The Implications of the Structural Choice of CVC Units on the Incumbent's Innovativeness

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Abstract

By highlighting the importance of the relationship between incumbents and venture firms for the generation of economic rents, we explore the often-disregarded aspect of the structural setup of corporate venture capital (CVC) programs and their influence on the investor’s knowledge creation. We examine the relationship of the corporation with venture firms in the rent-generation process to answer our research question on how the structural choice of CVC units influences the degree of innovativeness of incumbents. To do so, we abstract the totality of structural characteristics into two distinct legal forms, namely internal and external CVC units. We empirically investigate their association with their parent organizations’ level of knowledge creation by developing a model for the relational rent-generation for CVC activities. A quantitative analysis of 477 global CVC units with data from 1985 to 2015 does not find evidence on superiority of one specific structural mode but reveals that the investment experience significantly moderates the relationship between unit structure and innovativeness. Our mixed results emphasize the complexity of the structural design of CVC programs by highlighting shortcomings of the employed categorization based on the legal structure and thus unveils the need for future research for a better understanding of the underlying dynamics.

Keywords

Corporate venture capital; organizational design; innovation performance; relational view; organizational structure; external knowledge sourcing

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Abbreviations

CVC	-	Corporate Venture Capital
gof	-	Goodness of Fit
IRR	-	Incidence Rate Ratio
IVC	-	Institutional Venture Capital
LP	-	Limited Partner
M&A	-	Mergers and Acquisition
SIC	-	Standard Industrial Classification
VC	-	Venture Capital
PE	-	Private Equity
R&D	-	Research and Development

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1 Introduction

Although corporations' involvement in growing entrepreneurial ventures has already occurred since the early 1960s, it has been highly vulnerable to economic upturns and downturns like the dotcom bubble and the financial crisis (CB Insights, 2019). In recent years, the phenomenon of corporate venture capital (CVC) has increasingly raised economic awareness and obtains high importance in the corporate environment, showing in a constantly growing share of CVC in total venture capital (VC) investments (CB Insights, 2019). The 2018 Global CVC Report displays that incumbents such as *Intel*, *Salesforce* or *General Electric* from various industries pursue investments in promising new ideas to increase their innovativeness with deal sizes largely exceeding the ones of institutional VC (IVC) funds (CB Insights, 2019). Since 2013, the total investments of corporate investors experienced a more than five-fold increase to a total of $57.1 billion in over 3,234 deals worldwide in 2019 (CB Insights, 2020). The $1.25 billion Series D round in satellite communications company *OneWeb* backed by *Airbus* and *Qualcomm Ventures* constitutes the most prominent investment of 2019 (CB Insights, 2020). It reflects the current peak of growing deal volumes in the aspiration to assimilate disruptive knowledge and thereby remain competitive in a fast-changing environment (March, 1991; Wadhwa & Kotha, 2006).

The organizations' dependency on constantly creating new and rearranging existing knowledge in the effort to achieve a sustainable competitive advantage has been widely discussed in the literature (Dodgson, 1993). Traditionally, corporations focused mostly on internal research and development (R&D), however, the importance of external knowledge sources such as CVC has increasingly been recognized to facilitate innovativeness (Cohen & Levinthal, 1990). Nowadays corporations widely use CVC as an opportunity to learn from venture firms and it has become "*an integral part of a firm's innovation toolkit"* (p. 8), as also indicated by the significant increase in the programs' durability (Dushnitsky, 2012). However, while some scholars highlight the CVC units' strategic importance for organizations (Dushnitsky & Lenox, 2006), others denote them as *"value destroyers"* (Allen & Hevert, 2007, p. 273). Such controversial opinions remark the complexity of the phenomenon and raise the necessity to further research the underlying relationships between CVC and its value creation potential for the parent corporation.

The growing reliance on CVC for essential knowledge creation involves important considerations on how to optimally integrate the program into the organization (Asel, Park, and Velamuri, 2015). Previous research has comprehensively emphasized how the different objectives of the corporations that seek involvement in venture firms shape the arrangement of CVC programs (Chesbrough, 2002; Siegel, Siegel, & Macmillan, 1988; Winters & Murfin, 1988). Further attention has been directed towards the pursued investment strategy and the associated uncertainty with focus on the degree of technological diversification and the venture's stage of development at the time of the investment (e.g., Wadhwa & Basu, 2013; Wadhwa, Phelps, & Kotha, 2016; Yang, Narayanan, & de Carolis, 2014; Yang, Narayanan, & Zahra, 2009). Fewer, however equally important, contributions have been developed on the CVC program's structural form, particularly on the characteristics and differences among varying setups (e.g., Asel *et al.*, 2015; Dushnitsky, 2012; Hill, Maula, Birkinshaw, & Murray, 2009; Siegel *et al.*, 1988).

As incumbent firms continue to implement CVC as an *"innovation vehicle"* (p. 8) in their corporate framework, the programs' structure and subsequent implications on the innovativeness of the corporation among others become increasingly relevant in both academia as well as practice (Dushnitsky, 2012). The Boston Consulting Group emphasizes that *"corporate leaders need to ensure that the organization is set up to embrace innovation and collaborate across functional boundaries to extract the full value of new technologies and knowledge"* (Bielesch, Brigl, Khanna, Roos, & Schmieg, 2012, p. 14). The essence of the question on the optimal structural setup of CVC programs for the innovation success and resulting competitiveness of incumbents induced us to further research this aspect.

CVC activities can be pursued in several different forms, such as by establishing a wholly owned subsidiary, setting up an independent investment fund, or investing directly from the balance sheet of the parent organization (Dushnitsky, 2012). The occurrence of these legally and structurally different modes therefore raises an important question for managers: *Which structure is most advantageous when establishing a CVC program?* Several scholars have attempted to identify and analyze the different structural setups of CVC units (Asel *et al.*, 2015; Dushnitsky & Shapira, 2010; Siegel *et al.*, 1988; Winters & Murfin, 1988). However, the literature on this topic is incomplete for two reasons. First, most studies capture the individual characteristics of the distinct CVC modes rather than the modes themselves. For instance, Dushnitsky and Shapira (2010) investigate the varying personnel decisions and performance schemes, whereas Siegel *et al.* (1988) analyze implications of a diverging degree of autonomy. This offers no opportunity for evaluating on one preferential structural setup. Second, existing studies concentrate on survey-based qualitative research approaches, thus raising risk for biases and restricting their studies to small data sets. To the best of our knowledge, no study exists that abstracts the totality of structural characteristics into two distinct legal forms, namely internal and external CVC units, and empirically investigates their association with their parent organizations' level of knowledge creation. This identified gap in research is especially surprising when considering manifested implications from the organizational design literature, which highlight the link of structural aspects to the ability of a firm to continuously drive economical change and innovativeness that generate a sustainable competitive advantage (Gibson & Birkinshaw, 2004; March, 1991).

This thesis seeks to address this gap by investigating the implications of the structural setup of a CVC unit on the organization's innovation performance. To do so, we will study the phenomenon of CVC and its different modes through the lens of the relational view (Dyer & Singh, 1998), which enables us to understand the rent-generation from CVC activities that result in a competitive advantage. Based on this analysis, we will attempt to provide an indication for a potential superiority of one structural form. Additionally, the related aspects of CVC experience and uncertainty are considered in order to elaborate on a potential interrelatedness. We will develop a conceptual framework and derive three distinct hypotheses, which will be tested empirically to answer the following research question:

How does the structural choice of CVC units influence the degree of innovativeness of incumbents?

To address our research question, we choose a quantitative approach with a data sample of 477 CVC units[1] that made at least one minority equity investment in the period from 1985 to 2015. Using a cross-sectional analysis allows us to investigate the incidence of a relationship between the CVC unit's structure and the level of the parent firm's innovativeness, assuming stable conditions over time. In our analysis, we specifically investigate whether an external structure can be associated with a higher level of patents relative to an internal structure. Additionally, we focus on the investment experience and

1 The raw data set consisted of 1,433 unique CVC programs but was subject to a number of iterations, resulting in the final set of 477 CVC units. This data collection process will be explained in more detail in the methodology section.

uncertainty of the CVC units, two factors shown to influence innovativeness in connection with CVC (Yang *et al.*, 2009), and potential interaction effects with the structural setup.

Based on an extensive review of existing literature, we derive considerable differences in character traits of internal and external CVC units. The results of our empirical model, however, show no significant superiority of any of the two structures but reveal an interaction effect between the experience of CVC programs and their structure. We derive explanations for our findings from the concepts of organizational learning and the relational view. Therefore, this thesis offers a first attempt to point out the importance of structural aspects in the decision-making process for organizations configuring CVC programs. We further contribute to existing CVC literature by highlighting the complexity of structural differences as there is no "black and white" in the organizational design of CVC units.

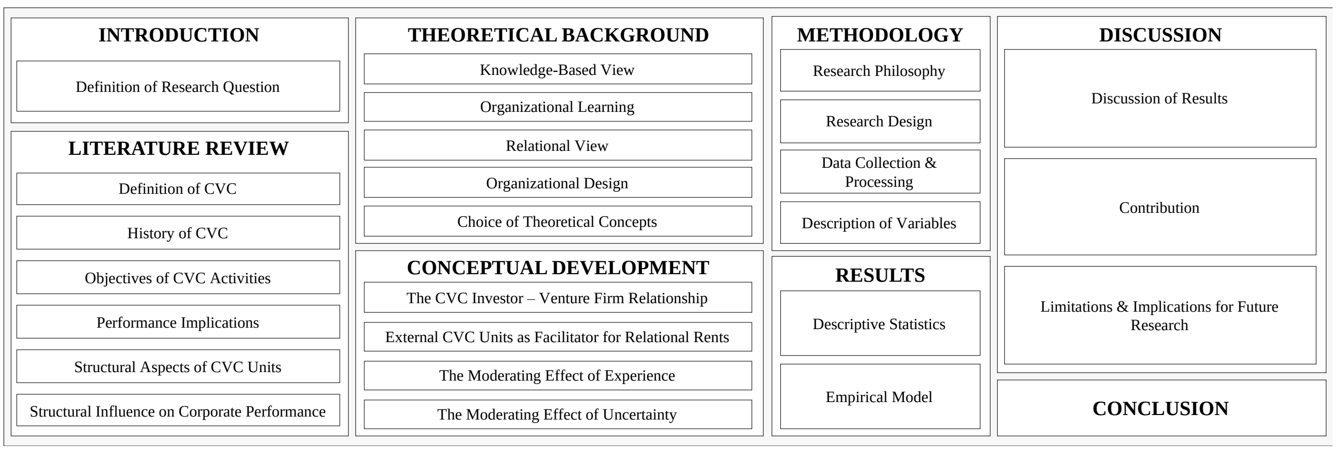

Figure 1 *Structure of this thesis*

To answer our main research question, this thesis is divided into eight chapters (*Figure 1*). The structure of this work is as follows: After the introduction, chapter two provides an extensive overview of existing literature on the phenomenon of CVC. We will start with an outline on a clear definition of CVC. Further, we will review existing streams of literature on CVC objectives, structural aspects, and performance. The chapter will end with a presentation of the limited existing research on the impact of structural aspects on the performance of incumbent firms to point out the existing research gap. Subsequently, we will introduce the applied theoretical concepts in chapter three. In chapter four, we will connect the introduced concepts based on the existing literature to develop a theoretical framework for our research question. To entangle the complex context, we will split the section in parts, leading to our three main hypotheses. First, we investigate the initial influence of internal and external structures on firm innovativeness. We will then continue with an elaboration on the potential interaction effects of CVC program structure with experience and uncertainty. Thereafter, we will introduce our research approach including the empirical model and relevant variables. Chapter six is devoted to presenting our descriptive and empirical results. The results will be discussed and put into perspective in chapter seven. We will also use the opportunity to reflect on the limitations of our research and suggest opportunities for future research, before concluding with final remarks on the contributions of this work in chapter eight.

2 Literature Review

2.1 Definition of CVC

The term CVC has by now been defined in several dimensions and even though delimitations and characteristics have been interpreted differently, CVC broadly concerns the involvement of corporate investments in independent start-ups in exchange for equity stakes (Chesbrough, 2002; Dushnitsky, 2012; Keil, 2000). However, we believe that this interpretation does not fulfill the multifaceted requirements of this work and CVC shall thus be defined not only in more detail but also in the context of corporations' venturing activities in general. We will start with a review of existing literature on the definition of CVC and will then elaborate on the differences of the distinct corporate venturing modes.

Gompers and Lerner (2000) relate CVC directly to IVC and the participation of the corporation in the private equity (PE) market. Accordingly, Keil (2000) defines CVC activities as corporate programs that *"provide funding and related services to entrepreneurial firms in return for an equity stake"* (p. 11). Chesbrough (2002) additionally points out that investments need to be external as well as without third party intervention (such as through third-party managed funds) to be categorized as CVC. The author therefore also excludes all externally managed funds that are established for the sole purpose of investing for one particular corporation. Röhm (2019) relaxes this definition by including externally managed funds where the corporation is the sole limited partner (LP). More agreement prevails on the exclusion of funding of internal programs as well as investments in external ventures by financial institutions (Chesbrough, 2002; Dushnitsky & Tucci, 2004). Further, existing literature has well recognized that a strategic focus, besides the financial goal of IVC, is an essential part of CVC (Chesbrough, 2002; Dushnitsky, 2012; Dushnitsky & Tucci, 2004). Building on the definitions of Gompers and Lerner (2000), Keil (2000), and Chesbrough (2002), Dushnitsky (2012) develops three main defining characteristics of CVC: a strategic objective next to financial goals, legal independence and private ownership of the ventures, and finally the transfer of a minority equity stake. Based on these characteristics, he defines a CVC activity as a *"minority investment by an established corporation in a privately held entrepreneurial venture"* (Dushnitsky, 2012, p.2). We consider this definition as most complete and will therefore use it for further assumptions and considerations throughout this work.

After defining the term CVC, the focus now lies on evaluating the context of corporate venturing and related venturing modes, in order to reflect on the framework of CVC. CVC is interpreted as a specific mode of the broader term external corporate venturing which itself is a subcategory of corporate venturing (Keil, 2000). *Figure 2* depicts the various corporate venturing modes of an organization.

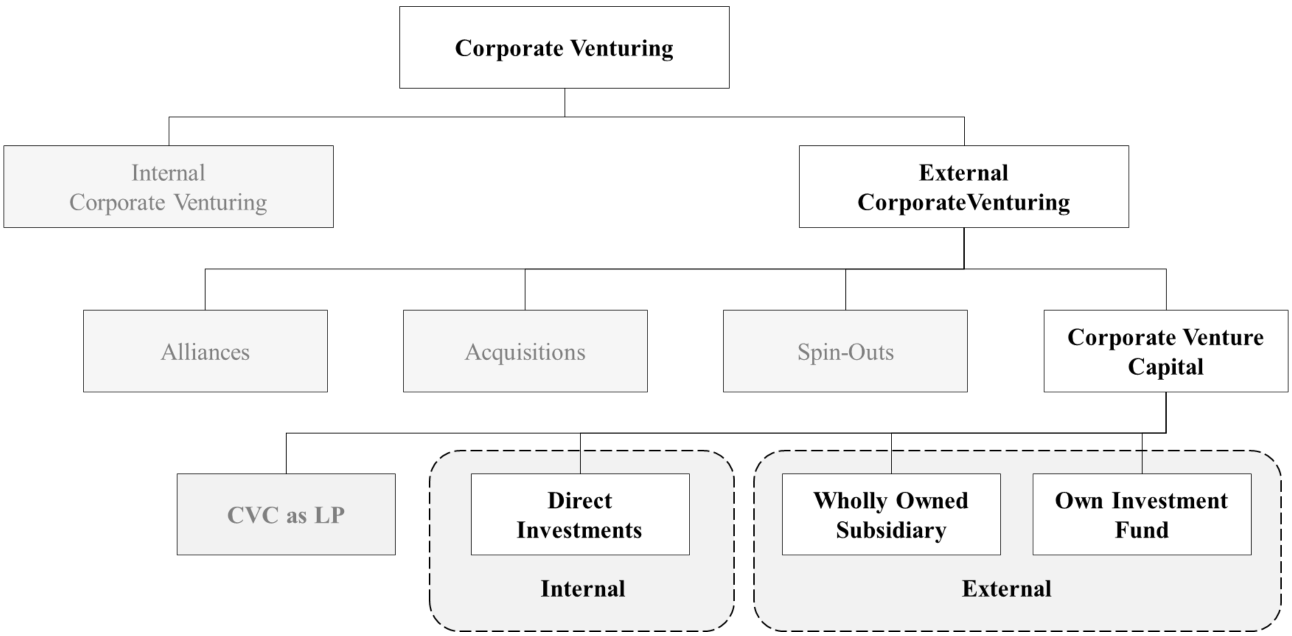

Figure 2 *Modes of external corporate venturing (adapted from Keil, 2000)*

Corporate venturing refers to the *"overall activity of building new businesses in an established organization"* (Keil, 2000, p. 9). It represents both internal and external activities. Internal corporate venturing[2] activities refer to programs where the company develops new businesses within its existing organizational structures, whereas external activities seek opportunities to support the creation of independently acting new businesses outside of the corporation (Sharma & Chrisman, 2007). External programs, known as external corporate venturing, can be divided in four different forms: alliances, acquisitions, spin-outs, and CVC (Keil, 2000). While they share several characteristics, it is important to note that they cannot be used synonymously.

[2] Due to the limited scope of this thesis, we do not further elaborate on the different modes of internal corporate venturing activities. An extensive overview of these modes can be found in Keil (2000).

According to Dushnitsky (2012), alliances refer to relationships between two or more companies that follow a common objective, include capital commitments and potentially involve equity. The main focus of such collaborations is not a capital infusion but rather a knowledge-exchange between associated parties (Dushnitsky, 2012). The author further elaborates that acquisitions depict the complete takeover of one company by another, which usually results in the integration of the acquired firm into the existing corporation. With an acquisition, a corporation seeks to take over full control, which is not the case with CVC activities. Spin-outs are independent ventures developed and founded by individuals that have previously worked in corporations acting in the same or closely related industries of the corporation. However, spin-outs differ tremendously from CVC. Even though both are built on the relationship between the corporation and the start-up, spin-outs constitute a *"corporate outflow"*, while CVC aims for a *"corporate inflow"* (Dushnitsky, 2012, p. 4).

Concluding, based on the introduced literature, we rely on Dushnitsky (2012) for the following definition: CVC is an external venturing activity of an organization that refers to minority equity investments in privately held venture companies that seek to pursue a strategic objective. This definition shall apply for the remainder of this thesis.

2.2 History of CVC

The history of CVC can be divided into four waves representing the cyclical structure of corporate investments (Dushnitsky, 2012). These contrasting waves reflect the diversity and extensive development of CVC throughout the years and will thus be illustrated in the following.

The first CVC wave started in the early 1960s with large international conglomerates tapping into the venturing world. CVC activities focused almost exclusively on the United States (CB Insights, 2018). Pioneers such as *DuPont* or *Exxon* started funding young firms seeking to enter the market with innovative ideas (CB Insights, 2018). Scholars identify three major motivations for venture investments in the first wave of CVC: a general diversification trend of large conglomerates, large amounts of slack at the corporations' disposal that needed to be used effectively, and the emerging success of the first IVC funds (Gompers & Lerner, 1998). The pioneering companies were not primarily looking for new technologies outside their firm borders but rather for new markets or financial returns (CB Insights, 2018). As Gompers (2002) notices, conglomerates used both internal and external investment opportunities rather than limiting themselves to one form of access to new technologies and markets. Furthermore, the companies chose different modes to achieve desired outcomes; some investments were made directly from the balance sheet, some through independent venture funds, and a limited number of corporations established dedicated venture units (Gompers, 2002). The ending of the first wave was initiated by a sudden breakdown of the IPO market in 1973 and consecutive lower returns from venture investments (CB Insights, 2018). Additionally, macroeconomic factors such as the oil shock eliminated corporations' excess cash flows thus leading to the decision to terminate venturing efforts (Dushnitsky, 2012).

The second wave emerged during the first years of the 1980s and had its main market again in the United States (CB Insights, 2018). The reasons for the recurrent increase of corporations' participation in the private equity market can be narrowed down to two main factors (Gompers, 2002). The first factor were regulatory changes, such as allowing pension funds to invest into more risky venture firms and decreasing the top tax rate on capital gains, the second factor was the rise of the technology sector and computers in particular (Gompers, 2002). The new focus on breakthrough technologies in different sectors made venture investments more favorable and created a hype about entrepreneurship (Gompers, 2002). For the years following, CVC investments increased in importance in the overall venturing market and reflected with an investment pool of $2 billion roughly 12% of the total VC funding in 1986 (Gompers & Lerner, 1998). However, this rise came to a sudden stop in the late 1980s, when the economy experienced a severe crash and both independent and corporate investments deteriorated (CB Insights, 2018).

The third wave arose during the mid-1990s, when the Internet introduced a new hype making corporations increase their venturing activities again (Dushnitsky, 2012). This was mainly due to the opportunities deriving from the spreading of the Internet across industries and the firms' reasonable concerns that internal resources would not be sufficient to make use of new technologies and innovations (Dushnitsky, 2012). While during earlier waves mainly corporations in R&D-intense industries such as pharmaceuticals pursued external venturing opportunities, now also media and service corporations entered the VC markets (Gompers & Lerner, 2001). The target ventures during this phase, usually Internet- or technology-based, heavily relied on funding from independent or corporate venture capitalists and were highly valued even though no revenues were generated. The high valuations of start-up companies ultimately led to the burst of the so-called dotcom bubble, causing many technology firms to file for bankruptcy and stocks in public markets to decline by more than 50% in one day. Conclusively, many CVC programs had to be terminated (CB Insights, 2018). Again, CVC followed economic ups and downs (Dushnitsky, 2012). After this third major decline in investment amounts and frequency, scholars started to pay closer attention to the data CVC offered. Compared to independent venture capitalists, corporate investors on average invested less often (1.76 versus 5.75 investments per year) and spent more per investment (Gompers & Lerner, 2004).

The fourth wave started in the early 2000s, when public markets recovered, and venture investments started another sharp increase (Dushnitsky, 2012). In many ways, this wave resembled the former cycles in moving with the economy, as the financial crisis in 2008/2009 resulted in a decline of investments (CB Insights, 2018). Furthermore, the investment focus remained on internet-based ventures as well as on the traditional target industries, such as pharmaceutical, biotechnology, and semiconductors.

Observations of the CVC investing waves show the highly cyclical character of CVC (Dushnitsky, 2012). As Dushnitsky (2012) states, investment patterns of corporations in venturing firms depend on the general state of the firm's industry as well as other macroeconomic factors such as changes in regulations. It also shows that CVC is more volatile than IVC, indicating that in turbulent times venture investments do not obtain highest priority from the corporations (Gompers & Lerner, 1998). However, as Dushnitsky (2012) points out, the current wave also shows an incremental change. While corporations formerly did not fully commit to their venturing investments and CVC was simply seen as a supporting tool for internal R&D, in this current wave corporations acknowledge CVC as an integrated part of the corporate development and strategic innovation strategy (Chesbrough & Tucci, 2004; Dushnitsky, 2012). This structural change is supported by a bigger life span of individual corporate venturing programs, indicating a more sustained commitment towards the investments (Dushnitsky, 2012). Start-ups reflect the most innovative knowledge pools which corporations seek to engage with and learn from through the commitment of both financial means and time (Dushnitsky, 2012).

Concluding, the observable stronger connection of internal R&D and external knowledge gathering through corporate venturing in the currently ongoing, fourth phase of CVC development has significantly changed the way firms, traditional VCs, and scholars view CVC (Dushnitsky, 2012). In the following, we will elaborate on the current field of CVC research regarding the performance implications as well as structural differences and comparisons to IVC funds to establish a knowledge base that builds the fundament for our work going forward.

2.3 Objectives of CVC Activities

Several researchers have focused on analyzing the objectives that corporations seek to pursue when establishing CVC units. As per definition, CVC is a form of VC, where corporations actively participate in the PE market (Keil, 2000). This gives reason to assume that, similar to IVC, investing corporations aim for positive financial returns (Keil, 2000). Whereas the financial objective can be clearly defined and generally relates to returns on investments, there is a larger scope of potential strategic objectives a corporation might choose to pursue (Chesbrough, 2002). It has been assessed that corporations are required to position themselves competitively in their target market in order to achieve sustainable profits (Schumpeter, 2013). As Dushnitsky and Lenox (2005a) summarize, a competitive advantage is achieved through innovation, a task that is often associated with start-up companies rather than well-established corporations. Corporate venturing in its different forms is thus often used as a vehicle for corporations to overcome potential innovation obstacles in the corporate setup through the combination of internal resources and externally acquired knowledge (Dushnitsky & Lenox, 2005a). Siegel *et al.* (1988) conduct a survey-based study to analyze the primary objectives of corporations entering the VC market. While *financial return* had the highest average rating, a large variance in the responses indicates a mixed view of corporate venture capitalists on financial objectives (Siegel *et al.*, 1988). Among the strategic objectives the *exposure to new technologies and markets* ranked highest, followed by the *potential to manufacture or market new products*, the *potential to acquire companies*, and the *potential to improve manufacturing processes* (Siegel *et al.*, 1988). The results underline the strategic objective to externally acquire knowledge and add value to the corporation that exceeds direct monetary returns, which has also been confirmed by later studies (Dushnitsky & Lenox, 2005a; Keil, Autio, & George, 2008).

In an early trend analysis, Winters and Murfin (1988) similarly find that corporations participate in VC markets for either financial returns or corporate development. For the latter, the authors name the window to technology, potential acquisitions following the initial investment, and technology licenses as the most important benefits. This underlines the objective of external knowledge generation for improved innovativeness as a main theme for CVC units (Winters & Murfin, 1988). The results further highlight the impact of a clearly defined set of objectives on the setup and the success of a CVC unit. Similarly, Gompers and Lerner (2000) show that clear expectations of outcomes need to be defined when setting up the CVC program due to general incompatibilities of financial and strategic objectives. According to Winters and Murfin (1988), CVC programs main task is to establish an additional channel in the corporation's innovation strategy. However, they also acknowledge that even though a strategic objective builds the unit's focus, some positive financial return is still expected. In this sense, CVC units compete with IVC funds, but are willing to accept lower returns in exchange for strategic benefits (Winters & Murfin, 1988; Chesbrough, 2002).

Chesbrough (2002) establishes an even clearer distinction and elaborates on the two defined fundamental objectives. According to the author, strategically driven CVC units also pursue at least some goal of positive financial returns, even if the requirements are low in anticipation of additional learning and a corporate development effect. Some financially driven CVC units do not expect strategic effects and are evaluated in reference to IVC (Chesbrough, 2002). However, corporations seem to forecast higher financial returns due to superior experience in relevant industries and technologies (Chesbrough, 2002).

Dushnitsky and Lenox (2005a) suggest that CVC is mainly seen as an access point to an external pool of knowledge. The authors explain the effect of the obtained external knowledge in two different ways. Firstly, the corporation accelerates organizational learning and secondly, it gains a window to emerging technologies (Dushnitsky & Lenox, 2005a). Organizational learning can entail an increase in the firm's absorptive capacity, the adaption of the start-ups' culture and innovativeness, or the generation of insights from investing processes and potential failures (Dushnitsky & Lenox, 2005a; Schildt, Maula, and Keil, 2005). Dushnitsky and Lenox (2005a) find a positive association between organizational learning through CVC, specifically absorptive capacity, and the level of innovativeness, which consequentially leads to an increased chance of establishing a competitive advantage. In addition, Keil and his colleagues (2008) define such organizational learning as "*disembodied experimentation*" (p. 1475) where well-established corporations learn about required capabilities through participation in new (start-up) environments and trends. An important fact of acquiring stakes in new ventures and actively participating in new processes, for example through board seats, is that corporate representatives are *"freed from the constraining influence of established cognitive frameworks and dominant logics within the parent* *corporation"* (Keil *et al.*, 2008, p.1485), which enables them to acquire the actual capabilities necessary to improve innovativeness (Dushnitsky & Lenox, 2005a). The findings indicate that the acquisition of innovation capabilities and experience in innovative environments is a major objective for corporate investors (Keil *et al.*, 2008). CVC is therefore a potential source of knowledge to overcome corporations' innovation obstacles (Dushnitsky & Lenox, 2005a).

So far, scholars have mostly focused on using external knowledge as a window to new technologies (Benson & Ziedonis, 2009; Dushnitsky & Lenox, 2006; Siegel *et al.*, 1988). Corporations investing in related industries expect to be actively exposed to novel products or complements to their existing product portfolio in order to either form synergies with the new ventures or use the channel as an alert mechanism to be prepared for demand changes (Chesbrough, 2002; Maula, Keil, and Zahra, 2013). Dushnitsky and Lenox (2005a) find that the level of CVC activity is positively associated with the number of issued patents. Thus, corporations conducting CVC were able to use technologies or products brought to them by new ventures for internal R&D purposes and the generation of patents (Dushnitsky & Lenox, 2005a). Building on this finding, Smith and Shah (2013) show that the technology accessed through minority equity stakes in ventures in the medical devices industry is used as input for further internal R&D processes. Dushnitsky and Lavie (2010) further complement this research stream by investigating the interrelatedness of CVC investments and alliance formation. They find an inverted U-shaped relation, indicating that CVC investment first increases with more alliance formation but then diminishes with the increasing number of alliance formations. Additionally, they find that investments in internal resource stocks and CVC experience lead to a diminishing effect of the presented relationship (Dushnitsky & Lavie, 2010).

Souitaris and Zerbinati (2014) further highlight the emergence of exposure to new technologies in their case studies with six corporate venturing units. They show that one strategic objective is to *"see technology before technology actually happens"* (Souitaris & Zerbinati, 2014, p. 330) in order to make use of it before competitors can. Dushnitsky and Lenox (2006) add the use of corporate venturing as a scanning mechanism for novel technologies and complementarities between the ventures and the investing firm as an additional corporate objective. Such cmplementarities have been researched in more detail by Brandenburger and Nalebuff (2011) who find that firms may be able to create additional demand of their existing product portfolio by investing in ventures offering complementary products.

Summarizing the existing body of literature on the objectives of CVC activities, CVC units either follow financial or strategic objectives (Chesbrough, 2002). The strategic focus is thereby of higher importance and distinguishes CVC from IVC (Dushnitsky, 2012). On the strategic level, the overall aim is to overcome potential obstacles of established corporations to innovate and constitute a competitive advantage (Maula *et al.*, 2013). This goal can be achieved in two different ways, either through participation in a novel environment and subsequent acquisition or creation of necessary capabilities for innovation, or through a direct exposure to innovative technologies the firm can use for continuous internal R&D (Dushnitsky & Lenox, 2005a).

2.4 Performance Implications of CVC

With the increasing implementation of CVC, the assessment of its performance has raised much interest in both the corporate environment and academia. Depending on whether scholars paid primary attention to the venture firm, the CVC unit, or the investing firm, different perspectives have evolved on performance implications. These perspectives reveal a complex picture of CVC, as Dushnitsky (2012) highlights that the success for one player does not necessarily constitute success for the other parts. In the following, we will first elaborate on the existing research performed on the implications of CVC on the performance of venture companies. Proceeding, we will then continue with an extensive review of existing literature on the performance of the CVC unit itself and finally on the performance of the investing corporation.

2.4.1. Implications on Venture Performance

While some literature shows evidence about negative effects of CVC investments on venture performance due to unfair exploitation (Alvarez & Barney, 2001), general consent exists on the fact that start-up companies on average benefit from financial backing by corporations (Gompers & Lerner, 1998; Maula & Murray, 2002; McNally, 1997). According to McNally (1997), this benefit is mostly of strategic nature and shows for instance as access to the corporations' management, technical expertise or distribution channels. Gompers and Lerner (1998) shift their focus to financial aspects and find that CVC-backed venture firms are at least as successful as IVC-backed venture firms regarding to their valuation or IPO. The results show that the effect is stronger if there is some strategic fit between the venture and the investing corporation. Complementary evidence is reported by Ivanov and Xie (2010) who find that a valuation premium is achieved by those ventures that are strategically complemented by the investing corporation. While those collective findings indicate a positive association between CVC and ventures, Dushnitsky (2012) points out the relevance for future research to investigate whether this superior performance of ventures results from the actual influence of CVC or simply the investing corporation's ability to select outstanding ventures. Contrary to most other existing literature, Weber and Weber (2007) specifically regard the relationship of the venture firm with the corporation (through the CVC unit) as the primary source for performance. They investigate the performance of portfolio firms under the light of the relational view. The authors show that more knowledge sharing resulting from a better relational fit is associated with higher venture performance in terms of sales (Weber & Weber, 2007). They further find that especially trust as well as conative and affective fit positively affect the knowledge transfer between the portfolio companies and the CVC unit. Similar findings are revealed by Zahra and Allen (2006) who specifically investigate implications from the CVC relationship on the entrepreneurial ventures. They highlight that beneficial venture performance requires proactive relationship management, frequent engagement, and effective contracting with CVC investors (Zahra & Allen, 2006).

2.4.2. Implications on CVC Unit Performance

Dushnitsky (2012) denotes the measurement of the performance implications of CVC units as especially difficult for multiple reasons. First, the diverse range of objectives makes it difficult to define a standardized measure that can determine the performance of CVC units. Strategically driven CVC units pay less attention to financial returns and differ in their investment approaches from IVC funds, who purely focus on financial performance (Dushnitsky, 2012). Second, there is no fixed set of measures within the strategic perspective to collectively compare the performance across CVC units. Regardless of these obstacles, some scholars were successful in investigating the achievements of the pursued objectives of CVC units by using qualitative survey-based approaches (Asel *et al.*, 2015; Siegel *et al.*, 1988).

Siegel *et al.* (1988) explore both the objectives and effects of corporate venturing activities. They find that managers report high satisfaction for the performance on strategic objectives, such as the *exposure to new technologies and markets* and *opportunities to manufacture and market new products*.

Furthermore, the *return on investment* was rated as being highly satisfactory among the 52 responding CVC units. The survey also reveals that units with more organizational autonomy, were associated with improved achievement of objectives. In a study on strategically focused CVC units, Sykes (1990) provides supporting results, as 40% of the survey respondents indicate positive value creation. He observes that continuous relationships between the venture and the CVC unit are associated with higher strategic value. Beyond that, the portfolio return on investment is encountered to be positively related to strategic value. Gompers and Lerner (1998) conducted a large-scale empirical study on CVC units' performance using their survival rate as performance measure. Accordingly, IVC funds are associated with higher longevity than CVC units (Gompers & Lerner, 1998). They furthermore find that CVC programs with a higher degree of strategic fit with the parent corporation are associated with a lower likelihood of termination, thus indicating a better performance of these units compared to less strategically driven programs (Gompers & Lerner, 1998).

As described, the literature has covered several perspectives of performance indications of CVC units. In several surveys and large-sample studies, variations of financial and strategic performance measures were used to evaluate CVC units on their ability to achieve pre-defined objectives. Despite offering important insights, it has to be acknowledged that most works on CVC level performance use self-reporting questionnaires, which can be subject to significant bias and therefore need to be evaluated carefully (Dushnitsky, 2012). The wide bandwidth of performance measures underlines the contradicting views on the original question of how to assess CVC units and continuously leads to differing results.

2.4.3. Implications on Corporate Performance

Scholars have spent significant efforts on the analysis of CVC investments' impact on the performance of the investing corporation (Dushnitsky, 2012). Dushnitsky (2012) states that the assessment of parent corporations reveals two more challenges in addition to the previously discussed difficulty of measuring financial and strategic impact. First, results can be observable either on a short-term basis or a longer time horizon, depending on the overall objective. Second, the success of an entrepreneurial venture or the CVC unit does not necessarily constitute success for the corporation, and vice versa. Therefore, measures used for assessing the performance of IVC funds such as the internal rate of return, multiples, or number of IPOs do not reflect the strategic value created by the CVC (Jääskeläinen, Maula, & Seppä, 2006). Asel *et al.* (2015) additionally point out the time lag of financial results with realization time spans of five to ten years after the investments.

After conducting research on the relationship of CVC activities and R&D expenses in corporations, Chesbrough and Tucci (2004) advocate for the use of strategic rather than financial performance measures. They encounter an *“association between internal R&D and external CVC investment”* (Chesbrough & Tucci, 2004, p. 18), which shows that CVC shall be examined in the bigger context of the corporation’s innovation strategy and that financial measures do not capture the full benefits.

Dushnitsky and Lenox (2005a) follow this view and examine the success of CVC activities in regard to the innovativeness of firms. The authors use a citation-weighted count of patents of the investing corporation as a measure for innovativeness and therefore performance and find that CVC investments are positively associated with firm innovativeness. Furthermore, they discover that the CVC contribution is greater when firms have a higher level of absorptive capacity (Dushnitsky & Lenox, 2005a). The authors explain this effect with the better ability to transfer and process knowledge if sufficient capacity is present within the organization. Wadhwa and Kotha (2006) choose a related approach in investigating the rate of knowledge creation by also considering the firm’s patents as a measure of innovativeness. Differently to Dushnitsky and Lenox (2005a), they focus on the number of successful patent applications in any given year, rather than on the forward citations of the patents. Furthermore, they measure CVC activity as the number of investments in unique ventures in any given year rather than by total invested dollar amounts, as Dushnitsky and Lenox (2005a) do. Wadhwa and Kotha (2006) discover an inverted U-shaped relationship between CVC activity and corporate innovativeness in contrast to the linear relationship found by Dushnitsky and Lenox (2005a). These diverging findings are explained by the use of different approaches, specifically the operationalization of CVC activity (Wadhwa & Kotha, 2006). By using the number of unique start-ups instead of the total invested dollar amounts, the authors put more focus on the potential involvement of the CVC unit with the ventures, which they claim is necessary for knowledge absorption (Wadhwa & Kotha, 2006).

Using the same performance measure as Wadhwa and Kotha (2006), Yang *et al.* (2009) examine the effect of experience on the innovation performance of corporations. They show that through experimental and acquisitive learning, CVC units are enabled to improve selection and valuation capabilities and therefore pursue investments of higher quality. The authors further demonstrate a diminishing effectiveness of additional experience when uncertainty is high. More recently, Wadhwa *et al.* (2016) investigated further influencing factors of CVC units on firm performance. They find that portfolio diversity shows an inverted U-shaped relationship with the parent's innovativeness, measured by forward citation-weighted count of patents. This relationship is positively moderated by the amount of available knowledge that firms can access through the portfolio ventures (Wadhwa *et al.*, 2016). As a result of portfolio diversity, access to more non-redundant knowledge and an increased willingness to share knowledge because expertise seems less substitutable are found to positively affect innovation performance albeit insufficient absorptive capacity to assimilate diverse knowledge and limited resources for similar knowledge dimensions negatively impact performance (Wadhwa & Kotha, 2016).

While the discussed literature mainly focuses on the strategic outcomes of CVC, there also exists considerable work on the financial perspective. Gompers and Lerner (2000) strove to compare IVC funds with CVC units by their fund returns and investigated the performance by measuring the success of the ventures receiving the funds, for instance in their exit performance. Additionally, they used the valuation of the ventures at the time of the investment to draw conclusions on the investment performance. They find that CVC programs are at least as successful as IVC funds (Gompers & Lerner, 2000). Further, they remark that success for CVC units particularly exists where there is a strategic overlap between investor and venture (Gompers & Lerner, 2000).

Allen and Hevert (2007) conducted a study of 90 U.S. information technology corporations and measured financial performance as the internal rate of return of the CVC programs. However, the authors acknowledge significant differences between CVC units and IVC funds and thus refrain from comparing respective rates of return and rather set the CVC units' returns in relation to the investing corporations' cost of capital. In contrast to Gompers and Lerner (2000), CVC activity is generally associated with negative returns and the units are titled as *"value destroyers"* for the parent companies (Allen & Hevert, 2007, p. 273). Nonetheless, Allen and Hevert (2007) reflect on the aforementioned challenges in measuring CVC performance by recognizing the limitation of the financial analysis as it ignores strategic benefits, which might offset financial value destruction. Dushnitsky and Lenox (2006) address this issue in developing a model that financially quantifies strategic impact of CVC units on their parent corporations. They use *Tobin's q* as a firm value measure, as it takes the time lag between investment and realized performance into account and reflects expected future earnings of firms (Dushnitsky & Lenox, 2006). They conclude that external CVC activities are positively associated with value creation for the investing firm, conditional to sector- and firm-specific factors such as particular strategic objectives (Dushnitsky & Lenox, 2006).

More recently, Yang *et al*. (2014) used *Tobin's q* to investigate the relationship between industry diversification within the venture portfolio and firm value. The authors focus on the effect of the venture portfolio on the investors' performance. They observe a curvilinear association between portfolio diversification and firm value. Benson and Ziedonis (2009) take a different perspective in assessing performance by claiming that CVC shall be considered as an aid for companies in acquiring technology start-ups. Firms acquire knowledge about relevant technologies and the investment processes through extensive screening and due diligence before pursuing an investment, which enables them to perform better in the acquisition of entrepreneurial ventures (Benson & Ziedonis, 2009). According to the researchers, the appropriate criteria to assess CVC performance and its impact on the investing parent is therefore the acquisition performance, measured as the change in stock price around the acquisition announcement to account for the market's expectation on future cash flows. The results reveal a positive association between CVC activity and the acquisition performance, however, with a diminishing effect (Benson & Ziedonis, 2009).

In conclusion, large attention has been paid to the investigation of performance implications of CVC activities. General consent exists on the positive contribution of CVC to firm value (Dushnitsky & Lenox, 2006; Gompers & Lerner, 2000; Wadhwa & Kotha, 2006). Furthermore, our summary of the existing literature on the performance of CVC allows a thorough understanding of the different available measures and resulting obstacles, thus revealing the complexity of CVC and subsequent value creation. The different studies also expose the numerous perspectives on evaluating CVC performance as well as the factors that impact the relationship between CVC activity and performance, both on a firm level and an industry level (Dushnitsky & Lenox, 2005a; Wadhwa *et al.*, 2016, Yang *et al.*, 2014). Depending on whether the CVC unit establishes strategic or financial objectives, appropriate measures and outcomes differ significantly (Asel *et al.*, 2015; Chesbrough & Tucci, 2004; Yang *et al.*, 2014). While financial measures are easier to quantify, strategic measures give broader insights into motivations and objectives but can at the same time be subject to bias due to subjective judgement (Dushnitsky, 2012).

2.5 Structural Aspects of CVC Units

CVC programs are subject to a difficult balancing act. On the one hand, they are part of large corporations and their organizational structures. On the other hand, their primary activity, equity investments in start-up companies, resembles that of IVC funds which are generally set up as limited partnerships. The following section will be devoted to a review of existing literature on character differences of CVC programs with diverging legal structures. *Table 1* depicts the identified character dimensions which will be further elaborated in the following.

