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Sergey Anokhin  
*Kent State University, USA*, sanokhin@kent.edu

Daniel Örtqvist  
*Luleå University of Technology, Sweden*

Sara Thorgren  
*Luleå University of Technology, Sweden*

Joakim Wincent  
*Luleå University of Technology/Umeå School of Business, Sweden*

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RISKY INFORMATION EXCHANGE: HOW NETWORK POSITION CAN CAUSE DIFFICULTIES FOR CORPORATE INNOVATION

Sergey Anokhin, Kent State University, USA
Daniel Örtqvist, Luleå University of Technology, Sweden
Sara Thorgren, Luleå University of Technology, Sweden
Joakim Wincent, Luleå University of Technology/Umeå School of Business, Sweden

ABSTRACT

To enhance innovation effectiveness, many incumbent corporations make equity investments in young technological startups. Four out of five corporate investors syndicate at least some of their investments with other incumbents. While syndication practices may be beneficial to incumbent corporations, in this study we elaborate on the notion of information exchange paradox to demonstrate that syndication may be detrimental to corporate innovation. Using a unique data set of investment decisions of 163 corporations over four years, we show that for some corporations the losses of participating in syndicate networks may outweigh the gains. In particular, we demonstrate that syndication network centrality negatively moderates the ability of a corporation to benefit from its investments. We also show that the effect is particularly strong in highly concentrated industries but is virtually non-existent in industries with low concentration. This supports a contingency view of syndication and implies that benefiting from equity investments in startups is a non-trivial task for managers of incumbent corporations.

INTRODUCTION

While the benefits of open innovation practices are many, contingency factors shaping their effectiveness – for instance, the extent to which external ideas are converted into corporate patents – have not been documented sufficiently. The present study addresses this notable shortcoming. We explore these contingencies in a specific setting which we believe is of particular importance for the study of open innovation – equity investments by incumbent corporations into promising new ventures – commonly referred to as corporate venture capital (CVC). Venture capital practices are at the very core of the transition from a closed to an open innovation paradigm (Chesbrough, 2003). Adoption of the venture capitalists-like practices by the established firms is thus one of the major archetypal phenomena in the world of open innovation.

While previous studies have largely postulated a positive relationship between CVC investment intensity and corporate learning and patenting (Dushnitsky & Lenox, 2005b; Keil, Zahra, & Maula, 2004), our current understanding of the role of contingency factors that may affect this association is at best scarce. We explore how the interplay of two possible contingencies – deal syndication and industry concentration – shapes the effect of CVC investments on corporate patenting.

Deal syndication – an approach to financing new ventures where multiple incumbents pool their resources to invest jointly in new ventures of interest – by virtue of bringing fellow investors close to each other in a syndication network results in network externalities from which incumbents may both gain and lose. Generally, financial benefits of syndication include higher and more certain financial returns due to risk sharing, risk reduction and access to deals flow (Lockett & Wright, 2001; Ruhnka & Young, 1991), whereas strategic benefits have to do with the
opportunity to observe and learn from fellow investors’ conduct with respect to CVC investments as well as to internalize innovative ideas championed by the syndicate partners and the partners’ investees. However, syndication has its own costs: firms not only gain from network externalities but also contribute to them. Inasmuch as firms are heterogeneous in terms of their involvement with CVC, some firms may lose more than they gain from becoming close to fellow investors. It is not at all clear whether strategic benefits of syndication could outweigh possible losses for firms with above-average CVC involvement: they cannot learn a great deal from their less active partners while risk their own unique capabilities imitated away. Besides, the know-how developed by the incumbents’ investees may be appropriated by their (more agile) syndicate partners. In fact, such firms may competitively suffer from being close to fellow investors.

As such, deal syndication presents corporate investors with what we call an information exchange paradox: flow of information within such syndicates should be both open and closed. Otherwise the incumbents will neither be able to learn from their investments nor will be able to protect their own sources of competitive advantage from being imitated away by the fellow investors. Accordingly, it is critical to explore the role of the information exchange paradox in corporate venture capital practices. Sadly, beyond a mere recognition of the fact that many deals are syndicated, the effects of deal syndication in the open innovation context have not received adequate treatment in the extant literature even though many deals are co-funded by multiple corporations.

