase its technology development process which, in turn, could be beneficial for the CVC investor patenting output and innovation absorption. This reasoning leaves room for additional research on the possible impacts of co-investors when considering patenting activity in the context of CVC investments. Furthermore, the benefits of participating in a bigger round size are particularly consistent with the view that internal CVCs are more likely to invest in late-stage companies that have already shown results in the industry (Asel et al., 2015). Indeed, a more detailed study that distinguishes the sample CVC investors used in this research between internal and external CVCs may further add evidence to this view.

Finally, mixed evidence is found on the effects of CVC on R&D intensity. In the first place, a certain degree of caution is needed when interpreting results with weaker statistical significance. Secondly, companies in the selected timeframe showed one year lagged the number of investments that tends to positively impact R&D spending over sales, while the current year number of investments shows an opposite effect on R&D efforts. Indeed, the results do not point in the direction of the complementarity between CVC and R&D, as previously demonstrated by Sahaym et al. (2010).

In conclusion, the effects of a higher R&D intensity by CVC-investing firms relative to firms that do not invest in CVC have not been confirmed, ultimately rejecting *RQ 3*.

6. CONCLUSION

The European CVC industry has been prospering in the last decade. Nevertheless, academic research still lags in casting light on drivers, determinants, and causalities regarding this phenomenon. Conversely, the results of this research point out that studies on European companies that pursue innovation by investing in innovative ventures deserve to be carried out. In fact, positive signals conveyed to financial markets and greater levels of innovation evidenced for such companies provide an initial starting point to further unwind the nature of these relationships. In particular, the impact of co-investors on innovation levels and the implication of the CVC fund orientation on corporate investors' exit performance are only a few of the open questions arising from this study.

Indeed, it is acknowledged that this analysis has certain limitations. Firstly, the specific time frame characterized by rapid growth in deals and amounts in venture capital may bias the results. The hyped period from 2014 onwards may not allow disentangling a short-term market sentiment versus an effective and intrinsic benefit in the practice of CVC. Future studies may look at specific time frames characterized only by downturns or upward trends to compare different market contexts and better test the validity of the results in this sense. Secondly, all the variables from the sample of European listed companies used in this study were rightly skewed, meaning that there are few hefty companies that invest heavily and frequently in start-ups in Europe. With this regard and given the period of increasing growth of the market, research in future years may benefit from a bigger and more mature venture capital ecosystem in which investors' differences of investments size will ideally reduce. Finally, the scarcity of available data on venture capital implied the use of proxy variables to test the proposed hypotheses. For example, the use of citation-weighted level of patents instead of the gross value of patents, brands, and trademarks will convey a more granular view on the effects of innovation on CVC investors. Furthermore, the use of single investors' ticket instead of the total round size would be beneficial to reflect the real commitment of different companies in cases of rounds with co-investors, together with more precise analysis. In particular, future studies may also build on the results of this study by using different indicators, such as investment IRR or abnormal returns at investment date, to consolidate the evidence on the benefits of CVC activity in the European context, while solving unexplored issues that have already been studied in the North American literature and that also emerged in this research. In this regard, the use of more detailed sources and databases may be beneficial.

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APPENDIX A

Table A.1. CVC list (Part 1)