Character Dimension	Internal CVC Unit	External CVC Unit	Literature
Legal Structure	Integrated unit with on-balance sheet investments	Separate legal entity with off-balance sheet investments (wholly owned subsidiary, fund)	Asel *et al.* , 2015; Birkinshaw *et al* ., 2002; Dushnitsky, 2012; Kann, 2002; Winters & Murfin 1988; Yang *et al.* , 2016
Decision-making Authority	Centralized; Low degree of decision-making authority; Tight structure	Decentralized; High degree of decision-making authority; Loose structure	Birkinshaw, 2002; Dushnitsky, 2004; Siegel *et al.* , 1988
Parent Involvement	High; Strong strategic alignment	Low; Independent investment focus	Asel *et al., 2015;* Dushnitsky & Shaver, 2009; *Hill* et al.*, 2009;* Keil *et al.* , 2008; Souitaris & Zerbinati, 2014; Yang et al., 2016
Personnel Decisions	Mostly internally sourced, Firm-specific expertise; Fixed salaries	VC/Investment experienced; Bonus schemes & carried interest	Asel *et al.,* 2015; Dushnitsky, 2004; Dushnitsky & Shapira, 2009; Siegel *et al.* , 1988; Sykes, 1992
Orientation	Towards parent organization	Towards VC community & Portfolio companies	Asel *et al* , 2015; Dushnitsky, 2004; Keil et al., 2008; Souitaris *et al.* , 2012; Winters & Murfin, 1988
Financial Commitment	Periodic/ad-hoc funding	Fixed dedicated pool of funds	Siegel *et al.* , 1988

Table 1 *Overview of Character Dimensions*

Dushnitsky (2012) identifies four structural forms based on the *legal structure*. According to his research, the corporation initially faces the decision between setting up an own program or choosing to invest in an existing IVC fund which he labels as *"CVC as LP"*[3] (Dushnitsky, 2012, p. 23). If a corporation decides to establish a CVC program, it can do so by directly investing in ventures through existing operating business units, setting up a wholly owned subsidiary dedicated for venturing activities, or establishing its own fund (Dushnitsky, 2012). Winters and Murfin (1988) distinct between similar CVC structures. Based on large empirical data, Kann (2002) finds consent with previous categorizations from Dushnitsky (2012) in classifying CVC programs into CVC as LP, dedicated funds, and corporate-managed funds. Contrarily to Dushnitsky (2012) and Winters and Murfin (1988), Kann (2002) does not distinguish between direct investments and wholly owned subsidiaries and thus refrains from defining the modes along their legal structure. Her research further discloses that firms investing in complementary ventures tend to invest as LP, while firms with the aim to increase their R&D capabilities are more likely to establish a corporate-managed unit. Her results show a significant relationship between CVC objectives and unit structure (Kann, 2002). Birkinshaw, van Basten Batenburg, and Murray (2002) focus on a narrower perception of CVC modes and investigate a sample of CVC programs distinguished only between direct investments (internal) and separate subsidiaries (external). Asel *et al.* (2015) pick up this approach by examining two groups, namely internal and external CVC programs, driven by the legal structure. Therefore, opening a venture fund and establishing a wholly owned subsidiary are both labelled as external, whereas direct investments through existing business units resemble internal CVC programs (Asel *et al.*, 2015).

According to a survey-based study conducted by Siegel *et al.*, (1988), the majority of programs encounter an approval by the corporate prior to each investment. The authors show great differences between internal and external CVC units in regard to *decision-making authority*. External CVC units (denoted as pilots) are associated with a high degree of decision-making authority, whereas internal units (denoted as co-pilots) experience a high level of dependency (Siegel *et al.*, 1988). Similarly, in a sample of corporate-managed CVC programs divided into direct investments and legally separate subsidiaries, Birkinshaw and colleagues (2002) show significant differences in the decision-making authority of CVC

[3] Technically, this is not considered as CVC in this thesis, because the corporation does not actively pursue investments and has little to no say in the strategic direction of the investments. For the sake of completeness this type is therefore presented in the literature review but will not be considered in our following analysis.

programs. Specifically, they point out that strategically driven programs are associated with less decision-making power regarding the investment and hiring decisions than financially driven units and thereby agree with Kann (2002) on a significant relationship between objectives and structure of CVC units (Birkinshaw *et al.*, 2002). Dushnitsky (2004) agrees in the previously mentioned findings and particularly points out that internal CVC units are subject to a tighter connection with the corporation than external units.

Hill *et al.* (2009) research the suitability of the IVC model for the CVC environment, thereby implicitly investigating the optimal level of *parent involvement*. The scholars specifically elaborate on the influence of structural parameters such as carried interest compensation, VC communication, investment staging and autonomy on strategic and financial performance of CVC programs. In their evaluation, they further differentiate between two types of autonomy (Hill *et al.*, 2009). While they define vertical autonomy as the independence from senior executives in investment decisions, horizontal autonomy refers the independence from influences from other business units in the corporation. More recently, Souitaris and Zerbinati (2014) build on the study conducted by Hill *et al.* (2009) and further investigate the investment practices of CVC units compared to IVC funds. The decision between an integrated and an arm's length structure builds a central logic of their research. The legal set up of the CVC program (i.e. the decision to directly invest or establish a subsidiary) thereby reflects the different degrees of parent involvement in the investment process (Souitaris & Zerbinati, 2014). They find that CVC units *"tend to involve their single limited partner (the parent) in deal approval"* (Souitaris & Zerbinati, 2014, p. 335). The authors provide three explanations for the parent's high involvement rate: ensuring the strategic fit, creating engagement between the corporate and the CVC program, and enabling access to corporate resources, both in form of knowledge and tangible assets (Souitaris & Zerbinati, 2014).

Asel *et al.* (2015) conduct qualitative interviews with managers of 23 CVC programs to investigate the differences of investing directly or through a separate entity. Internal units generally interact more with other units of the organization during the deal sourcing process than external programs, while external units tend to engage with the portfolio companies rather than with other business units, which also indicates less business unit engagement in the post investment period (Asel *et al.*, 2015). Yang *et al.* (2016) conduct research on the degree of autonomy of CVC programs and the implications on portfolio diversity. They show that tightly controlled internal units are subject to more monitoring by the investing corporation than autonomous units that are established as wholly owned subsidiaries. Yang *et al.* (2016) find that structural autonomy is positively associated with portfolio diversification, explained by the lower level of monitoring and more importantly by the weaker involvement of the parent organization in strategic decisions. This is an important result given previously found connections of portfolio diversification and value creation (Yang *et al.*, 2014). Dushnitsky and Shaver (2009) highlight the importance of acknowledging differences in parent involvement, as this might influence the ventures' perception to enter a partnership with the CVC unit. Wholly owned subsidiaries are more independent from the parent company which can be signaled to the start-up company (Dushnitsky & Shaver, 2009). However, the authors do not investigate such involvement of the parent organization on the performance but rather focus on the initial relationship formation (Dushnitsky & Shaver, 2009). Keil *et al.* (2008) examine knowledge assimilation from CVC activities and provide insights on trade-offs of different formal setups. They find that structural aspects can create barriers to optimal disembodied experimentation, *"a form of experimentation outside organizational boundaries"* (Keil *et al.*, 2008, p. 1477). Specifically, the authors consider the involvement of the parent corporation and decision-making authority. Structural proximity can therefore have both negative and positive effects (Keil *et al.*, 2008). For instance, they show in that a strong involvement of the parent organization through deal approvals can prevent exploration of fields outside the organization's established environments. However, full isolation from the corporation might negatively affect knowledge assimilation and capability internalization (Keil *et al.*, 2008).

Siegel *et al*. (1988) further point out differences in the CVC units' *personnel decisions*, which range from offering base salaries as commonly used in corporate structures, to incentive-driven payment options such as participation in investment returns. In accordance with Siegel *et al*. (1988), Asel *et al.* (2015) find that internal units mainly source corporate employees with firm-specific expertise, while external units tend to recruit employees with IVC backgrounds. Their survey further suggests that internal units typically offer personnel a base salary similar to other business units, whereas external units align with IVC funds and often compensate employees with carried interest. Dushnitsky (2004) explains these differences with the potential tensions between internal structures and other corporate business units, as there is a high interaction and differences in compensation would increase the risk for disagreements. As a result, he argues that personnel incentives in external units are stronger, compared to those of internal units (Dushnitsky, 2004). In a case study of eight large corporations, Sykes (1992) explores the reasons for the choice between *"equality and equity"* (p.253). Respondents name the forced equality of CVC and corporate personnel, limited financial risk, easier personnel transfer, and objective alignment with the corporation as the main drivers for flat salaries. Contrarily, talent recruitment, career risk, and level of effort are named as arguments to implement performance-based compensation schemes (Sykes, 1992). Dushnitsky and Shapira (2010) find a correlation between compensation practices and investment behavior. While CVC programs in general tend to invest less risky, units with performance-based pay are associated with deals that have the characteristics of IVC deals (Dushnitsky & Shapira, 2010).

Winters and Murfin (1988) argue that the structure fundamentally shapes the CVC unit's *orientation* and how it deals with entrepreneurs and the parent corporation, which subsequently affects how accepted it is by the VC community and how employees and other business units view and support the venturing activities. They claim that separate CVC subsidiaries enable closer relationships with entrepreneurs, are more accepted in the VC community, and signal more commitment that leads to higher improvement within the organization (Winters & Murfin, 1988). Another aspect is the direction of communication either straight to the top management of the corporation in a more centralized way or rather horizontally to other business units without the interference of top management (Keil *et al.*, 2008). The optimal direction is dependent on the strategic mandate of CVC programs and can lead to structural barriers if not chosen appropriately (Keil *et al.*, 2008). Asel *et al.* (2015) underline this interdependency of the structural set up and the program's objective and thereby recognize the complexity of the optimal structure in CVC. The authors conclude that internal units tend to follow the direction of the parent firm more closely than externally structured funds, leading to a trade-off between slower processes and strategic alignment (Asel *et al.*, 2015). Souitaris, Zerbinati, and Liu (2012) constitute the orientation of CVC units towards the parent as *"endoisomorphism"* (p.477) and the orientation towards the venture as *"exoisomorphism"* (p. 477). The authors find that the external orientation is associated with an organic management system of the CVC unit and the internal orientation with a mechanistic management system (Souitaris *et al.*, 2012). According to Dushnitsky (2004), internal CVC units are rather directed towards their parent organization, which facilitates communication with other business units and ensures an efficient knowledge flow. Contrarily, external units can mitigate entrepreneurs' fear of imitation by focuses more on the relationship with venture firms (Dushnitsky, 2004).

Siegel *et al.* (1988) also base their distinction of CVC types between external and internal programs on the dependency on the corporation constituted by the level of *financial commitment*. Around 50% of the programs have a fixed dedicated pool of funds, while the other half either receives funding on an ad-hoc basis or periodically (Siegel *et al.*, 1988). According to the authors, financial commitment constitutes dedication towards the CVC activities in general and the venture firms in particular (Siegel *et al.*, 1988).

The provided overview organizes the considerable amount of existing research on the governance and structural aspects of CVC programs. Conclusively, while several distinct modes of CVC are identified (Dushnitsky, 2012), more recent studies largely investigate structural aspects on internally versus externally oriented CVC units, distinguished by the foundation of different legal structures (Asel *et al.*, 2015; Birkinshaw *et al.*, 2002; Siegel *et al.*, 1988). However, most literature investigates the antecedents of the structural decision and demonstrate interrelation of the objectives and the setup, rather than implications on the innovativeness of the parent organization.

2.6 Structural Influence on Corporate Performance

The previously summarized literature offers a wide variety of research approaches, performance measures and facets of structural aspects in order to understand CVC and explain associated benefits, but also reveal the high complexity of the research field. However, while existing works highlight the importance of aligning the CVC program's structure and objectives (Souitaris & Zerbinati, 2014; Winters & Murfin, 1988), less attention has been paid to the relation of structure and performance, especially with respect to internally structured CVC programs compared to externally structured CVC programs. In this chapter, we will review the limited existing literature dealing with the impact of structural decisions on the performance implications of CVC programs and point out significant research gaps.

Siegel *et al.* (1988) provide insights into the effect of the level of interconnection between the CVC unit and the corporation on the achievement of self-defined objectives. While highest financial returns are associated with a setup related more to IVC, strategic goals seem to require closer involvement of the parent corporation to ensure strategic alignment (Siegel *et al.*, 1988). Moreover, the authors uncover that pilots[4] are associated with higher performance, particularly resulting from increased authority, higher committed capital, and the avoidance of cultural incompatibilities. Despite, they argue that copilots weigh reported obstacles stronger than pilots, directly deriving from too close control from the corporate. Building on these results, the authors propose an independent CVC program with committed capital and incentive-driven compensation schemes to be most advantageous (Siegel *et al.*, 1988).

Hill *et al.* (2009) find that incentive pay, a higher degree of vertical autonomy, investment syndication, and specialization are associated with higher financial performance. Contrarily, horizontal autonomy, investment staging, and increased communication with other VC firms are positively associated with strategic performance. The authors therefore observe a positive relationship between the autonomy from the corporation and the two dimensions of performance and thus confirm with the argumentation of Siegel *et al.* (1988) (Hill *et al.*, 2009). Given the mixed results for strategic and financial performance, the suitability of the IVC model however cannot be generalized for all CVC programs but rather needs to be adapted depending on the program's specific objectives (Hill *et al.*, 2009).

Lee, Park, and Kang (2018) also investigated the effect of autonomy on innovation performance but thereby specifically differentiated between explorative and exploitative performance. In their study, they define exploitative innovation as knowledge creation in directly related industries, whereas explorative innovation is associated with knowledge creation in unrelated areas (Lee *et al.*, 2018). It is found that autonomy is positively associated with explorative activities but negatively associated with exploitative activities (Lee *et al.*, 2018). In accordance with Yang *et al.* (2016), the positive impact on explorative innovation is explained by the larger distance to the parent organization associated with more freedom in search and decision-making. Based on their findings, they contrarily suggest that for related innovation the parent organization's expertise is of high value, which is why autonomy hinders performance in such a case (Lee *et al.*, 2018).

Sykes (1990) investigated 31 strategic CVC programs with the aim to find structural parameters influencing the value creation in the parent corporation. He discovers that the structure of the CVC program has a significant influence on the investment's value contribution. Respondents of his

4 Siegel *et al.* (1988) describe external CVC programs with a higher level of autonomy as pilots and internal programs as copilots. In order to correctly convey their findings, we have adapted their denotations in this paragraph.

questionnaire rate direct investments slightly better compared to investments as LP for achieving strategic goals as a result from enhanced relationships and improved contacts to the VC community (Sykes, 1990). The author finds that program structures providing frequent contact with the ventures and the VC community, offering deal flow, and enhancing other business relationships are considered to be more advantageous. Hereby, the first two advantages are associated with external structures, whereas business relationships are specifically strengthened through direct investments (Sykes, 1990). Sykes (1990) thus implicitly acknowledges the complexity of choosing the optimal structure for CVC units.

The presented studies probe the influence of the structural aspects of a CVC program on the investing corporation's performance. Structural characteristics such as autonomy from the parent corporation, incentive-based pay, and relationship building are examined to be the most influencing factors (Hill *et al.*, 2009; Siegel *et al.*, 1988; Sykes, 1992). However, investors need to consider differing influences of such factors on strategic and financial performance when establishing a CVC program (Hill *et al.*, 2009). This becomes particularly evident in the study of Hill *et al.* (2009), in which horizontal and vertical autonomy have contradicting effects on both strategic and financial performance.

Concluding, the review of existing literature shows that there is a considerable lack of knowledge on the effects of legal structures on the performance of CVC programs for the investing corporation. Despite some considerable interest in the modes of CVC and specifically the structural differences of internal and external CVC units, it is noteworthy that resulting corporate performance implications have rarely been investigated. The few existing studies considering CVC structure in their evaluations on corporate innovation performance particularly focus on individual character traits rather than examining the structural modes (Hill *et al.*, 2009; Siegel *et al.*, 1988). Further emphasis needs to be put on the fact that the existing works mainly focus on qualitative assessment and rather small data sets, leading to a risk of bias (Dushnitsky, 2012). Moreover, the presented studies tend to focus on CVC as the window and access point to new knowledge rather than investigating implications of subsequent interactions after the initial investment (Dushnitsky & Lavie, 2010; Dushnitsky & Shapira, 2009). Zahra and Allen (2006) bridge this gap by applying a relational capital perspective to investigate the CVC relationship and its implications on value creation. However, contrary to our work, they emphasize implications for venture firms. This thesis seeks to fill the revealed research gap by empirically examining legally distinct internal and external CVC programs and the potential influence on innovativeness of investing corporations.

3 Theoretical Background

3.1 Knowledge-Based View

The knowledge-based view is a theoretical concept in the broader context of the theory of the firm, which is seen to be an extension of the resource-based view (Curado & Bontis, 2006). In the past, scholars have disagreed on whether the knowledge-based view constitutes a standalone theory of the firm, however, as Foss (1996) argues, it does not explicitly explain the existence of firms and is thus only complementary to existing theories of the firm. This view has gained a lot of acceptance (Keil, 2002; Liebeskind, 1996) and our work will take on this view.

Contradictory to the traditional resource-based view, the knowledge-based view argues that input factors are not naturally occurring resources, but rather created factors derived from knowledge within the firm (Liebeskind, 1996). Accordingly, knowledge is considered to be the most valuable resource to generate superior Ricardian rents and thus achieve a competitive advantage (Grant, 1996). Knowledge is referred to as *"information whose validity has been established through test of proof"* (Liebeskind, 1996, p. 94). The central concept of the knowledge-based view is to recognize firms as *"heterogeneous, knowledge-bearing entities"* (Foss, 1996, p. 470), whereby the knowledge is owned by specialized employees (Grant, 1996). The heterogeneity of the firm is resulting from context dependency of knowledge, which implies that the created knowledge itself is the result of a unique process as well as of previously existing organizational knowledge (Tsoukas, 1996). The essential role of the firm is then to coordinate the distribution and use of the existing knowledge to create further knowledge that embraces new technologies and products (Nonaka, 1994). However, diverging goals of individual members in different business units of the organization might create a problem of cooperation and coordination (Grant, 1996). As there are different types of knowledge, which differ in tangibility, the described re-creation process of absorbing, distributing and using knowledge can be vulnerable to obstacles (Nonaka, 1994). While explicit knowledge is readily codifiable and transferrable, tacit knowledge is often subjective, experience-based, and thus difficult to transmit and incorporate (Nonaka, 1994). Concluding, the knowledge-based view offers the fundament for the understanding of the following concept of organizational learning.

3.2 Organizational Learning

3.2.1 Fundamentals of Organizational Learning

Dodgson (1993) highlights that in the context of organization theory, the learning process is *"the way firms build, supplement and organize knowledge and routines around their activities and within their cultures, and adapt and develop organizational efficiency"* (p. 377). The specific goal of organizational learning is therefore the retention of competitiveness and innovativeness in particularly uncertain environments (Dodgson, 1993). Innovation in its essence is a process of revolutionizing the existing structure through the establishment of a new one and is seen as an important facilitator of competitive advantage (Schumpeter, 2013). West and Farr (1990) highlight that the new elements need a certain degree of change but do not necessarily be entirely novel. A distinction can be made between radical innovations that disrupt whole industries and incremental innovations that aim for continuous improvement in the process of change (West & Farr, 1990). Dodgson (1993) highlights the conflict between efficiency efforts and innovation, which is referred to as the *"productivity dilemma"* (Dodgson, 1993, p. 380). By constantly reevaluating existing and challenging new knowledge, this conflict eventually enhances organizational learning (Dodgson, 1993). Schön and Argyris (1996) distinguish three levels of learning, single-loop-learning, double-loop-learning, and deutero-learning. Through this distinction they emphasize the complexity of organizational learning. While single-loop-learning reflects absorption of information from the environment without modification, double-loop-learning demonstrates a process including proactive changes in the underlying knowledge and existing concepts (Schön & Argyris, 1996). The authors define deutero-learning as the process of learning how to perform single- and double-loop-learning.

According to Huber (1991), *"an organization learns if any of its units acquires knowledge that it recognizes as potentially useful to the organization"* (p. 89). Four steps in the process of organizational learning are defined: knowledge acquisition, information distribution, information interpretation, and organizational memory (Huber, 1991). Knowledge acquisition is the process of obtaining additional knowledge and can be pursued in different ways such as experienced-based learning, congenital learning, grafting, searching, and vicarious learning, which is defined as learning through observation (Huber, 1991). The organizational learning from experience of other organizations poses an additional aspect in the process of knowledge acquisition and is enabled through a transfer of information in codes, processes, or routines (Levitt & March, 1988). The distribution of information becomes relevant when acknowledging that knowledge or information lies with individuals or units within the organization (Grant, 1996). The resulting transfer enables the creation of new ties between existing and new knowledge, potentially leading to additional synergies and therefore broader organizational learning (Huber, 1991). The step of information interpretation refers to the sense making of new information for the organization and can further enhance organizational learning (Huber, 1991). The author argues that various interpretations allow for a higher range of potential behaviors in the firm, hence leading to a higher degree of organizational learning. The last step of the organizational learning process refers to the organizational memory, which denotes the storage of the newly acquired knowledge within the organization and constitutes a critical point to make use of the learnings (Huber, 1991). The storage of information is highly dependent on whether the nature of knowledge is tacit or explicit, as the different types require different levels of effort to be stored and replicated (Nonaka, 1994). In this context, Levitt and March (1988) emphasize the routine-based concept of organizational memory. According to their research, firms store knowledge through routines and thus make information available for individuals and units that have not been part of the original learning experience. Such routines, defined as *"repetitive, recognizable patterns of interdependent actions"* (Feldman & Pentland, 2003, p. 95), ensure that knowledge is captured and deepened within the organization, even with considerable personnel turnover (Levitt & March, 1988). Levitt and March (1988) highlight that routines change over time by adapting to what has been learned and shown to be the most efficient way of using the learnings. They add that the accessibility of knowledge varies depending on the frequency the routines, which store that particular knowledge, are used. If routines are intended to be learned from others, such as through imitation, firms need to consider potential costs to adapt to the sourcing routines (Levitt & March, 1988).

Organizations differ in the ability to learn and thus in their ability to adapt in order to develop efficiency (Dodgson, 1993). However, as Levitt and March (1988) elaborate, learning itself can be learned and consequently used to build competitive advantages through knowledge. Through more exposure to learning activities and favorable outcomes in those processes, the procedures will become more familiar to the organization, making it more efficient in learning (Levitt & March, 1988).

3.2.2 Absorptive Capacity of Organizations

Routines enable firms to strengthen and optimize organizational learning (Levitt & March, 1988). Nonetheless, researchers acknowledge additional moderating factors. Cohen and Levinthal (1990) argue that external sources are an especially important factor for successful innovation in the organizational learning process. In this context, they highlight that organizations are heterogeneous in their ability to take in the available external information and transform it into knowledge (Cohen & Levinthal, 1990). This ability is labelled as absorptive capacity and is defined as the *"ability to identify, assimilate, and exploit knowledge from the environment"* (Cohen & Levinthal, 1989, p. 569). Cohen and Levinthal (1990) further elaborate on absorptive capacity being the result of existing knowledge within the firm. If that existing knowledge is related to and relevant for the field of the new knowledge to be obtained, the effect of absorptive capacity is elevated (Cohen & Levinthal, 1990). In order to enable the exploitation of external information and thus making full use of the firm's absorptive capacity, organizations are dependent on individual employees transferring the information into the organization and between units (Cohen & Levinthal, 1990). Firms therefore need effective communication structures. As Cohen and Levinthal (1990) argue, individual employees acting as an interface between the sources and the recipient of the knowledge can take an effective role in the learning process. Such centralized structures especially facilitate organizational learning if the new knowledge differs significantly from existing knowledge in the organization and individuals can act as moderating gatekeepers (Cohen & Levinthal, 1990). However, the authors further elaborate that a single gatekeeper is not the most effective link in uncertain environments and when the organizations intends to obtain diffuse or unrelated knowledge.

In a separate work on the specifics of R&D and the development of absorptive capacities in a firm, Cohen and Levinthal (1989) moreover discuss that learning activities do not only facilitate the procurement of new knowledge about technologies and innovations, but inherently enhance the organization's capability to take in and process information. This sheds new light on objectives of learning endeavors but also on networking activities of organizations (Cohen & Levinthal, 1989). The aim of external knowledge acquisition through R&D and venturing can be twofold, finding actual new technologies and additionally increasing the firm's ability to recognize new opportunities and actively obtain new knowledge (Keil, 2002). According to Cohen and Levinthal (1989), absorptive capacity thus poses a potential rational why firms undertake R&D. It offers the advantage over an acquisition of technologies or patents to allow the firm to learn how to make actual use of new information and knowledge. This is especially true for investments in basic research or research in fields not directly connected to the business of the organization (Cohen & Levinthal, 1989). In those cases, the authors argue that firms use R&D to actively improve absorptive capacity to be able to better identify potentially useful findings from other firms, institutions, or universities in the future. Furthermore, similarly to knowledge itself, absorptive capacity is cumulative and path dependent (Cohen & Levinthal, 1989). Thus, absent initial investments in R&D and absorptive capacity in a specific field can result in a continuous knowledge gap. This effectively constitutes that the attractiveness of investing in those fields in subsequent periods diminishes and consequently the firm will not be able to close the knowledge gap (Cohen & Levinthal, 1989).

In their reconceptualization, Zahra and George (2002) use a dynamic capability view to distinguish two components of absorptive capacity. They define potential absorptive capacity as referring to knowledge acquisition and assimilation competencies. Thus, it describes the exposure of the firm to available information as well as the opportunities to actually acquire the knowledge (Zahra & George, 2002). Realized absorptive capacity is reflecting the transformation and exploitation of knowledge, indicating the ability of a firm to make use of the acquired knowledge within the organization. Eventually, the realized absorptive capacity creates organizational learning and resulting competitive advantages. The ratio of the realized to the potential capacity is termed as the efficiency factor of organizational learning (Zahra & George, 2002).

Both the traditional view on absorptive capacity (Cohen & Levinthal, 1989; 1990) as well as the reconceptualized view by Zahra and George (2002) agree on the role of a firm’s absorptive capacity on its learning process and resulting innovativeness. Cohen and Levinthal (1989; 1990) thereby solely emphasize the acquisition and exploitation of outside knowledge. Accordingly, the prior knowledge within the firm is the success factor for absorptive capacity and reflects a path-dependency. Zahra and George (2002) follow a more specified concept and define absorptive capacity as a set of capabilities that are embedded in organizational routines. They emphasize the importance of the firm’s ability to transform the acquired knowledge in order to create value (Zahra & George, 2002). Moreover, the authors argue that absorptive capacity is not only dependent on the organization’s prior knowledge, but also on the complementarity of the new information and the diversity of knowledge sources. This differentiation leads to the conclusion that absorptive capacity does not necessarily follow a patterned path, but that the focus of organizational learning is rather continually redefined (Zahra & George, 2002).

3.2.3 Exploitation and Exploration

As has been noticed by Dodgson (1993) and Clark *et al.* (1985) that a conflict can arise in the context of organizational learning between existing and new knowledge in an organization, resulting from tensions between efficiency and innovation. In a seminal work on organizational learning, March (1991) denotes this conflict as an interaction between exploration and exploitation. Exploration is considered an activity to enhance innovation and is associated with risk taking, search, experimentation, and flexibility (March, 1991). Exploitation reflects efficient processes within an organization, driven by production, refinement, and implementation (March, 1991). Some scholars argue that exploitation is exclusively reserved for activities using past knowledge without creating new knowledge (Rosenkopf & Nerkar, 2001). However, other scholars argue that both exploration and exploitation are linked to learning. Benner and Tushman (2002) suggest that the two activities differ in their direction of learning, where exploitation considers learning in existing fields and exploration attempts learning in new environments. Baum, Li, and Usher (2000) support this view in saying that exploitation reflects learning from local search and the constant improvement of existing routines.

March (1991) recognizes the general incompatibility of efficiency and innovation in saying that the two concepts require substantially different setups and mentalities. However, he also provides arguments for a necessary balance between the two activities by demonstrating that each activity alone is not sufficient to adequately use knowledge in order to gain a competitive advantage. With a sole focus on exploitation, firms risk falling behind competitors that continue to work on improvements and fail to capture further industry developments, while entirely devoting resources to exploration bears the risk of losing time and resources in ideas that do not prove to be successful (March, 1991). March (1991) therefore sees the main challenge not in the tension itself but in balancing the efforts and scarce resources devoted to exploration and exploitation. Contrastingly, Gupta, Smith, and Shalley (2006) show in their work that under certain conditions specialization for either exploration or exploitation might be a suitable decision, specifically if the organization is considered to be part of a broader social system. Exploration and exploitation vary in their value for the organization especially in a timing factor (March, 1991). A firm that exploits existing knowledge focuses on improving currently available opportunities to gain short-term efficiency. Contrarily, the firm focuses on developing routines and opportunities for long-term returns but might abandon current revenue options when exploring new knowledge (March, 1991). In his argumentation, March (1991) highlights a strict mutual exclusivity between exploration and exploitation in a sense that they cannot be pursued to the full extent at the same time. Gupta *et al.* (2006) agree with this classification to a certain extent, dependent on the scarcity of required resources. However, the authors introduce a model of orthogonality for situations where the areas of exploration and exploitation are only loosely connected. If exploration and exploitation are occurring in different domains, a high level of one activity does not disqualify a high level of the other but rather supports its outcomes (Gupta *et al.*, 2006).

Following the argumentation of March (1991), exploitation and exploration require special managerial attention to ensure optimal balancing of scarce resources. In the organizational context, this ability to effectively be aligned and adaptive is broadly referred to as ambidexterity (Gibson & Birkinshaw, 2004). An ambidextrous organization pursues a dual strategy in order to combine the initiation and execution of innovation (O'Reilly & Tushman, 2008). O'Reilly and Tushman (2008) further highlight the difficulty of managing two distinct streams but argue that it is a necessary challenge for organizations as markets and technologies continue to evolve over time. Ambidexterity can take on a structural or a contextual perspective in the organizational design, facing different challenges and approaches (Gibson & Birkinshaw, 2004). These aspects will be further elaborated in section 3.4 on organizational design.

3.3 Relational View

Several different streams have been established in the research field on the Theory of the Firm. Beyond the earlier-introduced knowledge-based view, one stream remarks the relational view introduced by Dyer and Singh (1998), which understands competitive advantage as a result of interorganizational cooperation. Different to the resource-based view and the knowledge-based view, the relational view thereby considers a network of firms as the primary unit of analysis (Dyer & Singh, 1998). The main idea of the relational view is that superior returns, critical for a sustainable competitive advantage, result from interfirm relationships and resources spanning across the boundaries of firms. In other words, network interactions enable firms to receive *"social capital"* (p. 297), which can be the basis for competitive advantage (Gulati, 1998). Specifically, competitive advantages can be achieved and sustained through the generation of relational rents, which are defined as profits *"generated in an exchange relationship that cannot be generated by either firm in isolation and can only be created through the joint idiosyncratic contributions of the specific alliance partners"* (Dyer & Singh, 1998, p. 662). Evaluating the networks of two or more firms, four dimensions of relational rent sources are identified by the authors. These four determinants are *(a) relation-specific assets*, *(b) knowledge-sharing routines*, *(c) complementary resources and capabilities,* and *(d) effective governance mechanisms* (Dyer & Singh, 1998). In general, the determinants occur individually, however, scholars have acknowledged that there is a certain interrelatedness, specifically between *'complementary resources and capabilities'* and *'relation-specific assets'* (Maula *et al.*, 2003).

Relation-specific assets denote assets that are specialized to be used within the boundaries of a relationship with one or more partners. Such resources increase the opportunity for cooperation between the partners and thus enable the creation of relational rents (Dyer & Singh, 1998). Depending on the context of the relationship, the required assets can be site specific, specific to physical assets, or human asset specific (Williamson, 1985). For instance, Weber, Bauke, and Raibulet (2016) depict that human asset specificity is especially of high importance in minority equity investments in order to strengthen the relationship between the investing corporation and the target firm and eventually enhance performance. Physical asset or site specificity investments, however, demark little additional value for this particular relationship and superior rents (Weber *et al.*, 2016). Regardless of the type of assets, Dyer and Singh (1998) argue that the higher the investment in assets that specialize in intensifying and strengthening the partnership, the greater the potential relational rents.

Interfirm knowledge-sharing routines represent repetitive interactions between partners that empower the transfer and creation of knowledge (Grant, 1996). Building on the concept of absorptive capacity for the exploitation of external knowledge sources (Cohen & Levinthal 1990), the relational view considers a partner-specific absorptive capacity to be crucial for ideal knowledge-sharing (Dyer & Singh, 1998). According to Dyer and Singh (1998), the specific absorptive capacity accumulates with the frequency and intensity of implemented routines in the relationship because firms work together and learn to communicate efficiently with the right persons in the network. Such efficient interaction is particularly valuable if knowledge is non-codifiable (Nonaka, 1994). An amplifying influence on the effect of interorganizational knowledge-sharing is connected with the alignment of incentives (Dyer & Singh, 1998). This suggests that all parties need to have some incentive in the relationship to act transparent, otherwise the potential of relational rents cannot be exhausted (Dyer & Singh, 1998).

Another possible determinant for relational rents is the use of *complementary resource endowments*, which describe the collection of resources owned by the members of the dyad and used jointly to generate synergies (Dyer and Singh, 1998). Therefore, both firms benefit from the partnership and create relational rents if the combined resources are more valuable, rare, and difficult to imitate than individually (Weber *et al.*, 2016). Hereby, the authors point out that a lack of experience in partnerships as well as lower capabilities to evaluate and acquire information might hinder the matching of the right resources (Dyer & Singh, 1998).

Lastly, Dyer and Singh (1998) name *effective governance* systems as a key factor for relational rents. The authors refer to the fact that the parties of a network can employ efficiency mechanisms to either lower transaction costs or provide incentives for value-creation initiatives by aligning their governance systems. For example, trust may be an effective governance attribute as it can work as a safeguard, endorsing partners to invest more and thus increase the potential for relational rents (Dyer & Singh, 1998). In summary, the relational view posits that most and foremost relational dyads of two or more partners are the source for innovation and sustainable competitive advantage.

3.4 Organizational Design

The structure of an organization defines how the firm operates, considering aspects of coordination, supervision, and decision-making authority, and thus affects the operational outcomes (Pugh, Hickson, Hinings, & Turner, 1969). According to Weber (2009), organizational structure is characterized by the division of labor and responsibilities, the interaction between employees, and the existence of rules and standardized processes. On this foundation Burns and Stalker (1961) argue that extrinsic and firm factors influence the optimal type of management and thus no generalization about an optimal design can be made. However, they develop two organizational forms that reflect the extremes of organizational design (Burns & Stalker, 1961). The authors differentiate between a mechanistic and an organic structure and characterize them along the five dimensions specialization, formalization, centralization, hierarchy, and communication.

A mechanistic structure is defined by a high degree of formality including many rules and standardized processes, specialized and clearly determined tasks for individuals, a centralized structure, a strict hierarchy of autonomy, and primarily vertical communication towards the top of the of the organization (Burns & Stalker, 1961). Such a mechanistic system enables firms to efficiently set up operations and is thus most suitable in stable industry environments (Burns & Stalker, 1961). The other extreme, the organic management system, is appropriate for changing environments, where problems cannot be strictly broken down. Burns and Stalker (1961) characterize the organic form by an informal setup, individual tasks that are continuously adjusted and redefined with a low degree of employee specialization, a decentralized structure, collaborative work rather than a strict hierarchy, and communication across all levels of the organization.

A centralized setup is associated with the consolidation of knowledge, control, and authority at the top of the hierarchy in an organization, whereas a decentralized system follows an approach of a diffused network of control (Daft, 2014). As summarized by Daft (2014), decentralization shows more flexibility, a higher involvement of individuals, and quicker decision-making. Higher focus on horizontal coordination further encourages adaption to changing environments and increased levels of innovation (Daft, 2014). However, the author also acknowledges the risk of inefficient communication as well as agency problems, resulting from competing objectives which might lead to a preference of a centralized structure in certain environments (Daft, 2014).

The orientation of the organization towards exploration or exploitation, or a combination of both further influences the structure (March, 1991). As has been noted before, diverging focuses might require a distribution across time or space in order to achieve desired outcomes (March, 1991). Gupta *et al.* (2006) recognize that there is little consent about the way organizations can achieve such a balance. They discuss two main mechanisms introduced in earlier research: simultaneous ambidexterity and punctuated equilibrium (Gupta *et al.*, 2006). According to Benner and Tushman (2003), an ambidextrous structure refers to an organization where exploration and exploitation coexist in highly differentiated, loosely connected subunits. Building on the established concept of orthogonality, they argue for coexistence and suggest that exploration and exploitation can be pursued simultaneously if they are delegated to organizational subunits (Gupta *et al.*, 2006). A spatial separation enables corporations to pursue both exploitative and explorative activities at the same time across departments or domains (March, 1991).

Gupta *et al.* (2006) emphasize that this structure is only applicable in the organizational context, not for a single subsystem or individual. A punctual equilibrium poses the second option for the management of exploitation and exploration within an organization, where the firm applies a cyclical structure and gives sequential attention to either exploration or exploitation (Gupta *et al.*, 2006). According to Gupta *et al.* (2006), this structure is especially suitable if exploration and exploitation are mutually exclusive, such as when the activities compete for scarce resource and their domains are closely related.

Gibson and Birkinshaw (2004) develop an additional approach, which they classify as contextual ambidexterity, and strives to combine alignment and adaptability within one unit rather than building on separation. The authors argue that in organizations where the contextual factors discipline, stretch, support, and trust are successfully in place, individuals can engage in both exploitation and exploration within one business unit. These contextual factors encourage ambidextrous behavior and enable employees to individually judge on how to divide resources depending on differing demands within one business unit (Gibson & Birkinshaw, 2004). In essence, this approach reflects a *"multidimensional construct, with alignment and adaptability each constituting a separate, but interrelated, nonsubstitutable element"* (Gibson & Birkinshaw, 2004, p. 211). This stands in direct contrast to previously elaborated ambidextrous organizations where efficiency and innovation activities are strictly separated (Gupta *et al.*, 2006). Gibson and Birkinshaw (2004) argue that contextual ambidexterity resolves the coordination dilemma which occurs between business units in a structural ambidexterity, as they do not further diverge in their activities with regards to exploitation and exploration. Moreover, separating existing processes and business development into different units necessarily creates cooperation costs that can be avoided by establishing a contextual environment for ambidexterity within a unit (Gibson & Birkinshaw, 2004). Instead of only accounting for the organizational level, arguments first brought up by March (1991) are applied on the business unit level. Highest performance in a business unit can thus be facilitated if business units devote to *"aligning themselves around adaptability"* (Gibson & Birkinshaw, 2014, p. 221), therefore building a balance between efficiency and innovation.

3.5 Choice of Theoretical Concepts

In line with the existing literature on CVC, we consider knowledge as the essential resource that is aimed to be acquired or created through CVC and the subsequent learning processes (Keil *et al.*, 2008; Maul *et al.*, 2005; Weber & Weber, 2007). Therefore, we build our theoretical foundation on the knowledge-based view and its assumptions on the criticalness of knowledge for the generation of Ricardian rents (Grant, 1996). However, we consider this perspective on CVC incomplete, as it neglects the dyad between the investing corporation and the venture firms (Zahra & Allen, 2006). Yet, it is often specifically the underlying relationship that enhances knowledge transfer and assimilation beyond the actual transaction (Foss *et al.*, 2013). Zahra and Allen (2006) discuss that the collaboration between investing corporations and venture firms is necessary as *"when a relationship develops between two or more social actors, it becomes possible for them to share what they know, collaborate, and reveal the 'hidden code' in the information being transferred."* (p. 394). Therefore, it is not the knowledge itself that generates supernormal rents, but rather the joint interaction between incumbent and venture (Zahra & Allen, 2006). Weber *et al.* (2016) find the relational concept (Dyer & Singh, 1998) to be applicable and explanatory in the context of CVC.

This work attempts to shed light on the structural aspects of CVC units and subsequent implications on incumbents' innovation performance. The identified character dimensions reveal large differences especially in the decision-making authority, personnel decisions, and orientation of the units [5]. Building on the work of Weber *et al.* (2016) on the suitability of the relational view (Dyer & Singh, 1998) on CVC, we consider the structural differences to particularly affecting the relationship between incumbents and venture firms. In accordance with Zahra and Allen (2006) as well as Weber *et al.* (2016), we therefore extent the perspective of the knowledge-based view (Grant, 1996) with its assumptions on organizational learning by the relational view (Dyer & Singh, 1998) in order to develop a suitable theoretical model in the context of CVC to answer our research question.

[5] For a complete overview of the identified character dimensions and the differences of internal and external CVC units we refer to *Table 1*.

4 Conceptual Development

The existing literature on the impact of CVC focuses on the acquisition, transfer, and ultimately creation of knowledge to increase innovativeness. Surprisingly, little effort has been made to analyze the influence of the CVC unit's structure on the innovation performance of incumbents. Our work attempts to fill this gap by developing a theoretical model that seeks to explain the potential relationship between structural differences in CVC programs and knowledge creation. In this section, we will build on the presented theoretical approaches of the knowledge-based view (Grant, 1996) and the relational view (Dyer & Singh, 1996) to connect organizational learning with the construct of CVC. We thereby recognize knowledge as the key resource for innovativeness, while arguing that this knowledge becomes especially valuable when embedded in effective relationships (Zahra & Allen, 2006). Based on the previously presented theories, we apply theoretical reasoning to evaluate the two predominant structural forms of CVC programs regarding their impact on innovativeness. We differentiate between an organization's internal setup to seek direct investments in ventures and the establishment of a sperate legal entity, as these two modes pose the largest structural differences.

4.1 The CVC Investor – Venture Firm Relationship

In the ambition of sustaining a competitive advantage, an organization's overall goal is to achieve superior economic rents by ensuring both current revenue streams through exploitation of existing knowledge and future revenues by innovating through exploration of new knowledge (March, 1991). Organizations are therefore required to frequently pursue efforts to learn by acquiring and creating knowledge, which resembles a critical resource (Dodgson, 1993; Grant, 1996; Huber, 1991). Existing research has demonstrated the criticalness of external knowledge sources to enable such organizational learning for the company's competitive advantage (Chesbrough, 2003; Laursen & Salter, 2006). Further, it is not only the acquisition of external knowledge in general that increases innovativeness, but also the degree to which the firm is able to absorb and transform that knowledge into valuable output after initially acquiring the knowledge (Dushnitsky & Lenox, 2005b). In the process of exploration, organizations can specifically enhance organizational learning by leveraging the interorganizational relationship to external knowledge sources and subsequently gain a competitive advantage (Dyer & Singh, 1998; Weber & Weber, 2007). The maintained relationships enable firms to achieve "*a supernormal profit jointly* *generated in an exchange relationship that cannot be generated by either firm in isolation"* (Dyer & Singh, 1998, p. 662).

