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The performance effects of corporate venture capital: a meta-analysis

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Abstract
The effect of corporate venture capital (CVC) investments is far from being conclusively discussed in literature. Although the expected benefits of CVCs for corporations and start-ups are undisputed, empirical evidence is mixed. We combine and analyze the results of 32 CVC studies, including 105,950 observations: Our results suggest that while CVC investments are positively linked to start-ups' and investors' as well as strategic performance, we find no significant relationship between CVC investments and financial outcomes. The effects are moderated by the timing of the investment, the country and industry-effects. For instance, CVC investments in North America and the ICT sector report significant positive effects, while we find no statistical evidence for the health care sector.

Keywords Corporate venturing · Innovation · Entrepreneurship · Performance · Corporate venture capital (CVC) · Meta-analysis

JEL Classification G24 · L25 · L26 · M13

1 Introduction

In order to seek strategic renewal, corporations can both explore and exploit external business innovations, for example through collaborating with start-ups. As one form of corporate venturing, firms use *Corporate Venture Capital* (CVC) to perform minority-stake equity investments in rather new, non-public start-ups (Covin et al., 2021; Urbano et al., 2022). Nowadays, large and well-known corporations across industries and regions own

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CVC units, including Google, Microsoft or Salesforce. In 2018, for example, corporations had invested a total of 53bn$ and performed 2740 deals with 773 active CVCs globally (CBInsights, 2019).

The 'Raison d'etre' for CVCs as an intermediary balancing the needs between corporations and start-ups, the demand and supply side, seems convincing: At first glance, CVC promise win–win effects for both the corporation and the selected start-ups due to complementarity and matching of their resources (Alvarez-Garrido & Dushnitsky, 2016; Anokhin et al., 2016; Chemmanur et al., 2014; Park & Steensma, 2012; Pierrakis & Saridakis, 2019; Rossi et al., 2017; Van De Vrande et al., 2011): Corporations get access to new ideas, future strategic options, while start-ups benefit from financing, professional advice and guidance, and through access to relevant business networks and corporate resources. While the advantages for both parties seem to be rather obvious, disadvantages, like loss of intellectual property, lock-in effects or reduced entrepreneurial freedom, might also emerge from CVC investments. Yet, empirical evidence on the performance implications of CVC is rather mixed (see e.g. Allen & Hevert, 2007; Colombo & Murtinu, 2017; Dushnitsky & Lenox, 2005; Katila et al., 2008; Lin & Lee, 2011; Park & Bae, 2018) asking for a more conclusive discussion of whether CVC offer promised benefits; or whether there might also be potential drawbacks.

Going beyond existing literature reviews, we choose a meta-analytical research approach to contribute to filling the existing gap in the literature. Contributions in management literature are not necessarily groundbreaking new theories but come from reviewing and clarifying existing studies (Makadok et al., 2018) and meta-analyses have become a popular essential and critical domain for the advancement of theory and evidence-based practice in management (Bergh et al., 2016; Combs et al., 2019; Gooty et al., 2019). While traditional literature reviews synthesizes present rich case evidence (see Combs et al., 2019, p. 5), quantitative meta-analysis technique allows synthesizing and aggregating individual research findings into one single effect size (Bergh et al., 2016, p. 478; Hunter & Schmidt, 2004, p. 35). Therefore, meta-analysis is a commonly used method to explain and control for heterogeneity between existing studies and research findings and is mainly applied when evidence is inconsistent. The goal of meta-analysis is further to "understand the results of any study in the context of all other studies" (Borenstein et al., 2021, p. 336). Meta-analysis also allows to investigate the reasons why the reported outcomes vary from study to study, and which role the study context and research design characteristics may play in explaining inconsistencies in previous findings. Thus, given the mixed empirical literature, using a meta-analytical research approach promises valuable insights and expands our knowledge about the performance effects and mechanisms of CVC investments.

Initially identifying 109 studies, our meta-analysis finally synthesizes 105,950 observations across 32 studies. The results of our study contribute to the conversation on CVC in several ways. First, we find evidence for the overall positive effect of CVC investments on performance. Therefore, both corporations and start-ups mutually benefit from CVC investments. Second, when differentiating between performance outcomes, we find that CVC investments are positively linked to strategic performance measures (e.g. patent citations or product introductions), while we find no evidence that CVC investment is linked to higher financial performance (measured through e.g. subsequent funding or IPO probability). Thus, CVC investments may be more motivated and driven by strategic reasons, than (myopic) financial goals. Thereby, CVC investments differ from other equity investors, like traditional VCs.

Finally, the results of our meta-analysis reveal that part of the heterogeneity can be explained by differences regarding the design and the context of selected studies. We find

evidence that results are sensitive towards the timing of investments, the country of investments and industry-related effects. Our study aims to identify and point out 'blank areas' on the map of CVC investment for future research, for example regarding CVCs as a vehicle to spur start-up performance and a company's strategic competitiveness.

The remainder of the paper is structured as follows: In Sect. 2, we review recent advances and controversies in the literature on CVC. Based on our discussion, we develop our main research model and hypotheses in the Sect. 3. Section 4 describes our methodological approach, including the selection of relevant studies, used metrics and coding strategy. The results are given and discussed in the next chapter, Sect. 5. Finally, Sect. 7 concludes and summarizes the main insights and contributions of our study.

2 Literature on CVC

Corporate Venture Capital is described as minority-stake equity investment from large corporations in rather new, non-public start-ups for which they provide expertise to gain a specific strategic advantage and ensure financial performance (Bertoni et al., 2013; Christofidis & Debande, 2001; Colombo & Murtinu, 2017; Gompers & Lerner, 1998). CVC is an established form of corporate venturing and start-up support (Bielesch et al., 2012; Pierrakis & Saridakis, 2019) and funds are still set-up by major corporations today, as the example of Alliance Ventures demonstrates.[1] Corporate venturing is part of corporate entrepreneurship activities and describes often autonomous vehicles that are used as link to resources outside a corporation[2] (Audretsch et al., 2016; Chua et al., 1999; Urbano et al., 2022). Corporations are "making an investment in external start-ups" (Fenwick & Vermeulen, 2016, p. 3), where the investments "facilitate the founding and/or growth of external businesses" (Covin & Miles, 2007, p. 183). As corporations not only offer financial funding but also non-financial support, CVC is also referred to as "smart capital" (Schilder, 2007). CVC is a smart form of financing as it goes beyond pure financial interest and considers technology and business development, investor outreach or legitimacy (Bjørgum & Sørheim, 2015) and can be achieved through consulting and monitoring (Schilder, 2007). CVC seems to have specific appeal for both parties.[3] Therefore, more than 25% of all venture capital investments globally were made by corporations in the last 3 years (PwC & CBInsights, 2019). Historically, financial return was the major objective for CVCs (Siegel et al., 1988). Over time, however, the importance of strategic considerations increased, like obtaining a window on technology, opening up to new markets, getting access to talent and starting a cultural rejuvenation (Anokhin et al., 2016; Dushnitsky & Lenox, 2006; Wadhwa & Kotha, 2006). Start-ups aim, besides financial funding, at complementary assets and capabilities as well as networks and experts that only corporates can offer (Asel et al., 2015; Gans & Stern, 2003; Ivanov & Xie, 2010; Park & Bae, 2018). Despite its financial and strategic objective (Chesbrough, 2002), it remains unclear whether CVC is value-enhancing for the involved parties.

[1] See https://www.alliance-2022.com/ventures/.

[2] Besides CVC investments, corporations might engage in joint ventures or M&A activities as part of their corporate venturing activities.

[3] Start-ups also can get funding and non-financial support from multiple sources, like independent venture capital funds, business angels, specific banks or loan providers, like the German Kreditanstalt für Wiederaufbau (KfW).

The empirical literature reflects in parts the trade-off between benefits and costs. The results are not as convincing as often taken for granted. While a broad consensus exists on the overall positive effects of CVC (e.g. Colombo & Murtinu, 2017; Dushnitsky & Lenox, 2005; Lin & Lee, 2011), a few studies doubt the generous incentives of corporations supporting start-ups, stating that "CVC programs as an investor class were (direct) value destroyers" (Allen & Hevert, 2007, p. 273) and concluding that "CVC-backed start-ups do not outperform" their control group (Park & Bae, 2018, p. 332).