Investor name	*CVC parent company*	*Parent company macro-sector*	*HQ country*	*Total investments*	*Active portfolio*	*Median round amount ($M)*	*Median valuation ($M) post money*	*Exit*
Mobile Ventures	1&1 Drillisch	ICT	Germany	4	1	3	10.55	2
ABB Technology Ventures	ABB Ltd	Manufacturing	Switzerland	62	25	10.2	39.39	15
Adidas Ventures	Adidas AG	Manufacturing	Netherlands	20	12	4.14	55.44	1
Air Liquide Venture Capital	L'air Liquide	Green Technologies	France	38	26	7.31	20.05	8
Airbus Ventures	Airbus SE	Manufacturing	United States	49	35	10.98	42.19	1
Allianz X	Allianz SE	Services	Germany	40	24	30.07	253.77	8
InnovAllianz	Allianz SE	Services	France	7	5	6.05	23.33	0
Amadeus Ventures	Amadeus It Group S.A.	Services	Spain	25	11	4.78	22.17	6
Audi Electronics Venture	Volkswagen AG	Manufacturing	Germany	10	7	18	182.75	7
Aviva Ventures	Aviva PLC	Services	United Kingdom	21	13	5.27	14.67	2
BASF Venture Capital	BASF SE	Manufacturing	Germany	88	30	8.98	41.19	23
Leaps by Bayer	Bayer AG	Life Sciences	Germany	n.a.	n.a.	16.08	38.35	11
BayWa r.e. Energy Ventures	Baywa (Xet)	Green Technologies	Germany	4	4	4.92	18.39	0
BillerudKorsnäs Venture	BillerudKorsnäs AB	Manufacturing	Sweden	8	5	4.23	14.31	0
BMW i Ventures	Bayer. Motoren Werke	Manufacturing	United States	79	42	18.81	85.21	15
Bouygues Telecom Initiatives	Bouygues S.A.	ICT	France	68	49	2	4.95	15
BP Ventures	BP PLC	Green Technologies	United Kingdom	92	41	9.2	45.86	23
Centrica Innovations	Centrica PLC	Green Technologies	United Kingdom	16	11	6.02	19.64	1
Open CNP	CNP Assurances	Services	France	13	10	12.47	49.95	0
dmg ventures	Daily Mail 'A'	Services	United Kingdom	23	13	5.76	30.72	3
Daimler	Daimler Ag	Manufacturing	Germany	108	48	44.77	688.1	83
Dassault Développement	Dassault Systemes	Manufacturing	France	22	3	3.88	13.19	9
T-Venture	Deutsche Telekom AG	ICT	Germany	164	28	7.16	45.85	99
DSM Venturing	Koninklijke Dsm N.V.	Life Sciences	Netherlands	89	43	5.52	18.56	33
Innogy Innovation Hub	E.On SE	Green Technologies	Germany	92	76	3.33	10	n.a.
E.ON Strategic Co-Investments	E.On SE	Green Technologies	Germany	29	11	15.95	62.77	n.a.
E.ON Venture Partners	E.On SE	Green Technologies	Germany	4	n.a.	14.5	39.85	n.a.
Edenred Capital Partners	Edenred S.A	Services	United Kingdom	22	12	4.9	25.13	2
EDP Ventures	Edp Energias De	Green Technologies	Portugal	35	26	1.1	13	4
EnBW New Ventures	Enbw Enge.Baden (Xet) Wurtg.	Green Technologies	Germany	10	9	4.68	28.28	0
ENGIE New Ventures	Engie Sa	Green Technologies	France	38	18	7.65	19.63	13
Equinor Ventures	Equinor Asa	Green Technologies	Norway	119	53	7.49	44.98	49
Ericsson Ventures	Telefonaktiebolaget	ICT	United States	n.a.	n.a.	14.34	137.43	11
Evonik Venture Capital	Evonik Industries Ag	Life Sciences	Germany	29	19	3.59	19.23	5
Experian Ventures	Experian Plc	Services	United States	20	12	11.49	48.17	3
Fielmann Ventures	Fielmann (Xet)	Manufacturing	Germany	2	2	4	22.51	0
Fresenius Medical Care Ventures	Fresenius Medical Ca	Life Sciences	Germany	9	7	10.91	33.77	1
SR One	Glaxosmithkline	Life Sciences	United States	206	38	21.82	48.86	113
Renault Venture Capital	Regie Renault	Manufacturing	France	4	4	14.78	45.38	0
H&M CO:LAB	Hennes & Mauritz Ab	Manufacturing	Sweden	11	7	4.51	16.55	0
Henkel Ventures	Henkel Ag And	Manufacturing	Germany	16	12	3	11.45	3
Hikma Ventures	Hikma Pharmaceutical	Life Sciences	United Kingdom	13	9	12.1	78.87	2
Iberdrola — PERSEO	Iberdrola Sa	Green Technologies	Spain	14	7	7.21	54.03	5
KPN Ventures	Koninklijke Kpn Nv	ICT	Netherlands	25	17	5.25	39.43	4
BOLD (Business Opportunities for L'Oréal Development)	L'oreal S.A.	Manufacturing	France	5	5	14.48	24.44	0
LVMH Luxury Ventures	LVMH Moet Hennessy	Services	France	n.a.	n.a.	4.89	32.07	1
SAATCHiNVEST	M&C Saatchi	Services	United Kingdom	30	19	1.35	6.9	6

Table A.1. CVC list (Part 2)