CVC remarks the prime example for an organization's external explorative activities (Wadhwa & Basu, 2013). Even though there is some financial objective connected to CVC, scholars have repeatedly highlighted that firms predominantly pursue CVC as a window to new technologies (Winters & Murfin, 1988), as an accelerator for organizational learning and absorptive capacity (Dushnitsky & Lenox, 2005a; Keil et al., 2008), and as an indicator for trends in the industry (Keil et al., 2008).

Interestingly, most literature on the influence of CVC focuses solely on the above-mentioned window to new technology, thus ignoring subsequent relationships with the venture firms and further handling of the new knowledge (Wadhwa & Kotha, 2006). Thereby, the literature mostly takes on a transactional perspective rather than stressing relational aspects (Zahra & Allen, 2006). However, some studies reveal that there is a significant connection between a firm's involvement with portfolio companies and knowledge creation (Keil *et al*., 2004; Wadhwa & Kotha, 2006). Such involvement can be achieved through the successive investment in relationships with the ventures, for instance through board seats in the portfolio companies (Dushnitsky & Lenox, 2005a; Zahra & Allen, 2006). In this sense, it becomes evident that the explorative activity of CVC consists not only of the direct access to new knowledge, but also of the intensive engagement with the external sources of the recognized opportunities to enable knowledge creation and ultimately gain a competitive advantage (Keil *et al.*, 2004; Zahra & Allen, 2006). Weber *et al.* (2016) support these findings and point out the potential of relational rent-generation of CVC activities.

Considering the relational view, it can therefore be argued that it is especially the consecutive interactions between the CVC unit as a representative of the investing organization and the portfolio companies that create value and unique relational rents and therefore ultimately strengthen the innovativeness of firms (Weber *et al.*, 2016). Such relational rents from engagement with external knowledge sources can significantly enhance general organizational learning opportunities if maintained beyond the initial knowledge access (Foss *et al*., 2013; Weber *et al*., 2016). The determinants of the relational rents are the *relation-specific assets, interfirm knowledge sharing routines, complementary resource endowments*, and *effective governance systems* (Dyer & Singh, 1998). The extent to which incumbents invest in these key factors, and more importantly how the structural differences of internal and external CVC units impact them, will determine the potential to generate relational rents and thus amplify organizational learning (Weber *et al.*, 2016).

Foss *et al.* (2013) argue that a decentralized approach within an organization can promote the required environment for relationship building with external sources of knowledge. Yet, existing CVC literature has so far largely neglected the question of how to structurally embed CVC programs in the corporation's locus to best facilitate close interactions for optimal relationship building with the venture. In line with Foss *et al.* (2013), we conceptualize that the structural aspects of CVC units inherently influence the innovativeness of organizations through their effect on the determinants for relational rents. Furthermore, existing literature has highlighted the influence of experience on relationships through routine building and the reinforcement of trust-based ties over time (Dyer & Singh, 1998; Wadhwa & Basu, 2013; Weber *et al.*, 2016). We therefore implement experience as a moderating factor into our model. Another emerging aspect to be considered is the uncertainty that is associated with minority equity investments (March, 1991; Yang *et al.*, 2009). More specifically, we consider this aspect as a potential moderating factor of the relationship between the corporation and the venture firm with reference to Williamson's (1991) argumentation about the risk of misalignment of partners due to uncertainty in the transaction. *Figure 3* summarizes our abstraction for the process of relational rent-generation between the investing corporation and the venture firm through CVC.

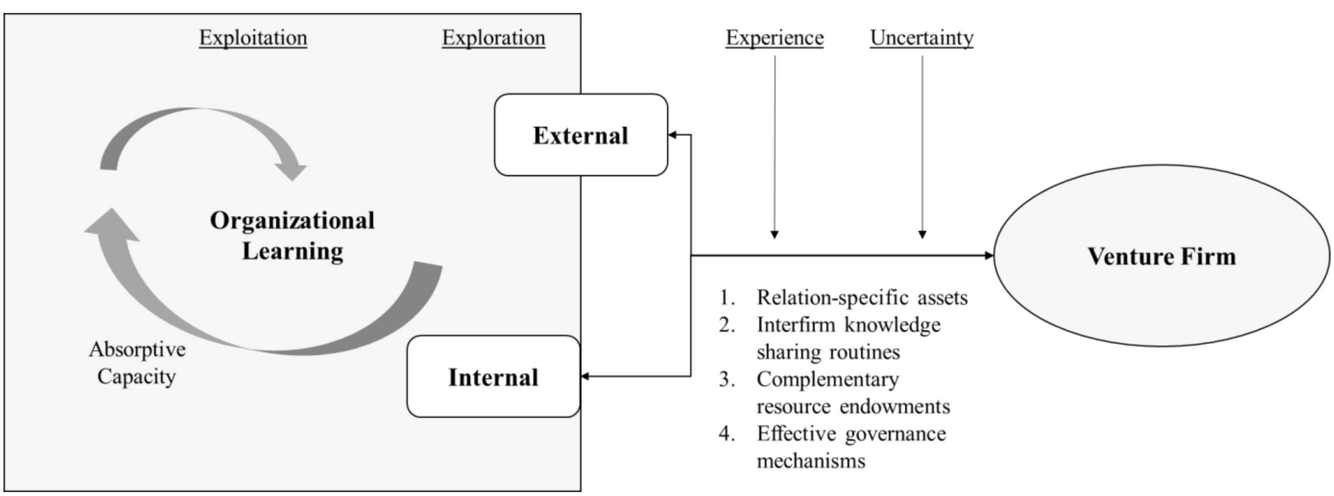

Figure 3 *Relational rent-generation between the incumbent and the venture through CVC*

Our work seeks to explain the structural effects of CVC units on the innovativeness of corporations. In the following, we will therefore use the developed conceptualization to theoretically analyze this effect based on the relationship between the CVC unit and the venture firm and the influences on the determinants of relational rents. Ultimately, we derive three hypotheses which will be empirically tested (*Figure 4*).

4.2 External CVC Units as Facilitator for Relational Rents

Our comprehensive review of the existing literature on the different modes of CVC programs has revealed several diverging character dimensions. We expect these characteristics to have an influence on how effective the CVC unit creates relational rents with the venture firms because of the inherently different orientation the modes reflect. We examine the different characteristics along the four determinants for relational rents introduced by Dyer and Singh (1998) to investigate which structural mode, internal or external, is superior for generating relational rents with venture firms.

A CVC unit's structure can influence the *relation-specific assets* a corporation commits to the relationship. Dyer and Singh (1998) show that a longer duration of the relationship and a higher frequency of interaction positively affect the potential for relational rent-generation. Weber *et al.* (2016) argue that particularly human asset specificity is of importance in the context of CVC, which accumulates through social interactions in relationships. We associate external units with a higher potential for the maintenance of relationships with start-up companies, because they are established as dedicated CVC programs, thus having the required resources and incentives to particularly focus on the relationship (Asel *et al.*, 2015). Contrarily, internal CVC programs are typically embedded in existing operating business units that also pursue other business matters and might not pay the same level of attention to venture firms (Winters & Murfin, 1988). In this case, exploitation and exploration activities reside in the same unit, which can potentially cause problems, as has been elaborated earlier (March, 1991). The stronger orientation of external units towards the portfolio companies strengthens the role of the investment manager in *"having a bird's eye view, [and to] act as a gatekeeper"* (p. 276) to support the venture in finding the focal contact points within the corporation (Weber *et al.*, 2016). Further, external CVC investors primarily recruit professional venture capitalists with previous investment experience and capabilities as well as a greater network in the VC community (Asel *et al*., 2015). In contrast, internal programs tend to mobilize personnel from within the organization with large firm-specific knowledge and strong ties to internal units (Asel et al., 2015). Accordingly, we argue that the employees of external units can better build and maintain in-depth relationships to the ventures due to their relational fit and experience in dealing with entrepreneurs and thereby facilitate the absorption and ultimately the creation of knowledge for the incumbent firm (Weber & Weber, 2007). This is shown to be of high importance in the corporation-venture relationship, because the management team in the venture is often the actual target of the investment (Weber *et al.*, 2016). Furthermore, the higher level of decentralization and long-term financial commitment associated with external CVC programs signal a stronger devotion towards the venture investments and additionally convey longevity of the CVC activities (Siegel *et al.*, 1988), which can enhance the potential for relational rents (Foss *et al.*, 2013). Especially more autonomous decision-making enables the CVC unit to further commit to relation-specific assets and thus react faster to arising opportunities that can create new knowledge (Hill *et al*., 2009). Contrastingly, internal CVC programs experience less distance due to closer ties to other internal structures which increases the risk to fail to recognize the full potential of knowledge opportunities from outside sources (Asel *et al*., 2015).

Interfirm knowledge-sharing routines are defined as regular repetitive interactions within relationships with the purpose of learning (Dyer & Singh, 1998). They enable the partners to identify where the new knowledge resides and how to connect it with existing organizational knowledge. In particular, such routines can for instance be facilitated by maintaining a board position in the venture firm and realizing regular meetings to ensure knowledge sharing (Dushnitsky & Shapira, 2010). To evaluate which unit structure best facilitates potential relational rents through knowledge-sharing routines, we shall consider two aspects introduced by Dyer and Singh (1998): partner-specific absorptive capacity and alignment of incentives. With regards to partner-specific absorptive capacity, external units might have an advantage resulting from investment experience which facilitates the managers' understanding of the needs of the entrepreneurs (Yang *et al.*, 2009). Considering the required alignment of incentives, the diverging orientation of internal and external CVC programs (Asel *et al.*, 2015; Souitaris *et al.*, 2012) and the involvement of the parent organization (e.g., Asel *et al.*, 2015; Dushnitsky & Shaver, 2009) play an important role. Strong relational ties and a high level of involvement from the corporation can hinder investment managers in the CVC unit to fully embrace the relationship with venture firms and support their development through interfirm knowledge-sharing routines (Dushnitsky, 2004). This is further reinforced by the differences in compensation in internal and external CVC units (Sykes, 1992). While personnel in external units is often compensated with performance pay and is thus incentivized to actively engage in the relationship with ventures, personnel in internal units might not be motivated to the same extent (Dushnitsky & Shapira, 2010; Sykes, 1992). Therefore, external units with orientation towards the portfolio firms (Asel *et al.*, 2015) are able to signal more commitment and transparency to the start-up companies, which discourages free-riding and lowers the ventures' fear of imitation through the corporation (Dushnitsky, 2004).

Complementary resource endowments are a determinant for relational rents because the relationship allows such resources to be jointly used which increases their value for the partners (Dyer & Singh, 1998). Although the resources of a corporation remain the same irrespective of whether the CVC unit is external or internal, it can be assumed that the orientation towards the parent firm of internal CVC units facilitates access to knowledge residing within the organization, as managers have stronger ties to employees with expertise in other business units (Asel *et al.*, 2015). However, Dyer and Singh (1998) highlight the potential enhancement of relational rents by aligning strategic and organizational complementarities with the venture firms. External CVC units facilitate strategic complementarity compared to internal CVC units because of a higher level of investment expertise and search and valuation capabilities (Yang *et al.*, 2009). Further, they are able to occupy a more prominent and information-rich position in their network, namely the VC community (Yang *et al.*, 2009). External CVC units also increase the potential for generating rents from complementary resources since their organizational setup is associated with a lower degree of formality and hence the culture often resembles that of entrepreneurial firms (Souitaris *et al.*, 2012). Lastly, Yang *et al.* (2016) find that more autonomous external CVC units are associated with a more diversified portfolio of venture firms. This indicates that external units are exposed to a higher amount of complementary resources compared to internal units that invest more in related and potentially knowledge-overlapping areas (Weber *et al.*, 2016). This assumption further supports a higher potential for relational rent-generation by external CVC programs.

The generation of supernormal relational rents can also be facilitated by informal or formal *effective governance system*s that minimize transaction costs and enhance efficiency (Dyer & Singh, 1998). Informal self-enforcing agreements are hereby considered to be of highest potential in the context of

CVC (Weber *et al.*, 2016). Such governance system is particularly represented by a high level of trust and reputation, as these factors enhance the willingness to share knowledge (Dyer & Singh, 1998). Weber and Weber (2007) support this finding in the context of CVC by explicitly showing a positive influence of trust and the relational fit on knowledge transfer. Trustful relationships become particularly important as the entrepreneurs have a say in selecting their investors and thus might hinder the organization from receiving access to and absorbing the knowledge of interest (Dushnitsky, 2004; Dushnitsky & Shaver, 2009). As mentioned, venture firms show a stronger fear of imitation, and therefore lower levels of trust towards the CVC unit, if it is stronger connected to the investing corporation (Dushnitsky, 2004). Accordingly, CVC programs that are structurally separated from their parent organization can mitigate such fear and thus lower transaction costs through a more effective governance system (Dushnitsky, 2004). Additionally, the distance from the corporation enables external units to better implement incentive-based pay for employees as a direct result from lower interactions and fewer tension points with other corporate business units (Dushnitsky & Shapira, 2010; Sykes, 1992). In accordance with Dyer and Singh (1998), we argue that aligned interests and enhanced motivation from well-defined incentives maximize the value of transactions and thus increase the potential for high relational rents. Consequently, we assume that CVC units established as external wholly owned subsidiaries better reinforce effective governance mechanisms through trust building and incentive alignment and thus benefit from relational rents that ultimately enhance the innovativeness of a firm.

Through the elaborated characteristics and their associated implications, we demonstrate how externally structured CVC programs can build stronger relationships and thereby facilitate valuable interactions to the ventures and the VC environment (Dushnitsky & Lenox, 2005a; Foss *et al.*, 2013; Hill *et al.*, 2009). Accordingly, we predict higher relational rents in the form of improved organizational learning through knowledge assimilation, which eventually enables increased innovativeness. We therefore expect an *external* effect and formulate the following hypothesis, which we will empirically investigate in this work.

H1: Incumbents with external CVC programs are associated with a higher level of innovativeness compared to incumbents with internal CVC programs.

4.3 The Moderating Effect of Experience

In the following, we will first discuss the potential impact of the investment experience of CVC units on the incumbent's innovativeness considering the CVC program's relationships with venture firms. Subsequently, we argue for a moderating effect of experience on the impact of the structural setup on innovativeness. The importance of experience in the process of organizational learning has already been highlighted by Levitt and March (1988), as they discuss the process of routine building and the concept of learning to learn. An increased exposure to learning opportunities moreover positively affects the absorptive capacity of an organization, which enables the firms to better explore external information and create knowledge (Cohen & Levinthal, 1990).

The concept of organizational learning is well applicable in the context of CVC, as repetitive encounters with learning opportunities help organizations to build and improve routines and capabilities as well as to generate new knowledge and create value (Yang *et al.*, 2009). Yang and his colleagues (2009) show that experience is associated with the creation of selection and valuation capabilities necessary for the investment process. Experienced CVC units are therefore better able to identify high quality target firms, which we assume to be associated with better knowledge and can thus facilitate higher levels of innovativeness for the parent corporation (Yang *et al.*, 2009). An increase in experience does not only improve the investment decisions of the CVC program, but also builds routines and capabilities across the parent corporation to absorb and transfer the newly gained knowledge (Levitt and March, 1988). For instance, the corporation adapts intra-organizational knowledge transfer routines by developing ties and coordination lines between the CVC program and key persons within the organization who can further apply the new information and create new knowledge (Foss *et al.*, 2013). Moreover, a higher level of investment experience brings larger exposure to a bandwidth of new knowledge, which improves the absorptive capacity of the CVC unit and the corporation enabling them to best utilize the external information and ultimately increase innovativeness through knowledge creation (Cohen & Levinthal, 1990).

As previously discussed, Dyer and Singh (1998) reveal that greater interfirm knowledge-sharing routines as well as partner-specific absorptive capacity can lead to a higher value creation in the relationship. Wadhwa and Basu (2013) further indicate that more experienced CVC programs are likely to build a reputation in the venture capital community as well as implement monitoring structures for improved management of their portfolio firms. We therefore argue that experience facilitates relationship building with external knowledge sources through more intense and frequent interactions and hence promotes knowledge creation.

Based on this reasoning, we expect the experience to have a moderating effect on the structural influence of CVC units on the innovativeness of incumbents. We argue that the ability to build interfirm relationships is most critical for the knowledge creation of investing firms (Foss *et al.*, 2013). While characteristics of external units such as decentralization promote relationship building with the ventures and the VC community, internal units might lack the appropriate structure to promote those ties (Foss *et al.*, 2013). Further, we state that experienced venture capitalists mostly recruited by external corporate investors have stronger investment capabilities (Asel *et al.*, 2015; Yang *et al.*, 2009). Nevertheless, we expect a diminishing effect of these advantages of external units, when the experience of the CVC investor is high since the internal programs overcome the difficulties in building meaningful relationships with external knowledge sources by being continuously exposed to ventures and the VC environment (Yang *et al.*, 2009). Through continuous interaction, internal CVC units can strive to build a trust base and reputation across their network (Weber *et al.*, 2016). Moreover, we described how experience facilitates the building of screening and valuation capabilities (Yang *et al.*, 2009). We argue that such learning is less relevant for external programs but more important for internal CVC programs since the personnel mostly does not hold any previous experience and investment capabilities at first. By establishing external ties and facilitated learning, internal CVC units can therefore increase the potential to generate relational rents through additional investment experience.

In addition, Foss *et al.* (2013) highlight the requirement for coordination to enhance knowledge creation and transfer when decision-making-authority is decentralized. As knowledge lies within individuals, coordination is essential to ensure a constant exchange of such knowledge (Cohen & Levinthal, 1990), which is inherently at risk as decentralized structures emerge within the corporation and communication lines are less direct (Daft, 2014). The relatedness of internal units towards the parent organization (Asel *et. al.*, 2015) eases such coordination within the corporation through existing communication or reporting lines. Moreover, it facilitates the establishment of internal, but also external knowledge-sharing routines (Weber *et al*, 2016). The close involvement poses further potential for generating relational rents through increased interaction with the venture due to higher technical expertise and the improved identification of complementary resources due to objective alignment (Foss *et al.*, 2013; Weber *et al.*, 2016). The effect of investment experience appears to have similar implications on CVC relationships as that of the external structure. We therefore anticipate that experience negatively moderates the structural effect on the innovativeness of incumbent firms. We propose the following hypothesis.

H2: The level of experience negatively moderates the structural impact of CVC units on the incumbent's innovativeness.

4.4 The Moderating Effect of Uncertainty

March (1991) denotes that explorative activities of organizations often come with high uncertainty since they primarily concern unrelated environments and technologies. Accordingly, they bear the risk of failure and often lead to unexpected or even negative outcomes (March, 1991). We will therefore analyze the influence of uncertainty for relational rent-generation and particularly focus on how it can moderate the structural effect of CVC units on the innovativeness of incumbents.

Prior literature shows that CVC investors face large uncertainties since they pursue equity investments in entrepreneurial ventures that have not yet proven their concept (Wadhwa & Basu, 2013). It is therefore difficult to evaluate whether the identified trends and technologies will materialize and thus corporations restrain from investing in relation-specific assets (Dushnitsky & Shapira, 2010). Moreover, the assessment of the ventures' management and development capabilities poses additional risk for the corporate investor (Wadhwa & Basu, 2013). The uncertainty is even higher for investments in venture firms in an early stage of their development since they lack a developed product and a track record of successes (Yang *et al.,* 2009). Investment managers are often not able to collect thorough information about the available opportunities and future demand of the new technologies (Yang *et al.*, 2009). This issue amplifies if the outside information from the venture is primarily of tacit nature and therefore difficult to codify and transfer (Nonaka, 1994). Additionally, entrepreneurs might be especially reluctant to build interfirm knowledge-sharing routines and communicate insights about their technologies as they fear imitation by the corporation (Dushnitsky, 2004). Further, the underlying lack in trust towards the corporate investor negatively affects the potential to generate relational rents from the collaboration due to less effective governance mechanisms (Dyer & Singh, 1998).

As a result of deviating abilities to facilitate outside relationships, we foresee differences among internal and external CVC units in the ability to manage the uncertainty in the investment portfolio. We have argued earlier that external CVC units are able to build more intimate relationships with their portfolio firms which ultimately enhances the transfer and understanding of knowledge (Dyer & Singh, 1998).

Uncertain and changing environments, such as in CVC, require decentralization in order to facilitate knowledge transfer (Cohen & Levinthal, 1990). However, this requires effective governance systems in relationships to mitigate risk and prevent negative outcomes (Williamson, 1991). Weber and Weber (2007) show that relational fit, manifested through trust, conative, and affective fit, significantly facilitates strong ties between the venture and the investing organization as it establishes an informal self-enforcing governance system. As previously discussed, the relationships between external CVC units and the venture firms are associated to have a higher trust level, relative to internal programs (Dushnitsky, 2004). Thus, these units are expected to have more effective governance systems in place which enhances the probability of knowledge sharing and relational rent-generation under uncertainty (Weber *et al*., 2016).

Moreover, the individual capabilities of the members of the CVC program might play a role in the management of uncertainty. Yang *et al.* (2009) point out the difficulty of managing high uncertainty of CVC investments in changing environments because learning is complicated as there is no time to fully evaluate complex problems when they arise. Employees that are experienced in pursuing VC investments and venture due diligences are rather able to constitute informed judgements about uncertain situations (Dushnitsky & Shapira, 2010). Thus, they are potentially better capable to evaluate investment targets and reduce the risk of bad investments, but also to deal with unforeseen challenges after the initial investment (Yang *et al*, 2009). In the relationships with the venture companies, these capabilities might lead to additional trust and knowledge sharing in case of problems, which inherently increases the potential for relational rents (Dyer & Singh, 1998). Additionally, less knowledge specificity is shown to further support adaptability to new situations in collaboration with the entrepreneurs (Wadhwa & Kotha, 2006). The inference arises that external units might be able to better achieve knowledge creation under uncertainty, given the fact that they tend to employ VC-experienced personnel, whereas internal units primarily recruit from inside the organization with more company-focused knowledge (Asel *et al.*, 2015).

Lastly, we consider the different degrees of autonomy among internal and external CVC units. Since the transfer of knowledge can be difficult under high uncertainty, for instance due to its tacit nature and the fast-changing environment, it seems beneficial to delegate the decision-making authority to the location where the knowledge is acquired (Grant, 1996). This is particularly given in external CVC units characterized by decentralization and independence from the parent organization (Siegel *et al.*, 1988). The delegation of autonomy to the external CVC unit as well as long-term committed capital amplify fast decision-making and adaptability (Asel *et al.*, 2015). Moreover, it incentivizes investment managers to maintain close relationships to venture firms for increased knowledge-sharing in order make well-founded decisions in uncertain environments. Concluding, we derive the following hypothesis on the moderating effect of uncertainty.

H3: The level of uncertainty positively moderates the structural impact of CVC units on the incumbent's innovativeness.

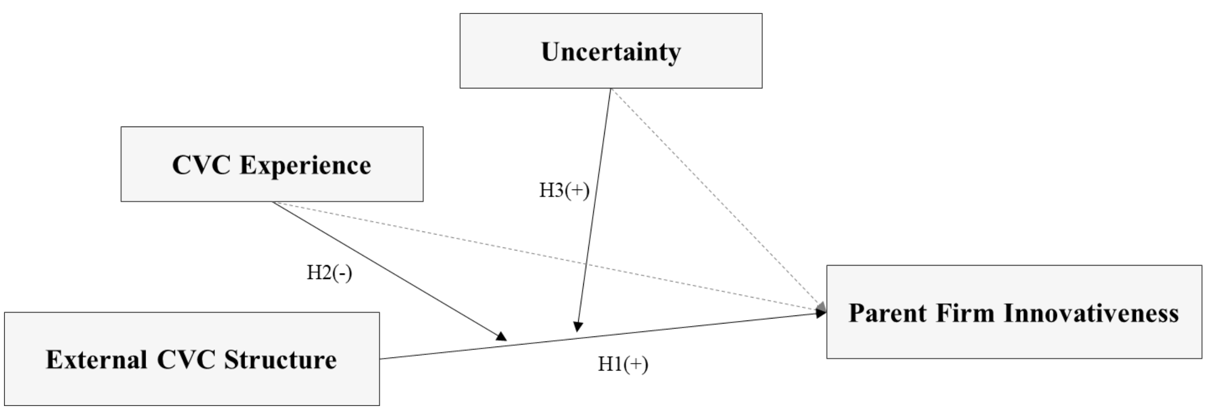

Figure 4 *The theoretical model*[6]

[6] Full arrows represent the derived hypotheses, dotted arrows show controlled relationships.

5 Methodology

Based on the exposition of Saunders, Lewis, and Thornhill (2016), the following section will provide an overview about the scientific stance and methodology we used in our work in order to answer our research question. We will first focus on the research philosophy to elaborate on the view and assumptions we make while conducting our study but also explain the approaches to develop our theory and hypotheses. Thereafter, we will put focus on the implemented research design by describing our methodological choice and the undertaken strategies as well as the considered time horizon. We highlight that we developed the methodological approach in line with the objective of our research, which entails to unveil a potential relationship between the structure of a CVC unit and the parent’s innovation performance.

5.1 Research Philosophy

This work relies on the ontological stance and the assumptions of the positivism as we take an objective and explanatory view to study the reality as we see it (Veal & Darcy, 2014). In our research, we aim to detect unambiguous regularities by using observable data (Saunders *et al.*, 2016). We claim to take a detached approach to our collection and analysis of measurable data, which we believe reflects the reality and therefore allows us to observe meaningful contributions. For the theory development, we find a deductive approach to be most applicable (Saunders *et al.*, 2016). We initially formulate our research question and use established concepts from previous works to build up our argumentation considering a set of boundary conditions and derive testable hypotheses, which we will subsequently evaluate in our empirical analysis. We operationalize the applied concepts from the CVC literature and our developed theory to obtain measurable and observable data. Especially, we apply reductionism by classifying the underlying structural setups of CVC units into two categories, namely internal and external programs, differentiating them by their legal independence from the parent organization. Moreover, we intent to widely generalize our results to a variety of companies (Saunders *et al.*, 2016). Therefore, we direct particular attention to selecting our sample and retaining a large size over the course of the study.

5.2 Research Design

In order to follow the previously described chosen methodological stance and our research focus, we have decided to pursue a multiple-method quantitative research design, which allows us to investigate our research question empirically with a large richness of data (Saunders *et al.*, 2016). We collect new data on the structural setup of CVC and complement it with archival secondary data on investments, financials and patents. Although secondary data can be biased, we consider its use as most beneficial for our research purpose due to its availability, completeness and reliable source (Veal & Darcy, 2014). Although our study entirely relies on quantitative data, we want to highlight our initiating endeavor to better understand the research's underlying context and problem by conducting qualitative semi-structured interviews (Saunders *et al.*, 2016) with five industry experts from different CVC units. This enabled us to first explore underlying mechanisms while simultaneously seeking for the most essential aspects for our research. The generated insights will be used at a later stage of this work to support the interpretation of our empirical results and put them into perspective (Saunders *et al.*, 2016). Due to the limited scope of this thesis as a result of constraints in time and resources, we restrained from including qualitative data such as large-scale questionnaires or surveys in our empirical analysis. This further enables an important contribution to existing research in the chosen field, as most existing studies solely focus on qualitative data. (Asel *et al.*, 2015; Siegel *et al.*, 1988).

Based on derived hypotheses, we use the collected data to explain and evaluate the relationship between the structure of CVC units and the innovativeness of the investing corporations based on statistical analysis (Saunders *et al.*, 2016). Given the purpose of our study, we decide to rely on cross-sectional data to *"describe the incidence"* (Saunders *et al.*, 2016, p. 200) of the relationship of the CVC unit's structure on knowledge creation across different organizations, as we assume a stable organizational structure of the CVC unit and therefore treat observations as time indifferent (Matthews & Ross, 2014). By differentiating between the investment and the post-investment period, we can still include a time component to capture the underlying effect. However, we do not strive to claim any causal relationships through our work. We tried to ensure the quality of our research by continuously evaluating the reliability of our model and the validity of the collected data, for instance using high-quality sources and regular tests (Veal & Darcy, 2014). The trustworthiness is aimed to be ensured through the chosen research philosophy (Saunders *et al.*, 2016).

5.3 Data Collection and Processing

In order to empirically investigate our research question, we consult various databases to establish a comprehensive set of data. First, we use *Thomson One Banker* to access granular data of minority investments (Thomson Reuters, 2020). Second, we source firm-specific financial information of the investing corporations through *Compustat* by Standard & Poor's (2020). Lastly, we rely on the publicly available *PatentsView* database, which entails official information on the patents granted or applied for provided by the United States Patent and Trademark Office (USPTO; *PatentsView*, 2020). Our approach aims to aggregate information about the CVC unit, including the structural component and associated investment data, firm-specific measures of the parent organization, and patent data held by the respective parent corporation. The granular investment data from the *Thomson One Banker* database in the period between 1985 and 2015 forms the starting point for our data collection. We identify the investors classified as "corporate" to retrieve minority investments in venture firms conducted by corporations and extract respective information on the name, nation, as well as minimum and maximum investment year, which facilitates the next steps of manual search. The resulting list contains 1,433 distinct investing CVC programs from 49 different nations and constitutes the base for the development of the dataset, which we divide into three phases: (1) the manual collection and cleaning of CVC investor data, (2) the matching of CVC unit and parent with the associated patent data and (3) the creation of the final dataset.

5.3.1 Identification of CVC Investors and the External Variable

In the first phase, we aim to clean the derived dataset from *Thomson One Banker* by identifying and removing non-strategic investors that were falsely classified as "corporate" in a manual evaluation process. We therefore perform an extensive online search to assess the underlying investment purpose by visiting the investor's website or accessing additional public information, for instance the annual report. This step ensures the reliability and quality of the data because the characteristics of corporate investors highly differ from those of non-strategic investors. More concretely, we exclude investors if the investment purpose is financially driven and no strategic value is recognizable, as is the case for IVC, large institutional investors, such as insurances, asset management firms, investment and commercial banks, as well as for holding firms, conglomerates, real estate firms, and non-profit organizations. For instance, we exclude a commercial bank, which invests for financial returns only, but include it when they seek strategically relevant investments, such as in Fintech or similar. Through this screening, we eliminate 519 falsely classified investors, which reduces our dataset to 914 strategically driven CVC investors. Consequently, we conclude that the classification of corporate investors of *Thomson One Banker* is not fully adequate and requires an additional manual assessment.

We then extend the derived dataset by undertaking further data collection to code the CVC programs as internal or external and to determine the associated parent corporation. This requires a manual approach and pervasive online search. We therefore review the investors' 10-K SEC filings including the list of subsidiaries in Exhibit 21, the annual reports, or other national equivalents, but also utilize the granular data of *Thomson One Banker* to find additional disclosed information like press releases on investment specifics. We ensure high validity by using official and highly reliable sources and perform two evaluation iterations on all relevant entries. Particularly, we collect two types of data of the corporate investors.

First, we aim to identify the CVC unit's underlying structural setup, which will serve as our independent variable. Following Dushnitsky and Shaver (2009), we code a binary variable based on the existence of a separate legal entity, which differentiates internal and external CVC units. Accordingly, the value of the variable equals 1 (external unit) if the program is structured legally independent from the parent as an own entity, fund or wholly owned subsidiary and operates as a dedicated CVC investor, and is therefore not involved in the firm's primary operations. If the CVC unit invests from the balance sheet and within the structures of the corporation the value of the variable is set to 0 (internal unit). While conducting our analysis, we notice that a high degree of missing information for investments pursued before 2000 imped our analysis. Consequently, we flag investors with such unclear legal structures by using a binary variable, so we can control for the reliability of the data at a later stage.

Second, we determine the associated parent corporation of the CVC investors in order to match the CVC unit with the parent's financial data and patent information. As a reference, we exploit the *Compustat* database, which provides a thorough overview of public companies including its location of listing (North America and global). If we can exclusively assign the parent organization to an entry in the *Compustat* database based on our online search, we directly use the respective corporation's name. For privately held companies, which are not included in *Compustat*, we apply the parent organization's name identified through our manual research. However, we later decide to exclude non-public companies to establish a reliable set of data, as no financial data is available for private companies in the *Compustat* database. Some difficulties further arise in finding the appropriate parent corporation when changes in the organization's history occur, such as through mergers and acquisitions (M&A) or spin-offs. In summary, we derive characterizing information on the CVC unit (name and nation), the years of minimal and maximum investment, the structural setup, the binary variable for data validation purposes, and the name of the parent corporation.

5.3.2 Matching of CVC Unit, Parent Organization, and Patent Database

In the second phase of the construction of the dataset, we manually match the identified CVC investors and their parent organization to the patent assignees retrieved from PatensView, which will constitute our dependent variable. For this purpose, we reduce the data on the patents to the assignee name, the assignee ID, and the number of patents. The degree of complexity of this exercise increases due to a fairly poor quality of data as already described in previous studies (Hall, Jaffe, & Trajtenberg, 2005). Particularly, we observe that one parent organization can be associated with multiple patent assignees with differing assignee IDs. In turn, the same assignee ID can also contain numerous entries due to abbreviations or misspellings. However, we can mostly identify one dominating entry which aggregates the majority of the assigned patents for the same assignee ID. As there is no unambiguous common identifier, we use the name of the parent organization to manually search for relevant entries within the PatensView database. We include all associated entries with a unique assignee ID, but only consider the one entry per assignee ID which unites most of the assigned patents. All patents per assignee will later be aggregated based on the unique assignee ID. Ultimately, we combine the CVC program's name with the parent organization's name and the associated patent data of all relevant assignees with unique assignee IDs. We utilize the parent organization as the common identifier to ensure a unique matching from the assignee to the CVC unit for every entry, which we will exemplify in the following.

CVC Unit	Parent	Assignee Name	Assignee ID
BMW i Ventures	BAYER MOTOREN WERKE AG	BMW Rolls-Royce GmbH	f0f8dc951e2e94716b1645e1ea39366a
BMW i Ventures	BAYER MOTOREN WERKE AG	Bayerische Motoren Werke AG	2e9d43cf73603ed007ccdba09c877741
BMW i Ventures	BAYER MOTOREN WERKE AG	Bayerische Motoren Werke Aktiengesellschaft	8ebde89594918b97d22deb20e79421c4
BMW Technologies Inc	BAYER MOTOREN WERKE AG	BMW Rolls-Royce GmbH	f0f8dc951e2e94716b1645e1ea39366a
BMW Technologies Inc	BAYER MOTOREN WERKE AG	Bayerische Motoren Werke AG	2e9d43cf73603ed007ccdba09c877741
BMW Technologies Inc	BAYER MOTOREN WERKE AG	Bayerische Motoren Werke Aktiengesellschaft	8ebde89594918b97d22deb20e79421c4

***Table 2** Matching of CVC unit, parent organization, and patent assignee for BMW*

As displayed in *Table 2*, we find that the distinct CVC programs *BMW i Ventures* and *BMW Technologies Inc* are associated with the same parent organization *Bayer Motoren Werke AG* (BMW). In *PatentsView*, we detect three associated assignees for BMW with individual assignee IDs. To ensure the unique matching of the CVC unit and the patent assignee at a later stage, we create one line of entry for every assignee per CVC program and parent organization. In the case of BMW, we observe two CVC programs for one parent organization associated with three assignees, which creates a total of six entry lines.

Moreover, some CVC programs and their associated parent organization cannot be found in the patent databank. We therefore assume that the corporation does generally not apply for or generate any patents. These entries remain empty and will ultimately lead to a patent count of zero. Furthermore, most of the privately held companies, which are not listed in *Compustat*, are not named in the patent database either, which supports the decision to exclude them from our sample. Based on this consideration, we drop 170 CVC units of private companies and proceed with a total number of 744 CVC programs. On the investor level, the resulting data therefore includes the name of the CVC unit, its nation, the years of minimum and maximum investment, the binary variable of the CVC unit's structure and the binary validation variable. Next, we assign all associated parent organizations, which could emerge from the corporation's history, such as from M&A within the investment period. Finally, we are able to connect all relevant patent assignees, the assignee IDs, and the respective total number of patents to the associated parent organization and ultimately to the corporate investor.

5.3.3 Creation of the Final Dataset

In the third phase, we merge the three primary databases in the data analysis software Stata, based on the previously performed manual steps. This creates the final dataset, which we will use for our empirical analysis. We first use the CVC unit's name to retrieve the associated granular investment data from *Thomson One Banker*. As our structural variable remains unchanged over time for the individual programs, we decide to gather cross-sectional data (Saunders *et al.*, 2016) by aggregating the information on the investor's level over the investment period. Since some corporations pursue multiple CVC activities which can even overlap in time, we create one entry for each of the parent's investment activities. We obtain the following list of investment related information from *Thomson One Banker* (*Table 3*).

The minimum year of investment
The maximum year of investment
The investor's experience as the period between the first and last investment
The number of different startups
The number of total investments
The total amount of invested equity in USD
The equity amount invested per investment
The equity amount invested per startup
The number of startups with differing SIC codes from the parent organization
The number of startups in differing nations from the parent organization
The number of investments in early stage
The average number of funding round
The average age of the startups at the time of investment

Table 3 *List of investment information derived from Thomson One Banker*

In the next step, we derive the relevant data from *Compustat*. As already mentioned, *Compustat* distinguishes between public corporation listed in North America and globally. Therefore, we start by separately merging the CVC program, the parent organization, as well as the minimum and maximum investment year with the *Compustat* data for North America and global by using the allocated parent's name. Subsequently, we define the time period of interest by dropping all data before and after the respective investment period of the CVC unit. We want to underline that the investing period and the period with available financial data need to overlap for at least one year to be able to proceed. Since the data availability of financial information is not given for 107 entries of the CVC investors, we continue with 637 CVC programs. We then calculate the average numbers of the various financial information across the investment period on the CVC investor level. An overview of the derived variables can be found in *Table 4*.

Average total assets per year
Average. capital expenditures per year
Average common equity per year
Average costs of goods sold per year
Average total long-term debt per year
Average dividends per year
Average earnings before interest and taxes per year
Average earnings before interest, taxes, depreciation and amortization per year
Average number of employees per year
Average gross profit or loss per year
Average intangible assets per year
Average inventories per year
Average liabilities per year
Average net income or loss per year
Average revenue per year
Average research and development expenses per year
Industry classification as SIC code

Table 4 *List of financial information derived from Compustat*

In the last step, we merge the patent data from *PatentsView* with the previously created investment and financial data. We retrieve various information on the patents granted between 1985 and 2015 (*Table 5*). Particularly, we focus on the total number of utility patents applied for by the parent organization within the investment period of the CVC unit and between the last investment year and 2015 including the number of associated claims and forward citations. As we have previously described, our manual search enables us to unambiguously match the CVC unit and the parent organization with the associated patent assignees. At first, we therefore count the number of patents and take the respective sum of claims and forward citations by assignee ID and application year. We then connect the generated patent data with the respective assignee ID from our dataset. Due to multiple assignee IDs per parent organization, we subsequently aggregate the number of patents, claims, and forward citations of all associated assignees to the parent organization's level by the application year. Lastly, we take the sum of all patents, claims, and forward citations over the investment period and calculate the same variables for the post-investment period until 2015. As already remarked, 135 parent corporations did not generate any patents in these periods. Therefore, we set the respective value to zero. Moreover, 160 programs, 85 external and 75 internal, pursued their last investment in 2015. Since this poses the last year of data availability, we cannot assign any patents for the period after the last investment was made. Even though those entries entail many relevant CVC investors, we decide to exclude them from our data due to misleading information in the final empirical model.

Our final cross-sectional dataset consists of 477 CVC programs of which 367 are internally and 110 are externally structured. It entails the name of the CVC investor, its structure, investment data from *Thomson One Banker*, financial data from *Compustat*, and patent data from *PatentsView*.

Cumulative number of patents applied for during the investment period
Cumulative number of claims for patents applied for during the investment period
Cumulative number of forward citations for patents applied for during the investment period
Cumulative number of patents applied for after the investment period until 2015
Cumulative number of claims for patents applied for after the investment period until 2015
Cumulative number of forward citations for patents applied for after the investment period until 2015

***Table 5** List of Patent Data derived from PatentsView*

5.4 Description of Variables

5.4.1 Dependent Variable

This work attempts to investigate the potential implications on innovativeness deriving from different structural setups of CVC programs. Based on the different goals that CVC units pursue, the performance and thus value creation for the investing corporation might manifest in different areas, which is reflected in the use of several different performance measures in the CVC research field (Siegel *et al.*, 1988; Hill *et al.*, 2009). Recent literature has primarily focused on patents as a proxy of a firm's innovativeness (Dushnitsky & Lenox, 2005a; Trajtenberg, 1990; Wadhwa *et al.*, 2016). Patents reflect the rate of knowledge creation of a firm, as they remark a change in the state of the art of used technologies and further offer information about the exact novelty of the firm's innovation (Hall *et al.*, 2005). While some studies use the cumulative count of patents to operationalize the rate of knowledge creation (Wadhwa & Kotha, 2006), other scholars argue that patents vary significantly in quality and level of novelty and thus cannot be compared (Trajtenberg, 1990). Therefore, multiple studies move away from this rather quantitative measure and use forward citation-weighted patent counts to measure innovativeness as forward citations show the impact of the patent on future patents and innovations and can thus give an implication on the quality of the firm's knowledge creation (Trajtenberg, 1990; Wadhwa *et al.*, 2016). Another measure for the rate of innovation, namely a patent's total claims, can be used. Patent claims essentially define the rights protected by the applied patents. Therefore, claims can reflect the degree of novelty and radicalness of a new patent and are thus applicable to use as a proxy for knowledge creation

(Dahlin & Behrens, 2005). However, patent claims reveal several shortcomings, as complex technologies are often described in more than one patent, thus biasing the ratio of claims per patent (Dahlin & Behrens, 2005).