We also introduce another moderating mechanism accentuating the relationships between a corporation’s CVC investments and corporate patenting. Industries vary greatly with respect to the dominant innovation logic (Malerba & Orsenigo, 1996). Some industries are effectively controlled by a few incumbents while others are increasingly entrepreneurial and are shaped by numerous smaller players (Hou & Robinson, 2006; Levy, 1985). While formal vehicles such as syndication networks that facilitate the information exchange may be required for incumbents to tap into open innovation wellsprings in industries dominated by a limited number of large competitors, our findings indicate that this is not necessarily the case in entrepreneurial industries where interaction between the holders of information often does not require such specialized forums. We thus maintain that the interaction effects of CVC and network structural position on corporate innovation may be particularly well-pronounced in highly concentrated industries.

In this paper we address these two contingency effects and provide some guidelines with respect to designing the architecture of corporate venture capital programs. The paper is organized as follows. First, because extant CVC literature has essentially ignored to date the issue of deal syndication, we provide a rather detailed description of the phenomenon, discuss the benefits associated with syndication as suggested by the independent VC literature, and explicate the expected benefits and drawbacks of syndicating deals by corporate investors. Second, we formalize our arguments and develop hypotheses. Third, we introduce our data, explain the methodology involved in testing the hypotheses, and present the results. The paper concludes with the discussion of our results, their implications for theory and practice, overview of the study’s limitations and suggestions for future work.

LITERATURE REVIEW AND HYPOTHESES

Deal Syndication and Corporate Innovation: Elaboration on the Information Exchange Paradox
Although there are numerous benefits to deal syndication, there are also certain theoretical reasons to believe that corporations may be better off not syndicating their investments with other incumbents if they are interested in absorbing the know-how from startups they support. The reason is that close connections to firms interested in similar technologies may backfire: those firms, too, may learn about the focal incumbent’s capabilities, operational processes, and know-how. In other words, in the process of joint supervision of the investee’s development – which often brings representatives of firms connected by a syndicate network into physical contact in the new venture’s board room – the corporation may lose some of its own otherwise ambiguous and socially complex know-how to the syndicate partners. In the process of new ventures development the corporation may absorb the proprietary information shared by co-investors as well as inadvertently disclose its own valuable information that under different circumstances would have remained protected from others. Besides, know how of strategic importance championed by the new venture may transfuse to the fellow investors. Using the bathtub metaphor, on balance, syndication may rather be a leak, not an inflow when it comes to accumulation of the corporation’s asset stock (Dierickx & Cool, 1989).

As noted earlier, there are parallels between deciding to syndicate and deciding to locate in agglomeration. Not surprisingly, prior studies have found that, for instance, semiconductor managers, concerned that their technology might spill over to existing firms, decided to avoid locations where their competitors were located when choosing new production sites (Yoffie, 1993). It is likely that syndication precludes corporations from extracting sustainable competitive advantage from their CVC investments since the same benefits could potentially accrue to all syndicate partners. Perhaps for that reason some researchers claim that substantively syndication is a way to manage risks and is driven by the desire to build a financially strong investment portfolio, not the need to invest in companies of strategic interest (Hardymon, DeNino, & Salter, 1983). It has also been suggested that a syndicated CVC investment is unlikely to be a means of sustainably superior performance; rather, it is a means to keep up with competitors because all gain access to the same information (Reaume, 2003).

Thus, to truly benefit strategically from CVC investments incumbents must solve a non-trivial information exchange paradox: they must ensure the free flow of information from new ventures to corporate parents as well as block the loss of valuable information to competitors. Being close to other incumbents allows corporations to tap into know-how advanced by co-investors and their investees but at the same time facilitates loss of valuable knowledge to syndicate partners. In other words, being close to fellow investors has its benefits and drawbacks. The corporation has to decide how deeply it wants to engage in the syndicate network, and whether it loses more than it gains by joining such forums for information exchange.

The Information Exchange Paradox and the Moderating Role of Network Centrality on the CVC Intensity and Corporate Innovation Relationship

To sum up our earlier arguments, the main benefit as well as the main drawback of deal syndication in the corporate innovation context is the possibility of knowledge spillover: While incumbents could learn from their investments and from the proprietary knowledge of their peers, so can also fellow investors learn from the incumbent corporation. This may harm rather than benefit the incumbent corporation’s innovative output. Thus, as with agglomeration, it is clear that deal syndication is a matter of give and take (Shaver & Flyer, 2000).