3 Theoretical background and hypotheses

3.1 Research model

In order to shed light on the performance effect of CVC investments, Fig. 1 presents the research model underlying this meta-analysis:

Our main hypothesis is on the overall performance of CVC investments (H1). This relationship is moderated by three dimensions of study design, namely time, country, and industry, leading to three subsequent hypotheses (H1a, H1b, and H1c). As shown in empirical studies (Bielesch et al., 2012; Chesbrough, 2000; Dushnitsky, 2011) and industry reports (CBInsights, 2017), time matters for CVC performance in several ways (H1a) including 'learning over time', business developments, new inventions and innovations and political changes. Second, country differences impact CVC investments, especially when differentiating the U.S. as a leading CVC market with other regions (Christofidis & Debande, 2001) (H1b). Third, industry specific effects on CVC performance are considered (H1c), as selected academic research focuses on specific industries only, like medical device industry (Howard et al., 2017), biotech (Alvarez-Garrido & Dushnitsky, 2016), automotive (Flamand & Frigant, 2017), telecommunication equipment manufacturers (Wadhwa et al., 2016), software companies (Dushnitsky & Lavie, 2010), or banking (Maxin, 2018), reflecting different "entrepreneurial regimes" (Audretsch & Caiazza, 2016; Audretsch et al., 2006; Fritsch & Mueller, 2006).

Additionally, studies differ by their way of measuring performance. As corporate venturing units pursue both financial and strategic objectives (Chesbrough, 2002), their performance is also differentiated accordingly (H2). Moreover, CVC investments yield different benefits and drawbacks for corporations than for start-ups. CVC investments are expected to have a positive overall performance effect for both the investor and the start-up, otherwise one of the two parties would abstain from entering the relationship (H3). In the next step, each hypothesis of our research model is developed in more detail.

3.2 Hypotheses development

Both corporations and start-ups lack some specific resources and capabilities to further improve their performance. Intriguingly, the other party in a CVC relationship is able to fill these gaps. Corporations are especially in need of innovations to face growing competition as the average tenure in the S&P 500 index was 61 years in 1958, and reduced to a mere 18 years in 2010 (Foster, 2012). One way to stay ahead of the competition is to innovate. Sources of innovation can be both internal and external (Drucker, 2002) with open innovation, strategic M&As and, most recently, the active collaboration with start-ups and entrepreneurial firms as central spillover mechanism (Wadhwa et al., 2016).

Start-ups, in contrast, face a liability of newness (Stinchcombe, 1965), especially regarding the availability of financing, access to markets and talents as well as technology and business expertise (Bock et al., 2018; Dushnitsky & Lenox, 2005; Radcliffe & Lehot, 2018). In short, the high failure rates of start-ups, the missing historical record of accomplishment, the lack of profit or revenue, as well as severe information asymmetries, hinder start-ups from accessing more traditional financing sources, like loans from banks. Lacking organizational structure and processes, as well as networks to the market, start-ups often fail to commercialize their ideas (Wang et al., 2017). Additionally, start-ups are unaware of specific business practices and market powers (Stinchcombe, 1965). Finally, start-ups lack—due to their young age—legitimacy in the market (Delmar & Shane, 2006). Intriguingly, start-ups can offer what corporations lack, whereas corporations can offer what start-ups need. Therefore, corporations and start-ups can complement each other, leading to positive performance (Katila et al., 2008). This leads us to hypothesis H1:

H1 CVC investment is positively associated with performance.

This hypothesis is grounded in the positive efficiency principle that CVCs only survive in a competitive world if they yield positive performance. Nonetheless, we are aware of adverse effects from different cultures, working styles, processes, and procedures as well as personnel. We assume that such adverse effects are reflected in the dimensions of time, region, and industry. Moreover, we suggest that different effects materialize on financial and strategic performance (H2a, H2b) as well as investor and start-up performance (H3a, H3b), respectively.

First, the timing of a CVC investment is relevant. The CVC phenomenon occurred broadly from the 1960s onwards (CBInsights, 2017). Since then four waves of CVC investment are observed.[4] The waves differ with regards to the objectives and motivations for CVCs,[5] the overarching strategic direction of corporations,[6] changing policies,[7] the development of new technologies changing the overall economic landscape,[8] the overall economic situation,[9] the occurrence of so-called "unicorn" start-ups,[10] the average lifetime of CVCs or the set-up and organization of CVC funds. Additionally, CVCs learn and change their priorities over time. Whereas 83% of CVCs pursued only strategic goals in 1996, this number was reduced to 42% at the beginning of this century, while financial investment criteria increased in importance (Weber & Weber, 2002). Lastly, CVCs improved their ability to attain their financial and strategic goals over time. In earlier waves, CVCs were rather experimental with regards to their objectives and organizational profiles (Hill &

[4] The waves are from 1960 to 1977, from 1978 to 1994, from 1995 to 2001 and since 2002 (CBInsights, 2017; Chesbrough, 2000).

[5] For example, the use of idle cash versus need for innovations.

[6] For example, changing from heavily diversified corporations to more focused firms.

[7] For example the introduction of a capital gains tax in the U.S. in the 1970s which slowed CVC investments (CBInsights, 2017).

[8] For example, the internet revolution has led to an explosion in business-to-business and business-to-consumer start-ups in the 1990s, the human genome project (HGP) stimulated the start-up scene in biotechnology in the 2000s and Apple's first smartphone revolutionized the Information and Communications Technology (ICT) industry with plenty of app-based start-ups, which are now shaping the manufacturing sector as well as the banking, finance, and insurance industries.

[9] For example, the oil crisis in the 1970s or the burst of the Dotcom bubble in the early 2000s.

[10] Unicorns are start-ups with a valuation above $1 billion.

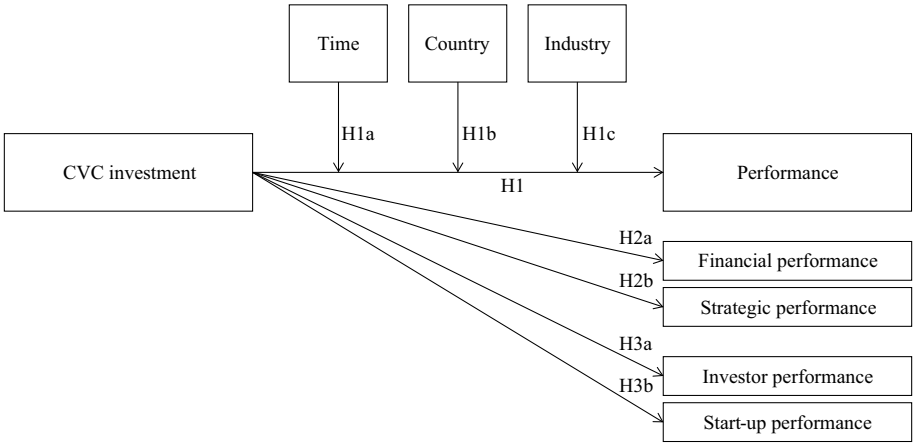

Fig. 1 Research model

Birkinshaw, 2008). Moreover, time plays a crucial role in a firm's ability to balance explorative and exploitative innovations and the resulting performance effects of ambidexterity (Mathias et al., 2018). The importance of time is also highlighted by the fact that many studies ought to control for it (e.g. Benson & Ziedonis, 2010; Dushnitsky & Lenox, 2005 among many others). Therefore, we conclude that

H1a The relationship between CVC investment and performance is moderated by the time of the investment.

The second dimension shaping CVC investment performance is a geographic or regional one. Although cross-region investments occur, most of the empirical studies focus on selective parts of the world, in particular the U.S. Geographic differences occur due to different regional sizes, growth rates, and cultures and are differentiated on the country level (Audretsch & Caiazza, 2016). Globally, CVC spend is biased towards North America (41%) and Asia (38%)[11] (CBInsights, 2019). CVC investment shifts more and more to Asia, increasing its share from 19% in 2013 to almost 40% in 2018 (CBInsights, 2019). Recently, countries in Africa, the Middle East and Russia have seen low growth rates for CVCs, whereas the North American and European as well as Chinese and Indian markets grew considerably (Radcliffe & Lehot, 2018). This demonstrates regional differences with regards to the size and development of CVC markets and perhaps the political power exerted by large corporations in China. Cultural differences also matter. The culture of a region impacts firm culture (Hofstede, 2001) and guides the mental models and behavior of individuals (Herbig & Dunphy, 1998; Hofstede et al., 2010). The performance effect of CVC investments will differ based on a region's uncertainty avoidance, assertiveness, future orientation and performance orientation.[12] Moreover, a region's innovativeness, availability of good scientists, as well

[11] The remaining investments are performed in Europe (17%) and Other (4%).