In this study, we use the patent count as the measure for innovativeness, as the available data is most accurate for this variable compared to claims and forward citations. However, we will consider the alternative innovativeness measure of claims per patent in our robustness tests for our final model. In line with Wadhwa and Kotha (2006), we operationalize the rate of knowledge creation as the cumulative count of patents issued by a firm *i* in the period after the last CVC investment until 2015, which is where our data stops (*Post Period*). Specifically, we use the application date of the patents rather than the granting date in order to reflect the actual period of knowledge creation, as it can take multiple years until a patent is accepted. In order to capture the time lag for the effect on knowledge creation of CVC (Dushnitsky & Lenox, 2006), our study only includes the patents which corporations applied for after the last CVC investment of the parent corporation. We have decided for this approach to avoid including patents which were applied for before the effect of CVC could have occurred. In our final model, the dependent variable is named *Patent Post*.

5.4.2 Independent Variable

The independent variable concerns the structural setup of the CVC units. We opt to differentiate the CVC programs by their legal structure, as we assume the structural differences to be most visible between wholly owned subsidiaries and internal units. Most prior studies in this field have focused on qualitative surveys instead of archival information from available databases, which is why little literature exists on a classification for structural differences (e.g., Asel *et al.*, 2015; Siegel *et al.*,1988). However, more recently Dushnitsky and Shaver (2009) have introduced a binary control variable for the legal setup of CVC programs, distinguishing between wholly owned subsidiaries and internal programs. In accordance with Dushnitsky and Shaver (2009) as well as Yang *et al.* (2016), we operationalize the structure of CVC programs as a dichotomous variable and assign a value of 1 to CVC programs that are legally independent from the parent company and the value of 0 to internally structured CVC units. As has been previously outlined, we conducted an extensive manual search to define the legal form of the CVC programs in our dataset. The variable is denominated as *External* in our final model and the further analysis in this work.

5.4.3 Moderating Variables

Several scholars argue for experience in CVC investments as an influencing factor for knowledge creation (Allen & Hevert, 2007; Gompers & Lerner, 2000; Wadhwa & Kotha, 2006). In order to depict and control for this experience effect, we use the cumulative number of equity investments of the parent organization in the period between the first and the last CVC investment. We operationalize the final control variable as a dichotomous variable where we split the data sample at the median[7] of five investments, thus creating one group of inexperienced CVC units (0) and one group of experienced CVC units (1). We label the variable for the investment experience of CVC programs as *Experience*. Our analysis also investigates a potential interaction effect of the structure and the experience of CVC units. We operationalize this interaction variable as the product of the two dichotomous variables *Experience* and *External* and label the resulting variable as *Experience x External*.

We further build on Dushnitsky and Shapira's (2010) study, which includes the uncertainty of CVC investments. The underlying data is the investment stage of the ventures at the time of the investment. The stages differ depending on the phase a start-up goes through, and whether it has already developed prototypes or generated revenues. It is generally acknowledged that investments in ventures in the early stage are associated with higher risk, which can have significant impact for the investing corporation (Dushnitsky & Shapira, 2010). Based on the underlying data, we have however deemed the simple count of investments in early stage ventures as unsuitable, since the total number of investments of the different CVC programs already varies greatly, and thus no comparability would be given. Therefore, we operationalize the control variable for the level of risk of the proportion of investments in early stage ventures of the total number of investments and further split the data sample at the threshold of 50% in two groups, one group that tends to invest rather in early stage start-ups (1) and one group that tends to invest in later stage start-ups (0). This dichotomous variable is labelled as *Uncertainty*. To test for the potential interaction effect of a CVC unit's structure at the level of uncertainty, we multiply the two dichotomous variables *Uncertainty* and *External* to operationalize the new variable *Uncertainty x External*.

[7] We use the median to create two subgroups of equal size and to adjust for extrema, as the underlying variable appears to be highly skewed.

5.4.4 Control Variables

First, we control for two potential timing effects. This is necessary because the post-investment and investment periods of the organizations in our dataset vary significantly. This is due to the fact that we consider all patents applied for in the period starting in the year after the organization's last investment in a venture until 2015, the last year in our data sample. The length of this period might influence our dependent variable for the reason that the firm has more time to apply for patents (Wadhwa & Kotha, 2006). We operationalize the variable *Post Period* as the number of years between the last investment and 2015. Additionally, we include the investment period (*Investment Period*), operationalized as the number of years between the first and the last CVC investment, to additionally control for the durability of the CVC units. We further use the variable as a control as it can influence the operationalized absorptive capacity, which will be described in the following.

We recognize differences in the existing levels of absorptive capacity of firms, which can influence the generation of new patents in the post-investment periods. We assume that firms with a higher level of existing absorptive capacity generate more patents as they are able to better exploit outside knowledge that flows to the organization. We control for absorptive capacity by considering the cumulative number of applied for and granted patents in the investing period (*Absorptive Capacity*).

We acknowledge that there are firm-specific factors that can potentially influence the level of knowledge creation of a corporation. We therefore apply several control variables commonly used in the analysis of CVC programs to our statistical model. For firm-specific heterogeneity, we control for firm size, financial stability, and slack. We first implement a variable for the investor size because it can have both a negative and a positive impact on the innovativeness of firms (Schildt *et al.*, 2005; Wadhwa *et al.*, 2016). This can for instance manifest in larger financial means or more manpower to invest in R&D and apply for more patents (Cohen & Levinthal, 1990). We employ the average number of employees of the parent organization during the investment period (*Size*) to control for these size effects. Further heterogeneities are controlled for by using the organizations' leverage (*Financial Stability*) as a proxy for financial stability, and the EBITDA-margin as EBITDA over sales (*Slack*) to calculate an approximation for slack. These last two variables might influence knowledge creation as they significantly influence available resources and financial opportunities (Chesbrough & Tucci, 2004). Consistently, we use the average annual amounts calculated over the active investment period for all firm-related control variables to ensure comparability.

Our data set further replicates a large variety of different industries. It is widely recognized that differences in organizational learning with respect to exploitation and exploration occur across those different industries (Dushnitsky & Lenox, 2006; Schildt *et al.*, 2015). Accordingly, we control for such industry-level differences by using dichotomous variables for the most common industries, based on the first three digits of the Standard Industrial Classification (SIC) code (*Industry Dummy*). An overview of all variables of the final empirical model is constituted in *Table 6.*

Variable	Type	Measurement/ Description	Data Source
Patent Post	Dependent	The cumulative count of patents applied for and later granted in the post-investment period	PatentsView
External	Independent	Dummy variable, 1 signifies external, 0 signifies internal	Manual search
Experience	Control	Dummy variable, split by median of investment period; 1 signifies experienced, 0 signifies unexperienced	Thomson One
External x Experience	Moderating	Product of variable *External* and variable *Experience*	Manual search & Thomson One
Uncertainty	Control	Dummy variable, proportion of investments in early stage ventures; 1 signifies early investor, 0 signifies late investor	Thomson One
External x Uncertainty	Moderating	Product of variable *External* and variable Uncertainty	Manual search & Thomson One
Post period	Control	The number of years after the last CVC investment until 2015	Thomson One
Absorptive Capacity	Control	The cumulative count of patents applied for and later granted in the investment period	PatentsView
Investment Period	Control	The number of years between the first and the last CVC investment	Thomson One
Size	Control	The average number of employees in the investing organization during the investment period	Compustat
Financial Stability	Control	The average leverage in the investing organization during the investment period	Compustat
Slack	Control	The average EBITDA margin in the investing organization during the investment period	Compustat

Table 6 *Overview of variables*

6 Results

6.1 Descriptive Statistics

In the following, we provide a descriptive overview of the characteristics of the final 477 CVC programs and their associated parent organizations, which we derived through our previously displayed data collection. We first portray the structural variable considering various dimensions, including the investment experience and uncertainty. Subsequently, we shed light on the patent data, which we apply as our performance measure and dependent variable in the empirical model. Lastly, we analyze the derived data for associations between the previously discussed measures in order to form a better understanding of the underlying dynamics impacting our research. We use the results and the generated insights as a first indication for our empirical model and the subsequent interpretation.

6.1.1 Descriptive Overview of the Structure of CVC Units

In this section, we compile the structural variable of the CVC program in consideration of various different market-specific, firm-specific and investment-specific aspects, for instance the parent's industry and size or the investment experience and uncertainty.

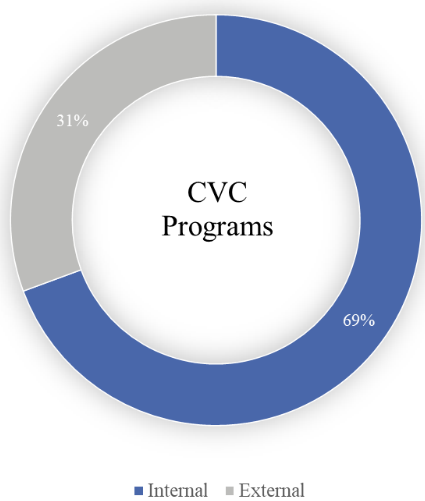

Figure 5 *Distribution of internal (367) and external (110) CVC programs*

The final dataset consists of 477 CVC programs from 444 distinct parent corporations. As shown in *Figure 5*, we observe a high preeminence of internal compared to external CVC programs. While 367 investors, or 77%, are internally structured, 110 units (23%) pursued their investments through a separate legal entity, which indicates a first tendency of parent organizations concerning the underlying structural decision.

Figure 6 shows the distribution of corporate investors across geographies. We notice a high concentration in the United States, accounting for 66.46% of the total sample. Japan accumulates the second most CVC programs with 7.55%. We can detect large differences in the structure of corporate investors across geographies. The programs in Europe are approximately equally distributed among the two forms, while North American corporations are dominated by internal CVC units (83%), which highly impacts the overall distribution of the sample, given the high prevalence of investors in the United States.

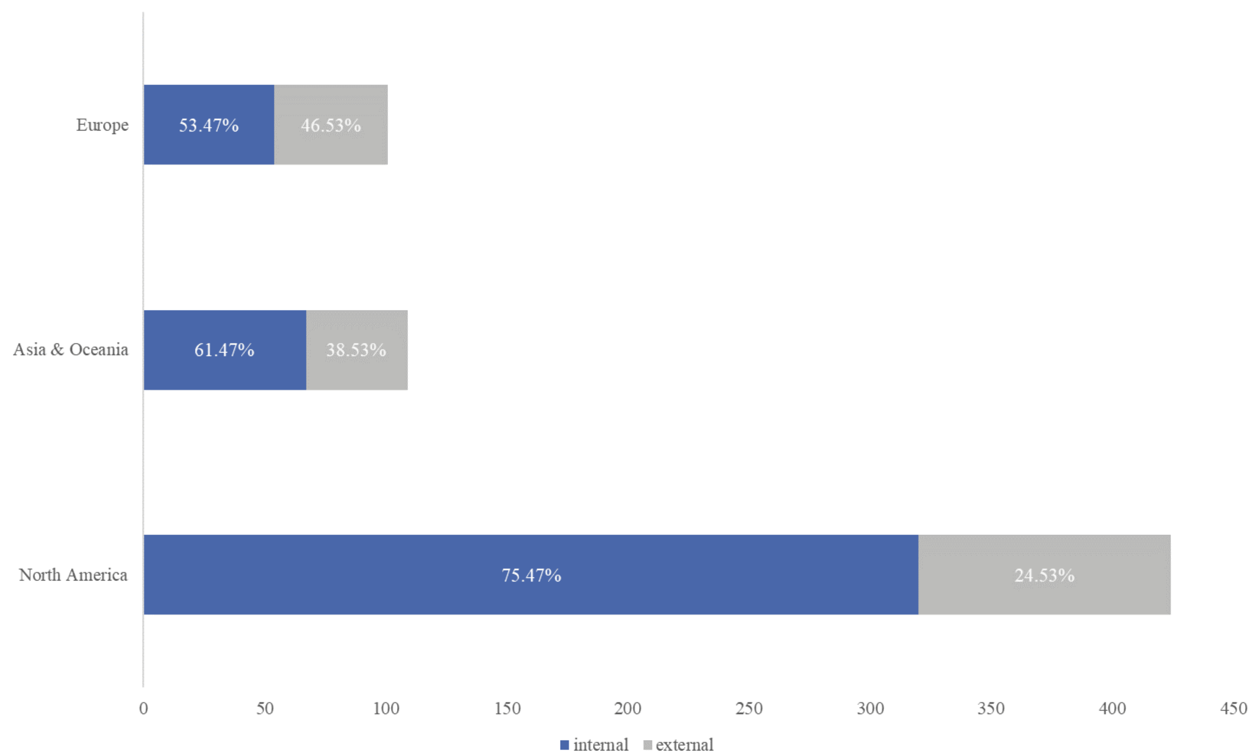

Figure 6 *Distribution of internal and external CVC investors across geographies*

As depicted in *Figure 7*, a similar concentration of CVC programs occurs across industries, which have been classified based on the three-digits SIC code for an in-depth understanding of the data.[8] We find 18.87% (90) of the total sample to be present in *737 - Computer Programming, Data Processing, And Other Computer Related Services ("software"*; e.g., *Microsoft* and *International Business Machines*). The next largest industries *481 - Telephone Communication ("telecommunication"; e.g., AT&T* and *Orange*) and *283 – drugs* (e.g., *Hoffmann-La Roche* and *Pfizer*), each represent approximately 6% of all corporate investors. We find large differences among the structural setup of CVC units across industries. Internal units accumulate shares of more than 80% in industries of the information and communication technology (ICT), such as in *366 - communications equipment* (e.g., *Apple* or *Ericsson*), *367 - Electronic Components and Accessories ("semiconductors"*; e.g., *AMD* or *Texas Instruments),* or *737 – software*. Corporations of other industries, such as in *283 – drugs*, more often establish external CVC units, however, the majority of units is still established internally.

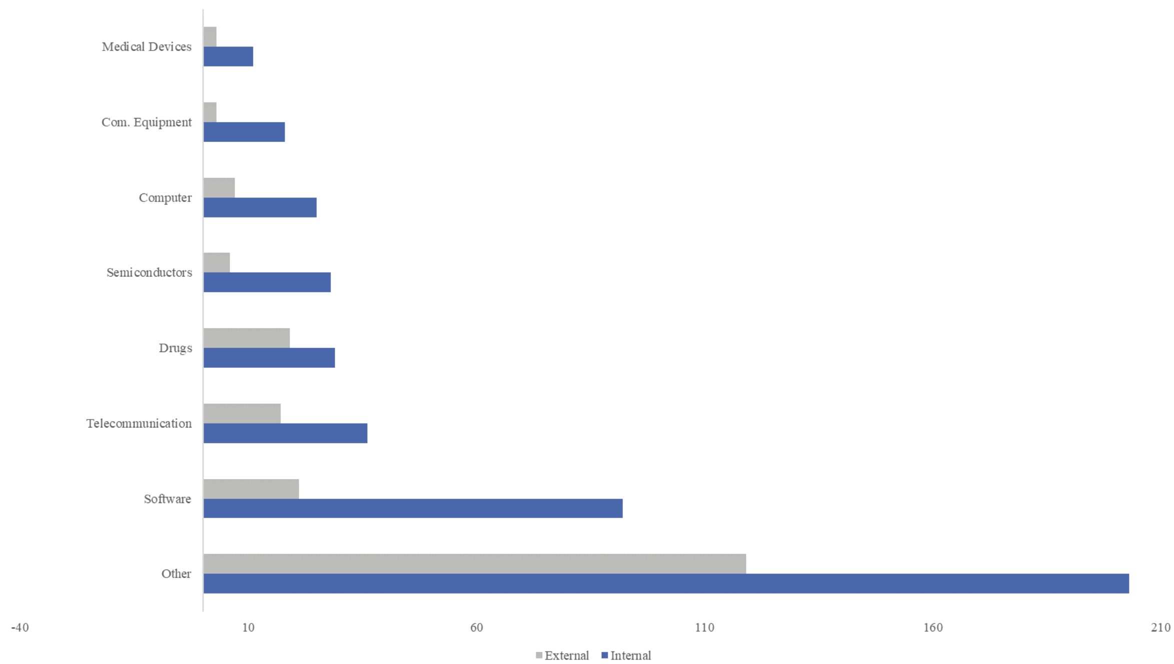

Figure 7 *Distribution of internal and external CVC investors across industries*

8 An extensive overview of the most prevalent industries based on the two-digits and three-digits SIC code, including a description, can be found in *Appendix A*.

The data set offers several insights about the CVC units' structure with respect to differences in firm-specific features of the parent organizations, which are displayed in *Table 7*. The association between the structural setup and the incumbent's size is measured as the average annual number of total employees over the investment period. Across all CVC units, corporations have an average size of 45,000 employees with a median of 11,000 employees. We observe that the average number of employees is significantly higher ($p<0.1$)[9] for incumbents with external CVC programs. Furthermore, large companies display a significantly larger ($p<0.1$)[10] proportion of external units than small companies.

Next, we will describe the relationship of the structural setup and the EBITDA-margin, which we apply as an approximation for financial slack, as the literature revealed the importance of excess cash for the exploration activities of corporations (Chesbrough & Tucci, 2004). As large outliers dominate the distribution, we exclude the outer 1% for the current descriptive consideration[11]. We observe a mean EBITDA-margin of 5.80% and a median of 12.74%. It becomes evident that corporations with external units are associated with a significantly higher ($p<0.1$) EBITDA-margin than organizations with internal programs. We further apply the leverage ratio as an alternative measure and indication for the parent's financial stability. After removing the top and bottom 1% of the distribution, we detect that corporations with external corporate investors show a significantly higher ($p<0.1$) leverage ratio than its peers. Accordingly, we find a significantly greater ($p<0.01$) proportion of external CVC units among the highly leveraged companies.

The literature demonstrates the interrelation of the CVC program's structure and its performance implications with its objective (e.g., Chesbrough, 2002; Siegel *et al.*, 1988), as well as with the pursued investment strategy (e.g., Wadhwa *et al.*, 2016; Yang *et al.*, 2014). We will therefore review the relevant investment-specific data regarding their associations with the structural setup to derive a better understanding of the underlying mechanisms for our empirical model. We operationalize the CVC units' investment experience as the total number of investments pursued within the investing period. We find

[9] For our analysis, we use a maximum significance level of 10%. The results of this and the subsequent t-tests of the current section can be found in *Appendices B-R*.

[10] For this and similar t-test of the current section, we split the sample into two subgroups of equal size by using the median.

[11] For more information we refer to *Appendix J*.

a mean of approximately 11 investments, while the median equals 5 investments, which indicates that many investors only seek few investments.[12] The investment data discloses that external CVC programs conduct significantly more ($p<0.05$) total investments than its internal peers. Experienced investors are in turn significantly more ($p<0.01$) externally structured than inexperienced programs. Additionally, we consider the number of years between the first and the last investment of the program as a measure of experience and durability. The mean durability across all investors equals 4 years whereas the median amounts to 6.5 years, which supports the previous indication that many companies only invest for short periods. However, we cannot identify any significant differences in the durability of internal and external CVC programs.

Further, we examine the corporate investors' accepted degree of uncertainty by considering the share of investments pursued in early stage venture firms relative to their total number of investments. Across the total sample, we discover a mean of 30.47% and a median of 22.22% for the proportion of investments undertaken in early stage ventures. Moreover, the results display that external CVC units invest significantly more ($p<0.1$) in early stages compared to their internal peers. We assume that external units tend to focus more on the exploration of new technologies. Moreover, Dushnitsky and Shapira (2010) reveal that performance-incentivized personnel takes higher risk, which poses a potential explanation for our observation.

[12] A more detailed analysis of the variable's distributions will be presented in Section 6.2.1.

Variable	Internal	External	Combined	Difference
Patent Post	1,270.33 (245.38)	850.78 (247.01)	1,173.58 (197.25)	419.55 (468.39)
Experience	9.45 (0.86)	15.69 (3.58)	10.89 (1.06)	-6.24** (2.51)
Uncertainty	0.29 (0.17)	0.35 (0.03)	0.31 (0.01)	-0.06** (0.03)
Post Period	11.01 (0.29)	7.72 (0.51)	10.26 (0.26)	3.27*** (0.59)
Absorptive Capacity	1,621.95 (324.51)	1,524.71 (429.93)	1,599.52 (268.44)	97.24 (637.95)
Investment Period	6.47 (0.37)	6.86 (0.66)	6.56 (0.32)	-0.39 (0.77)
Size	41.88 (4.17)	57.55 (9.93)	45.44 (3.94)	-15.67* (9.39)
Financial Stability	0.59 (0.06)	0.79 (0.10)	0.64 (0.05)	-0.19* (0.12)
Slack	0.04 (0.02)	0.12 (0.02)	0.06 (0.02)	-0.08* (0.05)

Note: Standard errors in parenthesis, ***p<0.01, **p<0.05, *p<0.1
Financial Stability and Slack excl. Top 1%.

Table 7 *Overview of t-tests for different investor characteristics*

6.1.2 Descriptive Overview of the Patent Data

The following section will focus on the illustration of the derived patent data from *PatentsView*. As previously described, we use the total number of patents applied for in the years after the last investment was made as our dependent variable and performance indicator of the parent organization's innovativeness. We need to carefully assess the absolute patent numbers, as the post-investment periods among the CVC programs highly differ. A last CVC investment in earlier years subsequently leads to a longer post-investment period, which we want to elaborate on first in the following.

Across the overall sample, we find a mean post-investment period of 10.26 years and a median of 12 years. Moreover, we discover post-investment periods between 13 and 16 years for approximately 40% of the CVC investors, of which 85% are internally structured, which stems from the developments during the dotcom bubble. In the period between 1999 and 2002, the CVC activities experienced a fast rise and termination, which is also reflected in shorter durability. Similar patterns can be recognized for the financial crisis in 2008. A more balanced distribution occurs for the more recent years. Of the CVC units pursuing their last investment in 2014, 60% are internally structured. This trend is also reflected in the post-investment periods, which are significantly longer for internal programs ($p<0.01$) and potentially impact the patent count in our data.

After having elaborated on the timing aspect as the foundation for the following analysis, we now explore the patent data in absolute as well as in annual terms to ensure comparability. The distribution of the total number of patents in the post-investment period is characterized by a strong over-dispersion. While the mean equals 1,174 patents, the data reveals that 50% of the incumbents have 21 patents or less and 75% of the incumbents file approximately 262 or less patents. Contrastingly, the corporations from the top 1% of the distribution generate more than approximately 28,000 patents in the period after their last investment. The right tail entails large technology-driven incumbents like *Canon*, *IBM* or *Hitachi*. The annual average number of patents equals 133 as the mean and 2.66 as the median. Interestingly, we can neither find a significant difference ($p>0.1$) in the total count of patents nor in the annualized number of applied patents when differentiating between internal and external CVC units (*Table 8*). This provides a first indication for the analysis of the relationship between the structural setup and the innovativeness of the parent organization.

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Intervall]
0	367	1270.327	245.3833	4700.868	787.7888	1752.865
1	110	850.7818	247.009	2590.652	361.218	1340.346
combined	477	1173.577	197.2537	4308.087	785.9807	1561.172
diff		419.545	468.3866		-500.8208	1339.911

diff = mean (0) - mean (1) t = 0.8957
H0: diff = 0 degrees of freedom = 475

Ha: diff < 0	Ha: diff != 0	Ha: diff > 0
Pr(T < t) = 0.8146	Pr(|T| < |t|) = 0.3709	Pr(T > t) = 0.1854

Table 8 *T-test of the total number of patents by internal and external*

Further, we unveil large differences in the innovativeness among industries which root in their respective nature and characteristics. For instance, the incumbents of the computer industry file significantly more patents with a total count of 4,680 ($p<0.01$) and annual numbers of 378 ($p<0.01$) due to the high speed and short product cycles within this field (Bilir, 2014). In contrast, the pharmaceutical companies generate only 520 patents since they face high regulatory requirements which lead to long and complex development cycles (Smith & Shah, 2013).

Besides analyzing the general innovativeness measured as the number of patents acquired within the post-investment period, we also shed light on the radicalness and quality which comes with it. Therefore, we consider the claims and forward citations generated per patent. While the mean of claims per patent averages 13, the average number of forward citations equals four. Further, we notice no significant difference ($p>0.1$) in the claims per patent between internal and external CVC investors. Despite, we recognize significantly more forward citations per patent ($p<0.05$) for internal programs, which however might be impacted by longer post-investment periods and needs to be assessed carefully.

6.1.3 Associations between the Structure of CVC Units and the Patent Data

In a next step, we intend to better understand the associations of the CVC programs' structure and the patents in the post-investment period considering relevant CVC-specific and firm-specific characteristics with focus on the investment experience and the uncertainty. *Table 9* provides an overview of the differences among the upper and lower half of the distribution of the respective characteristics regarding the total and annual patent count.

As already described, we measure the investing experience as the total investments pursued by the CVC program, as it mirrors the effects of relationships and organizational learning, particularly knowledge acquisition and transfer to the parent organization (Yang *et al.*, 2009). We divide the sample into two subgroups using the median number of total investments of 5. Although we cannot observe any significant differences in the total patent count, we find that CVC programs of experienced incumbent firms issue significantly more ($p<0.05$) patents per year than its inexperienced peers. Accordingly, CVC-experienced corporations issue approximately 180 patents per year while its inexperienced peers file on average 88 patents annually. Moreover, we find that internal investors with experience are associated with a significantly higher ($p<0.05$) total number of patents. This difference, however, diminishes when testing for the annual number of patents. Within the subgroup of inexperienced incumbents, we notice that external CVC investors generate more than the four-fold ($p<0.01$) of annual patents as the internal programs, when adjusting for the top 1%[13] of the distribution. Interestingly, we observe the same results when operationalizing the experience by using the investing period in years, the number of investments in unique start-ups and the total amount of equity invested in ventures. The results show differences between internal and external CVC units in association with the investor's experience and thereby already indicate a moderation effect.

The following description sheds light on the impact of the degree of uncertainty the CVC investors undertake on the innovativeness of the incumbents under consideration of the program's structural setup. As already elaborated, we codify the uncertainty through the percentage of investments pursued in early stage ventures. We split the sample at the 50%-mark, which indicates whether the program primarily invests in early or later stages. Surprisingly, we cannot notice a significant difference ($P>0.1$) in the total and annual patent count between the early and later stage investors. The same applies when investigating the differences for the structural setup within the individual subgroups of early and late investors. None of the results display a significant difference among the two structural setups. An indication for a moderation effect of uncertainty therefore does not become evident.

In a next step, we consider further firm-specific characteristics. We start by investigating the absorptive capacity of differently structured CVC units. We therefore split the sample at the median of 3 annual patents in the investment period. We can observe that companies with high absorptive capacity generate significantly more ($p<0.01$) annual patents in the post-investment period. The significant difference ($p<0.01$) remains even when removing the companies with 0 patents and adjust the threshold accordingly to the new median of 15 annual patents. However, we cannot notice a significant statistical difference ($p>0.1$) within the different groups when investigating for deviating structural setups.

[13] The top 1% consists of the following three companies: *IBM*, *Sony*, *Toshiba*.

Variable	Patent Post	Subgroup 1	Subgroup 2	Combined	Difference
Experience	Total	1,046.69 (299.80)	1,299.94 (257.00)	1,173.58 (197.25)	-253.25 (394.75)
	Annually	87.76 (23.18)	179.00 (31.58)	133.48 (19.69)	-91.25** (39.20)
Uncertainty	Total	1,101.05 (205.43)	1,494.19 (566.11)	1,173.58 (197.25)	-393.15 (508.76)
	Annually	129.09 (21.32)	152.87 (50.33)	133.48 (19.69)	-23.78 (50.80)
Post Period	Total	1,136.76 (242.27)	1,209.94 (311.08)	1,173.58 (197.25)	-73.18 (394.92)
	Annually	1,87.23 (33.01)	80.40 (21.17)	133.48 (19.69)	106.84*** (39.11)
Absorptive Capacity	Total	71.07 (43.73)	2,280.71 (379.96)	1,173.58 (197.25)	-2,209.65*** (381.69)
	Annually	3.84 (1.85)	263.67 (37.51)	133.48 (19.69)	-259.83*** (37.57)
Investment Period	Total	329.89 (288.52)	1,402.40 (269.72)	1,173.58 (197.25)	-472.51 (394.52)
	Annually	74.66 (21.94)	188.71 (31.78)	133.48 (19.69)	-144.06*** (39.09)
Size	Total	157.10 (48.90)	2,336.70 (414.58)	1,246.90 (214.94)	-2,179.60*** (417.46)
	Annually	20.45 (7.66)	257.28 (40.23)	138.87 (21.23)	-236.83*** (40.95)
Leverage	Total	574.70 (173.87)	1,787.31 (352.88)	1,181.00 (198.46)	-1,212.61*** (393.39)
	Annually	65.84 (16.01)	202.81 (35.73)	134.32 (19.81)	-136.32*** (39.15)
Slack	Total	1,319.87 (301.42)	1,052.15 (261.07)	1,186.01 (199.27)	267.72 (398.77)
	Annually	136.74 (27.12)	133.05 (29.15)	134.32 (19.81)	3.69 (39.82)

Note: Standard errors in parenthesis, ***p<0.01, **p<0.05, *p<0.1

Table 9 *Differences of patent count within subgroups*

We further separate the total sample by the companies’ size by applying the median of approximately 10,000 employees. Large companies generate a significantly higher (p<0.01) number of total as well as of annual patents compared to small companies. This significant difference supports our decision to include investor size as a control variable in our empirical model. However, we cannot observe any significant differences ($p>0.1$) between incumbents of external and internal CVC programs within the respective size groups. Further, we consider the financial stability, measured as the leverage ratio. We discover that highly leveraged corporations issue 3 times more ($p<0.01$) patents in absolute terms and annually than the less leveraged. However, we cannot find a significant difference ($p>0.1$) in the innovativeness within the respective leverage groups, when considering the structural setup of the CVC investors. Neither can we find any significant differences among the structural setups when reviewing the association of innovativeness and slack, approximated by the EBITDA-margin, even when accounting for the differing legal structures of the CVC investors.

Lastly, we use the previously discussed associations regarding the number of claims and forward citations as measures for radicalness and quality of the patents. While the results unveil that more experienced investors generate significantly more ($p<0.05$) claims per patent, we find mixed results for the number of forward citations. For internal and experienced investors, we find a significantly higher ($p<0.01$) number of claims per patent. For inexperienced internal investors, we observe significantly higher ($p<0.1$) counts of forward citations per patent. Further, the results suggest that programs investing primarily in early stage ventures issue significantly less ($p<0.1$) claims per patent than later stage investors. However, early stage investors accumulate significantly more ($p<0.05$) forward citations per patent. Within the group of later stage investors, we find that incumbents with internal programs generate significantly more ($p<0.05$) forward citations than its external peers.

Regarding the firm-specific characteristics, we can conclude that firms with high innovation rates during the investment period are also associated with a significantly higher ($p<0.01$) number of claims per patent in the post-investment period. Within the group of incumbents with a high absorptive capacity, we detect that internally structured investors are linked to significantly more claims ($p<0.01$) and forward citations ($p<0.05$). Moreover, larger companies generate significantly more ($p<0.01$) claims, however fewer forward citations per patent across the whole sample. Within the subgroup of companies with fewer financial slack, we find that internally structured investors are associated with significantly more ($p<0.1$) forward citations. Further, we observe a significantly higher number of forward citations for internal CVC investors within the group of higher leveraged firms.

After having analyzed the underlying patent data in detail by considering various factors like the structural setup, the investment experience, and the uncertainty of the investments, as well as various firm-specific factors, we better understand how the two diverging structural setups are associated with different degrees of innovativeness, radicalness, and quality of innovation. In the following, we will therefore focus on our empirical model, which aims to explain the impact of the structural dimension of CVC programs on the innovativeness of the parent organization in the post-investment phase. Further, we also take two moderating effects into consideration, namely the investing experience and the uncertainty of investments.

6.2 Empirical Model

6.2.1 Model Building

6.2.1.1 Summary Statistics

In the following section, we will describe the statistical approach conducted in order build our empirical model. We discuss the distribution and descriptive statistics of the included variables as well as the correlations among them. Based on this analysis, we will perform necessary transformations of the variables to ensure integrity of the model.

Variables	No. of Obs.	Mean	Standard Deviation	Skewness	Kurtosis	Min	Median	Max
Patent Post	477	1,173.58	4,308.09	5.83	40.42	0.00	21.00	35,817.00
Experience (Investments)	477	10.89	23.20	8.91	119.59	1.00	5.00	364.00
Uncertainty (Early Stage)	477	0.30	0.32	1.01	3.02	0.00	0.22	1.00
Post Period (in years)	477	10.26	5.62	-0.15	2.04	1.00	12.00	25.00
Absorptive Capacity (Patent)	477	1,599.52	5,862.88	6.51	57.00	0.00	10.00	68,375.00
Investment period (in years)	477	6.56	7.09	1.09	3.26	0.00	4.00	28.00
Size (Employees)	436	45.44	82.32	2.85	11.23	0.02	10.90	461.00
Financial Stability (Leverage)	474	0.69	4.02	5.75	186.77	-46.45	0.34	65.76
Slack (EBITDA)	472	-6.59	111.31	-18.70	368.28	-2,266.10	0.13	0.78

Table 10 *Descriptive Statistics of input variables*

Table 10 provides an overview of the summary statistics for the underlying variables included in our empirical model. As already explained, we remove 160 of 637 CVC programs since they invested until 2015, the last year of our available data. We thereby ensure that the remaining 477 entries show a relevant number of patents within the post-investment phase. We observe that the count of patents in the post-investment period *(Patent Post)* is highly concentrated on the left tail of the distribution. Accordingly, 129 incumbents do not issue any patents after conducting their last CVC investments. Half of all the companies register less than 21 patents, while the mean equals 1,173 patents. The standard deviation almost reaches the 4-fold of the mean, which is also reflected in the maximum number of patents of approximately 36,000. Finally, the highly positive skewness confirms the extreme overdispersion on the left side (*Figure 8*). The literature suggests applying a negative binomial regression model for such overdispersion, as it is well-applicable for using count data as the dependent variable. We therefore decide to use the negative binomial regression model also in our analysis (Wadhwa & Kotha, 2006).

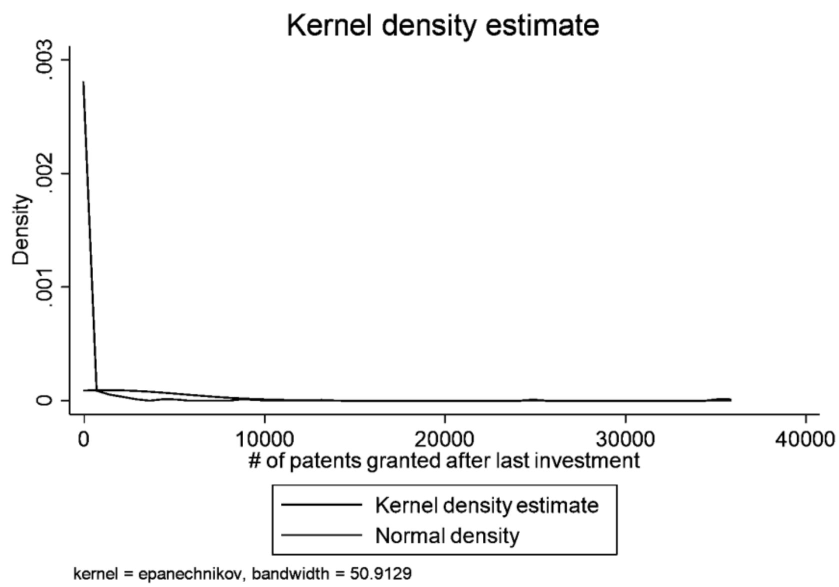

Figure 8 *Distribution of patent count post (derived from Stata)*

The total number of pursued investments by the corporate investors is also positively skewed which we can observe from a high standard deviation of 23.20 and a wide range of 364.00 investments respectively. The mean ranges at 10.89 investments, while the median equals 5 investments. As already described, we operationalize the total number of investments as a dichotomous variable *(Experience)* to represent the investment experience of the CVC program by splitting the group at the median of 5 investments. This measure allows us to adjust for the identified skewness of the variable. However, it also eliminates the natural variation, which we decide to accept in this case.

The percentage of investments in early stage ventures over the total number of investments represents our underlying variable for the degree of investment uncertainty and ranges between 0 and 1. While half of the investors pursue less than 22% of their investments in early stage ventures, the total mean equals a higher share of 30%. Although the measure is standardized by taking the proportion and therefore ranges between 0 and 1, we can notice a relatively high standard deviation of 0.32, which reflects the heterogeneity of investment strategies among CVC programs. As described, we create a dichotomous variable *(Uncertainty)* by dividing the total sample at the threshold of 50% into two distinctive subgroups, so we can recognize investors that primarily invest in early stage ventures under higher uncertainty.

Because the total number of patents is assumed to increase with longer post-periods, we decide to consider the time dimension using the respective number of years *(Post Period)* within this phase in order to put the total patent count into perspective. While the variable ranges between 1 and 25 years, we detect a mean of 10.26 and a median of 12 years, which points towards an even distribution. We conclude that the variable approximates a normal distribution and therefore do not undertake any further transformations in order to not eliminate further natural variance. Interestingly, based on the number of years in the post-investment period, we can decipher that the last investment of the average CVC investor was made in the early 2000s, which can be associated with the wide termination of CVC program after the dotcom bubble.

We use the accumulated number of patents granted over the investment period as a proxy for the incumbent's absorptive capacity *(Absorptive Capacity)*. Similar to the independent variable of the total number of patents in the post-investment period, we observe a strong overdispersion of entries on the left side of the distribution with zero or only few patents. Despite a slightly lower mean of 1,600 patents and a median of 10 patents relative to the patent count of the post-investment period, we notice an even higher standard deviation of 5,862, a range of 68,375 and a skewness of 6.5. This leads us to operationalize the absorptive capacity by taking the natural logarithm of the total count of patents granted while investing. The log-transferred distribution better approximates a normal distribution.

It is crucial to also incorporate the duration the CVC programs actively pursue investments *(Investment Period)* in order to relativize the total count of patents from a timing perspective. Additionally, the investing period is related to the number of years of the post-investment period as previously shown. Furthermore, it adds another dimension to the investment experience. The descriptive measures display an average investment period of approximately 6.5 years for the mean and 4 years for the median. While many CVC programs pursue investments only within the same year, the longest activity persists for 28 years. We apply the natural logarithm to minimize the standard deviation and thereby create an even distribution.

Further, we control for various firm-specific measures, which are derived from the *Compustat* database and averaged over the respective investment periods. The number of observations for the incumbents' firm size *(Size)* measured as the number of employees is slightly reduced due to missing entries within the database. While the average of employees equals 45,440 people in mean and 10,900 people in median, we find the company *Siemens* to be the largest employer with 460,000 employees. The standard deviation of 82,000 employees, which is almost twice as large as the mean, as well as the positive skewness of 2.85 exhibit an uneven distribution. A similar picture occurs for the leverage ratio *(Financial Stability)*, which we use to control for the financial stability of the corporation. The descriptive statistics disclose a dispersion of the data, which is particularly confirmed by the high difference between the median (35%) and mean (70%) and the high standard deviation of 4. Moreover, we discover large extreme values at both tails of the distribution as well as highly positive measures for skewness and kurtosis of 5.75 and 186.77, respectively. Lastly, we take the EBITDA-margin *(Slack)* as a percentage of sales as a proxy for free cash flow or financial slack into consideration, as it influences the financing exploration activities such as CVC (Chesbrough & Tucci, 2004). We recognize that the distribution is highly impacted by severe outliers on the lower tail, which leads to a negative mean of -6.57 as well as to a high standard deviation of 111.30, a strongly negative skewness of -18.70 and an extremely large kurtosis of 368.28. Based on the elaborated descriptive statistics, we decide to perform a logarithmic transformation for all three firm-specific variables. In a next step, we will assess the correlations among the variables in the operationalized and transformed form.

6.2.1.2 Correlations of Variables

While building our model, we continuously assess its validity and reliability by testing for collinearity and the explanatory power (Berenson, Levine, Krehbiel, 2012). We observe high correlations among some of the variables, when initially analyzing the derived dataset. Such correlations can however be explained because the variables measure similar aspects. For instance, the variables total number of investments, number of individual start-ups, total amount of equity invested, and number of years seeking investments all capture a measure of the CVC unit's experience and show a high degree of correlation. Accordingly, the size can be measured by the variables number of employees, total assets, and total revenues. To avoid multicollinearity within our model, we choose to only include the related variable with the highest explanatory power. However, some correlations still appear to be high and pose the risk of multicollinearity, which we will explain in the following.

The correlation matrix (*Table 11*) sheds light on some stronger correlations among several of the variables. We generally apply a cut-off value of 0.65. However, we notice a high correlation of 0.756 between (2) the structural variable and (4) the interaction effect of investment experience and the structural variable. A similar correlation of 0.536 can be detected for the correlation of (5) the binary uncertainty variable and (6) the interaction effect between uncertainty and the structural variable. Since we can explain the correlations with the multiplication of the binary variables of investing experience and uncertainty with the binary structural variable, we decide to disregard this deviance and still include all proposed variables in the model.

As already described above, we observe a high correlation of 0.6 among (3) the CVC experience, operationalized as a binary variable based on the number of investments pursued within this period, and (6) the investing period which appears to be comprehensive since more investments can be conducted in longer periods. We consider the investment period as a relevant measure impacting the patents issued within the post-investment period, but also use it to control for the total number of patents generated within the investment period. We therefore maintain both variables in the model, as the correlation is still acceptable.

Moreover, we want to elaborate on the correlations associated with the dependent variable, namely (1) total number of patents generated in the post-investment phase. We highlight that the variables of (9) absorptive capacity and (10) size might demonstrate high explanatory power due to their nature. However, the correlations can be described as moderate equaling 0.353 and 0.329, respectively, and therefore assume a limited risk of multicollinearity. Based on our considerations, we find the correlations to be acceptable and include all proposed variables in the model.