We believe that the incumbent corporation’s syndicate network centrality is instrumental in understanding the relationship between CVC intensity and corporate innovation. For incumbents
with below-average level of CVC intensity which do little of their own investment activity the benefits are most pronounced: Not only do they learn from their more active syndicate partners but also absorb ideas developed by their partners’ multiple investees. On the contrary, firms with above-average level of CVC intensity have little to gain and a lot to lose: While they cannot learn a great deal from those few projects their less active partners support, they lose their know-how to such partners through network connections because, as we said, new ventures’ board rooms are a forum where ideas are exchanged and knowledge flows freely.

Following the research of Freeman and others we argue that companies with very active CVC programs are more likely to experience difficulties in utilizing the most out of the rich information flows if they are close to co-investors (Freeman, 1979; Sykes, 1990). It seems much more promising to become deeply entrenched in syndicates when the corporation makes very few own investments. With large CVC portfolios there is a lot of information passing through the incumbent corporation. This information must be processed to eventually develop into a patent. However, if the corporation is involved in many new ventures there is a risk that the massive body of information cannot be processed efficiently and that important information leaks and is acted upon by others before the firm grasps the respective opportunities. Since patents are awarded on a first-come, first-served basis, a corporation may lose the rights to a technology to CVC partners that identify and extract the value of the information first. The corporation simply cannot control the spread of information as effectively as when managing a smaller investment portfolio.

Moreover, parallel support of many new ventures may provide the corporation with information of more general character because of the difficulties of being deeply involved in every venture. This means that the corporation may be left with information that is too general to be useful for patents which often require more specific and specialized information. In this sense, it can be far from beneficial, if not even detrimental to possess a central position when having a large investment portfolio.

For companies with smaller portfolios there are more benefits associated with possessing a central position in the network. At the same time, the potential leakage costs will be significantly smaller; due to fewer investees there is less information to leak but there is still a significant inflow of information by virtue of having a central position in the network, being connected to several other partners, and sharing their information. With fewer ventures to control, there will also be more time for processing appropriated information and judging whether it is of value and should be kept secret. Thus, being centrally positioned in CVC syndicate networks may be most beneficial for corporate patenting when the firm has low CVC investments. When the company is involved in substantial CVC support to a great number of ventures it may be better off to move far away from the center of the network to appropriate the innovation without sharing it unnecessarily with close partners.

On average, thus, firms with low CVC intensity will benefit the most in terms of improving their innovative stature by syndicating while corporations that support many new ventures will benefit the least, and could in fact competitively lose by inadvertently helping improve their competitors’ innovativeness. Hence, we expect a firm’s involvement into syndicate networks – that is, its closeness to fellow-investors – to negatively moderate the effect of CVC intensity on corporate innovativeness. To state formally:

_Hypothesis 1: Syndicate network centrality negatively moderates the relationships between a corporation’s CVC intensity and corporate innovation._
The Role of Industry Concentration

Our previous arguments build on the idea that syndicate networks function in part like specialized forums for information exchange and knowledge flows and thus may in many instances facilitate innovation. Yet, the logic of the innovative process – and the need in such specialized forums – is known to differ between industries. We argue that such forums may be less important in industries where ideas are exchanged naturally, independently of active encouragement or discouragement by corporations. An example of such a setting is Silicon Valley’s microelectronics research and manufacturing industry where ideas flow freely as people meet socially, switch employers or start their own businesses (Saxenian, 1994). Such industries are characterized by strong entrepreneurial dynamics and low concentration ratio (Chuang & Lin, 1999; Dean & Meyer, 1996; Kock & Santalo, 2005). Often, they exhibit high opportunity and low appropriability conditions that facilitate constant entry of new innovators, and low cumulativeness conditions, which do not allow the persistence over time of innovative success at the firm level – hence, few firms manage to grow large and establish any degree of control over their industries (Malerba et al., 1996). Because ideas cross corporate boundaries in such industries easily without specialized vehicles like syndicate networks, one could expect that the need for formal mechanisms facilitating open innovation is relatively unimportant there.