[12] The culture dimensions are based on the GLOBE (Global Leadership and Organizational Behavior Effectiveness) project (House et al., 2002).

as the motivation and skills of its people are just as important as failure tolerance, a supporting infrastructure, and the legal framework (Christofidis & Debande, 2001; National Venture Capital Association, 2015).

Differences in CVC investments among countries exist for many more reasons, like fiscal (e.g. taxes), stock market (e.g. market liquidity), regulatory (e.g. labor market and company laws), and infrastructural (e.g. research centers and technology parks) dimensions (Christofidis & Debande, 2001). In addition, financial markets differ by country, especially regarding their debt versus equity orientation (Christofidis & Debande, 2001), ownership structure, and concentration (Morck, 1996) as well as shareholder type and protection (Aguilera & Crespi-Cladera, 2016; La Porta et al., 2000). Moreover, the size of corporations differs and country-specific support programs for entrepreneurship and corporate venturing exist, like funds of funds, a strengthening of entrepreneurial research and education, tax breaks or the reduction of administrative burdens for start-ups (e.g. Danish Business Authority, 2014; European Commission, 2018; Gov.uk, 2016; Government of the Netherlands, 2014). As "the impact of the environmental factors on organizational innovation, specifically corporate entrepreneurship" is inevitable (Turró et al., 2014, p. 360), we hypothesize that

H1b The relationship between CVC investment and performance is moderated by the country of the investment.

Industry differences matter for CVC performance as confirmed by several studies (Bertoni et al., 2019; MacMillan et al., 2008; Zider, 1998) and market reports (CBInsights, 2019). Therefore, a selection bias towards individual industries like medical devices (Howard et al., 2017), biotech (Alvarez-Garrido & Dushnitsky, 2016), telecommunication equipment manufacturers (Wadhwa et al., 2016), automotive (Flamand & Frigant, 2017), software companies (Dushnitsky & Lavie, 2010), or banking (Maxin, 2018) exists.

Industries differ by their size, growth dynamics, competitive and regulatory environment, innovativeness as well as set-up and fix costs structure. First, with regards to size, biotech (22%), software (13%), and telecommunications (12%) are the industries with the highest CVC investments (MacMillan et al., 2008). Second, market competition and growth dynamics play a role in industry differences (Audretsch et al., 2014). Market competition, market information, and industry collaboration play a role in make-or-buy decisions (He & Nickerson, 2006) and thereby a corporation's decision to either focus on internal innovation (e.g. from R&D departments) or open up to external sources (e.g. through CVC). Additionally, waves of innovation and business cycles are often industry-specific. Third, industries differ by their fixed-cost structure and required initial investments. Developing a digital app requires fewer financial resources than an investment in the medical sector. Also, institutional isomorphism and the structure of inter-firm relationships differ across industries (Flamand & Frigant, 2017). Similarly, the search costs for external knowledge differ (Segarra-Ciprés & Bou-Llusar, 2018); therefore, CVC activities differ across industries. Moreover, industries differ with regards to the required entrepreneurial orientation of corporations (McKenny et al., 2018). Therefore, start-ups in some industries benefit more from corporate support than start-ups in other industries. In biotech, for example, start-ups benefit from corporate experience regarding Food and Drug Administration (FDA) approvals and patent applications (Alvarez-Garrido & Dushnitsky, 2016). This leads us to the hypothesis that

H1c The relationship between CVC investment and performance is moderated by the industry of the involved parties.

Following Anokhin et al. (2016), overall performance is an inappropriate and vague measure for CVC performance. Hardly any study on CVCs uses an overall performance measure since financial and strategic objectives and therefore performance differ distinctly. For financial performance revenue growth (Colombo & Murtinu, 2017), Tobin's Q (Dushnitsky & Lenox, 2006; Lin & Lee, 2011; Yang et al., 2014), financial returns (Zahra & Hayton, 2005), start-up valuation (Gompers & Lerner, 1998; Röhm et al., 2018) or subsequent funding (Gonzalez-Uribe & Leatherbee, 2018; Zahra & Hayton, 2005) are applied variables. Strategic performance is measured through patents and patent citations (Alvarez-Garrido & Dushnitsky, 2016; Corsino et al., 2019; Dushnitsky & Lenox, 2005; Keil et al., 2008; Smith & Shah, 2013; Wadhwa & Kotha, 2006; Wadhwa et al., 2016), publications and regulatory documents (Alvarez-Garrido & Dushnitsky, 2016; Smith & Shah, 2013), product introductions (Smith & Shah, 2013), R&D intensity (Paik & Woo, 2017), as well as web-based measures from social media or website-traffic (Gonzalez-Uribe & Leatherbee, 2018; Hallen et al., 2017). Accordingly, the performance of CVCs has to be separated in a financial and a strategic component. The question remains, whether the financial or strategic performance of CVC investments is superior.

Historically, scholars and practitioners believed that financial performance should be the leading objective for CVCs (Siegel et al., 1988). In the course of time, however, the perception changed from a shareholder value orientation towards a more long-term sustainable attitude, viewing CVC as a window on technology (Dushnitsky & Lenox, 2006). Nowadays, the primary objectives of CVC activities are access to new markets, applying non-strategic know-how, improving company value and image (Ernst et al., 2005), and 65% of the CVCs name strategic reasons as the main rationale for their investments (MacMillan et al., 2008).

The superior importance of strategic over financial performance for CVCs becomes even more evident when comparing CVCs to non-corporate independent venture capital funds (IVCs).[13] Financially, IVCs perform better (Bertoni et al., 2013; Maula et al., 2006),[14] whereas CVC-backing results in higher innovative output, especially for start-ups (Alvarez-Garrido & Dushnitsky, 2016; Chemmanur et al., 2014; Howard et al., 2017; Paik & Woo, 2017). The superiority of strategic performance comes from the offerings of CVCs, including non-financial resources and capabilities, manufacturing assets and knowledge, network access as well as idiosyncratic corporate processes (Basu et al., 2016; Chesbrough, 2000; Colombo & Murtinu, 2017; MacMillan & Block, 1993). Due to the complementarity of corporate and start-up assets, resources, capabilities, knowledge and networks, the collaboration of the two parties through a CVC yields strategic benefits. Taking all this into consideration, we infer that

H2a CVC investment is not associated with financial performance and H2b: CVC investment is positively associated with strategic performance.

[13] Although IVCs and CVCs differ, CVCs benefit from adopting several IVC practices and structures (Hill et al., 2009).

[14] Moreover, IVC-backed IPOs are positively associated with underpricing, CVC-backed IPOs negatively (Wang & Wan, 2013).

Following Ernst et al. (2005) as well as Dushnitsky and Lenox (2005), a CVC acts as intermediary between a corporation and a start-up, where the two players differ regarding their objectives, needs and structure. Whereas the one is a large, and often bureaucratically complex, firm that focuses on getting access to innovative ideas, the other is a small agile unit focused on getting access to financing and complementary resources. Both parties benefit from CVC investments to some degree, yet also face disadvantages.

Although not all investments generate superior financial returns, corporations are profit-seeking vehicles and are expected to invest their money wisely, i.e. when the investee can generate a return above the firms internal rate of return (Allen & Hevert, 2007).[15] Additionally, corporations benefit strategically, especially from having a window on technology (Dushnitsky & Lenox, 2005), where start-ups act as "listening posts" for corporations (Chemmanur et al., 2014). Thereby, corporations get access to external sources of innovation and learn about novel technologies (Bielesch et al., 2012). Corporations broaden their experience and strengthen their capabilities and knowledge. Corporations benefit through rejuvenating their culture by learning from more agile start-ups and through access to start-up ecosystems and networks (Agarwal & Helfat, 2009; Anokhin et al., 2016; Belderbos et al., 2018). Through CVC investments, corporations position themselves in the industry, getting access to new potential partners (Anokhin et al., 2016). Finally, collaborations with start-ups are often broadly communicated by corporations to signal their innovativeness and openness to collaborate with other market players (Anokhin et al., 2016; Belderbos et al., 2018). Such reputation effects are especially strong in the case of successful investment exits (Bienz & Walz, 2006).