Variables	No. of Obs.	Mean	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(1)	477	1,173.58	1											
(2)	477	0.23	-0.060	1										
(3)	477	0.50	-0.016	0.065	1									
(4)	477	0.14	-0.084	0.756	0.367	1								
(5)	477	0.18	0.075	0.068	-0.137	0.024	1							
(6)	477	0.05	-0.019	0.383	-0.010	0.243	0.536	1						
(7)	477	10.26	0.109	-0.200	-0.249	-0.114	0.040	-0.060	1					
(8)	477	0.26	-0.060	-0.001	0.600	0.189	-0.238	-0.013	-0.352	1				
(9)	477	1.80	0.353	0.093	0.349	0.123	-0.068	0.001	-0.254	0.416	1			
(10)	436	2.27	0.329	0.074	0.123	0.020	-0.080	0.075	-0.114	0.096	0.329	1		
(11)	422	-1.38	0.086	0.108	0.008	0.096	-0.060	0.020	-0.056	0.066	-0.011	0.388	1	
(12)	404	-2.02	-0.052	-0.001	0.145	0.080	0.013	0.039	-0.123	0.064	0.028	0.070	0.026	1

(1) Patent Post, (2) External, (3) Experience, (4) Expereince x External, (5) Uncertainty, (6) Uncertainty x External, (7) Post Period, (8) Investment Period, (9) Absorptive Capacity, (10) Size, (11) Leverage, (12) Slack

***Table 11** Correlation Matrix of Input Variables*

6.2.2 Regression Analysis

6.2.2.1 The Final Model

Based on the previous literature, we apply a negative binomial regression model to explain our dichotomous dependent variable and account for the left-sided overdispersion of the cumulative patent count (Wadhwa & Kotha, 2006). In accordance with Di Lorenzo and Almeida (2017), we build up our final model by specifying different stages. Model 1 includes the independent variable only, while Model 2 is specified with only control variables. Model 3 combines the independent variable with the control variables. Subsequently, we introduce the interaction effect of investment experience and structure in Model 4 and of investment uncertainty and structure in Model 5. In the last Model 6, we combine all considered variables and the moderators together, which will also be the basis for our interpretation since it reflects the most realistic model to explain our independent variable. Model 6, our final regression model, can be summarized as:

$$Patent\ Post\ =\ Exp(\ \beta_0 +\ \beta_1 * (External)\ +\ \beta_2 * (Experience)$$
$$+\ \beta_3 * (Experience\ x\ External) +\ \beta_4 * (Uncertainty)\ + + \beta_5 * (Uncertainty\ x\ External)$$
$$+\ \beta_6 * (Post\ Period)\ +\ \beta_7 * (Absorptive\ Capacity) +\ \beta_8 * (Investment\ Period) +\ \beta_7 * (Size)$$
$$+\ \beta_8 * (Leverage)\ +\ \beta_9 * (Slack)\ +\ \varepsilon_i)$$

In the following, we will depict the results of our regression considering a significance level of 10%. *Table 12* displays the Models 1-3 of our gradual approach. While we cannot find a significant influence of our independent variable (*External*) in the models, we notice the high significance ($p<0.01$) for the control variables *Post Period*, *Absorptive Capacity*, *Investment Period*, *Size*, and *Financial Slack*. This is also reflected in the significant F-statistic of 0.00 and the Pseudo R^2 of 0.109, which indicate a significant explanatory power of the model. We detect a positive relationship for all the mentioned variables with our dependent variable, except the investment period, which shows a negative relationship. We already elaborated on the relationship of the investment period on the patent count in the post-investment period at an earlier stage. Accordingly, we see that companies with longer investment experience tend to have fewer years in the post-investment period to generate patents.

In the next stages of our model building approach, we introduce the interaction effects of investment experience with structure and uncertainty with structure, first individually and lastly by combining all variables and effects in one model (*Table 13*). Initially, we introduce the investment experience, measured as a dichotomous variable based on the total number of investments, and the respective interaction effect. Within Modell 4, we find no significance ($p>0.1$) for the impact of the structural setup on the innovation rates of the incumbents in the post-investment period. However, we observe a significant positive ($p<0.05$) influence of the *Experience* as well as for the interaction effect *Experience x External* ($p<0.05$). The remaining control variables behave as in the previous models. We will elaborate on the implications of the investment experience and particularly the respective interaction with the structure when analyzing the results of our final model.

Patent Post	**(1)**	**(2)**	**(3)**
External	-0.401		-0.227
	(0.300)		(0.217)
Post Period (in years)		0.243***	0.238***
		(0.0196)	(0.0201)
Absorptive Capacity (Patent)		0.565***	0.568***
		(0.0208)	(0.0211)
Investment period (in years)		-0.138***	-0.149***
		(0.0390)	(0.0405)
Size (Employees)		0.359***	0.362***
		(0.0525)	(0.0532)
Financial Stability (Leverage)		-0.0109	-0.00732
		(0.0553)	(0.0555)
Slack (EBITDA)		0.337***	0.324***
		(0.100)	(0.101)
Constant	7.147***	0.445	0.532
	(0.144)	(0.368)	(0.377)
lnalpha	2.032***	0.780***	0.776***
	(0.0584)	(0.0754)	(0.0755)
Industry Dummy	No	Yes	Yes
Observations	477	346	346
Wald Chi²	1.651	463.0	464.1
Prob. > chi²	0.1989	0.0000	0.0000
Pseudo R²	0.000308	0.109	0.109

Note: Standard errors in parenthesis, ***p<0.01, **p<0.05, *p<0.1

Table 12 *Regression Results (Models 1-3)*

Patent Post	**(4)**	**(5)**	**(6)**
External	0.308	-0.297	0.227
	(0.345)	(0.238)	(0.368)
Experience (Investments)	0.509**		0.504**
	(0.243)		(0.242)
Experience x External	-0.876**		-0.843**
	(0.414)		(0.416)
Uncertainty (Early Stage)		-0.507*	-0.472
		(0.299)	(0.300)
Uncertainty x External		0.431	0.376
		(0.581)	(0.576)
Post Period (in years)	0.244***	0.236***	0.241***
	(0.0207)	(0.0200)	(0.0207)
Absorptive Capacity (Patent)	0.574***	0.572***	0.577***
	(0.0210)	(0.0214)	(0.0212)
Investment period (in years)	-0.180***	-0.160***	-0.193***
	(0.0494)	(0.0408)	(0.0501)
Size (Employees)	0.330***	0.358***	0.328***
	(0.0527)	(0.0535)	(0.0529)
Financial Stability (Leverage)	0.00965	-0.00285	0.0141
	(0.0566)	(0.0555)	(0.0566)
Slack (EBITDA)	0.314***	0.306***	0.297***
	(0.103)	(0.103)	(0.105)
Constant	0.268	0.578	0.320
	(0.394)	(0.380)	(0.396)
lnalpha	0.760***	0.769***	0.753***
	(0.0757)	(0.0757)	(0.0758)
Industry Dummy	Yes	Yes	Yes
Observations	346	346	346
Wald Chi²	470.4	466.7	472.8
Prob. > chi²	0.0000	0.0000	0.0000
Pseudo R²	0.111	0.110	0.111

Note: Standard errors in parenthesis, ***p<0.01, **p<0.05, *p<0.1

Table 13 *Regression Results (Models 4-6)*

Model 5 considers the effect of *Uncertainty* and the associated interaction effect *Uncertainty x External*. The results do not show significance for the structural effect. However, we want to highlight the direction of the respective coefficient, which becomes negative in contrast to all other models. The model building approach does not only reveal the importance of individual effects such as uncertainty, but also demonstrates how the results can change when including only parts of the final model. The impact of uncertainty is shown within this model through its significant and negative association ($p<0.1$) with the total patent count. Incumbents with CVC programs primarily investing in early stage start-ups seem to generate fewer patents than its peers investing in later stages. As we already laid out in our conceptual development, this can be due to several aspects. For early stage ventures, the assessment of trends and materialization potentials (Dushnitsky & Shapira, 2010), as well as of the venture's management capabilities (Wadhwa & Basu, 2013) becomes more difficult. Further, a lack of product specifications and track records hinders the codification and the transfer of knowledge (Yang *et al.*, 2009). As knowledge is often primarily of tacit nature and the ventures' most valuable resource, entrepreneurs might be resistant to share it due to a fear of imitation (Dushnitsky & Shaver, 2009). For the interaction of the investments' uncertainty with the structural setup, we cannot find a significant influence on the innovativeness of the incumbent. Although the presented models provide a better understanding of the underlying mechanisms and associations, they can only give a vague indication of the actual effect. A well-founded statement can only be made when capturing all relevant effects. Therefore, we will continue with the analysis of our final Model 6, which includes the dependent, the independent, the control variables as well as both interaction effects of experience and uncertainty.

In our final Model 6, we can observe a positive, however not statistically significant ($p = 0.537$) coefficient of *External* on the innovativeness of the incumbent, as already indicated by the previous models. Accordingly, we reject our first hypothesis on the positive impact of the external organizational structure of CVC units on the innovativeness of the corporation in the post-investment period. Contrarily to our own argumentation and elaborations of previous scholars, the results do not reveal that externally structured CVC programs lead to higher innovation performance. There are several arguments which could explain the results, which will be discussed at a later stage of this work.

In a next step, we will focus on the moderating effect of investment experience and the structural setup on the innovativeness in the post-investment period. We detect a significant and positive association (p<0.05) of the *Experience* on the total number of patents. The positive coefficient of 0.504 equals an incidence rate ratio (IRR) of 1.65 when applying the natural exponential function in accordance with Cirillo, Brusoni, and Valentini (2014). This indicates that an experienced investor with more than five total investments is associated with an increase in patents by the factor of 1.65 or 65%. In our theoretical analysis, we pose several potential explanations for this expected positive effect. We argue for the positive influence of organizational learning by building routines for knowledge-sharing across the parent organization (Levitt & March, 1988) and developing investing capabilities within the CVC unit, ultimately fostering better investments (Yang *et al.*, 2009). Moreover, experience enables the parent corporation to better assimilate new external knowledge through a strengthened absorptive capacity (Cohen & Levinthal, 1990). As an increase in investment experience can be associated to the enhancement of interfirm knowledge sharing routines (Dyer & Singh, 1998) and reputation (Wadhwa & Basu, 2013), the results justify the induced importance of relationship building and maintenance with the ventures and the VC community to facilitate knowledge absorption and creation (Foss *et al.*, 2013).

However, the individual effects of *External* and *Experience* need to be evaluated under considerations of the associated interaction effect. The interaction between the investing experience and the structure on the innovativeness of incumbent firms shows a significant result at the 5%-level. Therefore, we can confirm our second hypothesis which states that the investment experience negatively moderates the structural effect of CVC programs on the innovativeness of the parent company. This involves that external CVC units encounter a negative effect on the innovativeness when the investment experience is high. The resulting negative coefficient of -0.843 translates into an IRR of 0.43, which reveals that the structural effect on knowledge creation decreases by the factor of 0.43 or -57% under higher experience, which is in line with our expectations. Since external CVC units primarily recruit VC professionals with already existing investment capabilities and established relationships to the VC environment (Asel *et al.*, 2015), we argue that external CVC programs advance less from the gained experience due to a diminishing effect (Wadhwa & Kotha, 2006). Contrastingly, internal programs highly benefit from building relationships with the ventures through experience (Foss *et al.*, 2013) and can further enhance knowledge sharing and assimilation within the organization. Additionally, employees of internal programs potentially benefit more from organization learning, enabling the development of initially lacking investing capabilities (Asel *et al.*, 2015; Levitt & March, 1988; Yang *et al.*, 2009).

We already touched upon the association of the investment uncertainty and innovativeness when describing Model 5. Although we detect a similar direction of the impact and a p-value of just 0.115 in the final model, we contrastingly find no significant effect of *Uncertainty* on the innovation rates of incumbents at a 10%-significance level. In line with our expectations, we observe a positive coefficient for the interaction of U*ncertainty* and *External*. Due to a lack of significance, we however reject our third hypothesis, which assumed a moderating effect of uncertainty on the relationship between the CVC investor's structure and the innovativeness of the incumbent firm, so that external CVC units experience a positive impact on the innovativeness when it invest in early stage. We will closer discuss the associated implications of this result in the next section.

In comparison to the previously presented models, we find similar results for the remaining control variables. *Post Period*, *Absorptive Capacity*, *Size*, and *Slack* are significantly ($p<0.01$) and positively associated with the total patent count in the post-investment period, while the investment period shows a significant ($p<0.01$) but negative impact on innovativeness, as described earlier. The model building approach reveals that most of the explanatory power of the models stems from the above-mentioned variables, as illustrated by the Wald Chi^2 and Pseudo R^2. Most contribution comes from the control variables leading to an overall significance of the model based on the Chi^2 F-test.

6.2.3 Robustness Tests

We conduct several robustness tests in order to demonstrate the validity and soundness of our final model (Berenson *et al.*, 2012). Firstly, we operationalize our dichotomous variables for the investing experience and investment uncertainty differently by basing them on different variables. In Model 7, we adopt the total numbers of unique start-ups as an alternative proxy for the investment experience and split the sample in half by using the median. In Model 8, we replace the early stage variable with the average investment round as the measure for uncertainty. Secondly, we test for robustness by limiting our final sample to two focus groups. In Model 9, we only include CVC investors pursuing more than one investment over the investment period, as this is argued to show a higher commitment towards the CVC activity. In Model 10, we exclude the outliers within the upper 10% of the patent distribution in order to homogenize the sample. Thirdly, we consider a Poisson distribution including the robustness adjustments as an alternative regression model to estimate our independent variable. Lastly, we exchange the total number of patents for the total number of claims as our dependent variable, creating model 12.[14]

As we can observe in Model 7 to Model 10 (*Table 14*), the different operationalizations of variables as well as the change of scope of the sample lead to consistent results with our final model. We detect that our independent variable remains insignificant throughout the models. Although the significance levels partly differ, we can observe supporting evidence for the significance of *Experience* and the interaction effect *Experience x External* differing at a maximum level of 10%. In Model 8, we particularly see a change of significance from the 5%- to the 10%-level for both considered variables when adopting the investor's average investment round as a measure for uncertainty. When removing the upper 10% of the distribution from the sample in Model 10, the significance level of *Experience x External* increases to 10%.

In line with our final Model 6, we cannot observe a significant result for *Uncertainty* and the respective interaction effect *Uncertainty x External* in Model 7 to 9. However, the results disclose a change in sign for some of the models compared to our original model. In Model 8 and 9, we notice a positive association of *Uncertainty* with the dependent variable. Further, in Model 9 the coefficient of the interaction effect becomes negative, however only to a very small degree. Since this effect shows no significance across all models, it is difficult to account for the mentioned differences. In contrast to the final model, the results of Model 10 disclose a significant (5% significance-level) and negative influence of *Uncertainty*. This implies that early stage investors generate fewer patents, which can be explained by the higher risk for knowledge creation associated with such early stage investments.

In Model 11, we surprisingly not only discover significance on a 1%-level for *External,* but also see relevant changes in some of the other variables. *Experience* appears to be insignificant while the interaction effect becomes even more significant. Further, the sign of the interaction effect *Uncertainty x External* turns negative, as already observed and elaborated on for Model 9. We assess the appropriateness of the Poisson model by using the goodness-of-fit-function in Stata, which shows a high

[14] In accordance with the literature, we also test for the total number of forward citations generated in the post-investment period. This test, however, shows however differing results from the final model since the distribution is not well-applicable for our conducted panel regression. This is due to the dimension of time and a considerable time-lag that comes with it, as already described earlier in this work.

result[15] and therefore captures a bad model fit (Berenson *et al.*, 2012). The strongly significant ($p<0.01$) alphas across all other models confirm our decision to capture the analysis with a negative binomial regression model.

While most of the influences prevail in Model 12, the significance level of *Experience* and the respective interaction with *External* increases to 10%. Lastly, we want to refer to the control variables, which mostly behave in line with the final Model 6. Specifically, the largest influencing factors, namely the *Post Period* and *Absorptive Capacity*, remain consistent across all models. When reducing the sample to the companies with more than one investment, we detect that the *Investment Period* is no longer significant ($p>0.1$). This can be explained by the fact that investors with only one investment are associated with an investment period of zero, which could highly impact the distribution. Further, we can detect that *Slack* is no longer significant ($p>0.1$) within the Poisson model. However, we already assessed the overall unsuitability of this model.

Based on the performed tests we can conclude on the robustness, validity, and soundness of our empirical model, specifically regarding the discovered significance for the experience effect and its moderating influence. However, we want to highlight that we do not claim to explain any causational effects through this analysis.

[15] The exact numbers of the goodness-of-fit test can be found in *Appendix II*.

	(7) Start-Ups	(8) Inv. Round	(9) Inv > 1	(10) Top 10%	(11) Poisson	(12) Claims
External	0.227	0.0812	0.306	0.252	0.613***	0.254
	(0.368)	(0.389)	(0.402)	(0.411)	(0.209)	(0.440)
Experience (Investments)	0.504**	0.438*	0.471**	0.655**	0.0694	0.473*
	(0.242)	(0.251)	(0.237)	(0.271)	(0.395)	(0.281)
Experience x External	-0.843**	-0.742*	-0.887**	-0.781*	-1.158***	-0.950*
	(0.416)	(0.435)	(0.437)	(0.472)	(0.304)	(0.488)
Uncertainty (Early Stage)	-0.472	0.217	0.0444	-0.696**	-0.119	-0.512
	(0.300)	(0.222)	(0.413)	(0.349)	(0.181)	(0.351)
Uncertainty x External	0.376	0.332	-0.00482	0.987	-0.113	0.546
	(0.576)	(0.416)	(0.637)	(0.610)	(0.325)	(0.653)
Post Period (in years)	0.241***	0.245***	0.238***	0.217***	0.191***	0.260***
	(0.0207)	(0.0207)	(0.0211)	(0.0242)	(0.0223)	(0.0249)
Absorptive Capacity (Patent)	0.577***	0.568***	0.567***	0.503***	0.715***	0.570***
	(0.0212)	(0.0212)	(0.0224)	(0.0260)	(0.159)	(0.0247)
Investment period (in years)	-0.193***	-0.190***	-0.0881	-0.193***	-0.219***	-0.176***
	(0.0501)	(0.0496)	(0.0870)	(0.0580)	(0.0610)	(0.0588)
Size (Employees)	0.328***	0.327***	0.310***	0.161***	0.362**	0.357***
	(0.0529)	(0.0529)	(0.0534)	(0.0619)	(0.176)	(0.0650)
Financial Stability (Leverage)	0.0141	0.00980	-0.000447	0.00316	-0.0299	-0.0348
	(0.0566)	(0.0564)	(0.0594)	(0.0615)	(0.0470)	(0.0672)
Slack (EBITDA)	0.297***	0.337***	0.280***	0.355***	0.0486	0.372***
	(0.105)	(0.103)	(0.107)	(0.115)	(0.0992)	(0.119)
Constant	0.320	0.220	0.201	0.989**	-0.727	2.987***
	(0.396)	(0.404)	(0.443)	(0.462)	(0.493)	(0.473)
lnalpha	0.753***	0.750***	0.680***	0.792***		1.122***
	(0.0758)	(0.0759)	(0.0803)	(0.0835)		(0.0717)
Industry Dummy	Yes	Yes	Yes	Yes	Yes	Yes
Observations	346	346	306	302	346	346
Wald Chi²	472.8	473.5	417.9	267.9	1033.7	373.8
Prob. > chi²	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Pseudo R^2	0.111	0.111	0.110	0.0867	0.885	0.0641

Note: Standard errors in parenthesis, ***p<0.01, **p<0.05, *p<0.1

Table 14 *Robustness Checks (Models 7-12)*

7 Discussion

The following section is devoted to evaluating our empirical results critically and putting them into perspective within the derived theoretical conceptualization for the relationship between the investing corporation and the venture firm. We will discuss and interpret our findings, which will enable us to understand how our work contributes to the existing state of research in the field of CVC. To complete our comprehensive study, we challenge our research design and highlight opportunities for future research on the performance implications of the structural design of CVC programs.

7.1 Discussion of Results

With this work, we sought to elaborate on the effect of the structural differences of CVC units on the innovation performance of the investing parent organizations. The existing CVC literature demonstrates evidence on diverging characteristics but no extensive research on the full effect of the structure on the incumbent's performance exists (Asel *et al,* 2015; Siegel *et al.*, 1988). With the intention to close this gap, we aim to answer the question how the identified structural differences between internal and external CVC units are impacting the innovativeness of corporations in order to evaluate the potential superiority of one of the two forms. As a second objective, we investigate the moderation of experience and uncertainty on the structural effect in question. We developed a theoretical model based on the relational view as introduced by Dyer and Singh (1998), which seeks to explain the structural influences of CVC units on relational rents from relationships with venture firms.

As we have previously shown, our empirical model presents mixed result on our three hypotheses. Despite our expectations, we find no significant indication that external CVC programs are associated with a higher innovativeness of their parent organizations relative to their internal peers. We can, however, detect a significant interaction effect between the investment experience of CVC units and their structural setup, whereas the uncertainty level of investments and the structure do not show any significant interaction. In the following, we will elaborate on potential explanations for these results and discuss the arising implications.

Referring to the relational view (Dyer & Singh, 1998), we argued in *Hypothesis 1* that external CVC units are associated with a higher level of knowledge creation in their parent firm, resulting from increased relational rents. We reason that the decentralized structure of external CVC units with higher levels of decision-making authority reinforce an orientation towards the portfolio firms. This consequently enables legally independent programs to build strong relational ties with external venture companies and thus facilitates supernormal relational rents through the enhancement of knowledge transfer and assimilation. Against our expectations, our empirical model, however, shows no support for this argumentation. This is surprising since the existing literature offers supporting results on performance effects of autonomy factors (Siegel *et al.*, 1988) and the importance of decentralization for increased knowledge creation through enhancement of relationships (Foss *et al.*, 2013). By including both major aspects in our attempt to abstract the structure in two distinct legal forms for CVC programs, our argumentation for the superiority of the external setup appears legitimate and consistent with prior studies (Hill *et al.*, 2009; Lee *et al.*, 2018; Siegel *et al.*, 1988). Nonetheless, our empirical analysis offers no significant results for this reasoning and dismisses the assumption that external CVC units are associated with significantly higher innovativeness than internal CVC units.

From a relational point of view, our theoretical conceptualization relies on the assumption that the continuous interaction between the CVC unit and the external knowledge source, namely the venture firm, is most crucial for the creation of new knowledge (Foss *et al.*, 2013). We argue that the structural setup of external units provides better circumstances to maintain external relationships and thereby create higher relation rents (Foss *et al.*, 2013). Based on our reasoning, external units can particularly commit higher relation-specific assets through human capital and establish better knowledge-sharing routines (Weber *et al.*, 2016). However, this poses the risk of entering too many relationships, which might diminish the advantages due to less time and commitment to the individual relationships and thereby entails a potential explanation for our insignificant results (Wadhwa & Kotha, 2006). Our descriptive analysis reveals supporting indications, as we find external units to invest significantly more than its internal peers. Moreover, the establishment of interfirm knowledge-sharing routines can be hindered for external units when entrepreneurs rely on technical expertise and access to internal resources, which the external personnel often cannot provide as they might lack technical and firm-specific expertise (Asel *et al.*, 2015). Although we argue that external CVC units pursue more diversified investments (Yang *et al.*, 2016) and therefore pose a larger potential for complementary resource endowments, they might not be able to identify and utilize such complementarities because of the missing involvement of the parent organization.

Despite focusing on how the structure impacts the relationship between the CVC unit and the venture, further arguments for our results can be derived from the internal relationships between the CVC unit and the parent corporation, as they might also influence the potential for knowledge creation. Although the autonomous behavior of external units evidently fosters relationship building with the VC community and portfolio firms, it necessarily results in a higher level of disconnection from the parent organization and the other business units (Asel *et al.*, 2015; Dushnitsky & Shaver, 2009). However, knowledge assimilation requires coordination between the CVC unit and the parent to ensure optimal transfer and creation (Foss *et al.*, 2013). Particularly, the communication between the individuals who absorb the knowledge from external sources and the individuals who further process the knowledge within the parent organization needs to be clearly defined and executed (Foss *et al.*, 2013). In contrast to external units, internal programs are per definition closer connected to the parent organization and thus obtain higher strategic alignment which can result in more communication and knowledge sharing. Therefore, internally organized CVC program might facilitate the liaison with the parent through more defined structures, reporting lines, and established ties.

We observe distinct and hardly comparable effects of the CVC unit's structure on the maintenance of its two major relationships, namely to the ventures and the parents, for the efficient absorption, transfer, and creation of knowledge. Nevertheless, we still expect that the facilitation of the relationship to sources outside of the organization's broader boundaries (e.g., the relationship to the portfolio firms) is more critical for knowledge creation than the relationship between the CVC unit and other business units once the information resides within the organization. However, the disadvantage of external units compared to internal units in further distributing acquired knowledge to different foci in the parent organization might mitigate the advantage in preserving intimate external relationships.

A further potential explanation for the presented results for *Hypothesis 1* lies in the strict distinction of internal and external CVC units based on their legal structure. We have pointed out clear differences in the degree of autonomy, personnel decisions, capital commitment, duration, and objective alignment that have been identified by several scholars (Asel *et al.*, 2015; Siegel *et al.*, 1988; Winters & Murfin, 1988;

Yang *et al.*, 2016). Along these theoretical character dimensions, it is congruent to classify the CVC programs into the two categories, which has been applied in multiple prior works (Asel *et al.*, 2015; Dushnitsky & Shaver, 2009; Yang *et al.*, 2016). However, these characteristics might not necessarily be equally distinct in every CVC unit. This means for instance that an internal business unit could potentially have the same level of decision-making authority and the same proportion of VC-experienced personnel as a wholly owned subsidiary. Likewise, an external program could have strong ties with other business units, for example if it experiences a shift from an internal to an external setup and has maintained the relationships. This conjecture was also supported during one of our initial interviews[16] with employees from CVC programs that were conducted to receive a first overview on the characteristics and the implications of the structural setup. One investment manager from a legally dependent CVC program disclosed that they acted autonomously and received a fixed amount of long-term committed capital, independently from specific investment decisions. Another manager revealed that the distribution of decision-making power behaves more complex than conceptualized. Instead of keeping all decision-making authority at the top management level or fully delegate decisions to the investment managers in the CVC unit, the corporation implemented an investment threshold. While the investment managers decided upon smaller investments, an investment committee, composed of C-level managers and technical experts from the corporate, was required to sign off larger investments. Thus, both programs would claim some of the characteristics and advantages that we have attributed to external units but would still be classified as internal units.

Although the legal decision is only two-fold, the CVC units do not seem to be ‘either or’ but can lie along a continuum of modes. Hence, the conceptualization of the distinguishing characteristics into the two extreme forms ‘internal’ and ‘external’ might not reflect the full reality. The firms have multiple options to structurally establish the CVC unit considering the objectives of the program and the existing organizational design. In this regard, it is highly relevant to account for potential conflicts between exploration and exploitation when configuring the program in order to comply with the pursued intentions for ambidexterity. As we cannot capture the underlying characteristics of the CVC units and their parents in our data sample, such a classification does not seem to be appropriate. However, this does

[16] As described in the methodology section, we conducted five semi-structured interviews in an initiating endeavor to understand the structural aspects of CVC units from a managerial perspective. These interviews do not constitute part of the empirical analysis but are used at this point for supporting our theoretical reasoning.

not necessarily dismiss our primary argumentation for a structural effect on the innovativeness of parent firms since we have built our reasoning on the specific features associated with the two legal forms rather than debating only on the legal form itself. We aim to conceive a complex continuum of various possibilities into a more tangible measure. Thus, the rejection of our hypothesis is a necessary and perspicuous consequence.

Lastly, our insignificant results on the structural effect of CVC units shed light on the important, however often overlooked, aspect of the organizations' heterogeneity. Firms and their characteristics are clearly distinct from each other, and so are their optimal organizational designs (Burns & Stalker, 1961). Well adaptable to our research, Hill and Birkinshaw (2008) conclude that corporate venturing can only add value to the parent organization if the strategic and the organizational profile are critically aligned. This suggests that we cannot make one single generalization but need to take firm-specific features into account when considering the optimal structure of a CVC unit (Burns & Stalker, 1961). For instance, we would assume efficient coordination mechanisms to be in place for a well-diversified organization with multiple wholly owned subsidiaries to communicate between the different entities. As the knowledge transfer mechanisms within the boundaries of the organization are already implemented, the firm can rather focus on building relationships with external knowledge sources through the CVC program – the external mode might therefore be preferential. A less-diversified organization with an external CVC unit might similarly maintain outside relationships but achieves a less preferable innovation performance as fewer coordination mechanisms between the firms' entities are in place. Considering the heterogeneity of organizations, it is therefore difficult to determine one optimal structure applicable for all CVC units (Burns & Stalker, 1961). Whilst based on assumptions, these examples support that beyond our strict differentiation the structural setup of CVC units can still be relevant for the parent's performance if considered in the light of other firm-specific factors (Hill & Birkinshaw, 2008).

As our analysis reveals no significant result for the advantageousness of one structural setup, our previously elaborated arguments aim to discuss the potential reasons and the underlying dynamics. From a relational view perspective, we argue that the relationship to the external knowledge source is most important for the knowledge creation of the parent. However, we recognize that internal coordination might also influence the further assimilation of the knowledge. Moreover, we see a potential explanation for our result in abstracting the complex structural characteristics in two program designs differentiated by their legal form. Lastly, we highlight the importance of considering firm-specific factors.

For *Hypothesis 2*, we first reviewed the existing literature for an experience effect of knowledge creation through CVC. It was shown that more experience in CVC activities is associated with increased innovation performance, particularly attained through enhanced relationships and organizational learning resulting in new routines (Keil, 2004; Levitt & March, 1988; Wadhwa & Basu, 2013; Yang *et al.*, 2009). Our model shows a significant positive influence ($p<0.05$) of experience on the corporation's innovativeness and thus supports the findings from this prior research. Building on this existing evidence, we hypothesized an interaction effect between the investment experience and the CVC unit's organizational configuration on the parent's knowledge creation. In fact, the results reflect the sensitiveness of the differing structural characteristics associated with internal and external programs to the investment experience. In particular, we argued that the investment experience will negatively moderate the structural effect on the innovation performance. Our analysis demonstrates a negative significant coefficient ($p<0.05$), thus we confirm *Hypothesis 2*. The result suggests that there is a significant difference between the two structural setups of CVC units on the parent's innovativeness when the investment experience is high (see *Appendix HH*). Consequently, we reveal that the innovativeness of parent organization's with internal units highly benefit from investment experience gains of the program. This result was expected and will be further interpreted in the following considering the previous argumentations on organizational learning and relationship building.

Firstly, we argue that the previous investment experience of recruited VC professionals in external units can be replicated through direct learning from investments. We argue that VC-experienced employees are associated with better investments, as they have developed screening and valuation capabilities in prior roles (Asel *et al.*, 2015). Nevertheless, Yang *et al.* (2016) find that CVC units can develop such capabilities through repetitive learning-by-doing, which enables them to improve their investment performance. Assuming a decreasing marginal learning effect, internal CVC programs who predominately recruit corporate employees can therefore mitigate their shortcomings compared to external programs with pre-experienced personnel (Asel *et al.*, 2015). Additionally, inexperienced internal CVC programs often lack effective monitoring systems for portfolio firms, which limits the knowledge absorption and risk mitigation. Such mechanisms can however be implemented once they are developed through experience (Wadhwa & Basu, 2013).

Secondly, experience enhances relationship building (Dyer & Singh, 1998; Weber *et al.*, 2016). CVC units face two main stakeholder groups that demand engagement, namely the portfolio firms and the parent corporation. We reason that external and internal units differ in their ability to establish and strengthen these relationships. On the one hand, external units tend to be structured in a more informal way relative to internal programs, resembling the cultures of entrepreneurial environments and thereby facilitating interaction (Weber & Weber, 2007). Further, the existing relationships to the VC environment of pre-experienced investment managers from external units eases the relationship building (Asel *et al.*, 2015). The higher level of disconnection from the parent organization also enables external units to build and maintain relationships due to higher flexibility (Yang *et al.*, 2009). On the other hand, internal units tend to be more strategically aligned with their parent organization and can thus easier facilitate lines of communication with internal business units (Asel *et al.*, 2015), whereas there might be fewer exchange with the portfolio companies and the VC environment. This concerns especially the post-investment phase, which is critical for the ideal knowledge transfer and assimilation (Foss *et al.*, 2013). Internal units especially lack trust from entrepreneurs (Wadhwa & Basu, 2013) and are more restricted to engage due to higher involvement of the parent corporation (Asel *et al.*, 2015).

The discussed dimensions are impacted by the investment experience in various ways. Internal CVC programs mostly benefit from promoting external relationships. Accordingly, a higher number of investments results in increased interaction opportunities with start-up companies and the VC community, which enables the unit to build capabilities, gain trust, and establish ties in the VC environment. Additionally, experience brings an increase in repetitive encounters with the portfolio companies, which empower internal units to build critical interfirm knowledge-transfer routines with the ventures, such as lines of communication, particularly strengthened by a higher degree of technical expertise (Asel *et al.*, 2013; Foss *et al.*, 2013). In return, external units primarily benefit from experience by assembling relationships with internal parties. While we argue that a certain relatedness to the parent corporation necessarily exists from the very beginning, enhanced and frequent communication with employees in other business units on the grounds of investment decisions and knowledge transfer strengthens these important ties (Dyer & Singh, 1988). However, the complexity of coordination among separate legal entities persists and might hinder those interactions.

We suggest that the relational view provides valid arguments for why the investment experience fosters internal as well as external relationships and thereby might lead to a positive effect on the incumbent's innovativeness, but it also reveals crucial implications on the structural impact of CVC units. We argue that the relationships with external knowledge sources (i.e., the portfolio companies) are more critical in generating relational rents through the access to new knowledge and the subsequent assimilation. Although internal units might initially lack the ability to build such external relationships, the gain in investment experience increasingly exposes them to venture companies and the VC community, so they can shape relational capabilities as well as build and maintain more important external ties. Further, we highlight the importance of employees' investment capabilities for pursuing high-quality investments, which are crucial for knowledge creation and innovativeness. The aspect that corporate personnel in internal units can gain such screening and valuation capabilities through experience and associated learning is highly relevant and mitigates initial shortcomings (Yang *et al.*, 2009). Following this argumentation, external units have fewer learning potential through investment experience, which explains the diminishing effect of external CVC units on the parent's innovativeness when the programs are experienced. We want to highlight that the differing structural character dimensions between internal and external units remain evident. However, the implications on the ability to build relationships might change when the investors accumulate investment experience.

Based on our conceptual development, we expected a negative influence of the degree of investment uncertainty on the innovation performance of the parent organization due to difficulties in knowledge absorption in fast-changing environments. Although we reject this assumption, we notice a revealed p-value of 11.5%, which barely exceeds our significance threshold of 10% and therefore is still worth to consider. Existing studies (e.g., Dushnitsky and Shapira, 2010), explain that later stage investments have more clarity about their technological investments and new knowledge that can be assimilated more easily by the investing corporation. However, we acknowledge that explorative CVC activities in general are already characterized by a high level of uncertainty (March, 1991). The differentiation of development stages of the venture firms might therefore not capture the full extent of the effect of the uncertainty that CVC units and their parent organizations face, which might explain the insignificant result in our model.

More importantly, however, we want to analyze the interaction effect of the degree of uncertainty and the structural setup of CVC units on the parent's innovativeness. Based on prior literature, we derive three major reasons for arguing that the structural effect of CVC units on corporate knowledge creation increases if uncertainty of investments is higher (Weber & Weber, 2007; Weber *et al.*, 2016; Yang *et al.*, 2009). Despite the extensive theoretical argumentation, our empirical model does not provide supporting evidence for the significant interaction between the degree of uncertainty and the structural mode. We therefore reject *Hypothesis 3*. Surprising at first, the result can still be explained by our research.

First, we argued that due to a remarkable criticalness of information about changes and trends in highly uncertain environments, a stronger connection to the VC community and the portfolio ventures will facilitate a better overview of the underlying investment situation (Yang *et al.*, 2009). Additionally, as pointed out by Foss *et al.* (2013), closer ties with external knowledge sources allow for a better understanding of uncodified knowledge and the surrounding conditions. When uncertainty resides about the directions and advances of a start-up company, strong ties become particularly critical, which can be encouraged by external CVC units (Dushnitsky, 2004; Weber *et al.*, 2016). Nonetheless, internal ties with business units should not be underestimated. Especially in highly uncertain environments, as in the complex and fast-changing field of technology, the know-how of experienced researchers or technical experts within the parent corporation can be of essence for the correct evaluation of information and subsequent decisions. External CVC units might lack the appropriate evaluation input from such experts as a result of less company involvement (Asel *et al.*, 2015). This suggests that the lack of technical experience mediates the value of the relationship to external knowledge sources. Put differently, the drawback of missing expertise might hinder the external unit to use its advantageous position towards the venture firms to significantly better manage uncertainty.

Second, we discussed that more experienced personnel, especially from the financial and investment environment, has superior capabilities to make educated decisions in the pre-investment and post-investment phase (Dushnitsky & Shapira, 2010). As documented by other scholars (Asel *et al.*, 2015), external units are rather associated with such experienced personnel, thus we reasoned that external CVC programs are better suited to handle uncertainty. However, there are likely further implications that influence the investment behavior and performance under uncertainty. Dushnitsky and Shapira (2010) detect that managers receiving some form of performance pay, mostly evident in external units (Sykes, 1992), are less risk averse and tend to invest in even riskier projects that would otherwise be classified as too risky. As March (1991) concluded, explorative activities afflicted with risk often come with returns that are *"uncertain, distant, and often negative"* (p. 85). Therefore, it might occur that experienced managers are overconfident, and the investments are too uncertain as to be beneficial for the parent organization, even if managed by VC-experienced managers. Such negative impact could be intensified by a lack of effective monitoring mechanisms as a result of higher autonomy. Such governance systems could be less developed in external programs with a decentralized structure and higher decision-making authority (Asel *et al.*, 2015). While a higher level of autonomy gives reason to expect a better performance under uncertainty as it enables the units to react faster to changing environments (Siegel *et al.*, 1988), corporations with external CVC units risk losing the control over uncertainty and cannot assimilate the anticipated amount of new knowledge for successful innovativeness.

7.2 Contribution

This work emphasizes the complexity of CVC regarding its performance implications while considering the importance of the unit's structure, which is widely overlooked in practice and so far received little attention in academia. It further represents an early attempt to understand how a CVC unit's structure impacts the knowledge creation of incumbents and aims to identify a superior structural form for the corporations' innovation performance. Our research makes three major contributions.

Firstly, this work contributes to the large body of the CVC literature and extends it by considerations on the perspective of organizational design. We display the relevance of the ongoing discussion on the value creation potential of incumbent's involvement in venture firms and highlight the importance of the CVC unit's structure and subsequent implications for the knowledge creation of the investing firm. We therefore provide a clear distinction of various structural investment modes and establish a comprehensive overview of the different character dimensions of internally and externally structured CVC units. We reveal the complexity of different structures and elaborate on their impact on the relationship of incumbent firms and ventures. Ultimately, we contribute to the existing research on performance implications of the structural decision of CVC units for the parent organization. Based on our empirical work, we aim to provide an early attempt in identifying a superior CVC program's structure for the innovativeness of incumbents.

Secondly, our thesis contributes to existing literature on the relational view, organizational learning and organizational design by combining those three aspects. We rely on the relational view to derive a theoretical model for relational rent-generation. It explains the impact of organizational design decisions on the relationship between an organization and an external knowledge source, mediated by the CVC unit. Although this theoretical model is applied in the context of CVC within this work, it could be well applicable for similar relationships with other external knowledge sources, such as alliances or research collaborations. Moreover, this work can be seen as a scarce attempt to practically investigate the relational view.

Thirdly, we highlight the importance of CVC from a managerial perspective. We show the practical implications of the relationships between an organization's involvement in venture firms and its innovativeness, as corporations increasingly use CVC as a vehicle for innovation. We point out the relevance for managers to carefully assess the differences in a CVC unit's structure and associated implications on the innovation performance, but also the relationship with venture firms. This thesis may constitute as guidance for practitioners when establishing or reassessing the structure of CVC programs and the decisions that come with it. Further, we underline the necessity to align the unit's setup with the parent's characteristics and objectives. Moreover, we provide entrepreneurs with an overview to evaluate the characteristics of different program structures and the associated implications on their relationship with the corporate investor when considering potential funding.

Our work aims to bridge the gap in the CVC literature on the impact of the structural setup of CVC units on the innovation performance of incumbent firms by providing an early and rare attempt to empirically derive a conclusion on the superiority of one structural mode over the other. As we highlight our objective to understand and explain the underlying dynamics of structural decisions of CVC units on the performance of parent organizations, we do not claim to reveal causal relationships and conclusive evidence of the proposed findings.

7.3 Limitations of the Study & Implications for Future Research

Even though we have tried to capture all relevant information and considerations in our study, there are certain limitations to our analysis that we want to address and explain in the following. These limitations may have an impact on our previously evaluated results. We will specifically elaborate on limitations concerning the underlying theoretical concept, our data sources, as well as the applied empirical model. Complementary, we offer implication for future research to pick up on and extend the findings of this study.

7.3.1 Critical Considerations on the Theoretical Concept

First of all, we want to address the validity of a binary variable for capturing of the structural aspects of CVC programs. In line with widely accepted literature (Dushnitsky & Shaver, 2009; Yang *et al.*, 2016) this study operationalizes all CVC units into two groups, internal and external programs. This distinction is considered appropriate for a first conceptualization as it displays main differences in structural decisions. While it is clearly our main objective to understand the various implications of these two structural options, we need to accept that organizational structure is a complex phenomenon. As we have already addressed in the discussion of this thesis, the modes of CVC programs are rather to be seen as points on a continuum than as two extremes at the end of a spectrum, since the character dimensions can be implemented differently. As Lee *et al.* (2018) conclude, the same values for this binary variable could denote different levels of VC experience in personnel or decision-making autonomy. It would therefore be negligent to assume that the classification on the basis of the legal form of the CVC unit can depict the full reality. We are, however, certain that our analysis offers a valuable insight to the organizational implications for CVC, especially since the distinction offers an objective comparison, contrary to self-reported questionnaires. Our study constitutes a starting point for further research on the objective differentiation between internal and external structures.

By highlighting the complexity of the phenomenon and pointing out the shortcomings of the employed categorization, we additionally offer a nudge for future research. In order to improve the empirical analysis on the effects of establishing a CVC unit internally or externally, it would be valuable to extend our study by using qualitative approaches such as survey-based primary research that can help creating a strengthened dataset where the characteristics of CVC units are fully disclosed. Prior research has made first attempts in that direction (e.g., Asel *et al.*, 2015; Siegel *et al.*, 1988). However, no full-scaled study seems to be conducted to this date. Further, our theoretical conceptualization relies on the relational view and therefore strongly focuses on the external relationship between the CVC unit and the venture firm, widely neglecting the implications of the internal relationship between the CVC unit and the parent corporation, such as the need for coordination or internal knowledge transfer. To complement our study, future research could be conducted by investigating the structural impact on the internal perspective and derive a more complete picture of the underlying relationships and implications on the innovativeness of incumbents.