At the same time, due to significant R&D required to propel innovation, other industries are dominated by a few large-scale incumbent innovators who are naturally interested in protecting their developments from other large-scale industry participants such that the threat of imitation is minimized (Nelson & Winter, 1982). Incumbents have little access to their competitors’ stock of knowledge. Such industries are typically characterized by high opportunity, appropriability and cumulativeness conditions; Malerba and Orsenigo suggest that they are generally consistent with the so-called Schumpeter Mark II logic (Malerba et al., 1996). Incumbents are generally not inclined toward sharing their ideas with competitors, so the flow of knowledge between firms within such industries may require facilitation, and specialized forums such as syndicate networks may become the facilitation device. In these highly concentrated industries the information exchange forum created through syndication may be one of the few opportunities corporations have for information sharing. Although incumbents are typically secretive about their innovation practices, the CVC context may relax the situation. This implies that in highly concentrated industries the effects of information flows made possible by participating in syndicate networks will be more apparent, compared with the industries of the first type. Thus, the logic implied by our previous hypothesis should be particularly strong in highly concentrated industries but may be weaker (or even irrelevant) in less concentrated, fragmented, entrepreneurial industries. In other words:

Hypothesis 2: Industry concentration moderates the relationships between a corporation’s CVC intensity, network centrality and corporate innovation such that the effect implied in Hypothesis 1 is stronger in highly concentrated industries than in industries with low concentration.

METHODS

Data

To examine whether and when deal syndication is beneficial or detrimental for the incumbent’s innovation, we constructed and analyzed an extensive data set on corporate equity investments, patent applications, as well as accounting information that public corporations are required to
disclose. The data consisted of investment decisions of 163 corporations during the course of four years, rendering a set of data with 652 unique measurement points. Data were pooled from four major secondary sources. VentureXpert by Venture Economics and Corporate Venturing Directory & Yearbook (hereafter – the Yearbook) by AssetAlternatives were utilized to reconstruct the pattern of CVC investments by incumbent corporations. Both of these data sources have been used in CVC research extensively (Dushnitsky, 2002; Dushnitsky, 2004; Maula & Murray, 2000). Still, they are known to have certain deficiencies: the Yearbook may double count particular deals and VentureXpert may inflate the number of investment rounds (Lerner, 1995). Besides, the overlap between the databases is not perfect: each data source has information on some deals that the other database does not cover. We followed meticulous procedures to ensure data accuracy, to match data between the two databases, and to estimate and reduce redundancies. Thus, by carefully matching the data we were able to obtain the most accurate information on the CVC investments of the corporations. We only considered investments committed during 1998-2001 as this period is best covered by both databases. After matching the data on CVC deals reported by VentureXpert and the Yearbook, we merged our database with annual firm-level accounting and financial data from Standard & Poor’s Compustat. Since the data reported in the Compustat relate to a financial and not a calendar year of the corporation, we do not use annual aggregates reported by VentureXpert directly but rather look at the exact dates of particular deals to match them to appropriate financial years. Thus, for a corporation with a financial year starting in March and ending in February we would consider a CVC investment made in January of 2000 as a part of year 1999. Finally, we utilized the USPTO database to obtain information about patent applications by the incumbents. Again, we made sure that patent information complied with financial, not calendar year schedule adopted by the corporations. We deliberately excluded certain industries from the dataset (e.g., financial services, real estate, and hotels) as is conventional in the CVC research (Field, 1999). We also excluded companies for which it was not possible to designate a primary industry affiliation (e.g., General Electric). Our main reason for doing this was to reduce the noise and bias in the dataset following potential flaws in classification.

Dependent Variable

Our dependent variable is the number of patent applications filed by a corporation in any given financial year (i.e., the number of applications listing the focal incumbent as an assignee in the USPTO database). We utilized patent applications for a number of reasons. Many of the applications have not yet resulted in patents at the time of data collection due to a laborious and lengthy process that the patent office has to go through to grant the application (Ernst, 2001; Silverman & Baum, 2002). Accordingly, patent applications rather than granted patents represented a more accurate snapshot of a corporation’s innovation activities. Similarly, although considering patent citations accumulated over time would have been useful, those patent applications that have been granted could not have generated proper citation record yet (Dushnitsky & Lenox, 2005a). Finally, we believe that for the purpose of our study patent application is a proper metric because it reflects a corporation’s attempt to protect future appropriation of the benefits associated with a particular invention and as such firms prefer to file early even though the U.S. follows first-to-invent and not first-to-file legal approach to innovation. Thus, if a corporation absorbs innovation from its CVC investments, syndication partners or partners’ investees, patent application date and not patent grant date would provide the closest congruity to the moment of mastering the new technology.