On the other hand, also drawbacks of CVC investments exist. Besides tying up funds that might be invested somewhere else, the risk of losing intellectual property is especially high (Anokhin et al., 2011). Further drawbacks develop in the daily work and include managerial complexity, coordination costs as well as cultural differences that might lead to communication difficulties (Belderbos et al., 2018; Gaba & Dokko, 2016).

Similarly, start-ups also face benefits and drawbacks from CVC investments. Financing is the most pressing needs of start-ups and thereby also the major benefit they receive from CVCs (Maula et al., 2006; Park & Bae, 2018). Although start-ups can receive funding from multiple financial institutions or individuals, CVCs have two distinct advantages. First, corporations focus on strategic benefits, putting less pressure on financial returns (Bjørgum & Sørheim, 2015) and leading to a greater tolerance for failure (Chemmanur et al., 2014). Second, corporations use start-ups as "listening posts" for pioneering technologies and therefore also invest in start-ups that would not receive funding otherwise (Chemmanur et al., 2014). Moreover, start-ups benefit strategically, for example, through access to rare raw materials, use of R&D and testing facilities, scientific laboratories or clinical trial sites, large scale production and manufacturing on existing production lines, product portfolio extensions, advertising and distribution of products through existing marketing and sales channel, and the application of sales forces and customer service teams (Alvarez-Garrido & Dushnitsky, 2016; Asel et al., 2015). Through the use of complementary corporate assets, start-ups save time and money and ensure a shorter time-to-market for their innovation (Alvarez-Garrido & Dushnitsky, 2016; Gans & Stern, 2003). Start-ups benefit from the experience, advice, and capabilities available within a corporation, through

[15] Financial returns of CVC may be due to complementarities with internal assets and resources, its superior knowledge of markets and technologies, strong balance sheet, or network effects (Dushnitsky & Lenox, 2006; Siegel et al., 1988).

getting access to CVC personnel and thousands of corporate employees (Alvarez-Garrido & Dushnitsky, 2016).[16] Getting access to experience in business administration helps start-ups to commercialize their products (Gans & Stern, 2003), and set up functioning structures, organization, and processes (Park & Bae, 2018). Moreover, start-ups get access to an ecosystem[17] and a large network including strategic partners, science networks, and market players (Asel et al., 2015; Ivanov & Xie, 2010; Maula et al., 2006). Lastly, collaborating with corporations has an immense reputational aspect for start-ups, as the investment of a corporation with proven technological knowledge and successful previous start-up investments signals a positive performance expectation, a high quality and the commercial credibility of the start-up (Bjørgum & Sørheim, 2015; Maula et al., 2006; Stuart et al., 1999).

Nonetheless, start-ups also face drawbacks and costs of CVC investments, leading to a description of CVC collaboration as "swimming with the sharks" (Katila et al., 2008). The main concern of start-ups is the misappropriation of intellectual property and intangible assets through corporations (Dushnitsky & Shaver, 2009; Katila et al., 2008). Start-ups often aim at filling patent protection with corporate support (Katila et al., 2008), making the start-up's intellectual property vulnerable to corporate shirking. Therefore, start-ups are "fundamentally badly" protected from corporate expropriation of intellectual property (VentureCapital Magazin, 2019, p. 14 translated from German). Second, start-ups give up managerial decision power and entrepreneurial freedom if under CVC management (Ivanov & Xie, 2010). Also, collaborating with corporations limits the start-ups access to other players and open market resources (Park & Steensma, 2012). In addition, corporations may reduce or cut off the cooperation when the expected benefit equals the cost, after having absorbed the needed knowledge (Gaba & Dokko, 2016). Di Lorenzo and van de Vrande (2019) detect that ventures do not necessarily draw in investor knowledge. This creates a hold-up problem leading to the well-known phenomenon of underinvestment in relationship-specific investments (Crawford, 1990; Muthoo, 1998). Finally, cultural clashes between the corporation and the start-up may emerge (Gompers & Lerner, 1998) and corporate personnel refuse innovations by, and collaborations with, start-ups.

Clearly, benefits and drawbacks of CVC investments exist for both corporations and start-ups. Referring to the positive efficiency principle, CVC will only exist if it yields performance for all involved parties, especially as both start-ups and corporations can decide on one's own free will whether to enter such a relationship or not. Neither start-ups nor corporations would be willing to enter CVC investments if the costs would outreach the benefits. For many years, however, both parties have chosen to enter CVC relationships. Therefore, we hypothesize that

H3a CVC investment is positively associated with investor performance and H3b: CVC investment is positively associated with start-up performance.

[16] For example, founders can discuss their technology with in-house scientists, their advertising and product pricing with marketing experts, real-time industry trends with senior executives or business unit experts and regulatory issues with in-house attorneys as well as learn from previous successes and failures in product introductions (Alvarez-Garrido & Dushnitsky, 2016; Chemmanur et al., 2014; Ivanov & Xie, 2010; Maula et al., 2006).

[17] Also including other CVC-managed start-ups.

4 Methodology

In order to evaluate the performance of CVC investments, a meta-analytical approach is applied "to test the direction and significance of the bivariate relationships specified" (Bergh et al., 2016, p. 478). Meta-analyses are used since the 1980s in healthcare, medical, and psychology research and are described as "the statistical analysis of a large collection of analysis results from individual studies for the purpose of integrating the findings" (Glass, 1976, p. 3), which "uses a quantitative measure, effect size, to indicate the strength of relationship between the treatments and dependent measures of studies" (Gliner et al., 2003, p. 1376). Meta-analyses are applied when multiple studies on a topic exist, and, while conceptually similar, yield contradicting results.[18] Through the analytical combination of effect sizes, meta-analyses can be seen as a form of quantitative literature reviews with several explicit advantages. Combining multiple studies incrases the number of observations, leading to a higher statistical power of the detected results. Additionally, biases and disadvantages from the design of individual studies can be reduced or mitigated (Hunter & Schmidt, 2004, p. 35).

4.1 Literature search

The literature search was conducted in a sequential manner (Fig. 2):

First, a key word search in electronic research databases like Wiley Online Library, ProQuest, Emerald Publishing, and Google Scholar, among others is performed, based on key words identified from previous literature reviews (e.g. Röhm, 2018). 24 different key words were used including combinations and variations.[19] Similarly, start-up-oriented terms were applied to adequately include the start-up literature analyzing CVC collaborations[20] (e.g. Pahnke et al., 2015). Lastly, key words referring to the performance of CVC investments were used.[21] In addition, the reference list of existing CVC literature reviews were searched manually (e.g. from Chesbrough, 2002; Röhm, 2018) and entrepreneurship, management and innovation journals screened.[22] In addition, working papers were identified through Research Gate, SSRN and Web of Science. For the most recent years, conference papers were manually searched for the major conferences in this field, including the Academy of Management conference, the European Academy of Management conference, the Druid conference and Babson conference. Lastly, backward searches of the reference lists in identified studies were performed. For studies that were not available online, we reached out to the authors directly with limited success. This literature research took place in summer 2018, was refined in fall 2019 and yielded a total of 109 identified studies.

[18] Meta-analyses are, for example, also used in the context of performance of corporate entrepreneurship (Bierwerth et al., 2015), knowledge transfer effects (van Wijk et al., 2008), performance implications of equity holdings (Dalton et al., 2003) or success implications of human capital (Martin et al., 2013; Unger et al., 2011).

[19] Key words include Corporate venture capital (CVC), corporate venture capital investments (CVCI), corporate investor, corporate parent and CVC dyad.

[20] Key words include start-up, start-up financing, young venture, entrepreneurial firm, entrepreneurial finance, and portfolio company.

[21] Key words include financial, strategic and innovative performance, profitability, and growth or interorganizational learning and knowledge flows.