An additional proposal for valuable future research is the consideration of additional potential interaction effects. Our thesis examines the interrelatedness of organizational structure with investment experience and uncertainty which is based on existing literature (Foss *et al.*, 2013; Weber & Weber, 2007; Yang *et al.*, 2009) while keeping the perspective of the relational view. However, other factors deemed relevant for CVC impact on parent firm innovativeness such as portfolio diversification (Yang *et al.*, 2016) might act interrelated with the structural aspect. Moreover, in investigating the relationship between alliance formation and CVC investment, Dushnitsky and Lavie (2010) stress the importance of considering other venturing activities, both external and internal. Since our study focuses on CVC activities, we cannot exclude the risk of associating benefits or obstacles with CVC that are the result of other knowledge sourcing activities such as alliances. Investigating the influence of additional external knowledge sources could shed further light on implications for the organizational design and thus help managers and organizations to establish optimal CVC programs.

7.3.2 Limitations of Data Sources

We have put utmost effort and care to the collection of our data, however, there are a few limitations that shall be addressed in the following. We use a total of three databases for our final data sample. While offering extensive and highly valuable data for our study, each database needs to be handled with caution. The *Thomson One Banker* database is the source of our investment related information. We extracted data with investors classified as “corporate”. However, this classification included financial investors such as traditional VCs, asset managers, and non-profit organizations that fall out of the definition of a corporate investor. Thus, manual checks of all entries were required, which increase the risk of errors and bias (Saunders *et al.*, 2016). Further, we conducted manual search to identify whether the CVC units extracted from the database were external or internal. Although we restricted our search to reliable sources and carried out several double checks, this manual search poses some risk on the reliability of the data (Saunders et al., 2016). However, this risk is deemed minor, as for most entries sufficient information was available.

The *Compustat* database poses further limitations due to a lack of data availability. As described, we already removed 107 corporations from our initial raw data, since they did not contain financial data within the investment period. As discussed, we only included corporations with an overlap of the financial data period and the investment period of at least one year. This led to larger data availability but might also bias the financial information of some companies with missing entries in the investment period, as they rely on fewer data points to calculate the average. Other companies showed missing values for specific financial information across the total considered period. If this specific variable was included in our empirical model, we removed such corporation from the analysis. The shortcoming could have been reduced or even prevented by complex manual matching, which was deemed out of scope for this thesis. The *Compustat* database is further biased to a certain degree as it only contains financial data for public companies. Therefore, our final dataset excluded private companies, which led to a decrease of 170 entries. No research has been conducted so far on different implications for private companies, and we do not expect any, however, we cannot eliminate such a possibility with absolute certainty. Hence, it would be interesting to see future research conducting further studies in that regard.

Finally, the *PatentsView* data does not come without limitations either, resulting from issues due to misspellings. Specifically, in some cases one assignee ID had multiple entries. We mitigated these limitations by using multiple search terms and spellings to find all related entries during the matching process. Another limitation potentially influencing our results is the fact that the *PatentsView* database sources its data from U.S. authorities, thus we expect a potential bias as mostly patents registered in the U.S. are reflected.

7.3.3 Limitations of the Applied Empirical Model

Our thesis focuses on the CVC unit as the level of analysis. Whilst this ensures a suitable level of granularity for our research question, it also results in several limitations that would be interesting to further shed light on.

First of all, our cross-sectional analysis is based on the assumption of structural consistency over time. In other words, we assumed that no CVC program changed from internal to external or vice versa during the investment period. However, we cannot fully eliminate the possibility of such an occurrence. It would be interesting to devote future research efforts to investigate such cases, as it could offer valuable additional insights on structural influences on performance. Another aspect that potentially influences the results of our empirical analysis is the uneven distribution between internal and external units but also across industries and geographies within our data sample which increases the risk of bias. Furthermore, our level of analysis denotes that the dataset includes cases of investing corporations with multiple CVC programs. We cannot fully distinguish the total effect between those activities as some of these entries occur in overlapping investment periods. Additionally, patent related data occurs with a time lag, making it further difficult to assign it to particular knowledge creation activities.

Some attention shall be dedicated to our choice of using patent data to measure the innovativeness of investing corporations. While this is a widely accepted measure and frequently used by other scholars (Dushnitsky & Lenox, 2005a; Wadhwa & Kotha, 2006) it is exposed to several limitations. Patents do not seize knowledge creation to its full extent. This is the case because patents generally secure codifiable knowledge, whereas tacit knowledge such as know-how or software (which is typically protected by copyrights) is not represented. Therefore, a lower patent count does not necessarily depict a lower level of innovativeness. Furthermore, the usage of patents critically differs across industries (Chemmanur, Loutskina, & Tian, 2014). We consider a certain industry effect on innovativeness by using control variables for the largest underlying industries in our regression model but cannot be fully certain that the full effect is controlled for. Lastly, using the cumulative patent count as a measure for innovativeness might lead to an additional bias in the sense that it reflects the general innovativeness rather than the quality of such knowledge creation. An alternative would be to use forward citations of the granted patents, as it was done in previous studies (Trajtenberg, 1990; Wadhwa et al, 2016). However, we deemed this variable as inadequate for our study because it is subject to a truncation bias (Dushnitsky & Lenox, 2005b). Our data set only includes forward citations until 2015 and newer patents are likely to receive further forward citations beyond that cutoff date. Additionally, in our model we investigate the patent applications in the post-investment period of firms, which is operationalized as the number of years between the last CVC investment and 2015. This period varies significantly between the different CVC units and can be as short as one year for some entries. Whilst we can account for this timing effect when using the total patent count, this is not possible for forward citations because the longer the period we consider is, the more time there is to accumulate additional forward citations.

We have discussed the primary implications of and reasons for using a cross-sectional study in chapter 5.2 on our research design. However, we deem it necessary to highlight resulting limitations to give a comprehensive overview. Because we intend to investigate the effect of structure on the level of knowledge creation of the investing firm, we analyze the data at a certain point in time, thus avoiding complexity through restricting assumptions on time. In order to do so, we take the average for the financial data over time and aggregate the patent data to one line per CVC unit. While this naturally causes a less precise picture of the data, it allows us to use the sample for the cross-sectional analysis and smooth it for potential outliers over the years. However, using a cross-sectional analysis also forced us to exclude CVC units that were still active in 2015, the last year of our data set. CVC units active in 2015 (and potentially ongoing) therefore had a post-investment period of zero years and subsequently zero patents. These removed entries reflected some large companies that would have been valuable to include in our analysis. Furthermore, the use of a cross-sectional analysis prevents us from capturing the exact year of application of the individual patents as it only considers the cumulative count of patents in the full period. We therefore excluded patents applied for within active investment period from our dependent variable. A full picture would be shown if patents were already included when the parent organization was still active in CVC but considering a certain time lag of innovation (Dushnitsky & Lenox, 2005a). However, we believe that the applied cumulative count of patents in the period after the last CVC investment resembles a representative picture of the effect of CVC on the rate of knowledge creation.

Our empirical model includes a vast selection of controlling variables in order to account for as many influential outside effects as possible. The control variables have been derived from existing CVC and innovation literature. However, it is possible that further unobserved factors have potential to significantly impact our results.

Lastly, we conducted several robustness checks on our model to ensure a certain degree of validity. Although we find robustness for our significant results, other robustness tests could add legitimacy. Nonetheless, further tests were not deemed essential in the scope of our work, which is why we suggest additional tests with alternative proxies especially for our dependent variable as interesting approaches for future research. For instance, the innovativeness of firms could be operationalized as the R&D stock or forward citations of patents (Dushnitsky & Lenox, 2005a; Hall *et al.*, 2005).

Concluding, this thesis does not claim to be without shortcomings but offers a comprehensive overview and introduction for the research on structural influences on parent firms' innovativeness. The presented limitations offer several interesting opportunities for future research. We see our considerations and limitations on the classification of internal and external units as the most critical aspect for future research. In order to further investigate a potential structural impact and its orientation on innovation performance, additional studies including both quantitative and qualitative primary data would be necessary for a more granular categorization and thus more meaningful results.

8 Conclusion

This thesis was set out to investigate potential performance implications of different structural modes of CVC units on the investing corporation. Even though the existing research has devoted significant efforts towards the exploration of performance implications of CVC activities, the entirety of structural aspects has so far been largely neglected in this regard. The little research existing on this topic has made significant contributions towards understanding the performance implications of individual structural characteristics but has disregarded, how the structure of a CVC program influences the incumbent's relationship with venture firms and subsequently the innovativeness. We bridge this identified research gap by investigating how the structure of CVC units affects the innovativeness of incumbents through its relationship with venture firms.

Drawing on existing CVC literature, our research compiled an extensive overview of structural character dimensions of internal and external CVC units. Subsequently, these insights were combined with literature on the relational view and organizational learning to conceptualize a model of CVC relational-rent generation under the influence of structural differences of CVC programs. Considering further influencing factors, we theorized the CVC unit's investment experience and the degree of pursued investment uncertainty to influence the presumed relationship between the structural mode of the CVC unit and the knowledge creation of the parent organization. Based on this theoretical foundation, we derived three hypotheses. First, we argued for a superior impact of external units relative to internal units on the innovativeness of incumbents. Second, we hypothesized a moderating effect of experience and uncertainty on the relationship between the structural setup and the innovation rate of the investing firm.

Our empirical analysis of 477 CVC units finds mixed results on the effect of the structural component of CVC units on the innovativeness of incumbents. While our analysis neither shows significance for the individual structural effect of CVC units on knowledge creation, nor of the moderating effect of uncertainty on this relationship, we reveal a significant negative moderating effect of the investment experience on this relationship. These findings pose substantial implications on the importance of the CVC's structural setup considering various factors.

This work attempted to answer the research question on how the structural choice of CVC units influences the degree of innovativeness of incumbents. We found that the structure of CVC units is highly complex and cannot easily be abstracted into a dichotomous variable. The classification into external and internal units based on the legal structure does not necessarily depict the actual features of the character dimensions that are associated with the two modes. CVC units can individually adapt single characteristics that might separately affect the relationship to the venture firms and the subsequent relational rent-generation which consequently might have impacted our results. Nonetheless, the moderating effect of the investment experience reveals an overall impact of structure on the innovativeness of incumbents. We reason that the investment experience enables particularly internal CVC units to build meaningful relationships with external knowledge sources, while maintaining existing internal coordination for knowledge transfer. Although we cannot find differences among internal and external CVC structures for the incumbent's innovation performance when investment experience is low, we see larger benefits for internal CVC units when investment experience is high.

While there are several limitations to our analysis, our theoretical approach on the effect of structure on the innovativeness of incumbents from a relational point of view offers a first attempt for understanding a complex mechanism of organizational design in CVC. Our results support the assumed complexity and give reason to further investigate the implications of structural aspects of CVC programs on the incumbent – venture relationship and the rate of knowledge creation of the investing corporation. From a managerial perspective, the insights from our research become especially relevant when establishing CVC programs and strengthen relationships with ventures for the highest value creation. Thus, by acknowledging the importance and complexity of this research field, we unveil the need for future research for a better understanding of the underlying dynamics.

9 Bibliography

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10 Appendix

Appendix A: Distribution of CVC units among industries

Distribution of CVC units among industries based on 2-digits SIC code

SIC	Description	Freq.	Percent	Cum.
73	Business Services	134	21.07%	21.07%
48	Communications	84	13.21%	34.28%
36	Electronic And Other Electrical Equipment And Components, Except Computer Equipment	72	11.32%	45.60%
28	Chemicals And Allied Products	71	11.16%	56.76%
35	Industrial And Commercial Machinery And Computer Equipment	39	6.13%	62.89%
38	Measuring, Analyzing, And Controlling Instruments; Photographic, Medical And Optical Goods; Watches And Clocks	31	4.87%	67.77%
99	Nonclassifiable Establishments	23	3.62%	71.38%
50	Wholesale Trade-durable Goods	21	3.30%	74.69%
37	Transportation Equipment	17	2.67%	77.36%
49	Electric, Gas, And Sanitary Services	17	2.67%	80.03%
27	Printing, Publishing, And Allied Industries	15	2.36%	82.39%
33	Primary Metal Industries	10	1.57%	83.96%
59	Miscellaneous Retail	10	1.57%	85.53%
29	Petroleum Refining And Related Industries	8	1.26%	86.79%
67	Holding And Other Investment Offices	7	1.10%	87.89%
20	Food And Kindred Products	6	0.94%	88.84%
51	Wholesale Trade-non-durable Goods	6	0.94%	89.78%
87	Engineering, Accounting, Research, Management, And Related Services	6	0.94%	90.72%
13	Oil And Gas Extraction	5	0.79%	91.51%
60	Depository Institutions	5	0.79%	92.30%
26	Paper And Allied Products	4	0.63%	92.92%
63	Insurance Carriers	4	0.63%	93.55%
10	Metal Mining	3	0.47%	94.03%
32	Stone, Clay, Glass, And Concrete Products	3	0.47%	94.50%
39	Miscellaneous Manufacturing Industries	3	0.47%	94.97%
42	Motor Freight Transportation And Warehousing	3	0.47%	95.44%
61	Non-depository Credit Institutions	3	0.47%	95.91%
1	Agricultural Production Crops	2	0.31%	96.23%
16	Heavy Construction Other Than Building Construction Contractors	2	0.31%	96.54%
53	General Merchandise Stores	2	0.31%	96.86%
55	Automotive Dealers And Gasoline Service Stations	2	0.31%	97.17%
56	Apparel And Accessory Stores	2	0.31%	97.48%
58	Eating And Drinking Places	2	0.31%	97.80%
65	Real Estate	2	0.31%	98.11%
70	Hotels, Rooming Houses, Camps, And Other Lodging Places	2	0.31%	98.43%
80	Health Services	2	0.31%	98.74%
12	Coal Mining	1	0.16%	98.90%
21	Tobacco Products	1	0.16%	99.06%
23	Apparel And Other Finished Products Made From Fabrics And Similar Materials	1	0.16%	99.21%
45	Transportation By Air	1	0.16%	99.37%
57	Home Furniture, Furnishings, And Equipment Stores	1	0.16%	99.53%
62	Security And Commodity Brokers, Dealers, Exchanges, And Services	1	0.16%	99.69%
75	Automotive Repair, Services, And Parking	1	0.16%	99.84%
82	Educational Services	1	0.16%	100.00%
Sum		636	100.00%	100.00%

Distribution of CVC units among industries based on 3-digits SIC code

SIC	Description	Freq.	Percent	Cum.
737	Computer Programming, Data Processing, And Other Computer Related Services	113	17.77%	17.77%
283	Drugs	53	8.33%	26.10%
481	Telephone Communications	48	7.55%	33.65%
367	Electronic Components And Accessories	34	5.35%	38.99%
357	Computer And Office Equipment	32	5.03%	44.03%
999	Nonclassifiable Establishments	23	3.62%	47.64%
366	Communications Equipment	21	3.30%	50.94%
384	Surgical, Medical, And Dental Instruments And Supplies	14	2.20%	53.14%
483	Radio And Television Broadcasting Stations	12	1.89%	55.03%
371	Motor Vehicles And Motor Vehicle Equipment	11	1.73%	56.76%
484	Cable And Other Pay Television Services	11	1.73%	58.49%
491	Electric Services	11	1.73%	60.22%
-	Others	253	39.78%	100.00%
Sum		636	100.00%	100.00%

Appendix B: T-test on patent post by internal/external

```
. ttest patent_post if include == 1 , by(external)

Two-sample t test with equal variances
```

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
0	367	1270.327	245.3833	4700.868	787.7888	1752.865
1	110	850.7818	247.009	2590.652	361.218	1340.346
combined	477	1173.577	197.2537	4308.087	785.9807	1561.172
diff		419.5452	468.3866		-500.8208	1339.911

```
    diff = mean(0) - mean(1)                                      t =   0.8957
Ho: diff = 0                                     degrees of freedom =      475

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.8146         Pr(|T| > |t|) = 0.3709          Pr(T > t) = 0.1854
```

```
. ttest patent_post if include == 1 & patent_post < 28335 , by(external)

Two-sample t test with equal variances
```

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
0	362	829.0691	148.3323	2822.215	537.3651	1120.773
1	110	850.7818	247.009	2590.652	361.218	1340.346
combined	472	834.1292	127.3757	2767.309	583.8342	1084.424
diff		-21.71276	301.6041		-614.372	570.9465

```
    diff = mean(0) - mean(1)                                      t =  -0.0720
Ho: diff = 0                                     degrees of freedom =      470

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.4713         Pr(|T| > |t|) = 0.9426          Pr(T > t) = 0.5287
```

Appendix C: T-test on experience by internal/external

```
. ttest firm_invest_tot if include == 1, by(external)

Two-sample t test with equal variances
```

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
0	367	9.446866	.8578772	16.43456	7.75988	11.13385
1	110	15.69091	3.58313	37.58019	8.589261	22.79256
combined	477	10.88679	1.062026	23.195	8.799953	12.97363
diff		-6.244043	2.507638		-11.17148	-1.316607

```
    diff = mean(0) - mean(1)                                      t =  -2.4900
Ho: diff = 0                                     degrees of freedom =      475

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.0066         Pr(|T| > |t|) = 0.0131          Pr(T > t) = 0.9934
```

Appendix D: T-test on uncertainty by internal/external

```
. ttest stage_inv if include == 1, by(external)

Two-sample t test with equal variances
```

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
0	367	.2898362	.0165918	.3178524	.257209	.3224633
1	110	.3543929	.0288055	.302115	.2973012	.4114845
combined	477	.3047235	.0144301	.3151582	.2763689	.333078
diff		-.0645567	.0341656		-.1316911	.0025777

```
    diff = mean(0) - mean(1)                                      t =  -1.8895
Ho: diff = 0                                     degrees of freedom =      475

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.0297         Pr(|T| > |t|) = 0.0594          Pr(T > t) = 0.9703
```

Appendix E: T-test on post period by internal/external

```
. ttest post_year if include == 1, by(external)

Two-sample t test with equal variances
```

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
0	367	11.01362	.2856344	5.471968	10.45193	11.57531
1	110	7.727273	.5143332	5.394372	6.707881	8.746664
combined	477	10.25577	.257413	5.621985	9.749959	10.76157
diff		3.286351	.5928784		2.121363	4.45134

```
    diff = mean(0) - mean(1)                                      t =   5.5430
Ho: diff = 0                                     degrees of freedom =      475

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 1.0000         Pr(|T| > |t|) = 0.0000          Pr(T > t) = 0.0000
```

Appendix F: T-test on post period by internal/external

```
. ttest patent if include == 1, by(external)

Two-sample t test with equal variances
```

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
0	367	1621.946	324.5063	6216.647	983.8146	2260.076
1	110	1524.709	429.9309	4509.153	672.6001	2376.818
combined	477	1599.522	268.4429	5862.882	1072.042	2127.002
diff		97.23641	637.9505		-1156.318	1350.791

```
    diff = mean(0) - mean(1)                                      t =   0.1524
Ho: diff = 0                                     degrees of freedom =      475

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.5605         Pr(|T| > |t|) = 0.8789          Pr(T > t) = 0.4395
```

Appendix G: T-test on post period by internal/external

```
. ttest firm_exp_years if include == 1, by(external)

Two-sample t test with equal variances

   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
       0 |     367     6.47139    .3722144    7.130602    5.739442    7.203337
       1 |     110    6.863636    .6644151    6.968444    5.546787    8.180485
---------+--------------------------------------------------------------------
combined |     477    6.561845    .3245461    7.088194    5.924125    7.199565
---------+--------------------------------------------------------------------
    diff |           -.3922467    .7710877               -1.907412    1.122918
------------------------------------------------------------------------------
    diff = mean(0) - mean(1)                                      t =  -0.5087
Ho: diff = 0                                     degrees of freedom =      475

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.3056         Pr(|T| > |t|) = 0.6112          Pr(T > t) = 0.6944
```

Appendix H: T-test on size by internal/external

```
. ttest emp if include ==1 , by(external)

Two-sample t test with equal variances

   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
       0 |     337    41.87914    4.172718    76.60092     33.6712    50.08708
       1 |      99    57.54924    9.935532    98.85729     37.8325    77.26598
---------+--------------------------------------------------------------------
combined |     436    45.43726    3.942583    82.32356    37.68838    53.18614
---------+--------------------------------------------------------------------
    diff |            -15.6701    9.391742               -34.12905    2.788852
------------------------------------------------------------------------------
    diff = mean(0) - mean(1)                                      t =  -1.6685
Ho: diff = 0                                     degrees of freedom =      434

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.0480         Pr(|T| > |t|) = 0.0959          Pr(T > t) = 0.9520
```

Appendix I: T-test on financial stability by internal/external

```
. sum leverage if include == 1, det

                          leverage
-------------------------------------------------------------
      Percentiles      Smallest
 1%    -5.248845      -46.45269
 5%            0      -8.314163
10%            0       -7.11769       Obs                 474
25%     .0522695      -6.373433       Sum of Wgt.         474

50%     .3352357                      Mean           .6860066
                        Largest       Std. Dev.      4.017783
75%     .7858956       7.679099
90%     1.593218       13.43029       Variance       16.14258
95%     2.760624       15.29098       Skewness       5.754278
99%     7.301444       65.76415       Kurtosis       186.7749


. ttest leverage if include == 1 & inrange(leverage,-5.248845,7.301444), by(external)

Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
       0 |     357    .5929366    .0564983    1.067505    .4818242    .7040491
       1 |     108    .7854725    .1005294    1.044732    .5861847    .9847603
---------+--------------------------------------------------------------------
combined |     465    .6376546    .0493537    1.064257    .5406701    .7346391
---------+--------------------------------------------------------------------
    diff |           -.1925358    .1166599               -.4217843    .0367127
------------------------------------------------------------------------------
    diff = mean(0) - mean(1)                                      t =  -1.6504
Ho: diff = 0                                     degrees of freedom =      463

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.0498         Pr(|T| > |t|) = 0.0995          Pr(T > t) = 0.9502
```

Appendix J: T-test on slack by internal/external

```
. sum ebitda_margin if include == 1 , det

                        ebitda_margin
-------------------------------------------------------------
      Percentiles      Smallest
 1%    -3.472038        -2266.1
 5%    -.6421941         -848.6
10%    -.0964636      -12.10699       Obs                 472
25%     .0584701       -11.7404       Sum of Wgt.         472

50%     .1274246                      Mean          -6.585629
                        Largest       Std. Dev.       111.306
75%     .2158126       .5962021
90%     .3162335       .6389424       Variance       12389.03
95%     .3781592       .6904742       Skewness       -18.6998
99%     .5561818       .7846372       Kurtosis       368.2831
```

```
. ttest ebitda_margin if include == 1 & inrange(ebitda_margin, -3.472038,.5561818), by(external)

Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
       0 |     356    .0398033    .0246244     .464612   -.0086247    .0882313
       1 |     107    .1186375    .0234773    .2428507    .0720915    .1651834
---------+--------------------------------------------------------------------
combined |     463     .058022     .019745    .4248622    .0192208    .0968231
---------+--------------------------------------------------------------------
    diff |           -.0788342    .0467473               -.1706985      .01303
------------------------------------------------------------------------------
    diff = mean(0) - mean(1)                                      t =  -1.6864
Ho: diff = 0                                     degrees of freedom =      461

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.0462         Pr(|T| > |t|) = 0.0924          Pr(T > t) = 0.9538
```

Appendix K: T-tests on total and annual patent post by experience

```
. ttest patent_post if include == 1, by(experience_investments)

Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
       0 |     238    1046.685    299.7995    4625.082    456.0726    1637.297
       1 |     239    1299.937     256.999    3973.108    793.6539    1806.221
---------+--------------------------------------------------------------------
combined |     477    1173.577    197.2537    4308.087    785.9807    1561.172
---------+--------------------------------------------------------------------
    diff |           -253.2524    394.7524               -1028.929    522.4246
------------------------------------------------------------------------------
    diff = mean(0) - mean(1)                                      t =  -0.6415
Ho: diff = 0                                     degrees of freedom =      475

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.2607         Pr(|T| > |t|) = 0.5215          Pr(T > t) = 0.7393
```

```
. ttest patent_post_year if include == 1, by(experience_investments)

Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
       0 |     238    87.76162    23.17636    357.5474    42.10364    133.4196
       1 |     239    179.0067    31.57805    488.1848    116.7985    241.2148
---------+--------------------------------------------------------------------
combined |     477    133.4798    19.68832    429.9994    94.79302    172.1665
---------+--------------------------------------------------------------------
    diff |           -91.24504    39.19519               -168.2624   -14.22764
------------------------------------------------------------------------------
    diff = mean(0) - mean(1)                                      t =  -2.3280
Ho: diff = 0                                     degrees of freedom =      475

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.0102         Pr(|T| > |t|) = 0.0203          Pr(T > t) = 0.9898
```

```
. ttest patent_post if include == 1 & experience_investments == 0, by(external)

Two-sample t test with equal variances
```

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
0	197	959.4975	338.2613	4747.723	292.3985	1626.596
1	41	1465.61	626.1832	4009.529	200.0464	2731.173
combined	238	1046.685	299.7995	4625.082	456.0726	1637.297
diff		-506.1123	794.929		-2072.176	1059.951

```
    diff = mean(0) - mean(1)                                      t =  -0.6367
Ho: diff = 0                                     degrees of freedom =      236

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.2625         Pr(|T| > |t|) = 0.5250          Pr(T > t) = 0.7375
```

```
. ttest patent_post_year if include == 1 & experience_investments == 0, by(external)

Two-sample t test with equal variances
```

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
0	197	74.82238	25.51424	358.1094	24.50469	125.1401
1	41	149.9331	55.05623	352.5319	38.66027	261.2059
combined	238	87.76162	23.17636	357.5474	42.10364	133.4196
diff		-75.11069	61.31104		-195.8975	45.67616

```
    diff = mean(0) - mean(1)                                      t =  -1.2251
Ho: diff = 0                                     degrees of freedom =      236

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.1109         Pr(|T| > |t|) = 0.2218          Pr(T > t) = 0.8891
```

```
. ttest patent_post if include == 1 & experience_investments == 1, by(external)

Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
       0 |     170    1630.524    355.3983    4633.827    928.9316    2332.115
       1 |      69    485.4493    116.6001    968.5535    252.7773    718.1212
---------+--------------------------------------------------------------------
combined |     239    1299.937     256.999    3973.108    793.6539    1806.221
---------+--------------------------------------------------------------------
    diff |            1145.074    563.4339                35.09602    2255.052
------------------------------------------------------------------------------
    diff = mean(0) - mean(1)                                      t =   2.0323
Ho: diff = 0                                     degrees of freedom =      237

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.9784         Pr(|T| > |t|) = 0.0432          Pr(T > t) = 0.0216


. ttest patent_post_year if include == 1 & experience_investments == 1, by(external)

Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
       0 |     170    206.2218    42.55914    554.9033    122.2058    290.2379
       1 |      69    111.9548    30.08578    249.9112    51.91954      171.99
---------+--------------------------------------------------------------------
combined |     239    179.0067    31.57805    488.1848    116.7985    241.2148
---------+--------------------------------------------------------------------
    diff |            94.26707    69.56205               -42.77183     231.306
------------------------------------------------------------------------------
    diff = mean(0) - mean(1)                                      t =   1.3552
Ho: diff = 0                                     degrees of freedom =      237

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.9117         Pr(|T| > |t|) = 0.1767          Pr(T > t) = 0.0883
```

Appendix L: T-test on total and annual patent post by uncertainty

```
. ttest patent_post if include == 1, by(early)

Two-sample t test with equal variances
```

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
0	389	1101.046	205.432	4051.752	697.1471	1504.945
1	88	1494.193	566.1109	5310.591	368.9864	2619.4
combined	477	1173.577	197.2537	4308.087	785.9807	1561.172
diff		-393.1469	508.7581		-1392.842	606.5479

```
    diff = mean(0) - mean(1)                                      t =  -0.7728
Ho: diff = 0                                     degrees of freedom =      475

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.2200         Pr(|T| > |t|) = 0.4400          Pr(T > t) = 0.7800
```

```
. ttest patent_post_year if include == 1, by(early)

Two-sample t test with equal variances
```

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
0	389	129.0925	21.31604	420.4181	87.18306	171.0019
1	88	152.8737	50.32811	472.1195	52.84117	252.9063
combined	477	133.4798	19.68832	429.9994	94.79302	172.1665
diff		-23.78126	50.80043		-123.6026	76.0401

```
    diff = mean(0) - mean(1)                                      t =  -0.4681
Ho: diff = 0                                     degrees of freedom =      475

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.3200         Pr(|T| > |t|) = 0.6399          Pr(T > t) = 0.6800
```

```
. ttest patent_post if include == 1 & early == 0, by(external)

Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
       0 |     304    1165.993    249.8473    4356.237    674.3378    1657.649
       1 |      85    868.7647    293.2092    2703.255    285.6861    1451.843
---------+--------------------------------------------------------------------
combined |     389    1101.046     205.432    4051.752    697.1471    1504.945
---------+--------------------------------------------------------------------
    diff |            297.2287    497.5441               -680.9991    1275.457
------------------------------------------------------------------------------
    diff = mean(0) - mean(1)                                      t =   0.5974
Ho: diff = 0                                     degrees of freedom =      387

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.7247         Pr(|T| > |t|) = 0.5506          Pr(T > t) = 0.2753
```

```
. ttest patent_post_year if include == 1 & early == 0, by(external)

Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
       0 |     304    128.8618    25.88688    451.3532    77.92098    179.8026
       1 |      85    129.9174    30.97931    285.6152    68.31164    191.5232
---------+--------------------------------------------------------------------
combined |     389    129.0925    21.31604    420.4181    87.18306    171.0019
---------+--------------------------------------------------------------------
    diff |           -1.055593    51.64997               -102.6053    100.4941
------------------------------------------------------------------------------
    diff = mean(0) - mean(1)                                      t =  -0.0204
Ho: diff = 0                                     degrees of freedom =      387

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.4919         Pr(|T| > |t|) = 0.9837          Pr(T > t) = 0.5081
```

```
. ttest patent_post if include == 1 & early == 1, by(external)

Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
       0 |      63    1773.778    770.4674    6115.395    233.6354     3313.92
       1 |      25      789.64    442.7053    2213.526   -124.0587    1703.339
---------+--------------------------------------------------------------------
combined |      88    1494.193    566.1109    5310.591    368.9864      2619.4
---------+--------------------------------------------------------------------
    diff |            984.1378    1258.099                -1516.88    3485.156
------------------------------------------------------------------------------
    diff = mean(0) - mean(1)                                      t =   0.7822
Ho: diff = 0                                     degrees of freedom =       86

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.7819         Pr(|T| > |t|) = 0.4362          Pr(T > t) = 0.2181


. ttest patent_post_year if include == 1 & early == 1, by(external)

Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
       0 |      63    168.6307    65.85439     522.703    36.98962    300.2717
       1 |      25    113.1662    63.21155    316.0578   -17.29599    243.6285
---------+--------------------------------------------------------------------
combined |      88    152.8737    50.32811    472.1195    52.84117    252.9063
---------+--------------------------------------------------------------------
    diff |            55.46443    112.0846               -167.3524    278.2813
------------------------------------------------------------------------------
    diff = mean(0) - mean(1)                                      t =   0.4948
Ho: diff = 0                                     degrees of freedom =       86

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.6890         Pr(|T| > |t|) = 0.6220          Pr(T > t) = 0.3110
```

Appendix M: T-test on total and annual patent post by post period

```
. ttest patent_post if include == 1, by(post)

Two-sample t test with equal variances
```

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
0	237	1136.755	242.2747	3729.772	659.4579	1614.053
1	240	1209.938	311.0779	4819.197	597.133	1822.742
combined	477	1173.577	197.2537	4308.087	785.9807	1561.172
diff		-73.18223	394.9161		-849.1808	702.8163

```
    diff = mean(0) - mean(1)                                      t =  -0.1853
Ho: diff = 0                                     degrees of freedom =      475

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.4265         Pr(|T| > |t|) = 0.8531          Pr(T > t) = 0.5735
```

```
. ttest patent_post_year if include == 1, by(post)

Two-sample t test with equal variances
```

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
0	237	187.2341	33.01039	508.1885	122.2014	252.2668
1	240	80.39741	21.16827	327.9374	38.69721	122.0976
combined	477	133.4798	19.68832	429.9994	94.79302	172.1665
diff		106.8367	39.11286		29.98106	183.6923

```
    diff = mean(0) - mean(1)                                      t =   2.7315
Ho: diff = 0                                     degrees of freedom =      475

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.9967         Pr(|T| > |t|) = 0.0065          Pr(T > t) = 0.0033
```

```
. ttest patent_post if include == 1 & post == 0, by(external)

Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
       0 |     164    1306.774    337.6204     4323.65    640.1009    1973.448
       1 |      73    754.7945    204.8393    1750.148    346.4548    1163.134
---------+--------------------------------------------------------------------
combined |     237    1136.755    242.2747    3729.772    659.4579    1614.053
---------+--------------------------------------------------------------------
    diff |            551.9799    524.6561               -481.6504     1585.61
------------------------------------------------------------------------------
    diff = mean(0) - mean(1)                                      t =   1.0521
Ho: diff = 0                                     degrees of freedom =      235

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.8531         Pr(|T| > |t|) = 0.2938          Pr(T > t) = 0.1469
```

```
. ttest patent_post_year if include == 1 & post == 0, by(external)

Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
       0 |     164      202.28    45.04592    576.8693    113.3312    291.2288
       1 |      73    153.4323    35.39551    302.4194    82.87269     223.992
---------+--------------------------------------------------------------------
combined |     237    187.2341    33.01039    508.1885    122.2014    252.2668
---------+--------------------------------------------------------------------
    diff |            48.84764    71.58267               -92.17809    189.8734
------------------------------------------------------------------------------
    diff = mean(0) - mean(1)                                      t =   0.6824
Ho: diff = 0                                     degrees of freedom =      235

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.7522         Pr(|T| > |t|) = 0.4957          Pr(T > t) = 0.2478
```

. ttest patent_post if include == 1 & post == 1, by(external)

Two-sample t test with equal variances

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
0	203	1240.882	350.5982	4995.255	549.5802	1932.183
1	37	1040.162	618.177	3760.224	-213.559	2293.883
combined	240	1209.938	311.0779	4819.197	597.133	1822.742
diff		200.7196	863.1626		-1499.695	1901.134

```
    diff = mean(0) - mean(1)                                      t =   0.2325
Ho: diff = 0                                     degrees of freedom =      238

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.5918         Pr(|T| > |t|) = 0.8163          Pr(T > t) = 0.4082
```

. ttest patent_post_year if include == 1 & post == 1, by(external)

Two-sample t test with equal variances

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
0	203	81.89066	23.7816	338.8357	34.99864	128.7827
1	37	72.2047	43.39461	263.9591	-15.80366	160.2131
combined	240	80.39741	21.16827	327.9374	38.69721	122.0976
diff		9.685965	58.73991		-106.0306	125.4025

```
    diff = mean(0) - mean(1)                                      t =   0.1649
Ho: diff = 0                                     degrees of freedom =      238

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.5654         Pr(|T| > |t|) = 0.8692          Pr(T > t) = 0.4346
```

Appendix N: T-test on total and annual patent post by absorptive capacity

```
. ttest patent_post if include == 1, by(absorptive)

Two-sample t test with equal variances
```

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
0	239	71.06695	43.73481	676.1237	-15.08982	157.2237
1	238	2280.718	379.9605	5861.745	1532.187	3029.25
combined	477	1173.577	197.2537	4308.087	785.9807	1561.172
diff		-2209.652	381.6876		-2959.657	-1459.647

```
    diff = mean(0) - mean(1)                                      t =  -5.7892
Ho: diff = 0                                     degrees of freedom =      475

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.0000         Pr(|T| > |t|) = 0.0000          Pr(T > t) = 1.0000
```

```
. ttest patent_post_year if include == 1, by(absorptive)

Two-sample t test with equal variances
```

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
0	239	3.836955	1.846343	28.54376	.1996943	7.474216
1	238	263.6673	37.60541	580.148	189.5838	337.7509
combined	477	133.4798	19.68832	429.9994	94.79302	172.1665
diff		-259.8304	37.57207		-333.6584	-186.0024

```
    diff = mean(0) - mean(1)                                      t =  -6.9155
Ho: diff = 0                                     degrees of freedom =      475

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.0000         Pr(|T| > |t|) = 0.0000          Pr(T > t) = 1.0000
```

```
. ttest patent_post if include == 1 & absorptive == 0, by(external)

Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
       0 |     192    86.73958    54.40589    753.8702   -20.57397    194.0531
       1 |      47    7.042553    2.267079    15.54231     2.47916    11.60595
---------+--------------------------------------------------------------------
combined |     239    71.06695    43.73481    676.1237   -15.08982    157.2237
---------+--------------------------------------------------------------------
    diff |            79.69703     110.144               -137.2892    296.6833
------------------------------------------------------------------------------
    diff = mean(0) - mean(1)                                      t =   0.7236
Ho: diff = 0                                     degrees of freedom =      237

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.7650         Pr(|T| > |t|) = 0.4700          Pr(T > t) = 0.2350
```

```
. ttest patent_post_year if include == 1 & absorptive == 0, by(external)

Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
       0 |     192    4.536408    2.294734    31.79677     .010132    9.062684
       1 |      47    .9796153    .3873545    2.655569    .1999111     1.75932
---------+--------------------------------------------------------------------
combined |     239    3.836955    1.846343    28.54376    .1996943    7.474216
---------+--------------------------------------------------------------------
    diff |            3.556793    4.649319               -5.602478    12.71606
------------------------------------------------------------------------------
    diff = mean(0) - mean(1)                                      t =   0.7650
Ho: diff = 0                                     degrees of freedom =      237

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.7775         Pr(|T| > |t|) = 0.4450          Pr(T > t) = 0.2225
```

```
. ttest patent_post if include == 1 & absorptive == 1, by(external)

Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
       0 |     175    2568.891    493.4817     6528.15    1594.911    3542.872
       1 |      63    1480.238     415.126     3294.96    650.4131    2310.063
---------+--------------------------------------------------------------------
combined |     238    2280.718    379.9605    5861.745    1532.187     3029.25
---------+--------------------------------------------------------------------
    diff |            1088.653    860.1523               -605.9042    2783.211
------------------------------------------------------------------------------
    diff = mean(0) - mean(1)                                      t =   1.2657
Ho: diff = 0                                     degrees of freedom =      236

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.8966         Pr(|T| > |t|) = 0.2069          Pr(T > t) = 0.1034
```
#

```
. ttest patent_post_year if include == 1 & absorptive == 1, by(external)

Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
       0 |     175    279.5813    48.50138    641.6129    183.8546    375.3081
       1 |      63    219.4618    45.17128    358.5359    129.1657    309.7579
---------+--------------------------------------------------------------------
combined |     238    263.6673    37.60541     580.148    189.5838    337.7509
---------+--------------------------------------------------------------------
    diff |            60.11953    85.32963               -107.9855    228.2246
------------------------------------------------------------------------------
    diff = mean(0) - mean(1)                                      t =   0.7046
Ho: diff = 0                                     degrees of freedom =      236

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.7591         Pr(|T| > |t|) = 0.4818          Pr(T > t) = 0.2409
```

Appendix O: T-test on total and annual patent post by investment period

```
. ttest patent_post if include == 1, by(active_exp_wo2015)

Two-sample t test with equal variances
```

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
0	231	929.8918	288.535	4385.352	361.3821	1498.401
1	246	1402.402	269.72	4230.393	871.1365	1933.668
combined	477	1173.577	197.2537	4308.087	785.9807	1561.172
diff		-472.5107	394.5227		-1247.736	302.7149

```
    diff = mean(0) - mean(1)                                      t =  -1.1977
Ho: diff = 0                                     degrees of freedom =      475

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.1158         Pr(|T| > |t|) = 0.2316          Pr(T > t) = 0.8842
```

```
. ttest patent_post_year if include == 1, by(active_exp_wo2015)

Two-sample t test with equal variances
```

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
0	231	74.65861	21.9423	333.4941	31.425	117.8922
1	246	188.7143	31.78297	498.4964	126.1116	251.317
combined	477	133.4798	19.68832	429.9994	94.79302	172.1665
diff		-114.0557	39.08881		-190.8641	-37.24732

```
    diff = mean(0) - mean(1)                                      t =  -2.9179
Ho: diff = 0                                     degrees of freedom =      475

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.0018         Pr(|T| > |t|) = 0.0037          Pr(T > t) = 0.9982
```

```
. ttest patent_post if include == 1 & active_exp_wo2015 == 0, by(external)

Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
       0 |     183    861.0929    336.5072    4552.186    197.1358     1525.05
       1 |      48    1192.188    535.7592    3711.849     114.379    2269.996
---------+--------------------------------------------------------------------
combined |     231    929.8918     288.535    4385.352    361.3821    1498.401
---------+--------------------------------------------------------------------
    diff |           -331.0946    712.3702               -1734.733    1072.543
------------------------------------------------------------------------------
    diff = mean(0) - mean(1)                                      t =  -0.4648
Ho: diff = 0                                     degrees of freedom =      229

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.3213         Pr(|T| > |t|) = 0.6425          Pr(T > t) = 0.6787
```

```
. ttest patent_post_year if include == 1 & active_exp_wo2015 == 0, by(external)

Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
       0 |     183    62.99383    24.78133    335.2356    14.09818    111.8895
       1 |      48    119.1306     47.1092    326.3821    24.35912    213.9021
---------+--------------------------------------------------------------------
combined |     231    74.65861     21.9423    333.4941      31.425    117.8922
---------+--------------------------------------------------------------------
    diff |           -56.13678    54.07226               -162.6795    50.40597
------------------------------------------------------------------------------
    diff = mean(0) - mean(1)                                      t =  -1.0382
Ho: diff = 0                                     degrees of freedom =      229

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.1501         Pr(|T| > |t|) = 0.3003          Pr(T > t) = 0.8499
```

```
. ttest patent_post if include == 1 & active_exp_wo2015 == 1, by(external)

Two-sample t test with equal variances
```

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
0	184	1677.337	355.4936	4822.15	975.9438	2378.73
1	62	586.4677	139.9434	1101.916	306.6335	866.3019
combined	246	1402.402	269.72	4230.393	871.1365	1933.668
diff		1090.869	618.5592		-127.5279	2309.266

```
    diff = mean(0) - mean(1)                                      t =   1.7636
Ho: diff = 0                                     degrees of freedom =      244

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.9605         Pr(|T| > |t|) = 0.0791          Pr(T > t) = 0.0395
```

```
. ttest patent_post_year if include == 1 & active_exp_wo2015 == 1, by(external)

Two-sample t test with equal variances
```

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
0	184	207.9883	40.91442	554.9902	127.2637	288.713
1	62	131.514	33.50016	263.7805	64.52626	198.5017
combined	246	188.7143	31.78297	498.4964	126.1116	251.317
diff		76.47435	73.18861		-67.68774	220.6364

```
    diff = mean(0) - mean(1)                                      t =   1.0449
Ho: diff = 0                                     degrees of freedom =      244

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.8514         Pr(|T| > |t|) = 0.2971          Pr(T > t) = 0.1486
```