Independent Variables
We operationalized **CVC intensity** as the number of distinct ventures supported by the incumbent corporation in a given year. Prior research looked at the dollar amount of CVC investments (Dushnitsky et al., 2005a). Alternatively, some studies focused on the number of CVC deals (Wadhwa & Kotha, 2006). In the context of this particular study, both these measures have certain deficiencies over the one we propose. First, corporations may absorb the knowledge developed by the new venture regardless of the size of their investment (Reaume, 2003). In this sense, considering the dollar amount would only introduce unnecessary noise. Second, the amount invested is often simply a function of the investment round and is not indicative of the investment’s importance or relevance: later rounds typically require more significant investments (Gompers & Lerner, 1998). To that end, we specifically control for corporate preferences with respect to investment round (see the explanation of our control variables below). Third, the incumbent is in a position to learn from the venture regardless of the frequency of investments; in fact, multiple investments during the same period may simply reflect investment tranches or accounting practices adopted by the corporation. What is of importance is the number of distinct firms supported during a particular period and not how often the corporation transfers money to the respective accounts. Finally, most importantly, although the Yearbook lists specific investments it does not report amounts of each transaction. Hence, we were not able to re-estimate our model with an alternative operationalization of CVC intensity. However, analytical reports by Ernst & Young suggest correlation of over 0.90 between the number of deals and the amount invested. Our own calculations based on the data we managed to collect suggest a similar correlation coefficient of 0.85. Thus, we are confident that our independent variable is a high-quality reflection of the CVC activity of incumbent corporations.

**Syndicate network centrality** was operationalized as closeness centrality computed with the software Ucinet 6. The input matrix consisted of a dichotomous classification of whether or not two incumbent corporations co-financed any deals during the specified period. By analyzing all investments by all corporations in our sample we identified the new ventures that received funding from more than one incumbent and were able to map the syndication network. We use a centrality measure composed from the mean geodesic distance (i.e., the shortest path) between a vertex and all other vertices reachable from it, meaning that incumbent corporations in a syndication network that have short distances to other CVC investors are declared central actors, compared to non-central actors that have longer distances to other CVC investors in the network (Borgatti, Everett, & Freeman, 2002). We chose this particular centrality measure because it was specifically designed to estimate the expected time required for an incumbent corporation to transmit and access information and valuable knowledge in a network (Borgatti, 2005). This measure of centrality is highly correlated with other types of centrality measures, including degree centrality.

**Industry concentration ratio** was conceptualized as the four-firm industry concentration (i.e., the market share of the four largest firms within their four digit industries). The variable was computed based on the information from the Compustat database. This measure has been commonly and successfully adopted in previous studies to indicate the degree to which an industry is oligopolistic and the extent of market control held by the four largest firms in the industry (Chuang et al., 1999; Dean et al., 1996; Kock et al., 2005). The concentration ratio may vary from a low of 0 percent to a high of 100 percent, where 0 percent demarcates an extremely competitive market and 100 percent implies an extremely concentrated oligopoly or even monopoly situation.

**Control Variables**

We control for a number of things that may affect the pattern of the observed relationships in our sample. First, as said earlier, we need to control for the preferred investment round: some
firms may prefer to invest late when the startup already has a product or at least a prototype while others may prefer to invest in early-stage ventures where they may affect the direction of technological development. We label this variable *preferred investment stage*. According to the extant literature it is believed that early-stage investments are significantly riskier than the late-stage ones (Ernst & Young, 2002; Fredrikson & Klofsten, 2001). For this purpose we dichotomize investment stages into relatively risky (seed and early stages) and relatively non-risky (extension, later, and balanced stages). To create the variable we use the data from the Yearbook.

To partial out the effects of CVC investments on corporate patenting we control for the effects of the corporations’ *Internal R&D expenditures* and *firm size* (proxied by the log of sales). We included a control for *organizational slack* as slack has been deemed important for the study of corporate venture capital (Chesbrough & Tucci, 2004). In fact CVC intensity itself may be related to the corporation’s possessing extra resources which subsequently may influence its innovative outputs. Slack was in this study operationalized as the current ratio of assets to liabilities of the incumbent corporation (Singh, 1986). Finally, because some industries are more inclined to patent than others, we controlled for the effects of the *industry patenting propensity*. To that end we created a dummy variable that equaled 1 if the corporation belonged to the industry with above-average propensity to apply for patents and 0 otherwise. All variables nominated in dollars have been adjusted for inflation based on annual CPI indices reported by the Bureau of Labor Statistics.