Investor name	*CVC parent company*	*Parent company macro-sector*	*HQ country*	*Total investments*	*Active portfolio*	*Median round amount ($M)*	*Median valuation ($M) post money*	*Exit*
Maersk Growth	A.P. Moeller Maersk	Services	Denmark	23	20	4.08	21.37	0
Ad4Ventures	Mediaset	ICT	Italy	11	6	4	0	4
M Ventures	Merck KGaA	Life Sciences	Netherlands	100	53	10.64	24.17	16
Munich Re Ventures	Muenchener Ruckver	Services	United States	33	22	17.36	77.62	5
National Grid Partners	National Grid PLC	Green Technologies	United States	21	16	17.9	119.89	2
Inventages	Nestle S.A.	Manufacturing	Bahamas	64	11	6.63	15.86	37
Novartis Venture Fund	Novartis	Life Sciences	Switzerland	298	56	16.99	41.32	139
Orange Digital Ventures	Orange S.A.	ICT	France	34	22	14.89	58.32	5
Orange-Publicis Venture Fund	Orange S.A.	ICT	France	5	2	11.34	401.37	3
Orkla Venture	Orkla ASA	Manufacturing	Norway	6	5	1.19	6.09	0
Pearson Ventures	Pearson PLC	Manufacturing	United States	27	19	1.7	39.89	1
PGE Ventures	Pka.Grupa Energetyczna	Green Technologies	Poland	8	8	0.47	n.a.	0
Porsche Ventures	Porsche Automobil	Manufacturing	Germany	3	3	14.79	62.79	0
SevenVentures	ProSiebenSat.1 Media	ICT	Germany	77	22	11	88.76	50
Randstad Innovation Fund	Randstad NV	Services	Netherlands	24	13	6.59	25.32	9
REV Venture Partners	RELX PLC	Services	United Kingdom	70	17	8.35	27.08	32
Breed Reply	Reply	Services	United Kingdom	39	23	2.67	11.06	3
Repsol Corporate Venturing	Repsol S.A.	Green Technologies	Spain	20	12	2	35	2
Roche Venture Fund	Roche Holding AG	Life Sciences	Switzerland	135	32	22.91	70.56	78
CommIT Capital	Rostelecom	ICT	Russia	6	4	1.72	6.47	1
RTL Ventures	RTL Group (Xet)	ICT	Netherlands	15	4	1.1	5.33	7
Saab Ventures	Saab Ab	Manufacturing	Sweden	14	6	2.16	n.a.	3
Safran Corporate Ventures	Safran	Manufacturing	France	12	8	5.61	12.87	1
Saint-Gobain NOVA	Compagnie De	Manufacturing	France	7	7	3.28	16.27	0
Sanofi Ventures	Sanofi	Life Sciences	United States	58	25	26.87	65.28	21
SanomaVentures	Sanoma	ICT	Netherlands	37	18	0.9	7.99	10
SAP.iO	SAP SE	ICT	United States	n.a.	n.a.	4.53	15.28	13
Schibsted Growth	Schibsted ASA	ICT	Sweden	74	33	2	21.3	17
SEB Alliance	SEB S.A.	Manufacturing	France	22	13	4.85	9.94	2
Shell Ventures	Royal Dutch Shell	Green Technologies	Netherlands	80	53	10.74	37.42	15
Siemens Project Ventures	Siemens AG	Miscellaneous	Germany	9	6	148.14	363.24	8
Sixt ventures	Sixt Pref. (Xet)	Services	Germany	9	n.a.	5.85	n.a.	7
Sodexo Ventures	Sodexo	Services	France	9	8	4.4	23.49	1
Solvay Ventures	Solvay S.A.	Manufacturing	Belgium	9	8	3.6	6.92	1
Sonae IM	Sonae SGPS	Miscellaneous	Portugal	47	35	5.16	28.86	5
SUEZ Ventures	Suez S.A.	Green Technologies	France	10	5	3	8.98	5
Swisscom Ventures	Swisscom	ICT	Switzerland	120	42	5.19	23.99	49
Tate & Lyle Ventures	Tate & Lyle Plc	Manufacturing	United Kingdom	24	5	3.36	5.93	5
Tim Ventures	Telecom Italia	ICT	Italy	16	12	0.38	8.42	3
Wayra	Telefonica S.A.	ICT	Spain	896	484	0.05	1.3	300
Telefónica Innovation Ventures	Telefonica S.A.	ICT	Spain	61	28	4.58	51.98	28
Telia Ventures	Telia Company AB	ICT	Sweden	5	4	12.19	108.77	1
Thales Corporate Ventures	Thales S.A.	Manufacturing	France	14	n.a.	3.6	10.04	9
Total Carbon Neutrality Ventures	Total S.A.	Green Technologies	France	76	39	15.69	79.49	12
UCB Ventures	UCB S.A.	Life Sciences	Belgium	5	5	13.38	39.85	0
Unilever Ventures	Unilever Plc	Manufacturing	United Kingdom	125	55	5.01	24.64	35
UNIQA Ventures	UNIQA Insu Gr AG	Manufacturing	Austria	17	11	5	34.57	1
Vodafone Ventures	Vodafone Group PLC	ICT	United States	35	7	6.39	30.2	23
Volvo Group Venture Capital	Volvo AB	Manufacturing	Sweden	57	16	3.25	31.28	26
WPP Ventures	WPP PLC	ICT	United States	60	14	10.77	72.73	29