[22] Journals include the Strategic Entrepreneurship Journal, the Journal of Business Venturing, and the Strategic Management Journal.

Meta-analytical research requires the wide range of possible studies to be narrowed towards a 'relevant' set encompassing the topic of the research question. Including studies beyond the research topic, as well as missing relevant ones, would bias the results. To reduce the wide set of possible studies, we follow Card (2012, p. 38ff) and apply inclusion and exclusion criteria. First, we focus on CVCs and exclude studies on other corporate venturing vehicles.[23] This reduces the relevant set to 80 studies. Second, only empirical studies and in particular those providing information on sample size and bivariate correlation can be included (Hunter & Schmidt, 2004, p. 33), reducing the final data set to a total of 32 studies. Following broadly accepted statistical conventions regarding sample size, the small number of studies might raise questions regarding the viability of statistical analyses and regarding how many studies need to be included in a meta-analysis. Valentine et al., (2010, p. 245) conclude that "the answer is two studies", thus our dataset including 32 studies and 105,950 observations (see Table 1) is sufficiently large.

4.2 Funnel plot

Empirical research often suffers from potential publication biases. A publication bias occurs when only studies with statistically significant results or those confirming an anticipated relationship are published. This may result in an overestimation of effect sizes in a meta-analysis (Borenstein et al., 2021). Besides including working papers and studies presented at conferences, we test for such a publication bias by applying a funnel plot graph[24] as depicted in Fig. 3:

As shown by the solid vertical line, the combined effect size is almost *0.1*, and the two dotted lines present the pseudo 95% confidence limits of the standard error of *r* around the combined effect size, indicating that no serious publication bias exists for our sample as it also includes studies with low or even negative effect sizes. In addition, the rather low standard error of *r* of the included studies demonstrates a sufficient statistical quality of the included studies. Only two studies show a standard error of the effect size of above *0.08* (Allen & Hevert, 2007; Smith & Shah, 2013), most probably due to the large timeframe included in their underlying datasets.[25] Another outlier is the study by Lee et al. (2015) with a corrected $r = 0.5$. Here, the outlier effect might be explained by the dataset of US-based ICT investments during 1995–2005, encompassing the rise and fall of the Dotcom era.

4.3 Measurement and coding

Meta-analyses face the challenge of combining different measures of various studies to suitable constructs (Lipsey & Wilson, 2001). The combination requires a careful coding of included studies and their variables. Table 2 gives a summary of the coding and frequencies of variables:

[23] For example, corporate investments in IVCs, corporate incubators or corporate accelerators.

[24] A funnel plot represents "a scatterplot of the effect sizes found in studies relative to their sample size" (Card, 2012, p. 263).

[25] The dataset of Allen and Hevert (2007) includes CVC investments from the years 1988 to 2002, the study of Smith and Shah (2013) from 1987 to 2007.

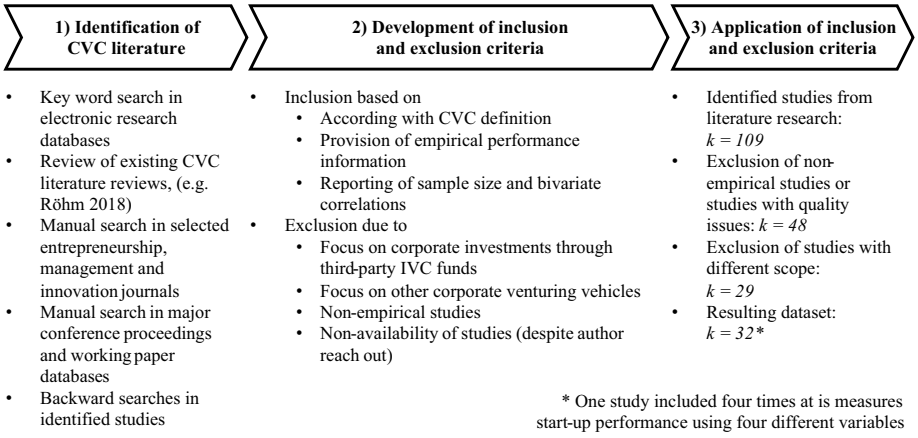

Fig. 2 Identification of relevant CVC literature

The variable *time* reflects the year of the CVC investments. Most studies include data beginning in the early 1990s, with the exception of Dushnitsky and Lenox (2005), starting in 1969. The most recent studies include data until 2010, like Colombo and Murtinu (2017) and Lee and Kang (2015).

Bielesch et al. (2012) argue that CVC investments come in waves, reflecting the costs and benefits of the investments, technological progress, business cycles or even exogenous shocks (CBInsights, 2017). In particular, the Dotcom bubble crises affected CVC investment drastically, where the amount of CVC investment took a hit and several firms even dismantled their CVC units. We therefore split the time period into a *pre-* and a *post-Dotcom* period (as well as a combination of the two), separating our dataset in three subsamples with 13 studies including CVC investments in the pre-Dotcom era, only three studies covering only the post-Dotcom era, and 16 studies encompassing both time periods.

Country differences are measured by two subgroups, namely whether the underlying study is focused on North America only or not. According to Röhm (2018), about 70% of the CVC literature is US-based and in our dataset 66% of the studies focus on North America. This overrepresentation characterizes the U.S. market as 'the' CVC market. It is the homeland of the first CVC,[26] still the biggest market for CVC investments worldwide,[27] the biggest VC market (Christofidis & Debande, 2001) and, of course, one of the largest global economies. All remaining studies are too heterogeneous to be differentiated by country. Some studies include country-data from Europe (Colombo & Murtinu, 2017), Taiwan (Lin & Lee, 2011) or a mix of multiple countries (e.g. Alvarez-Garrido & Dushnitsky, 2016; Belderbos et al., 2018), leading us to combine these studies as *other countries*.

Thirdly, we differentiate by the three industry variables, *ICT*, *Health Care* and *Multiple*. Most single industry studies focus either on *Information and Communications Technology* (*ICT*) (ten studies) or *Health Care* (five studies). The overwhelming number of high-tech

[26] The 1914 investment of DuPont in the 6-year-old automotive start-up General Motors (GM) is considered the first CVC investment ever. Other companies that adopted CVCs early on were Alcoa and 3M (CBInsights, 2017).

[27] In 2018, the global CVC spend was split in North America 41%, Asia 38%, Europe 17%, Other 4% (CBInsights, 2019).

Table 1 Studies included in meta-analysis

Study	Obs.	Focal object	Time	Region	Industry	Performance
Allen and Hevert (2007)	90	CVC investors	Multiple	North America	ICT	Financial
Alvarez-Garrido and Dushnitsky (2016)	545	Portfolio Company	postDotcom	Other	Health Care	Strategic
Anokhin et al. (2016)	12,000	CVC investors	preDotcom	Other	Multiple	Strategic
Belderbos et al. (2018)	385	CVC investors	postDotcom	Other	Multiple	Strategic
Benson and Ziedonis (2009)	242	CVC investors	Multiple	North America	ICT	Financial
Chemmanur et al. (2014)*	1834	Portfolio Company	Multiple	North America	Multiple	Strategic
Colombo and Murtinu (2017)	502	Portfolio Company	Multiple	Other	Multiple	Financial
Corredoira and Di Lorenzo (2019)	154	Portfolio Company	preDotcom	North America	Multiple	Strategic
Di Lorenzo and Sofka (2017)	1679	Portfolio Company	postDotcom	North America	Multiple	Strategic
Dushnitsky and Lenox (2005)	31,876	CVC investors	preDotcom	North America	Multiple	Strategic
Dushnitsky and Lenox (2006)	8630	CVC investors	preDotcom	North America	Multiple	Financial
Dushnitsky and Shapira (2010)	300	Portfolio Company	preDotcom	North America	Multiple	Financial
Gompers and Lerner (1998)	24,515	Portfolio Company	preDotcom	Other	Multiple	Financial
Ivanov and Xie (2010)	239	Portfolio Company	preDotcom	Other	Multiple	Financial
Keil et al. (2008)	659	CVC investors	preDotcom	North America	ICT	Strategic
Lee and Kang (2015)	1313	CVC investors	Multiple	North America	Multiple	Strategic
Lee et al. (2015)	178	CVC investors	Multiple	North America	ICT	Strategic
Lin and Lee (2011)	444	CVC investors	Multiple	Other	ICT	Financial
Pahnke et al. (2015)	1299	Portfolio Company	Multiple	Other	Health Care	Strategic
Park and Bae (2018)	762	Portfolio Company	Multiple	North America	Health Care	Strategic
Park and Steensma (2012)	508	Portfolio Company	Multiple	North America	ICT	Financial
Park and Steensma (2013)	508	Portfolio Company	Multiple	North America	ICT	Strategic
Schildt et al. (2005)	5091	CVC investors	preDotcom	North America	ICT	Strategic
Smith and Shah (2013)	128	CVC investors	Multiple	Other	Health Care	Strategic
Van De Vrande et al. (2011)	4302	CVC investors	preDotcom	Other	Health Care	Strategic
Wadhwa and Kotha (2006)	383	CVC investors	preDotcom	North America	ICT	Strategic
Wadhwa et al. (2016)	417	CVC investors	preDotcom	North America	ICT	Strategic