**Models and procedures**

Because the number of patent applications is a count variable, we utilized a population-averaged negative binomial estimation technique with equal-correlation structure (McCullagh & Nelder, 1989). The models were fitted by use of the generalised estimation equation approach (Liang & Zeger, 1986). In all, we report three models. Model 1 includes control variables. Model 2 tests Hypothesis 1 and includes a two-way interaction of CVC intensity and syndicate network centrality in addition to the independent and control variables. Model 3 tests Hypothesis 2 and includes a three-way interaction of CVC intensity, syndicate network centrality and industry concentration ratio along with the independent, control variables and required product terms.

**RESULTS**

The data reveals that on average corporations are rather active with their patenting efforts – the mean number of annual patent applications is close to two hundred. Incumbents in our sample invested significant amounts – close to nine hundred million dollars annually – into internal research and development, and supported between five and six distinct ventures in any given year with some firms like Intel sponsoring many times this number of new firms. The corporations had average sales of over twelve billion dollars per year. All variables are correlated in the expected direction; the magnitude of correlation coefficients is within conventional limits (Cohen, Cohen, West, & Aiken, 2003). To further reduce the threat of multicollinearity due to the presence of multiple interaction effects implied by Hypotheses 1 and 2, we standardized our predictor variables. Descriptive statistics including correlation table are available from the authors.

Table 1 presents the results of hypotheses testing. All three models rendered significant overall model chi-squares, with Model 2 demonstrating a significant improvement over Model 1 (Δχ²=83.66, Δd.f.=3, p<.001), and Model 3 being significantly better than Model 2 (Δχ²=161.00, Δd.f.=4, p<.001). Overall, the models show that all of the control variables except the preferred investment stage were significantly related to corporate patenting. Firm size, industry patenting propensity, and internal R&D were all positively related while organizational slack was negatively related to corporate patenting.
Model 2 provides strong support for Hypothesis 1. Syndicate network centrality negatively moderates the relationship between the number of distinct ventures supported by the corporation and corporate patenting ($b=-0.61, p<0.001$). Interestingly, the direct effect of CVC intensity is positive ($b=0.36, p<0.001$), which agrees to conventional wisdom, while the direct effect of network centrality is non-significant. To better understand the nature of the interaction between CVC intensity and network centrality in the context of corporate innovation we plotted the interaction (see Figure 1a). As the plot indicates, for corporations with low network centrality the effect of CVC intensity on patenting is positive, while for their counterparts occupying central position in syndicate networks the effect is rather negative. This agrees to our conceptual development presented earlier in the paper: apparently, there are important tradeoffs corporations need to consider when joining syndicates.

Hypothesis 2 was tested with Model 3. Indeed, we find support for a significant three-way interaction of CVC intensity, syndicate network centrality and industry concentration in the context of corporate innovation ($b=-0.68, p<0.05$). Importantly, regression coefficients reported in Models 1 and 2 retain their sign, magnitude, and significance thus indicating that the findings are robust. We plot the results in two separate ways. First, we present a comprehensive plot (Figure 1b) that demonstrates that CVC intensity and syndicate network centrality are potent predictors of corporate patenting only in industries characterized by high concentration while in the industries with low concentration their effect appears negligible. Consistent with our Hypothesis 2, the relationship revealed in Hypothesis 1 is particularly pronounced in highly concentrated industries while remaining effectively mute in the industries characterized by low concentration. Thus, based on the significance of the regression coefficient and the plot (Figure 1b), our results demonstrate support for Hypothesis 2.