Table A.2. CVC list descriptive statistics

	AUM	*Number of total investments*	*Number of active portfolios*	*Median round amount ($M)*	*Median valuation ($M)*	*Number of exits*
Mean	245.0	50.6	24.1	9.7	52.3	17.1
Mean (exl. Min/Max)	220.2	41.9	19.1	8.3	46.0	14.3
Median	133.3	23.0	13.0	5.6	28.6	5.0
Min	0.0	2.0	1.0	0.1	0.0	0.0
Max	1.332.8	896.0	484.0	148.1	688.1	300.0

APPENDIX B

Table B.1 summarizes the main descriptive statistics for the whole unbalanced panel of 7.223 observations of the 602 companies in the 12 years.

As it can be inferred from the table, all the variables on related to corporate venture capital that were taken into account show high differences in terms of mean and median, suggesting that none of the selected variables are normally distributed but rather rightly skewed. For example, the average EBITDA is €2.21 billion while the median is equal to €645 million, while the average value of total assets is €67.4 billion with respect to its median of €6.76 billion, ten times lower.

Furthermore, when considering standard deviation, it is possible to observe that there is great variability across firms in the periods under analysis for the selected variables. As a result, a data transformation procedure has been carried out in order to address the normality issues of the sample, further confirmed with a Q-Q plot analysis, as also outlined in the previous section.

Table B.1. Descriptive statistics

Variable	*Mean*	*Median*	*S.D.*	*Min*	*Max*
TOTAL ASSETS	67.400.00	6.760.00	226.000.00	0.00	2.700.000.00
EBITDA	2.210.00	645.00	4.410.00	-35.100.00	50.900.00
CAPEX	768.00	134.00	2.040.00	0.00	30.200.00
TOBIN'SQ	42.40	0.81	1.610.00	-574.00	112.000.00
SALES GROWTH	14.00	4.38	210.00	-100.00	13.800.00
R&D	403.00	52.60	1.160.00	0.00	18.600.00
PATENTS	1.160.00	43.90	4.890.00	0.00	89.900.00
R&D INTENSITY	0.24	0.01	4.46	-0.16	184.00
LEVERAGE	41.10	0.16	1.780.00	0.00	127.000.00

Following the log transformation, the set of variables that will be used in the regression models are presented in Table B.2.

Table B.2. Variables used in the regression models

Variable	*Mean*	*Median*	*S.D.*	*Min*	*Max*
SALES GROWTH	14.00	4.38	210.00	-100.00	13.800.00
R&D INTENSITY	0.24	0.01	4.46	-0.16	184.00
LEVERAGE	41.10	0.16	1.780.00	0.00	127.000.00
l_TOTAL ASSETS	9.09	8.94	2.02	-0.87	14.80
l_EBITDA	6.73	6.69	1.55	-1.04	10.80
l_CAPEX	5.00	5.11	2.09	-4.13	10.30
l_TOBIN'SQ	-0.08	0.00	2.03	-7.74	11.60
l_R&D	4.49	4.50	1.99	-4.07	9.83

Thanks to the log transformation, the variables *total assets, EBITDA, CapEx, Tobin's q,* and *R&D expenditure* follow a normal distribution, with approximately all of the variables presenting close values for Mean and Median, together with a moderate standard deviation. As a further normality check, Q-Q plots were produced in order to confirm the normality of the transformed variables.