Table 1 (continued)

Study	Obs.	Focal object	Time	Region	Industry	Performance
Yang (2012)	232	CVC investors	preDotcom	North America	Multiple	Strategic
Yang et al. (2014)	1233	CVC investors	Multiple	Other	Multiple	Financial

*Measures start-up performance using four different variables

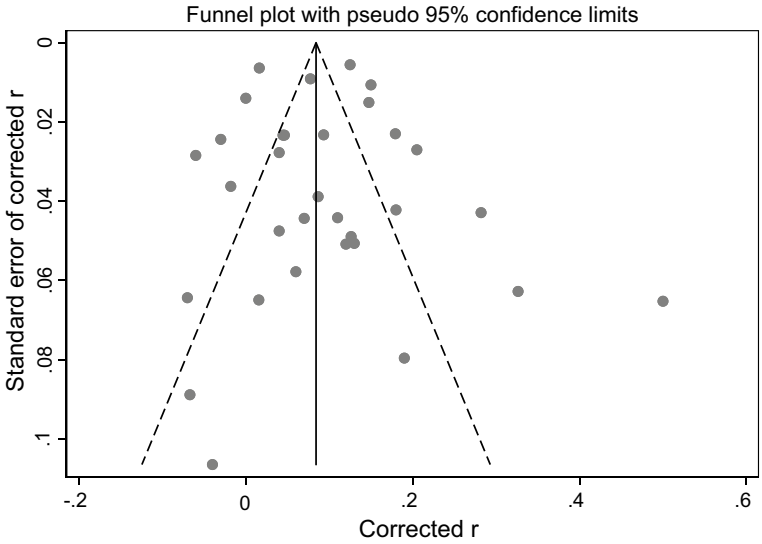

Fig. 3 Funnel plot of all studies with pseudo 95% confidence limits

Table 2 Coding and frequency of variables

Coding	Description	Observations	
Total CVC studies		32	100%
Time			
Pre-Dotcom	Studies only covering CVC investments before 2001	13	41%
Post-Dotcom	Studies only covering CVC investments after 2001	3	9%
Multiple	Studies covering CVC investments before and after 2001	16	50%
Country			
North America	Studies covering North America CVC investments only	21	66%
Other	Studies covering CVC investments in other countries or across countries	11	34%
Industry			
ICT	Studies covering ICT CVC investments only	10	31%
Health care	Studies covering health care CVC investments only	5	16%
Multiple	Studies covering CVC investments in other industries or across industries potentially including ICT or healthcare	17	53%
Performance			
Financial	Studies using a financial performance indicator	10	31%
Strategic	Studies using a strategic performance indicator	22	69%
Focal object			
Investor	Studies evaluating the effect of CVCs on corporate performance	17	53%
Start-up	Studies evaluating the effect of CVCs on start-up performance	15	47%

start-ups in an economy belong to the ICT sector, similar to the big CVC players.[28] The health care industry is seen as a high-risk industry with extremely high expected returns worldwide in the future, where start-ups are seen as a vehicle to detect the next blockbuster[29] (e.g. Park & Bae, 2018). While this industry is characterized by high fixed-costs and R&D investments, it is in particular the sector where the most promising and radical innovations are expected from start-up companies. Finally, the other 17 studies encompassing different sectors and industries are captured by the variable *multiple*.

Chesbrough (2002) argues that both financial and strategic goals are pursued by corporate venturing, leading us to split the performance effects of CVC investments into financial and strategic effects. We identified ten studies focusing on financial performance measures like profitability (e.g. Allen & Hevert, 2007), firm size (e.g. Dushnitsky & Lenox, 2006; Yang et al., 2014) or Tobin's Q (e.g. Dushnitsky & Lenox, 2006) and 22 studies analyzing strategic performance as measured by patent counts and patent citations (e.g. Dushnitsky & Lenox, 2005; Wadhwa & Kotha, 2006).[30]

Finally, we include the corporation or CVC (*Investor*) and the *Start-up* as moderator variables. To reveal the performance of CVC investment in general, also the start-ups should be taken into account. However, only seven studies are concerned about whether CVC investment also increases benefits for the start-up companies, whereas nearly half of the studies, namely 17, focus on corporate performance.

4.4 Meta-analytical approach

In our analysis, we follow the seven step approach by Card (2012) as well as Hunter and Schmidt (1990). For an overview see Fig. 4.

The first step is dedicated to the selection and collection of the effect size measuring the association between two variables. As suggested by Hunter and Schmidt (2004)[31] we apply the Pearson correlation coefficient r between a predictor and a criterion variable. The effect size is used to measure the relationship between multiple variables (Lipsey & Wilson, 2001)[32] and is consistently used in meta-analyses (e.g. Bierwerth et al., 2015; Daily et al., 2003; Unger et al., 2011). Most studies rely on the correlation between CVC investments and performance, but there are also a few on causational effects applying an instrumental variable approach (e.g. Pahnke et al., 2015; Park & Steensma, 2013) or panel data (e.g. Van De Vrande et al., 2011). The effect size r is collected for each and every study, either from reported correlations or derived from other test statistics as recommended by Card (2012, p. 97ff).

[28] The most active CVCs are those of Google, Microsoft, Amazon, Intel, Salesforce or Baidu (CBInsights, 2019).

[29] On average, the R&D phase of a new drug takes 12 years and costs around 1.15£bn, where often only 1 out of 10,000 compounds becomes available for patient treatment, see https://www.pharmaceutical-journal.com/publications/tomorrows-pharmacist/drug-development-the-journey-of-a-medicine-from-lab-to-shelf/20068196.article?firstPass=false.

[30] The importance of strategic goals in CVC investments may be reflected by the high number of studies analyzing this kind of performance.

[31] Other potential effect size measures are a standardized mean difference for comparing averages of numerical variables or an odds ratio for proportions of nominal variables.

[32] Where values of $r \pm 0.1$ indicate a small effect size, $r \pm 0.3$ a medium effect size and values of r exceeding ± 0.5 indicate a rather large effect size (Cohen, 1988, p. 79).

In a second step, the collected effect sizes *r* are converted to *Zr* using the Fisher transformation to cope with skewed distributions[33] (Card, 2012, p. 89). Through the transformation, effect sizes are symmetric around the population, improving the quality of combinations.

Third, *Zr* of each study is corrected to reduce biases, imperfections, and methodological errors inherent in individual studies. Thereby, more precise values for effect sizes are obtained, increasing accuracy and comparability across studies (Card, 2012, p. 129). Hunter and Schmidt (2004) suggest 'artifact corrections' in particular for unreliability[34] and poor validity[35] of measures. The corrections are expressed by value *a*, where $a = one$ reflects the absence of a bias. Corrections were performed for studies were sufficient information was provided by the authors. In addition, a uniform $a = 0.80$ artifact correction was performed similar to the approach of other scholars (e.g. Dalton et al., 2003; Read et al., 2009), without leading to different results.

In the fourth step, the Fisher transformed and corrected effect sizes *Zr* of each study are combined using weighted averages (Combs et al., 2019). Once combined, in step five, the average effect size is transformed back to *r*, which constitutes the combined effect size used going forward (Card, 2012, p. 89). This retransformation is appropriate since *Zr* is not bound by the interval ± 1. In contrast, r_c denotes a regular Pearson correlation coefficient, including the corrections performed in step three.