Appendix P: T-test on total and annual patent post by size

```
. ttest patent_post if include == 1, by(size_emp_final)

Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
       0 |     218    157.1009    48.89657    721.9492    60.72792    253.4739
       1 |     218    2336.702    414.5843    6121.264    1519.574    3153.829
---------+--------------------------------------------------------------------
combined |     436    1246.901    214.9369    4488.014    824.4575    1669.345
---------+--------------------------------------------------------------------
    diff |           -2179.601    417.4578               -3000.091   -1359.111
------------------------------------------------------------------------------
    diff = mean(0) - mean(1)                                      t =  -5.2211
Ho: diff = 0                                     degrees of freedom =      434

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.0000         Pr(|T| > |t|) = 0.0000          Pr(T > t) = 1.0000


. ttest patent_post_year if include == 1, by(size_emp_final)

Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
       0 |     218    20.45369    7.658081    113.0702    5.359952    35.54744
       1 |     218    257.2797    40.23093    594.0026    177.9863    336.5732
---------+--------------------------------------------------------------------
combined |     436    138.8667    21.22648    443.2219    97.14751    180.5859
---------+--------------------------------------------------------------------
    diff |            -236.826    40.95332               -317.3175   -156.3346
------------------------------------------------------------------------------
    diff = mean(0) - mean(1)                                      t =  -5.7828
Ho: diff = 0                                     degrees of freedom =      434

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.0000         Pr(|T| > |t|) = 0.0000          Pr(T > t) = 1.0000
```

```
. ttest patent_post if include == 1 & size_emp_final == 0, by(external)

Two-sample t test with equal variances
```

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
0	177	179.2147	59.97843	797.9611	60.8452	297.5842
1	41	61.63415	18.73931	119.9902	23.76058	99.50771
combined	218	157.1009	48.89657	721.9492	60.72792	253.4739
diff		117.5805	125.1624		-129.1155	364.2766

```
    diff = mean(0) - mean(1)                                      t =   0.9394
Ho: diff = 0                                     degrees of freedom =      216

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.8257         Pr(|T| > |t|) = 0.3486          Pr(T > t) = 0.1743
```

```
. ttest patent_post_year if include == 1 & size_emp_final == 0, by(external)

Two-sample t test with equal variances
```

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
0	177	23.17082	9.394222	124.982	4.631001	41.71064
1	41	8.723662	3.327754	21.30802	1.99802	15.4493
combined	218	20.45369	7.658081	113.0702	5.359952	35.54744
diff		14.44716	19.61807		-24.22021	53.11453

```
    diff = mean(0) - mean(1)                                      t =   0.7364
Ho: diff = 0                                     degrees of freedom =      216

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.7689         Pr(|T| > |t|) = 0.4623          Pr(T > t) = 0.2311
```

```
. ttest patent_post if include == 1 & size_emp_final == 1, by(external)

Two-sample t test with equal variances
```

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
0	160	2652.363	539.5319	6824.598	1586.789	3717.936
1	58	1465.914	448.6964	3417.17	567.4147	2364.413
combined	218	2336.702	414.5843	6121.264	1519.574	3153.829
diff		1186.449	936.8976		-660.1834	3033.081

```
    diff = mean(0) - mean(1)                                      t =   1.2664
Ho: diff = 0                                     degrees of freedom =      216

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.8966         Pr(|T| > |t|) = 0.2067          Pr(T > t) = 0.1034
```

```
. ttest patent_post_year if include == 1 & size_emp_final == 1, by(external)

Two-sample t test with equal variances
```

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
0	160	274.7488	52.05139	658.4038	171.9475	377.5501
1	58	209.0892	47.49241	361.6914	113.9873	304.1911
combined	218	257.2797	40.23093	594.0026	177.9863	336.5732
diff		65.65955	91.14325		-113.9845	245.3036

```
    diff = mean(0) - mean(1)                                      t =   0.7204
Ho: diff = 0                                     degrees of freedom =      216

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.7640         Pr(|T| > |t|) = 0.4721          Pr(T > t) = 0.2360
```

Appendix Q: T-test on total and annual patent post by financial stability

```
. ttest patent_post if include == 1, by(lev_final)

Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
       0 |     237    574.7004    173.8749     2676.77    232.1552    917.2456
       1 |     237    1787.308     352.883    5432.564    1092.105    2482.511
---------+--------------------------------------------------------------------
combined |     474    1181.004    198.4568     4320.71    791.0382     1570.97
---------+--------------------------------------------------------------------
    diff |           -1212.608     393.394               -1985.628   -439.5872
------------------------------------------------------------------------------
    diff = mean(0) - mean(1)                                      t =  -3.0824
Ho: diff = 0                                     degrees of freedom =      472

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.0011         Pr(|T| > |t|) = 0.0022          Pr(T > t) = 0.9989


. ttest patent_post_year if include == 1, by(lev_final)

Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
       0 |     237    65.83479    16.00525    246.3977    34.30338     97.3662
       1 |     237    202.8144    35.73057    550.0651    132.4228     273.206
---------+--------------------------------------------------------------------
combined |     474    134.3246      19.807     431.229    95.40399    173.2452
---------+--------------------------------------------------------------------
    diff |           -136.9796    39.15152               -213.9124   -60.04677
------------------------------------------------------------------------------
    diff = mean(0) - mean(1)                                      t =  -3.4987
Ho: diff = 0                                     degrees of freedom =      472

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.0003         Pr(|T| > |t|) = 0.0005          Pr(T > t) = 0.9997
```

```
. ttest patent_post if include == 1 & lev_final == 0, by(external)

Two-sample t test with equal variances
```

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
0	198	662.697	207.498	2919.756	253.4945	1071.899
1	39	127.9487	38.75869	242.0479	49.48585	206.4116
combined	237	574.7004	173.8749	2676.77	232.1552	917.2456
diff		534.7483	468.6436		-388.5312	1458.028

```
    diff = mean(0) - mean(1)                                      t =   1.1411
Ho: diff = 0                                     degrees of freedom =      235

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.8725         Pr(|T| > |t|) = 0.2550          Pr(T > t) = 0.1275
```

```
. ttest patent_post_year if include == 1 & lev_final == 0, by(external)

Two-sample t test with equal variances
```

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
0	198	73.08223	19.05136	268.0764	35.51144	110.653
1	39	29.04008	8.512585	53.16107	11.80725	46.27291
combined	237	65.83479	16.00525	246.3977	34.30338	97.3662
diff		44.04215	43.16264		-40.993	129.0773

```
    diff = mean(0) - mean(1)                                      t =   1.0204
Ho: diff = 0                                     degrees of freedom =      235

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.8457         Pr(|T| > |t|) = 0.3086          Pr(T > t) = 0.1543
```

```
. ttest patent_post if include == 1 & lev_final == 1, by(external)

Two-sample t test with equal variances

   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
       0 |     166    2018.048    477.2194    6148.542    1075.804    2960.292
       1 |      71    1247.831     374.691    3157.202    500.5334    1995.129
---------+--------------------------------------------------------------------
combined |     237    1787.308     352.883    5432.564    1092.105    2482.511
---------+--------------------------------------------------------------------
    diff |            770.2172    770.3643               -747.4853     2287.92
---------+--------------------------------------------------------------------
    diff = mean(0) - mean(1)                                      t =   0.9998
Ho: diff = 0                                     degrees of freedom =      235

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.8408         Pr(|T| > |t|) = 0.3184          Pr(T > t) = 0.1592
```

```
. ttest patent_post_year if include == 1 & lev_final == 1, by(external)

Two-sample t test with equal variances

   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
       0 |     166    212.8159    47.87297       616.8    118.2933    307.3385
       1 |      71    179.4306    41.54582    350.0713    96.57006    262.2911
---------+--------------------------------------------------------------------
combined |     237    202.8144    35.73057    550.0651    132.4228     273.206
---------+--------------------------------------------------------------------
    diff |            33.38531    78.13732               -120.5538    187.3244
---------+--------------------------------------------------------------------
    diff = mean(0) - mean(1)                                      t =   0.4273
Ho: diff = 0                                     degrees of freedom =      235

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.6652         Pr(|T| > |t|) = 0.6696          Pr(T > t) = 0.3348
```

Appendix R: T-test on total and annual patent post by slack

```
. ttest patent_post if include == 1, by(slack)

Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
       0 |     236    1319.869    301.4228    4630.545    726.0326    1913.705
       1 |     236    1052.148    261.0729    4010.678    537.8059    1566.491
---------+--------------------------------------------------------------------
combined |     472    1186.008     199.267    4329.187    794.4462    1577.571
---------+--------------------------------------------------------------------
    diff |            267.7203    398.7666               -515.8656    1051.306
------------------------------------------------------------------------------
    diff = mean(0) - mean(1)                                      t =   0.6714
Ho: diff = 0                                     degrees of freedom =      470

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.7488         Pr(|T| > |t|) = 0.5023          Pr(T > t) = 0.2512
```

```
. ttest patent_post_year if include == 1, by(slack)

Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
       0 |     236    136.7409    27.11646    416.5709    83.31848    190.1633
       1 |     236    133.0466    29.15465    447.8822    75.60877    190.4845
---------+--------------------------------------------------------------------
combined |     472    134.8938    19.88692    432.0546    95.81569    173.9718
---------+--------------------------------------------------------------------
    diff |            3.694252    39.81577               -74.54471    81.93321
------------------------------------------------------------------------------
    diff = mean(0) - mean(1)                                      t =   0.0928
Ho: diff = 0                                     degrees of freedom =      470

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.5369         Pr(|T| > |t|) = 0.9261          Pr(T > t) = 0.4631
```

```
. ttest patent_post if include == 1 & slack == 0, by(external)

Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
       0 |     178     1358.91    375.8435    5014.378    617.1991    2100.621
       1 |      58    1200.052    421.4699    3209.819    356.0727    2044.031
---------+--------------------------------------------------------------------
combined |     236    1319.869    301.4228    4630.545    726.0326    1913.705
---------+--------------------------------------------------------------------
    diff |            158.8584    701.5239               -1223.252    1540.968
------------------------------------------------------------------------------
    diff = mean(0) - mean(1)                                      t =   0.2264
Ho: diff = 0                                     degrees of freedom =      234

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.5895         Pr(|T| > |t|) = 0.8211          Pr(T > t) = 0.4105
```

```
. ttest patent_post_year if include == 1 & slack == 0, by(external)

Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
       0 |     178    130.4767    33.21477    443.1403    64.92873    196.0246
       1 |      58    155.9656     42.5779    324.2636    70.70485    241.2264
---------+--------------------------------------------------------------------
combined |     236    136.7409    27.11646    416.5709    83.31848    190.1633
---------+--------------------------------------------------------------------
    diff |           -25.48896    63.09509                -149.796    98.81807
------------------------------------------------------------------------------
    diff = mean(0) - mean(1)                                      t =  -0.4040
Ho: diff = 0                                     degrees of freedom =      234

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.3433         Pr(|T| > |t|) = 0.6866          Pr(T > t) = 0.6567
```

```
. ttest patent_post if include == 1 & slack == 1, by(external)

Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
       0 |     184    1219.152     328.223    4452.233    571.5643     1866.74
       1 |      52    461.2115    220.8208    1592.361    17.89536    904.5277
---------+--------------------------------------------------------------------
combined |     236    1052.148    261.0729    4010.678    537.8059    1566.491
---------+--------------------------------------------------------------------
    diff |            757.9406    629.2847               -481.847     1997.728
------------------------------------------------------------------------------
    diff = mean(0) - mean(1)                                      t =   1.2044
Ho: diff = 0                                     degrees of freedom =      234

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.8852         Pr(|T| > |t|) = 0.2296          Pr(T > t) = 0.1148
```

```
. ttest patent_post_year if include == 1 & slack == 1, by(external)

Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
       0 |     184    144.4178    36.09937    489.6757    73.19332    215.6423
       1 |      52    92.81018    34.47787    248.6234    23.59297    162.0274
---------+--------------------------------------------------------------------
combined |     236    133.0466    29.15465    447.8822    75.60877    190.4845
---------+--------------------------------------------------------------------
    diff |            51.60763    70.41047               -87.11181    190.3271
------------------------------------------------------------------------------
    diff = mean(0) - mean(1)                                      t =   0.7330
Ho: diff = 0                                     degrees of freedom =      234

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.7678         Pr(|T| > |t|) = 0.4643          Pr(T > t) = 0.2322
```

Appendix S: T-test on claims and forward citations per patent by experience

```
. ttest claims_post_patent if include == 1  , by(experience_investments)

Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
       0 |     238    11.89431    .6286108    9.697735    10.65593    13.13269
       1 |     239    13.89925    .5254087    8.122621    12.86421     14.9343
---------+--------------------------------------------------------------------
combined |     477    12.89888    .4116261     8.99005    12.09005    13.70771
---------+--------------------------------------------------------------------
    diff |           -2.004947    .8189697               -3.614199   -.3956959
------------------------------------------------------------------------------
    diff = mean(0) - mean(1)                                      t =  -2.4481
Ho: diff = 0                                     degrees of freedom =      475

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.0074         Pr(|T| > |t|) = 0.0147          Pr(T > t) = 0.9926
```

```
. ttest claims_post_patent if include == 1 & experience_investments ==1 , by(external)

Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
       0 |     170    14.82332    .5840925    7.615634    13.67026    15.97638
       1 |      69    11.62257    1.072606    8.909734    9.482217    13.76292
---------+--------------------------------------------------------------------
combined |     239    13.89925    .5254087    8.122621    12.86421     14.9343
---------+--------------------------------------------------------------------
    diff |            3.200753    1.143124                .9487705    5.452735
------------------------------------------------------------------------------
    diff = mean(0) - mean(1)                                      t =   2.8000
Ho: diff = 0                                     degrees of freedom =      237

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.9972         Pr(|T| > |t|) = 0.0055          Pr(T > t) = 0.0028
```

```
. ttest forwcit_post_patent if include == 1 & experience_investments ==0 , by(external)

Two-sample t test with equal variances
```

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
0	197	5.620854	.948884	13.31822	3.749521	7.492187
1	41	1.660372	.5112451	3.273566	.6271069	2.693637
combined	238	4.938586	.7958522	12.27781	3.370738	6.506434
diff		3.960482	2.096248		-.1692669	8.090232

```
    diff = mean(0) - mean(1)                                      t =   1.8893
Ho: diff = 0                                     degrees of freedom =      236

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.9700         Pr(|T| > |t|) = 0.0601          Pr(T > t) = 0.0300
```

Appendix T: T-test on claims and forward citations per patent by uncertainty

```
. ttest claims_post_patent if include == 1  , by(early)

Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
       0 |     389    13.25035    .4519055    8.912969    12.36186    14.13884
       1 |      88    11.34525    .9822899    9.214696    9.392847    13.29766
---------+--------------------------------------------------------------------
combined |     477    12.89888    .4116261     8.99005    12.09005    13.70771
---------+--------------------------------------------------------------------
    diff |            1.905092    1.058734               -.1752887    3.985472
------------------------------------------------------------------------------
    diff = mean(0) - mean(1)                                      t =   1.7994
Ho: diff = 0                                     degrees of freedom =      475

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.9637         Pr(|T| > |t|) = 0.0726          Pr(T > t) = 0.0363
```

```
. ttest forwcit_post_patent if include == 1  , by(early)

Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
       0 |     389    3.513525     .386982    7.632477    2.752681    4.274369
       1 |      88    6.492697    2.427999    22.77664    1.666787    11.31861
---------+--------------------------------------------------------------------
combined |     477    4.063142    .5487575    11.98504    2.984855    5.141428
---------+--------------------------------------------------------------------
    diff |           -2.979171    1.409636               -5.749065   -.2092778
------------------------------------------------------------------------------
    diff = mean(0) - mean(1)                                      t =  -2.1134
Ho: diff = 0                                     degrees of freedom =      475

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.0175         Pr(|T| > |t|) = 0.0351          Pr(T > t) = 0.9825
```

```
. ttest forwcit_post_patent if include == 1 & early ==0 , by(external)

Two-sample t test with equal variances
```

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
0	304	3.962174	.4748724	8.279684	3.027709	4.89664
1	85	1.908944	.4661031	4.297258	.9820469	2.835841
combined	389	3.513525	.386982	7.632477	2.752681	4.274369
diff		2.05323	.9318527		.2211029	3.885358

```
    diff = mean(0) - mean(1)                                      t =   2.2034
Ho: diff = 0                                     degrees of freedom =      387

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.9859         Pr(|T| > |t|) = 0.0282          Pr(T > t) = 0.0141
```

Appendix U: T-test on claims and forward citations per patent by absorptive capacity

```
. ttest claims_post_patent if include == 1 , by(absorptive_capacity)

Two-sample t test with equal variances

   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
       0 |      95    14.76047    1.017279    9.915207    12.74064     16.7803
       1 |     238    16.63041    .3387034    5.225261    15.96316    17.29767
---------+--------------------------------------------------------------------
combined |     333    16.09695    .3798249    6.931154    15.34978    16.84411
---------+--------------------------------------------------------------------
    diff |           -1.869942    .8361338               -3.514748   -.2251355
------------------------------------------------------------------------------
    diff = mean(0) - mean(1)                                      t =  -2.2364
Ho: diff = 0                                     degrees of freedom =      331

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.0130         Pr(|T| > |t|) = 0.0260          Pr(T > t) = 0.9870
```

```
. ttest claims_post_patent if include == 1 & absorptive_capacity ==1 , by(external)

Two-sample t test with equal variances

   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
       0 |     174    17.21034    .3854239     5.08409     16.4496    17.97108
       1 |      64    15.05374    .6647254    5.317803    13.72539    16.38209
---------+--------------------------------------------------------------------
combined |     238    16.63041    .3387034    5.225261    15.96316    17.29767
---------+--------------------------------------------------------------------
    diff |            2.156603    .7525264                .6740756     3.63913
------------------------------------------------------------------------------
    diff = mean(0) - mean(1)                                      t =   2.8658
Ho: diff = 0                                     degrees of freedom =      236

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.9977         Pr(|T| > |t|) = 0.0045          Pr(T > t) = 0.0023
```

```
. ttest forwcit_post_patent if include == 1 & absorptive_capacity ==1 , by(external)

Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
       0 |     174    5.414451    .9173265    12.10037    3.603858    7.225044
       1 |      64     2.06834    .4373596    3.498877    1.194347    2.942334
---------+--------------------------------------------------------------------
combined |     238    4.514656     .687048    10.59926    3.161155    5.868158
---------+--------------------------------------------------------------------
    diff |            3.346111    1.537455                .3172215       6.375
------------------------------------------------------------------------------
    diff = mean(0) - mean(1)                                      t =   2.1764
Ho: diff = 0                                     degrees of freedom =      236

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.9847         Pr(|T| > |t|) = 0.0305          Pr(T > t) = 0.0153
```

Appendix V: T-test on claims and forward citations per patent by size

```
. ttest claims_post_patent if include == 1  , by( size_emp_final )

Two-sample t test with equal variances
```

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
0	218	12.23881	.6912136	10.20565	10.87646	13.60116
1	218	14.54434	.4888525	7.217821	13.58083	15.50784
combined	436	13.39157	.4264167	8.903842	12.55348	14.22967
diff		-2.305524	.8466127		-3.969495	-.6415535

```
    diff = mean(0) - mean(1)                                      t =  -2.7232
Ho: diff = 0                                     degrees of freedom =      434

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.0034         Pr(|T| > |t|) = 0.0067          Pr(T > t) = 0.9966
```

```
. ttest forwcit_post_patent if include == 1  , by( size_emp_final )

Two-sample t test with equal variances
```

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
0	218	5.794762	1.130081	16.68545	3.567422	8.022103
1	218	2.686945	.3479218	5.137004	2.001207	3.372684
combined	436	4.240854	.5952147	12.42845	3.071	5.410708
diff		3.107817	1.182427		.783822	5.431811

```
    diff = mean(0) - mean(1)                                      t =   2.6283
Ho: diff = 0                                     degrees of freedom =      434

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.9956         Pr(|T| > |t|) = 0.0089          Pr(T > t) = 0.0044
```

Appendix W: T-test on claims and forward citations per patent by financial stability

```
. ttest forwcit_post_patent if include == 1 & lev_final ==1  , by( external)

Two-sample t test with equal variances
```

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
0	166	3.90148	.8940989	11.51966	2.13613	5.66683
1	71	1.50663	.3634919	3.062837	.781668	2.231591
combined	237	3.184035	.6389943	9.837192	1.925174	4.442897
diff		2.39485	1.389169		-.3419662	5.131667

```
    diff = mean(0) - mean(1)                                      t =   1.7239
Ho: diff = 0                                     degrees of freedom =      235

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.9570         Pr(|T| > |t|) = 0.0860          Pr(T > t) = 0.0430
```

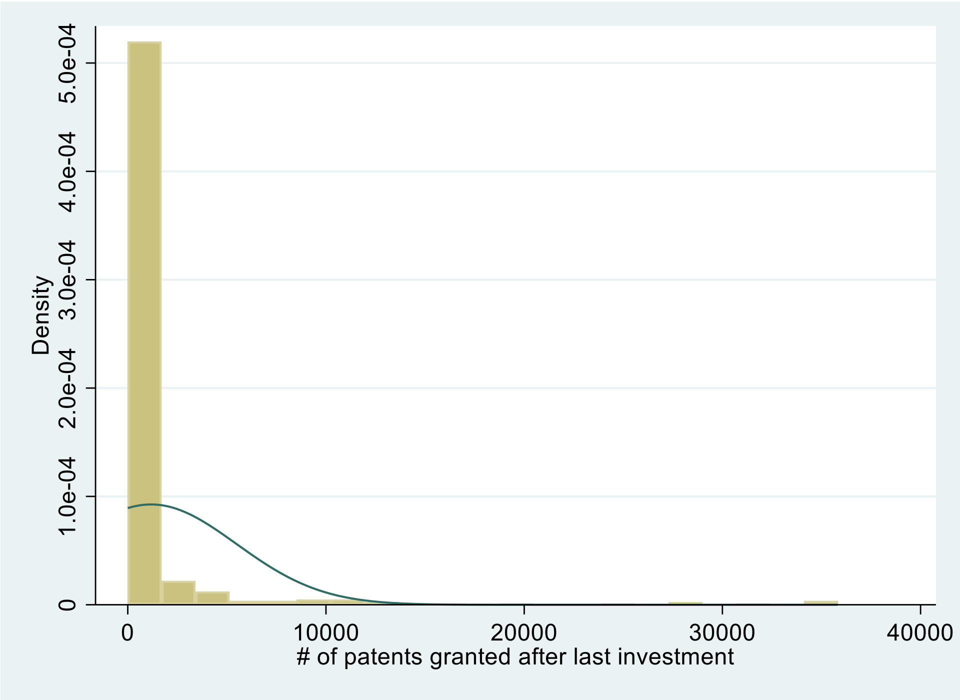
Appendix X: T-test on claims and forward citations per patent by financial stability

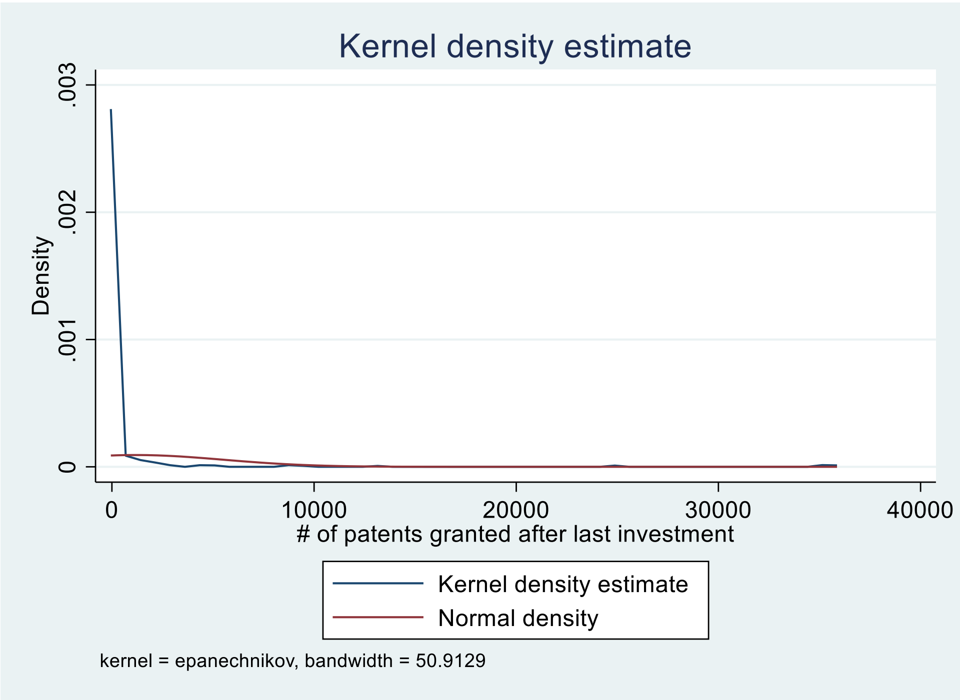
```
. ttest forwcit_post_patent if include == 1 & profit_final ==0 , by(external)

Two-sample t test with equal variances
```

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
0	178	4.785518	.7081115	9.447386	3.38809	6.182946
1	58	2.507069	.6461893	4.921231	1.213098	3.801041
combined	236	4.22556	.5602108	8.606122	3.121884	5.329237
diff		2.278449	1.295429		-.2737452	4.830643

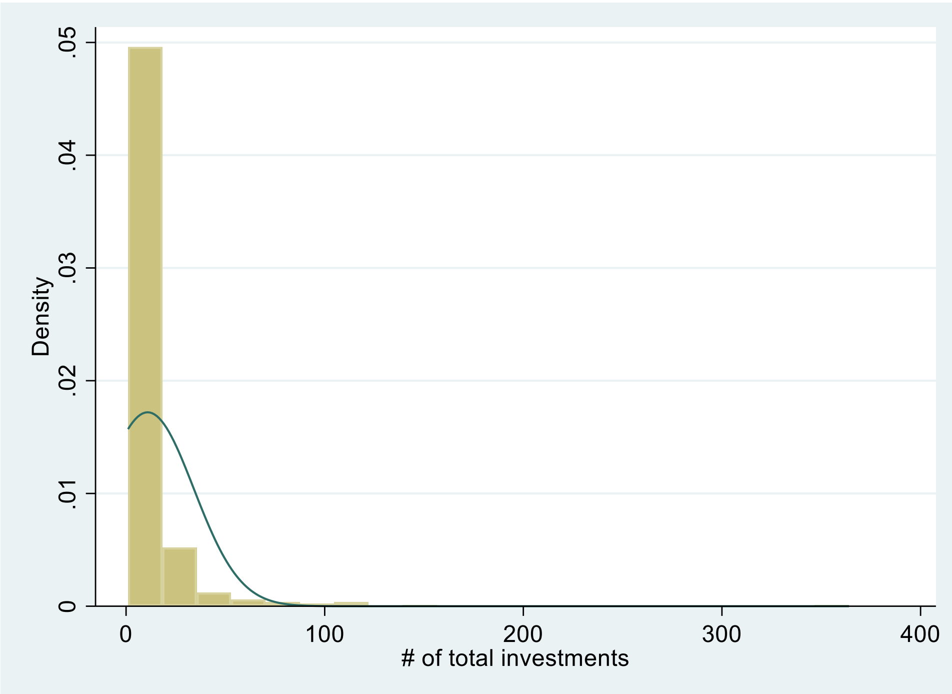
```
    diff = mean(0) - mean(1)                                      t =   1.7588
Ho: diff = 0                                     degrees of freedom =      234

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.9600         Pr(|T| > |t|) = 0.0799          Pr(T > t) = 0.0400
```

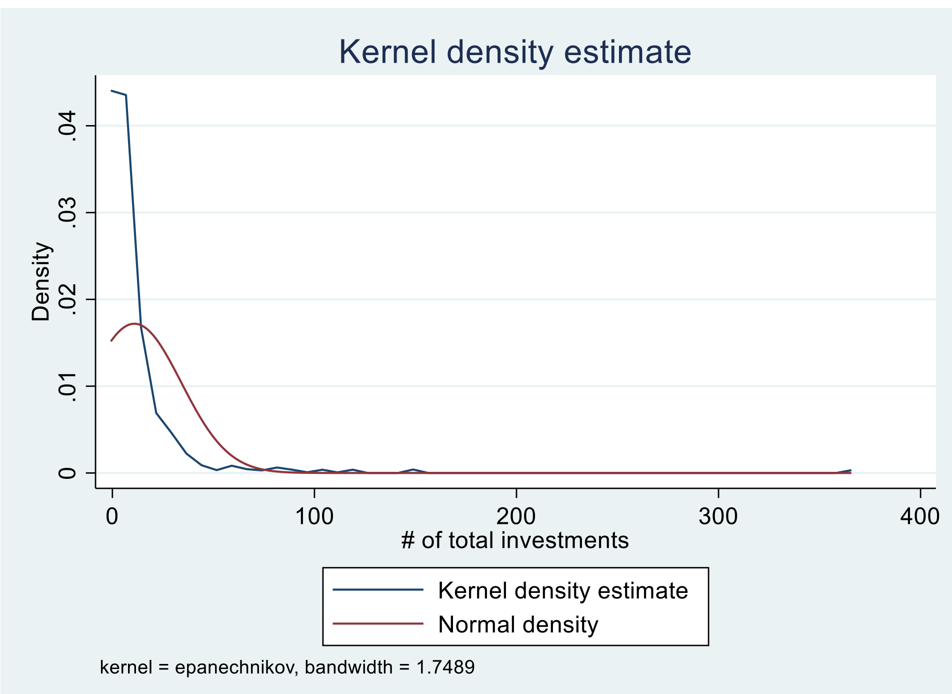
Appendix Y: Distribution of patent post



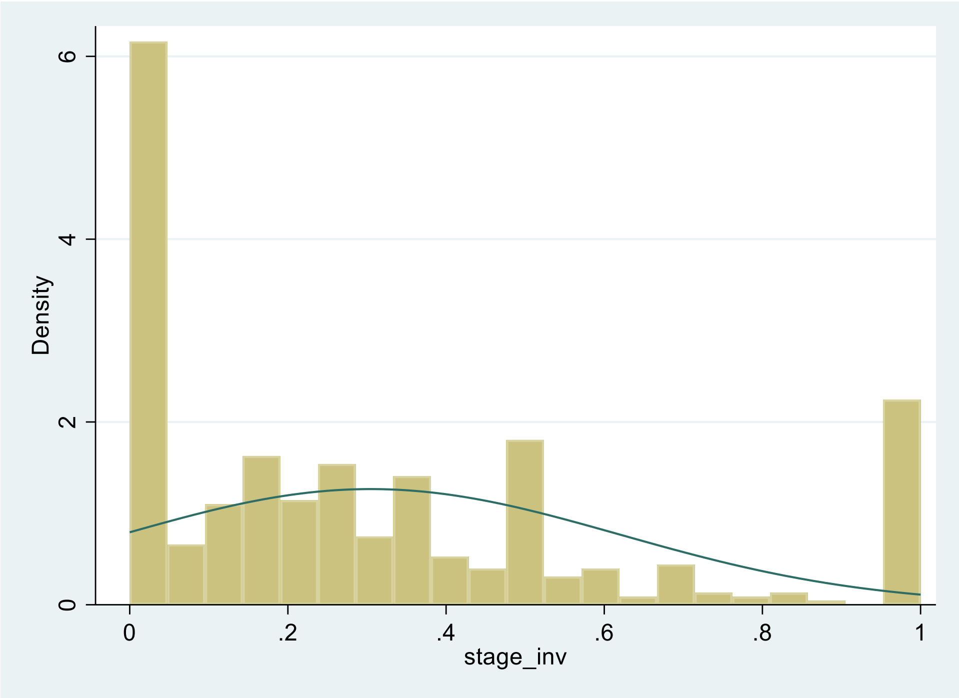


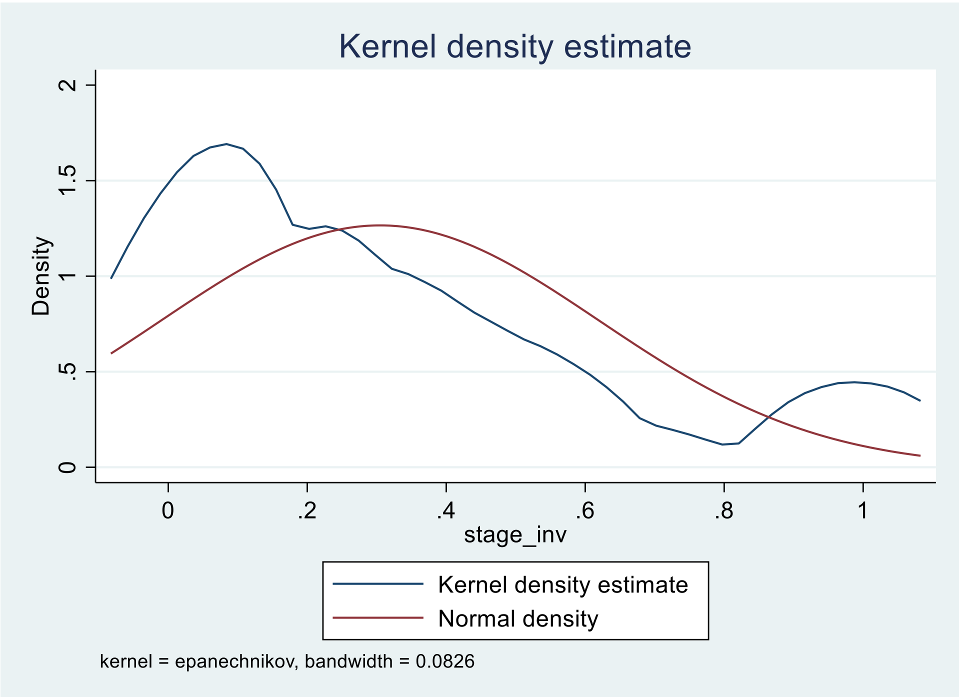
Appendix Z: Distribution of experience



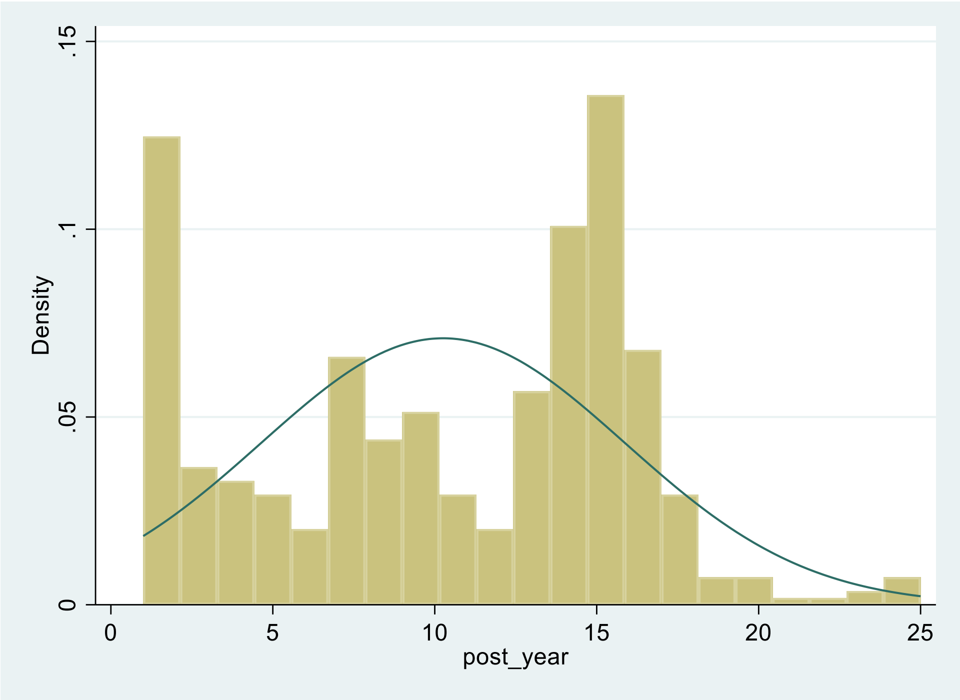


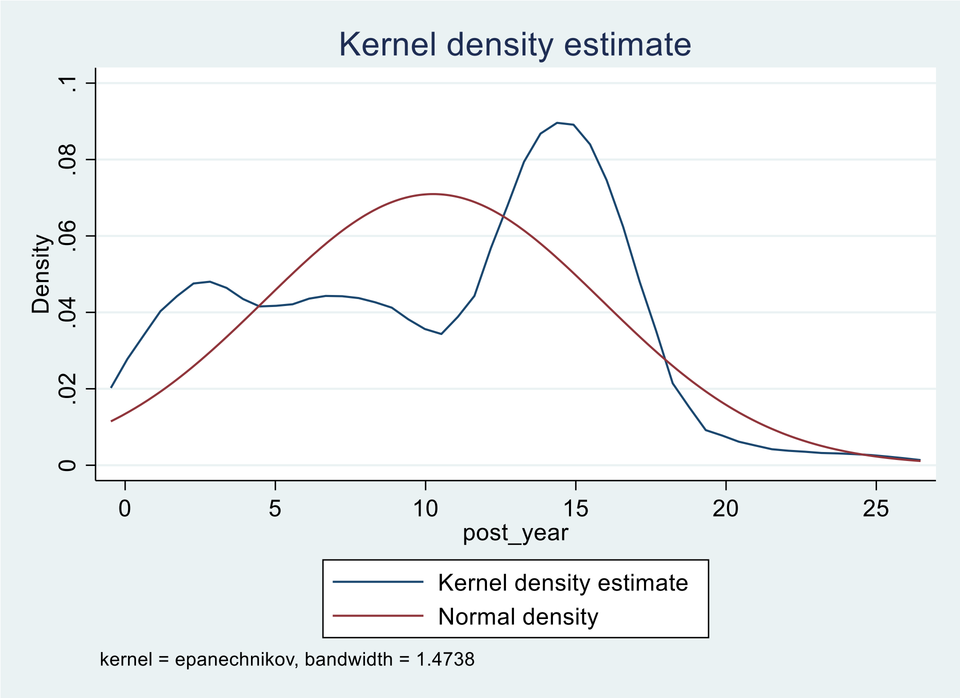
Appendix AA: Distribution of uncertainty



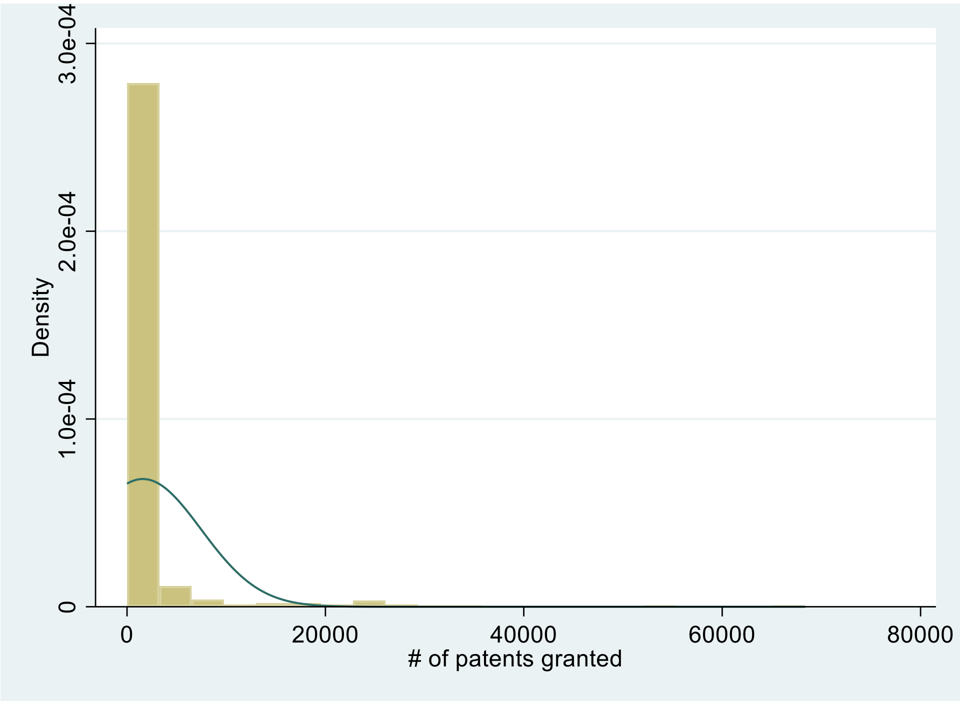


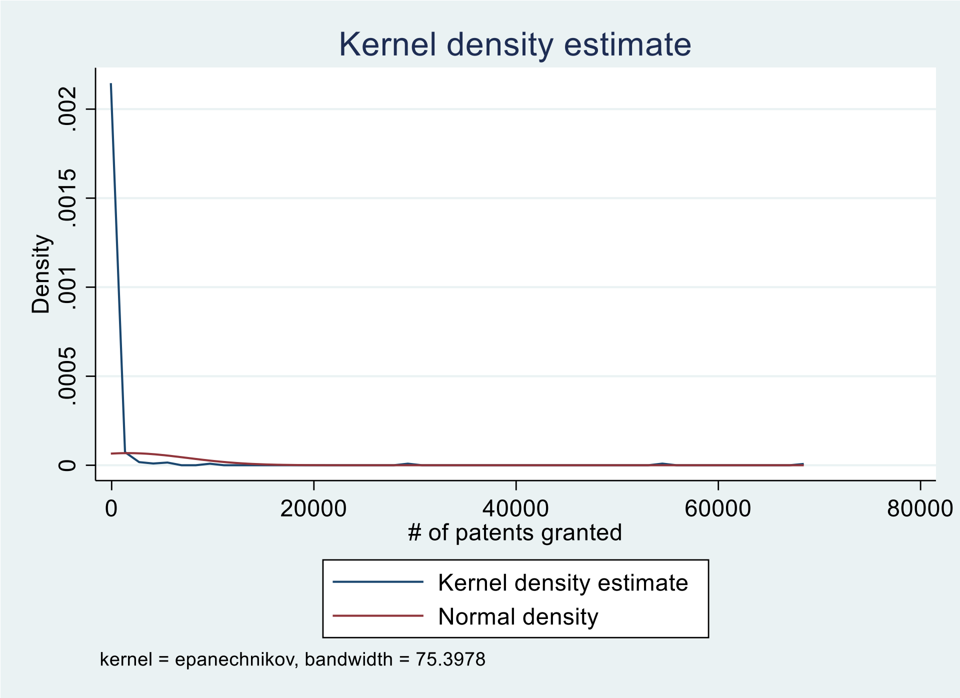
Appendix BB: Distribution of post period