With respect to CVC variables, the descriptive statistics relative to the CVC-investing companies are shown in Table B.3 and Table B.4. It should be noted that for all the non-CVC-investing companies the following variables were labelled with zero.

Table B.3. Descriptive statistics relative to the CVC-investing companies

CVC (dummy variable)	*Number of firms*	*Yes*	*No*
All firms	602	577	6647
CVC-investing firms	92	577	527

Table B.4. Descriptive statistics relative to the CVC-investing companies

Variable	*Sample*	*Mean*	*Median*	*S.D.*	*Min*	*Max*
CVC DEALS	All firms	0.52	0.00	4.08	0.00	166.00
	CVC-investing firms	6.45	4.00	13.06	0.00	166.00
CVC AMOUNTS	All firms	6.74	0.00	70.90	0.00	4560.00
	CVC-investing firms	84.40	23.89	237.60	0.00	4560.00
CVC EXIT	All firms	0.16	0.00	1.41	0.00	64.00
	CVC-investing firms	1.89	1.00	4.62	0.00	64.00

Across the whole sample of 602 firms, there are 577 firm-year observations in which a company has done at least one investment in start-ups (CVC dummy variable = *Yes*), opposed to 6647 firm observations that did not invest in corporate venture capital. However, when looking at the CVC investing sub-sample only, the number of years in which a firm has not engaged in corporate venture capital activity is 527, showing a quite balanced activity. For the sake of completion, it is noted that 25 of the 92 CVC-investing firms were active throughout more than 10 years, while 37 were active between 5 and 9 years between the selected time-frame and 31 of the companies pursued CVC activity during less than 4 years between 2008 and 2019.

Finally, as the descriptive statistics on the whole sample for the number of CVC investments, round size, and the number of exits is showing low values because of the high number of non-CVC investing in the sample, additional statistics relative to CVC investing only firms are provided. Again, the selected CVC variables show a rightly skewed distribution, with an average number of investments in one year of 6.45 and a median of 4. Moreover, the average total deal size of the year of €84.40 million, compared to the median value of €23.89 million suggests that few companies participated in bigger rounds, while the majority of the CVC-investing companies invested in capital increases of less relevant amounts. Finally, the variability in the number of exits equal to 4.62 is also highlighted, when compared to its mean value of 1.89 per year.

APPENDIX C

Table C.1. Model variables

Variable	***Description***	***Source***
CVC	Dummy variable filled with 1 if the investor has made at least one investment in a year or 0 otherwise.	PitchBook
CVC DEALS	The total number of investments made in the year (i.e., the number of invested start-ups).	PitchBook
CVC AMOUNTS	Cumulated transaction amount of every deal in the year (both capital increase or acquisition).	PitchBook
CVC EXIT	The number of exits the parent company made in the year (i.e., when a CVC company liquidates an investment previously made in a startup, selling its stakes to another investor).	PitchBook
TOTAL ASSETS	The sum of total current assets, long term receivables, investment in unconsolidated subsidiaries, other investments, net property plant and equipment, and other assets.	Thomson Reuters Eikon Refinitv Workspace
R&D	All direct and indirect costs related to the creation and development of new processes, techniques, applications, and products with commercial possibilities. These costs can be categorized as: 1) Basic research, 2) Applied research, and 3) Development costs of new products.	Thomson Reuters Eikon Refinitv Workspace
SALES GROWTH	(Current *year's net sales or revenues/*last *year's total net sales or revenues* - 1) * 100. The calculation uses restated data for last year's values where available.	Thomson Reuters Eikon Refinitv Workspace
PATENTS	The gross value of brands, patents, and trademarks.	Thomson Reuters Eikon Refinitv Workspace
TOTAL DEBT	All interest-bearing and capitalized lease obligations. It is the sum of long and short-term debt.	Thomson Reuters Eikon Refinitv Workspace
LEVERAGE	The ratio of *TOTAL DEBT/TOTAL ASSETS.*	Thomson Reuters Eikon Refinitv Worskspace
EBITDA	Earnings of a company before interest expense, income taxes, and depreciation. It is calculated by taking the pre-tax income and adding back interest expense on debt and depreciation, depletion and amortization, and subtracting interest capitalized.	Thomson Reuters Eikon Refinitv Workspace
CAPEX	Funds used to acquire fixed assets other than those associated with acquisitions. It includes but is not restricted to: Additions to property, plant, and equipment, investments in machinery and equipment, net of disposal.	Thomson Reuters Eikon Refinitv Workspace