In step six, heterogeneity among studies is tested. Heterogeneity of effect sizes is present when "the deviation among studies does exceed the amount of expected deviation" (Card, 2012, p. 184), i.e. if differences in effect sizes among studies are larger than what can be attributed to random sampling effects. In case of heterogeneity, one can infer that "effect sizes are not all estimates of a single population value, but rather, multiple population values" (Card, 2012, p. 188). In order to test for heterogeneity, the test statistic *Hedges Q* is derived. *Q* measures the amount of heterogeneity and follows a χ^2 distribution. If *Q* is statistically significant, heterogeneity is present, i.e. the effect sizes of individual studies are part of different populations. While *Hedges Q* just indicates heterogeneity, it fails to measure its magnitude. This is captured by the measure I^2, which takes values between 0 and 1.[36] Once heterogeneity is detected, model choice, i.e. fixed versus random effects (step seven), as well as moderator and subgroup analysis, are suggested to handle group size effects (step eight).

Step seven is dedicated to applying either a random or a fixed effects model. In simple terms, a fixed effects model assumes homogeneity, where the confidence intervals of all studies overlap with a single population effect size, computed by weighting the individual study effect sizes by the sample size of the underlying dataset (Card, 2012, p. 229ff). In contrast, a random effects model incorporates unexplained heterogeneity and computes a distribution of a population effect size based on the inverse variance method for the weighting of studies. *Hedges Q* and *I* reveal a high degree of heterogeneity within our sample, leading us to rely on the random effects model. Moreover, applying a random effects model

[33] The transformation is specifically useful for studies with limited sample sizes, like those often seen in social sciences.

[34] Unreliability is present if a nonsystematic error is inherent in measurements.

[35] Insufficient measure validity occurs if the used variable does not exactly measure the intended construct, which is often the case for 'performance'.

[36] $I^2 \approx 25\%$ represents small heterogeneity, $I^2 \approx 50\%$ medium heterogeneity, and $I^2 \approx 75\%$ large heterogeneity, while $I^2 \approx 0\%$ reflects a homogenous sample (Huedo-Medina et al., 2006).

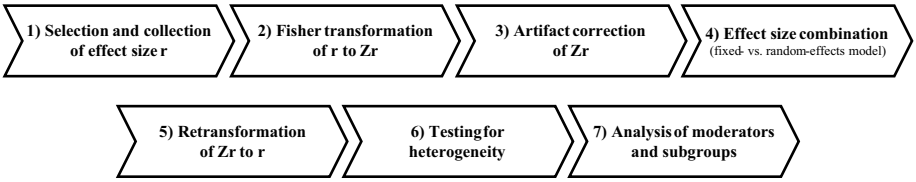

Fig. 4 Multi-step approach to statistical meta-analysis (derived from Card, 2012; Hunter & Schmidt, 1990)

allows for unconditional inferences and generalizability of findings beyond the included studies[37] (Card, 2012, p. 229ff). A fixed effects model attributes high weights to the studies of Dushnitsky and Lenox (2005, 2006), as well as Anokhin et al. (2016), leading to slightly different results.

Finally, in step eight, we perform moderator and subgroup analysis to cope with heterogeneity to identify characteristics of the studies that are associated with studies finding higher or lower effect sizes (Card, 2012, p. 198). Subgroup analyses are performed as identified in our hypothesis section, by building subgroups and then estimating the heterogeneity between the subgroups, Q_B.[38]

5 Results

Table 3 presents the results of the random effects model. It refers to the effect of CVC on performance (H1) as well as the influence of time, region, and industry (H1a–H1c). Moreover, the effect of CVC on financial (H2a) and strategic (H2b) as well as investor (H3a) and start-up (H3b) performance is evaluated.

Our main variables of interest are the combined effect size r_c, the test for statistical significance z, as well as the heterogeneity measures Q, Q_B and I^2.

The statistically significant effect coefficient for the CVC investment ($r_c = 0.094$, $p = 0.000$) in the first line suggests that CVC investment does, in general, lead to performance effects and thereby confirms our first hypotheses, H1, although the overall effect is rather small. However, as the positive and statistically significant $Q = 458.74$ shows, heterogeneity is dominating the results, with an I^2 value exceeding 90%. According to our basic framework on CVC performance, we consequently apply moderators and subgroup tests, following our set of hypothesis.

Splitting the dataset in different time periods reveals that time has a significant effect on CVC performance. The moderator analysis supports H1a with positive and statistically significant coefficients. As expected, the pre-Dotcom effect is largest with $r_c = 0.102$ ($p = 0.000$). Interestingly, the smallest effect of only $r_c = 0.088$ ($p = 0.003$) is found for studies covering both pre- and post-Dotcom investments. One out of the three post-Dotcom studies finds a negative effect of CVC investment, whereas the other two find a positive effect, making a conclusive answer impossible.

In addition, country effects matter for performance, supporting H1b. The effects for North America ($r_c = 0.103$, $p = 0.000$) and mixed ($r_c = 0.077$, $p = 0.001$) groups are positive

[37] Especially under the assumption that the included studies are representative for the overall population.

[38] Heterogeneity between and among groups is computed in line with Borenstein et al. (2021).

Table 3 Random effects model of impact of CVC investment on performance

Hypo	Moderator	k	n	r_c	95% CI	z	p_z	Q	p_Q	Q_B	p_{QB}	I^2
H1	*CVC investment → performance*	32	105,950	0.094	0.066–0.122	6.64	0.000	458.74	0.000			0.932
H1a	Time									5.64	0.060	
	Multiple	16	14,543	0.088	0.034–0.143	3.18	0.003	151.99	0.000			0.901
	Post-Dotcom	3	2609	0.090	− 0.055–0.234	1.21	0.225	22.37	0.000			0.911
	Pre-Dotcom	13	88,798	0.102	0.063–0.142	5.09	0.000	278.74	0.000			0.957
H1b	Region									95.5	0.000	
	North America	21	60,358	0.103	0.069–0.138	5.84	0.000	226.06	0.000			0.912
	Other	11	45,592	0.077	0.032–0.123	3.35	0.001	137.18	0.000			0.927
H1c	Industry									19.86	0.000	
	ICT	10	8520	0.095	0.020–0.169	2.49	0.013	71.22	0.000			0.874
	Health care	5	7036	0.070	− 0.012–0.151	1.68	0.094	31.71	0.000			0.874
	Multiple	17	90,394	0.101	0.065–0.137	5.52	0.000	335.95	0.000			0.952
H2	*CVC investment → financial vs. strategic performance*									65.16	0.000	
H2a	Financial	10	36,703	0.054	− 0.011–0.118	1.63	0.103	165.17	0.000			0.946
H2b	Strategic	22	69,247	0.109	0.078–0.139	6.96	0.000	228.40	0.000			0.908
H3	*CVC investment → investor vs. start-up performance*									128.5	0.000	
H3a	Investor	17	67,603	0.107	0.071–0.144	5.82	0.000	214.14	0.000			0.925
H3b	Start-up	15	38,347	0.080	0.041–0.119	4.00	0.000	116.15	0.000			0.879

k number of studies, *n* accumulated sample size, r_c reliability corrected effect size, *CI* confidence interval, *z-value* z-value of Wald test for statistical significance of mean effect size, *Q* total Hedge's Q for heterogeneity, Q_B Hedge's Q for between group heterogeneity based on inverse variance method, I^2 I^2 Index for total heterogeneity

and statistically significant, revealing heterogeneity between the two moderator variables ($Q_B = 95.5$, $p = 0.000$).

The results also support H1c. CVC performance is shaped by industry effects, in particular in the ICT sector ($r_c = 0.095$, $p = 0.013$) and when multiple industries are considered ($r_c = 0.101$, $p = 0.000$). Surprisingly the singular effect of the health care industry does not seem to shape performance. As before, heterogeneity within the three included industries (with values of I^2 above 85%) and between the three subgroups, as shown by $Q_B = 19.86$ is large.