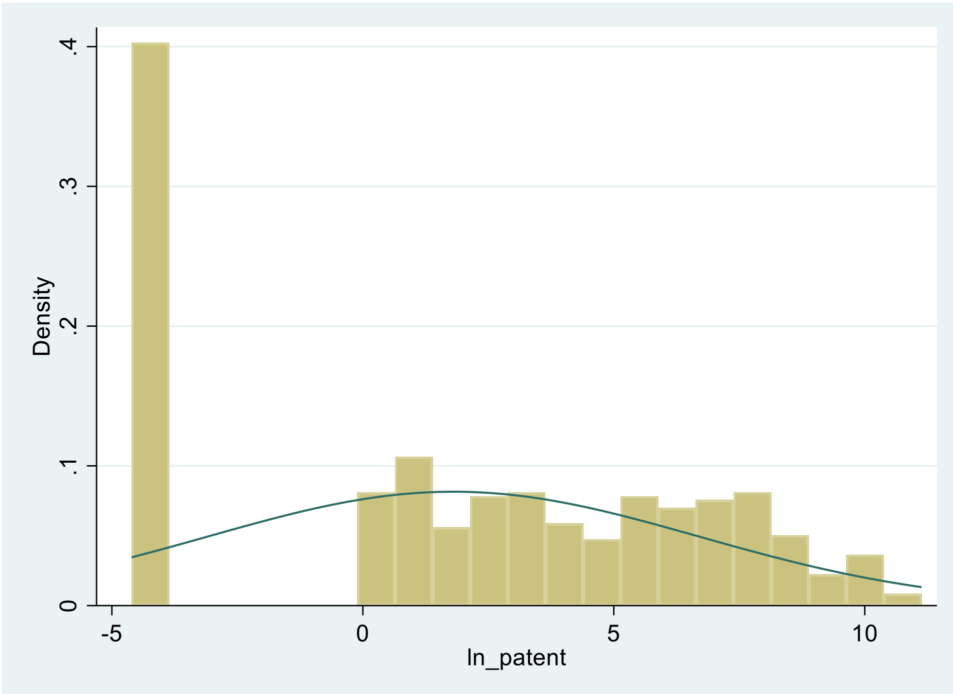


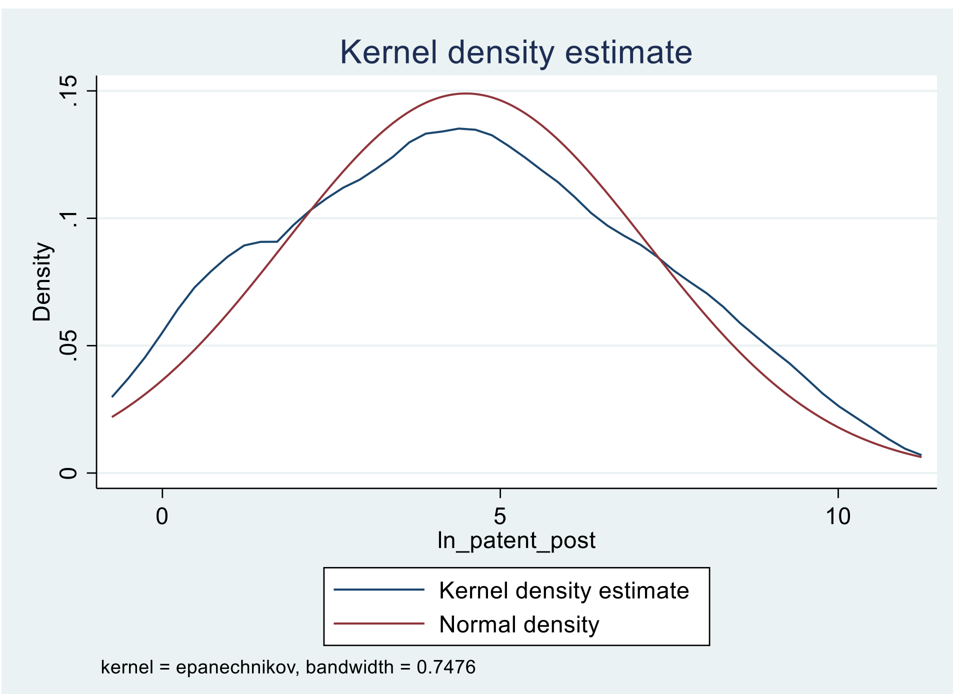


Appendix CC: Distribution of absorptive capacity

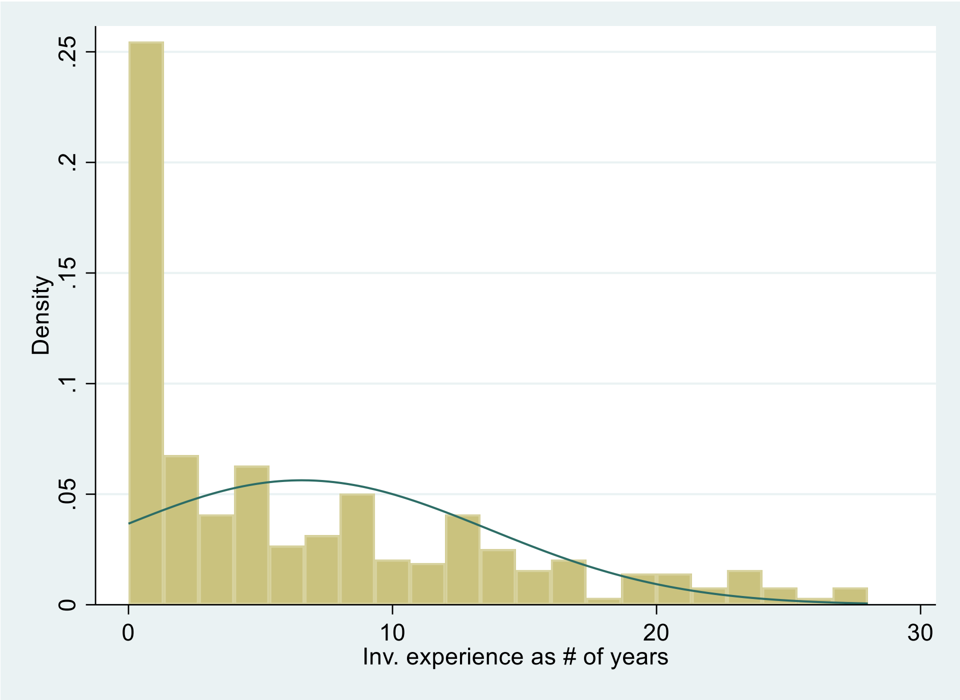


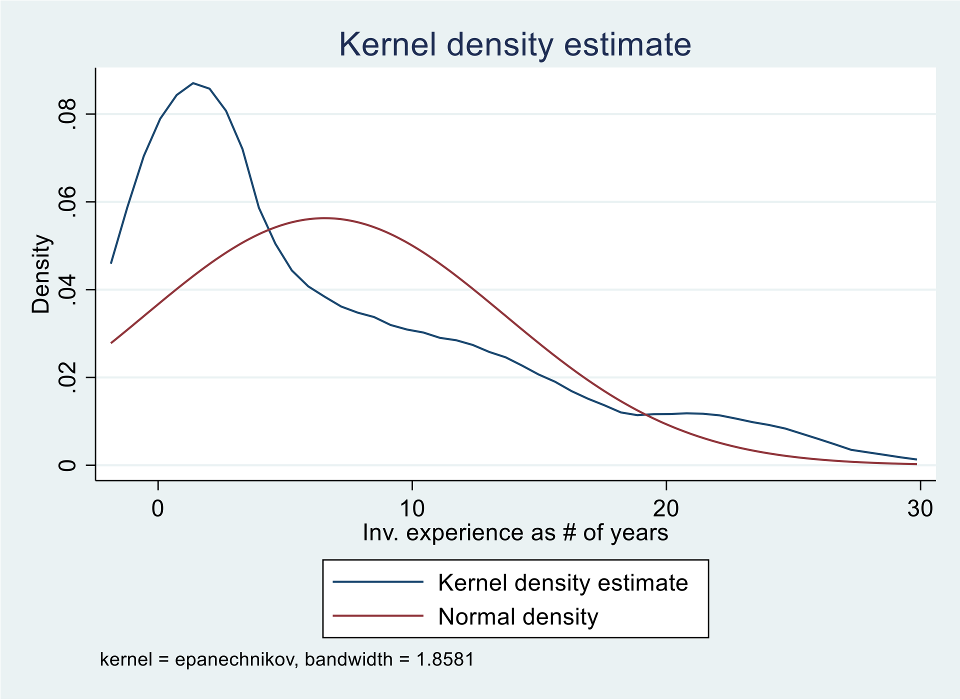


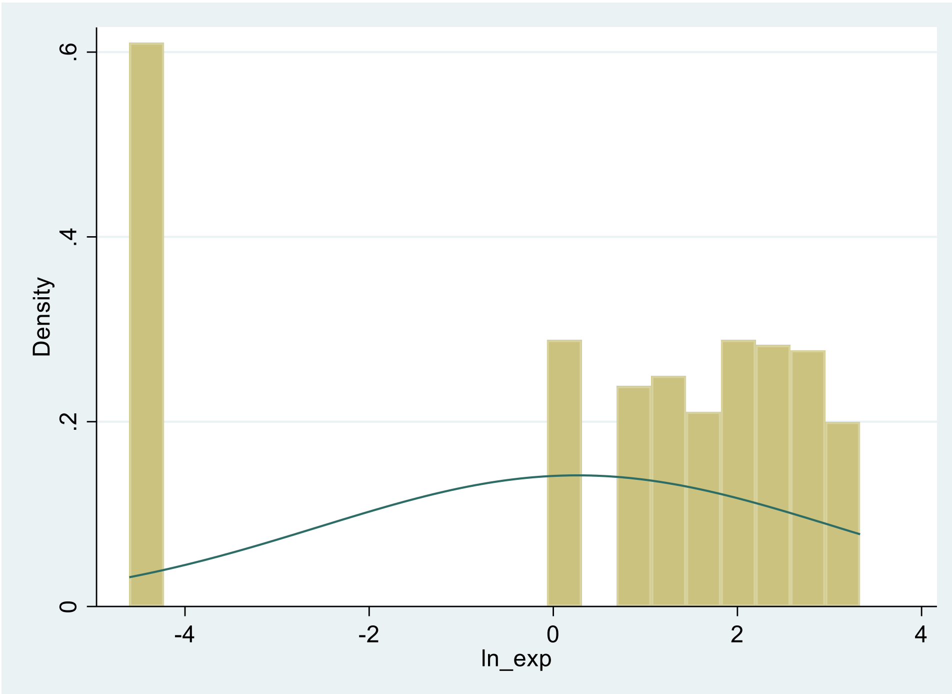

Density
0
.1
.2
.3
.4
-5
0
5
10
ln_patent


Kernel density estimate
Density
0
.05
.1
.15
0
5
10
ln_patent_post
Kernel density estimate
Normal density
kernel = epanechnikov, bandwidth = 0.7476

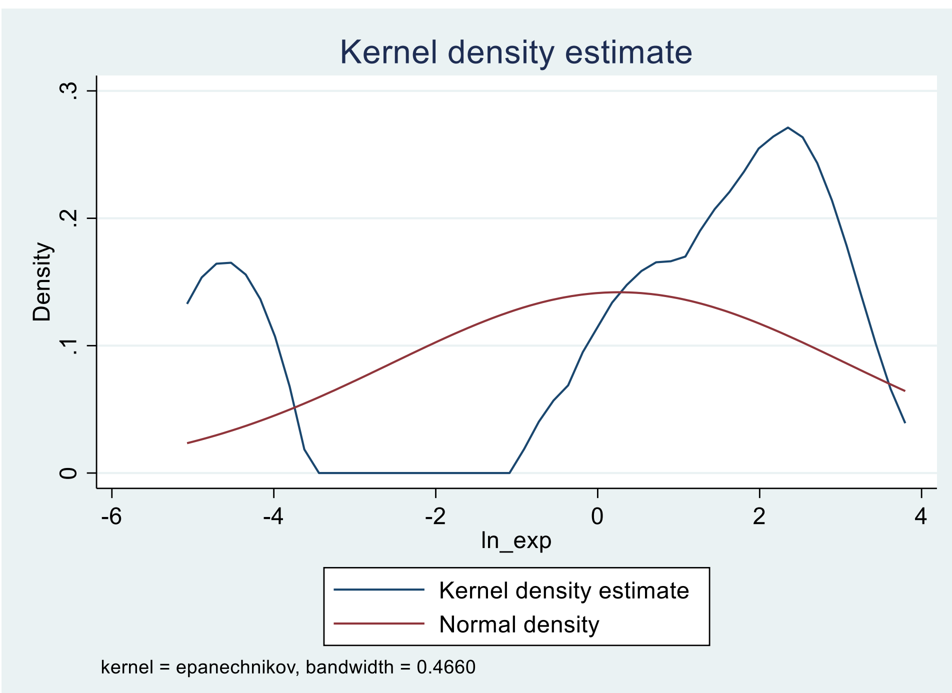
Appendix DD: Distribution of investment period





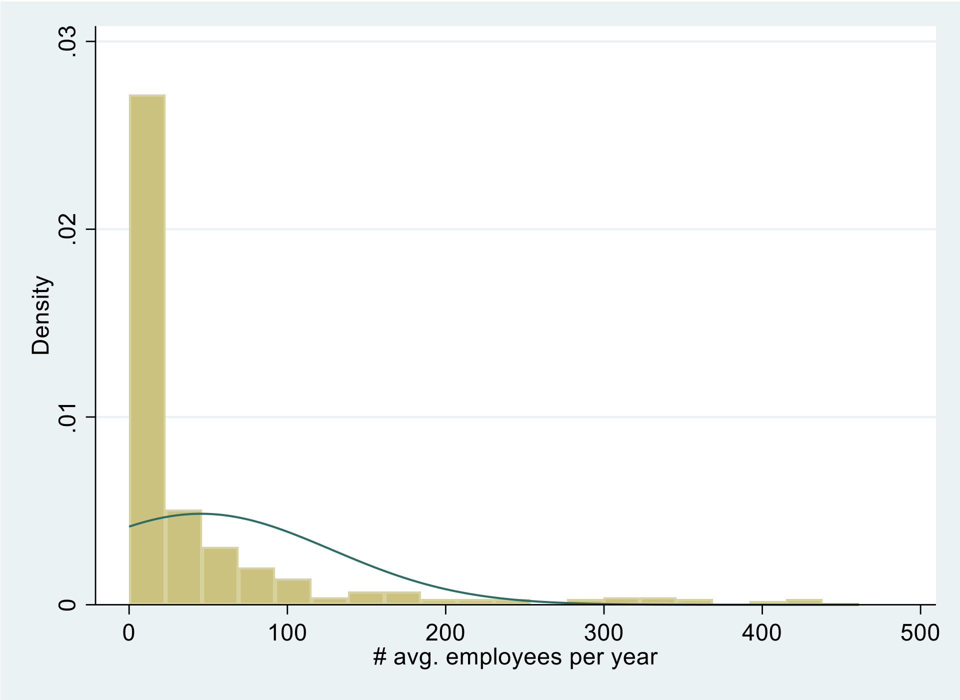


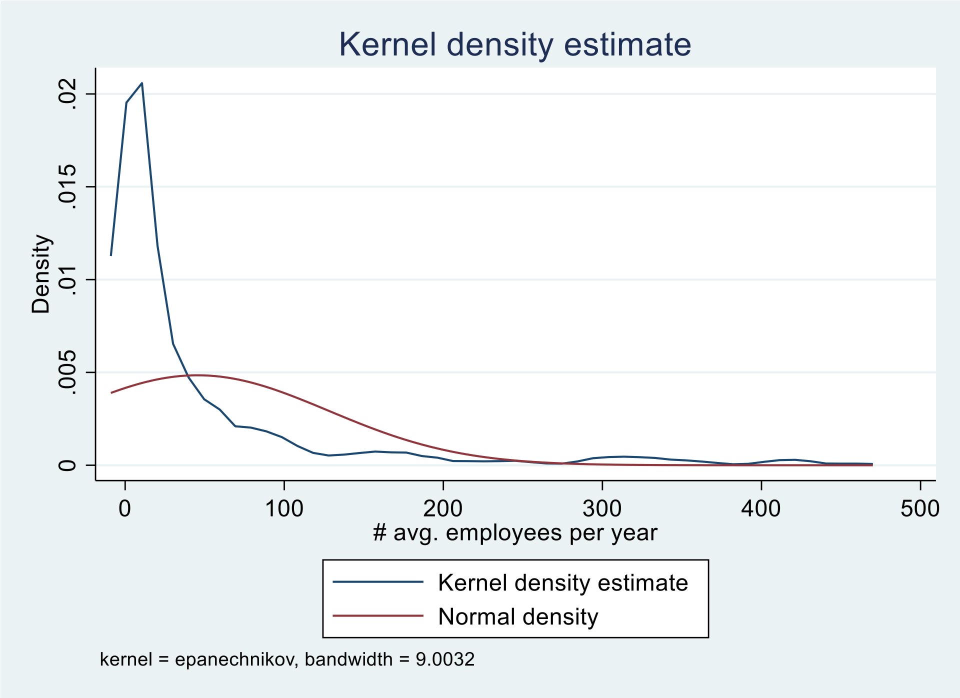
Density
0
.2
.4
.6
-4
-2
0
2
4
ln_exp

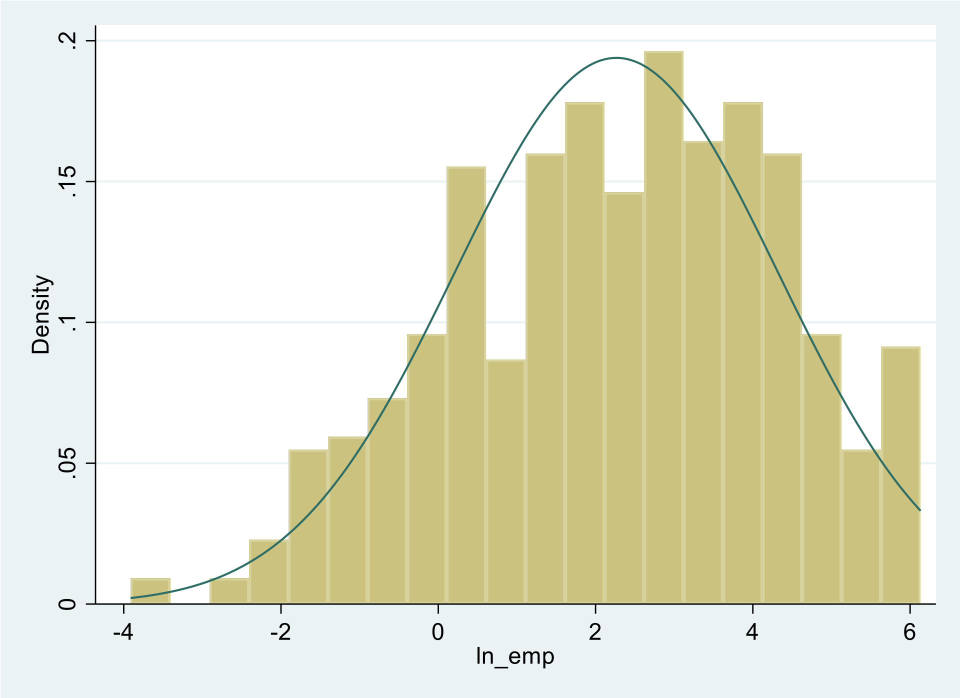


Kernel density estimate
Density
0
.1
.2
.3
-6
-4
-2
0
2
4
ln_exp
Kernel density estimate
Normal density
kernel = epanechnikov, bandwidth = 0.4660

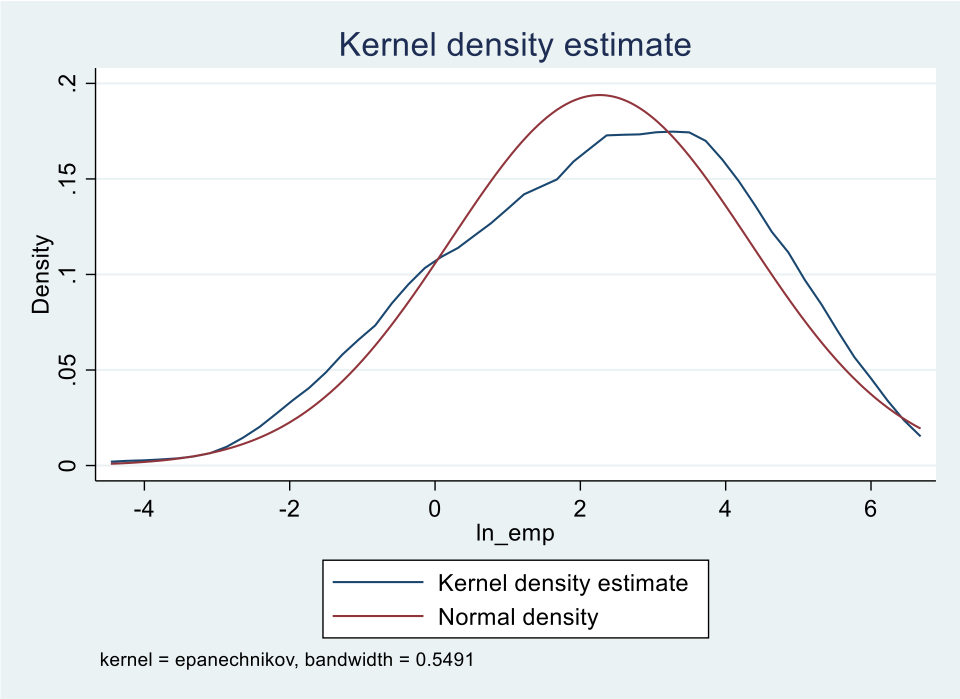
Appendix EE: Distribution of size





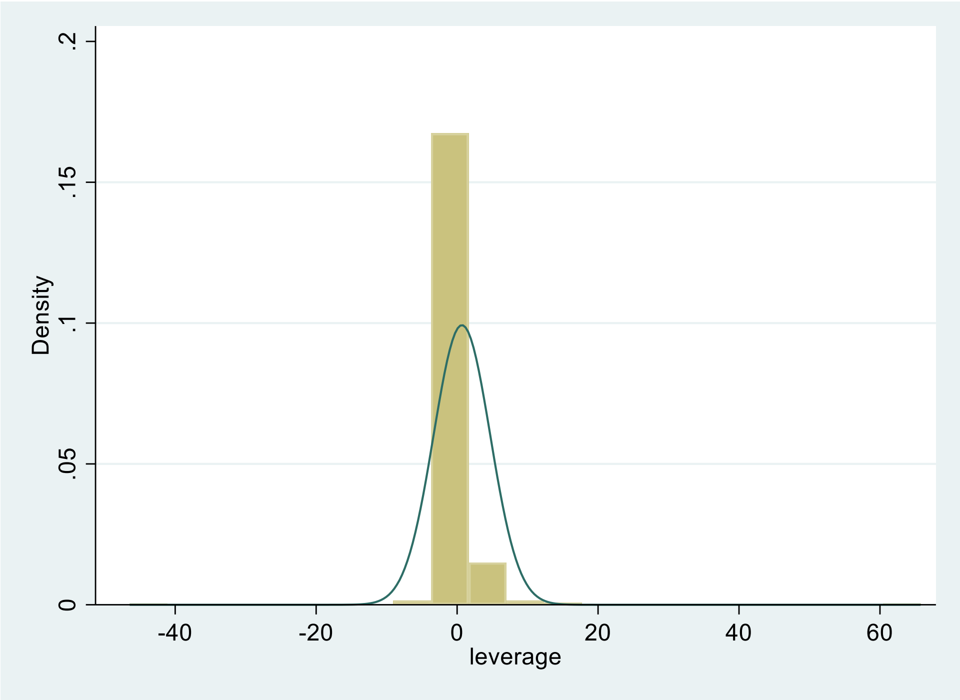


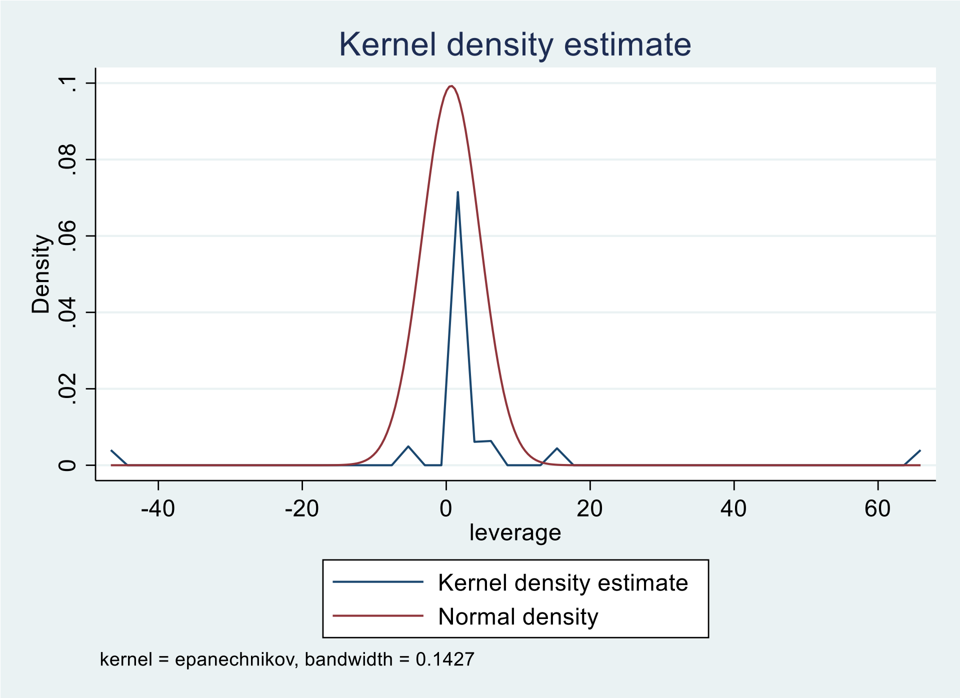
Density
0
.05
.1
.15
.2
-4
-2
0
2
4
6
ln_emp

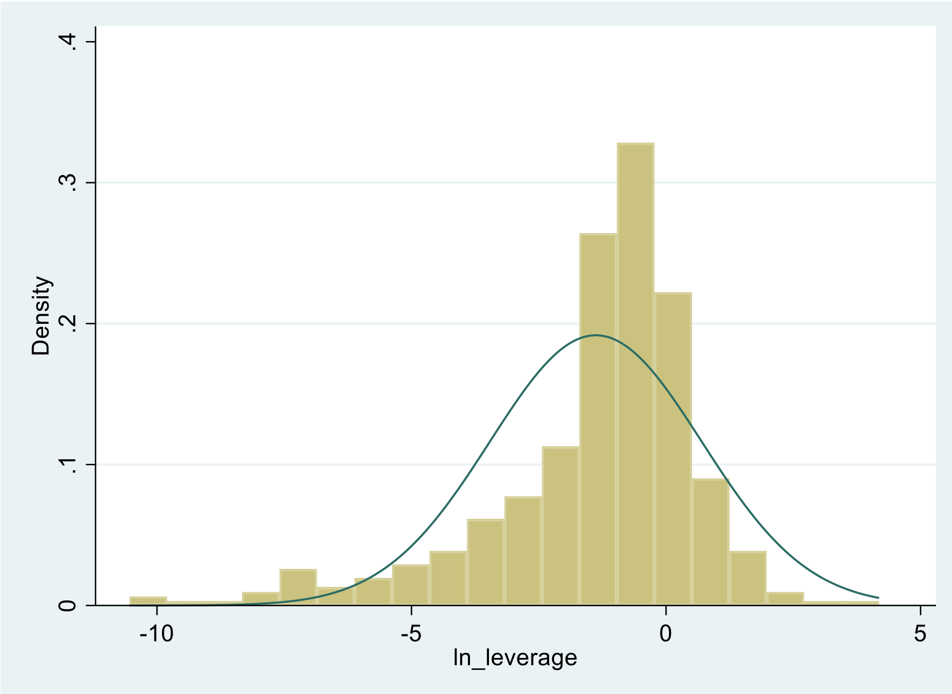


Kernel density estimate
Density
0
.05
.1
.15
.2
-4
-2
0
2
4
6
ln_emp
Kernel density estimate
Normal density
kernel = epanechnikov, bandwidth = 0.5491

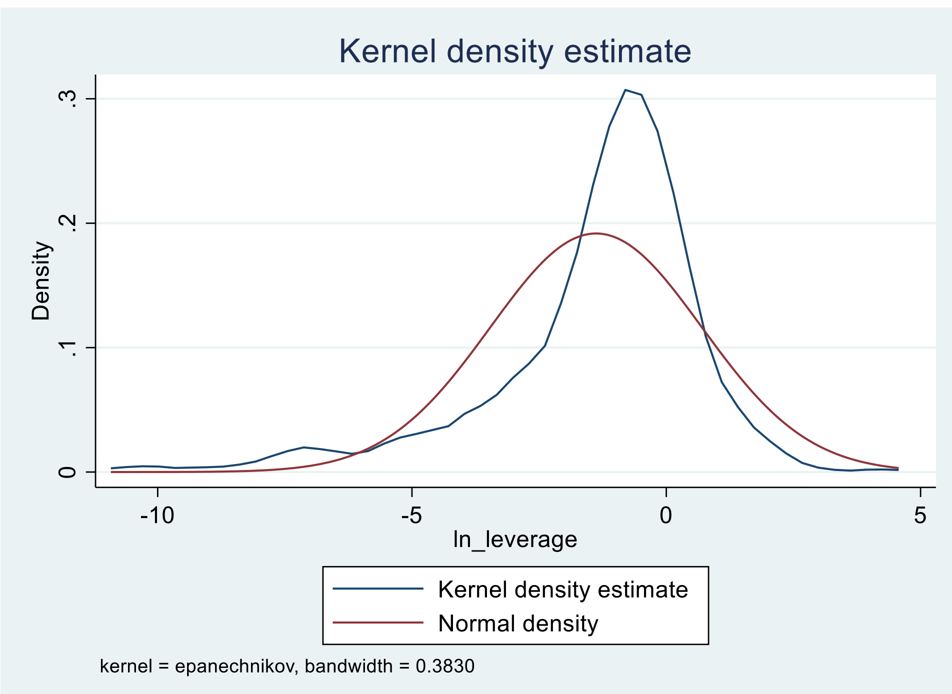
Appendix FF: Distribution of financial stability





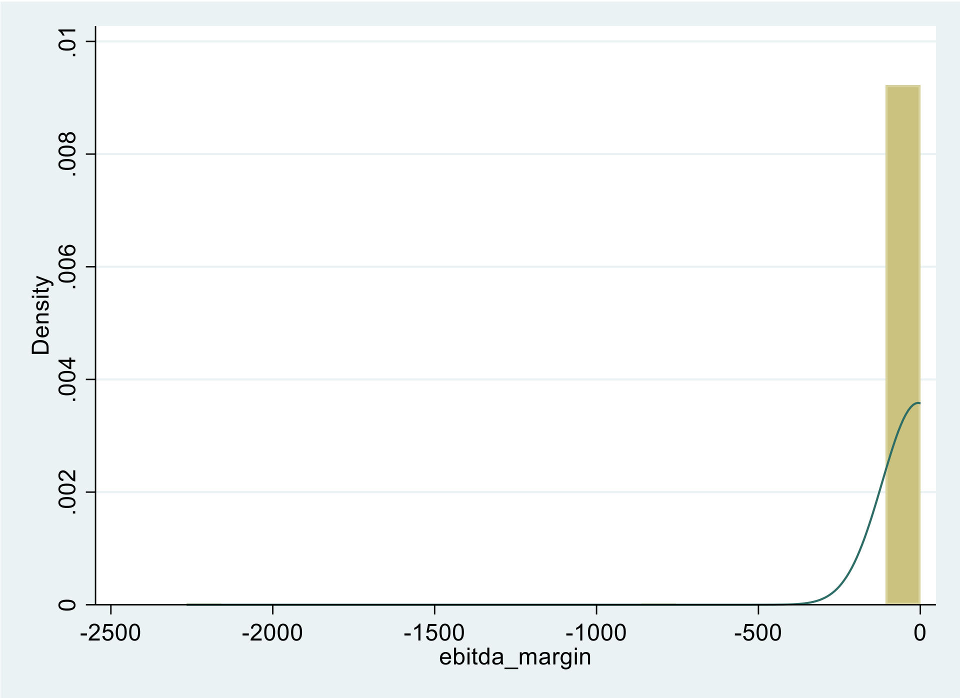


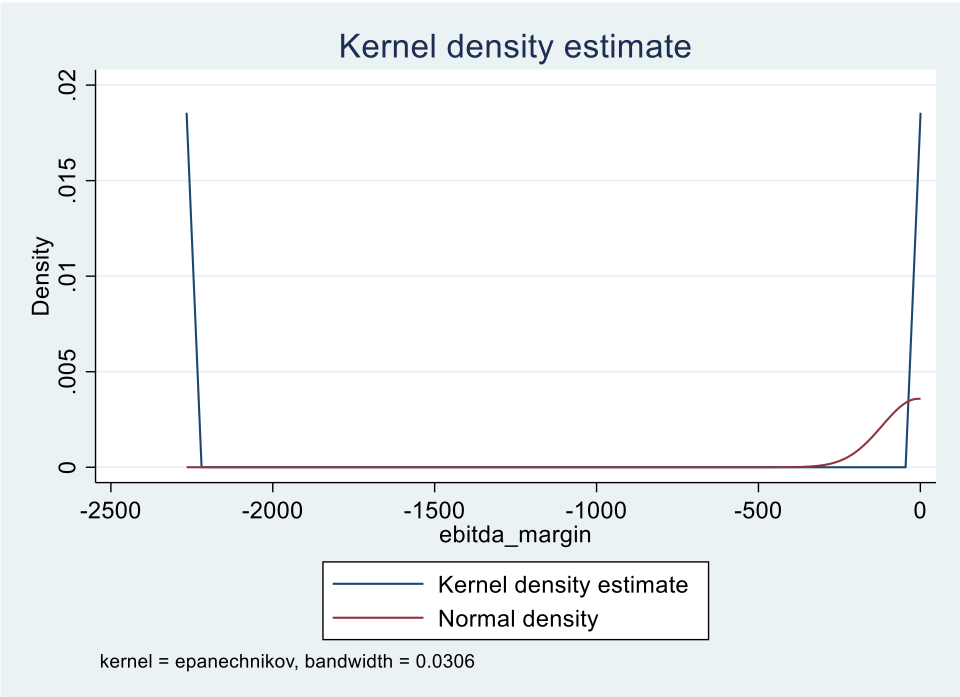
Density
0
.1
.2
.3
.4
-10
-5
0
5
ln_leverage

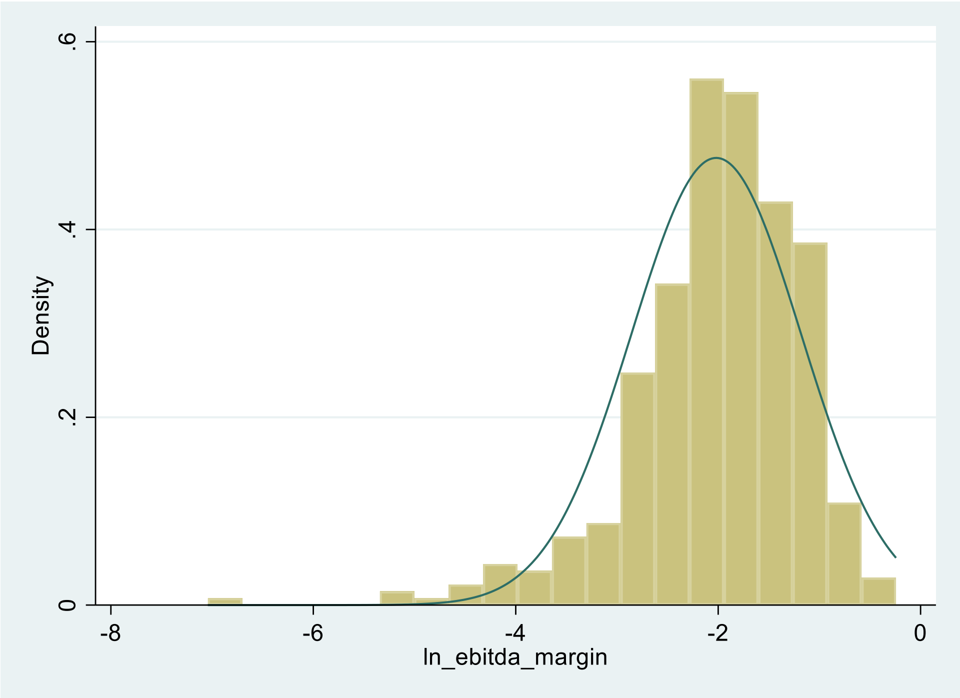


Kernel density estimate
Density
0
.1
.2
.3
-10
-5
0
5
ln_leverage
Kernel density estimate
Normal density
kernel = epanechnikov, bandwidth = 0.3830

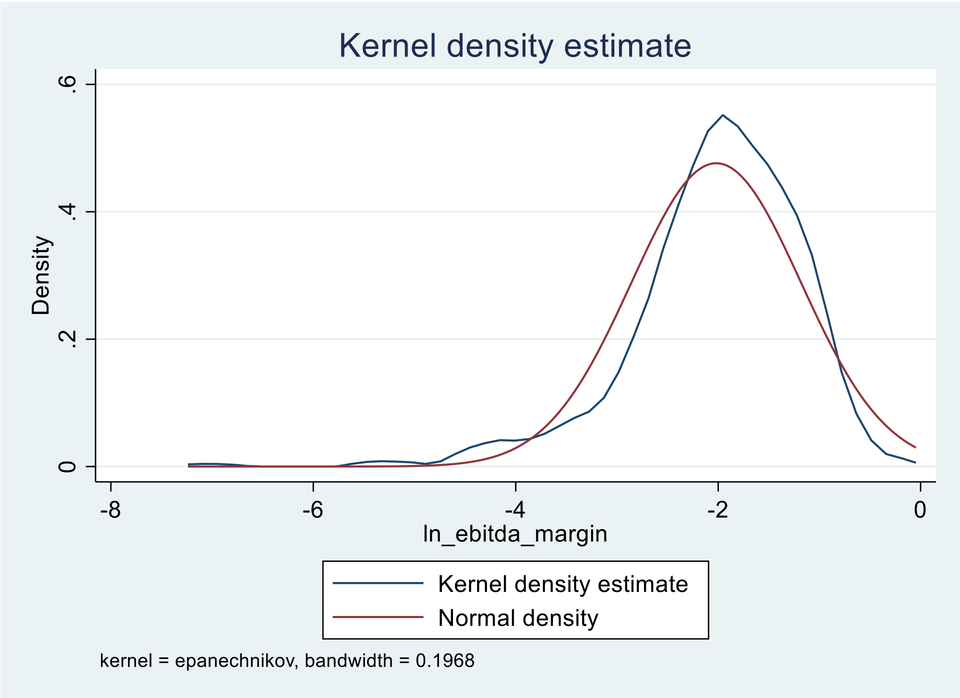
Appendix GG: Distribution of slack





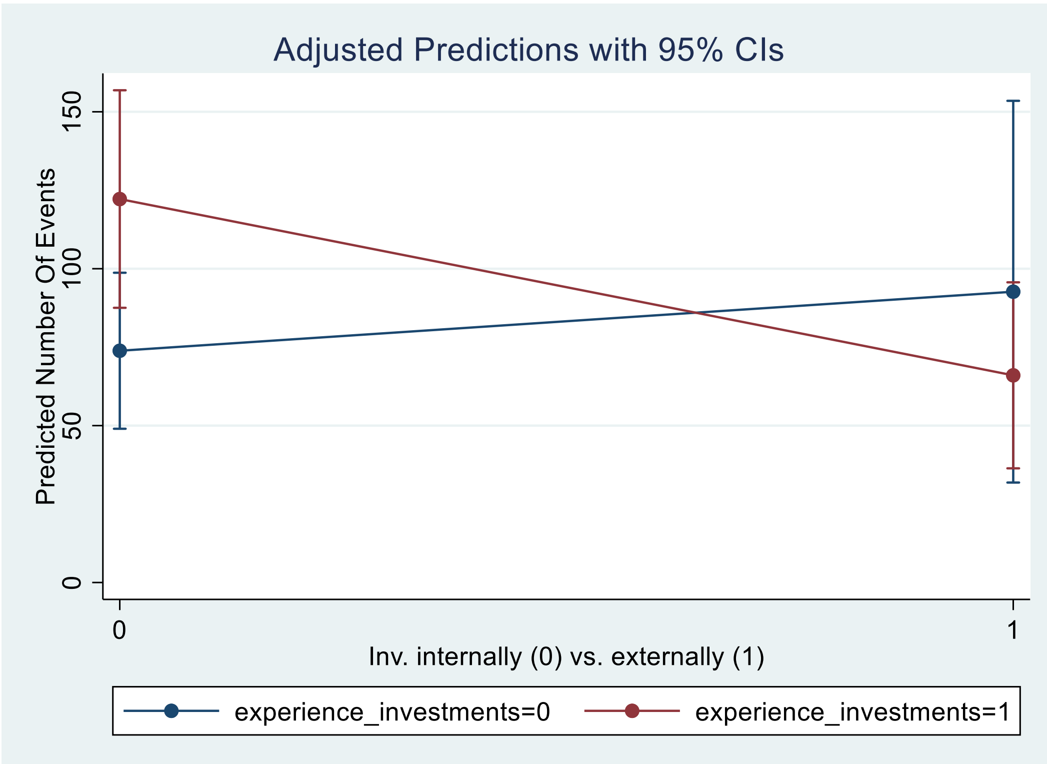


Density
0
.2
.4
.6
-8
-6
-4
-2
0
ln_ebitda_margin



Kernel density estimate
Density
0
.2
.4
.6
-8
-6
-4
-2
0
ln_ebitda_margin
Kernel density estimate
Normal density
kernel = epanechnikov, bandwidth = 0.1968

Appendix HH: Margins of moderating effect of experience



Appendix II: Gof-test for Poisson distribution

```
Deviance goodness-of-fit =  234361.2
Prob > chi2(327)         =    0.0000

Pearson goodness-of-fit  =  425150.4
Prob > chi2(327)         =    0.0000
```