H2 breaks down performance into financial (H2a) and strategic (H2b) parts. The coefficient for financial performance ($r_c = 0.054$, $p = 0.103$) is not statistically significantly different from zero—indicating that CVC investment does not increase financial performance. For strategic performance the coefficient ($r_c = 0.109$, $p = 0.000$) is statistically significant different from zero. Interestingly, while the studies measuring either financial or strategic performance are rather heterogeneous, the heterogeneity between both performance measures is (statistically) negligible. Our results corroborate our hypothesis H2 that CVC investment positively shapes strategic performance outcomes (H2b) but not necessarily financial performance (H2a).

Finally, CVC performance matters for both the investor and the start-up companies. We thus split the studies into the two subgroups according to hypotheses H3a (investors) and H3b (start-ups). The results clearly show that CVC investment pays for both the investors ($r_c = 0.107$, $p = 0.000$) and the start-ups ($r_c = 0.080$, $p = 0.000$), thus supporting both hypotheses.

6 Discussion and contribution

This meta-analysis focuses on the performance effects of CVC investments and the moderating effects of time, country, and industries. Our main finding shows that CVC investment pays and thus corroborates that start-ups provide expertise to gain a specific strategic advantage (Bertoni et al., 2013; Bock et al., 2018; Christofidis & Debande, 2001; Colombo & Murtinu, 2017; Gompers & Lerner, 1998). While we find positive and statistically significant performance effects for most of our moderator and subgroup analyses, our meta-analysis could not find any statistically significant evidence that CVC investment leads to stronger financial performance. This finding may indicate that CVC investment serves as a promising tool in strategic management to spur strategic performance (Radcliffe & Lehot, 2018) and thus differs from traditional VC investment, which is mainly concerned on short or medium term financial performance. Our study thus contributes to the literature on corporate entrepreneurship arguing that CVC investment is an important vehicle for large and established corporations to regain competitive and strategic advantage (Block et al., 2018; Foss & Lyngsie, 2014; Souitaris & Zerbinati, 2014).

A second contribution of our analysis is that CVC investment leads to a win–win effect for both the corporation and the selected start-ups (Alvarez-Garrido & Dushnitsky, 2016; Anokhin et al., 2016; Chemmanur et al., 2014). Our results could not confirm that CVCs in general behave like "sharks" with adverse performance effects on start-ups (Katila et al., 2008) or that CVC programs are value destroyers in general (Allen & Hevert, 2007, p. 273). CVC investment in start-ups could be described at first glance as an archetypical example for a bilateral 'partnership-specific investment relationship' where hold-ups are prone and ex-post bargaining may lead to value destroying results (see Williamson, 1985).

The results of this meta-analysis, in contrast, corroborate the view that larger established firms and start-ups organize their relationships as an entrepreneurial division of labor that pertains not only to the recognition of opportunities, but also to the evaluation and exploitation of opportunities and allocates these behaviors for both the investor's organizational architecture and the start-up (Foss, 2015, p. 15). The meta-analytical results may thus contribute to stimulate further research on how established firms organize and coordinate the 'entrepreneurial division of labor' and how and why CVCs serve as a vehicle within this process, as proposed by Foss (2015).

Our third contribution is that CVC investment performance is shaped by moderator effects, in particular time, country and industry. Most studies are based on datasets including the pre-Dotcom era. During that time, CVC investment was seen as a promising vehicle to improve performance (Christofidis & Debande, 2001). In studies combining pre- and post-Dotcom data the effect on performance is statistically positive, even when these results are mainly driven by the post-Dotcom era. The 'roaring 1990s', the era of the booming start-up scene, in particular in the U.S., with the exploding stock-markets in the high-technology sectors, had spurred CVC investment performance during that time. Only three studies cover the post-Dotcom era, namely those of Alvarez-Garrido and Dushnitsky (2016), Belderbos et al. (2018) and Di Lorenzo and Sofka (2017), focus in particular on this time period, with a rather small sample of observations. This puts some doubt on the positive performance effects of CVC investments, since most of the results are then driven by the pre-Dotcom era, an era characterized by a large amount of exaggeration on the future promise of high-tech start-ups, not only by equity investors but also by stock markets. Positive results of CVC investments from this literature should be interpreted more carefully and in the context of this time period. Otherwise, the small sample of studies in the post-Dotcom era calls for more empirical work in the more recent periods.

Even when CVC investment is labelled a worldwide phenomenon (CBInsights, 2019; PwC & CBInsights, 2019) the U.S. still remains the leading market with the longest history (Christofidis & Debande, 2001) and the highest frequency of CVC investments (Harrison & Fitza, 2014). Moreover, access to data on CVC investment is easier for the U.S., in particular firm data. To complete the picture on CVC investment performance additional evidence for countries besides the U.S. is necessary (Audretsch & Caiazza, 2016). Only then can different contexts like fiscal regulations, stock market liquidity, taxes or even cultural factors (Audretsch et al., 2014; Christofidis & Debande, 2001) be analyzed and discussed as drivers of CVC investments.

Finally, but not surprising, results differ by industries. Many empirical studies follow the quantity of CVC investments and focus on the ICT sector. The results reveal a positive effect on CVC performance. One explanation is that the absorption of knowledge, ideas, technologies, new applications or skills is associated with lower risk and costs compared to other sectors like the health care sector. Large CVC owners, like Apple, Microsoft, or Intel, possess sufficient absorptive capacity in the ICT sector that enables them to select the most promising start-ups, to support them to further develop and commercialize their ideas, leading to a win–win relationship for both companies. However, the industry effects may be overestimated since the Dotcom era is mainly dominated by the ICT sector, where deregulation and new technologies created a window of opportunity for start-ups and the internet and digitization booms increased the importance of CVCs (Christofidis & Debande, 2001). Several studies focus either on a mixed sample of industries, including the ICT sector, or the health care sector. The results of our meta-analysis could not find any statistically significant performance effects from CVC investment in health care. In contrast to the ICT sector, the adoption and

absorption of new technologies or applications is associated with higher costs and risks. Path-breaking developments in this sector are the results by chance and/or a trial and error process swallowing up large amounts of spending in R&D, where CVC investment is only a small part of it. In addition, CVC investment in the health care sector follows a long-term strategy, where performance lies, if at all, in the future.

Although a meta-analysis offers new insights, limitations also emerge. Like every empirical study, the quality of the results is driven by the quality of the data—in this case the studies included. In restricting this analysis only to studies published in peer reviewed academic journals, we try to reduce the 'quality biases'. However, this comes at the cost of a publication bias in that only published results are included and academic journals may favor studies with positive results. Albeit CVC investment is an increasing and promising topic in business, management and academia, there is only a small amount of empirical studies available. The total number of 32 studies, even though technically large enough to run meta-analytical estimations, reduces the explanation power of the results. Otherwise, large samples are associated with a lower risk that findings randomly deviate from the population-level relationship and statistical tests will let researchers claim statistically significant effects (Combs et al., 2019, p. 3). This rather small sample of included studies shows a large amount of heterogeneity across and within the moderating groups (especially region), and also the performance measures (strategic vs. financial) and the objects (CVC investor vs. start-up). This, of course, calls for future research analyzing CVC investments in the pre-Dotcom era, in countries others than the U.S. and in different industries and sectors. Future research should also consider more detailed moderators, for example including strategic and organizational aspects of CVC units or portfolio diversification (Yang et al., 2014). Finally, future research should further sharpen and differentiate the definition of performance, e.g. through further differentiating strategic performance in patent citations, product introductions, market access or measures of financial performance.

7 Summary and conclusion

CVC is a well-established form of corporate venturing. Due to its long history, positive performance effects are expected. Nonetheless, CVC investments come with benefits and disadvantages for the involved parties, making performance implications questionable. Literature yields contradicting results, thereby opening the avenue for a meta-analytical approach to conclusively determine the performance effects of CVCs.

Using 105,950 observations from 32 different studies we find that CVC investments are performance enhancing, for both corporations and start-ups. Our results detect that time, country, and industry moderate the effects. Especially after the Dotcom bubble burst, high performance is detected. Similarly, the performance in the U.S. outreaches the performance of other countries. Due to the high risk of successfully developing a pharmaceutical drug, no statistically significant effect of CVC investments in the health care industry is observed. As expected, strategic performance outperforms financial impacts. Although there is good rationale for a clear strategic focus, the finding that CVC investment does not lead to stronger financial performance is surprising and urges practitioners to rethink their CVC objectives and approach.

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Declarations

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