The three-way interaction plot (Figure 1b) also seems to suggest that the corporate strategies with respect to CVC intensity and syndicate network centrality could be ranked in terms of their patenting effectiveness related to highly concentrated industries. According to the plot, for the corporations in highly concentrated industries the best course of action to benefit from CVC investments is to support many new ventures while keeping distant from the center of the syndication network (strategy 1). The next best strategy appears to be the exact opposite – i.e., maintaining high involvement in the syndicate network (high centrality) while keeping own investments at a minimum (strategy 2). High centrality coupled with high CVC intensity constitutes the third best strategy (strategy 3). Finally, low CVC intensity together with low centrality is the least effective solution for stimulating corporate patenting through supporting technological startups (strategy 4). We ran a series of post-hoc analyses in form of t-tests to explore the differences between those strategies (results are available from the authors). Strategy 1 significantly outperforms the next best strategy 2 ($p<0.05$). Strategy 2, however, is not statistically different from strategy 3 (judged as the third best strategy according to the plot) in terms of patenting effectiveness. Strategy 3 only marginally outperforms strategy 4 with respect to patenting ($p<0.10$). This is particularly interesting because strategies 3 and 4 represent two extreme cases: high CVC intensity - high syndication network centrality (strategy 3) and low CVC intensity - low centrality (strategy 4); yet, the difference between them is only marginally significant if at all.

**DISCUSSION, LIMITATIONS AND CONCLUSION**

Extant literature has revealed that different modes of open innovation are not equal in terms of generating benefits for the incumbent firms. In this paper we analyzed conditions making one of...
those modes – corporate venture capital – more or less effective. We demonstrated that the effect of CVC largely depends on the corporation’s policy with respect to participating in syndicate networks, and that the effects are observed primarily in the industries with high levels of concentration but are virtually non-existent in fragmented industries. We suggest that our findings could be explained by what we call the information exchange paradox of corporate venture capital.

While previous studies have assumed that the effect of corporate venture capital investments on corporate innovation is uniformly positive and simply tried to suggest the types of firms corporations should support to benefit strategically, we ventured that under certain conditions corporations may lose more than they gain from supporting new technological startups. Because the vast majority – four out of five – corporations syndicate at least some of their investments, we set out to investigate the effect such practices might have on the ability of incumbents to benefit from their CVC involvement. Our analyses suggest that syndication may be considered one of the key variables explaining the effectiveness of corporate venture capital investments in the context of corporate innovation. Indeed, it significantly moderates the relationship between the number of ventures supported by the incumbent and corporate patenting. For the corporations positioned far away from the center of the network the relationship is positive: these incumbents should increase the number of firms supported with CVC in order to stimulate own patenting. However, for corporations positioned in the center of the syndicate network the relationship is in fact negative.

Our results also indicate that corporations which position themselves in the center of the syndicate network and at the same time support many new ventures do not get full benefits that corporate venture capital may provide. In fact, at best such strategy only marginally outperforms the ‘minimalist’ strategy when corporations support very few ventures and shy away from the center of the network. Thus, it appears that incumbents should make a conscious choice between CVC intensity and syndicate network centrality. Since supporting many new ventures requires significant resources, the choice may be dictated by the availability of own and borrowed resources that the corporation has at its disposal. However, because the first strategy (high CVC intensity and low syndicate network centrality) significantly outperforms the second one (low CVC intensity and high syndicate network centrality) as suggested by the t-tests we ran, perhaps corporations should develop approaches to managing their CVC budgets which would allow them to maximize the number of investees while minimizing the capital outflows. There may be two easy ways towards this objective. First, because the ability of the corporation to observe, understand and absorb the technology developed by the new venture does not really depend on how much the corporation invests, the incumbents may simply select to minimize their equity stakes in the ventures they finance (Reaume, 2003). Second, perhaps corporations should invest more in firms in the early stages of development, when investments tend to be much smaller in size (Murray, 1999). We know that the majority of incumbents prefer later-stage, less risky investments which cost them relatively more and thus may drain their CVC budgets quickly. Yet, in none of our models have the stage of investment been shown significant. Thus, perhaps corporations should consider changing their preferences with respect to investment round, and increase the number of ventures they support with the same budget. It will remain critical, of course, to stay away from the center of the syndicate network if the corporation is to benefit fully from such investments.

Our results also question the wisdom of engaging in CVC in fragmented industries characterized by low concentration. When the industry is dynamic, specialized forums for idea exchange such as corporate venture capital are not required: information flows freely regardless of the focused efforts of a few incumbents (Saxenian, 1994). While we cannot prove it with the data we have, perhaps other, more efficacious modes of open innovation could work better in such
environments. Alternatively, if we consider entrepreneurial dynamics in those industries itself to represent alternative modes of open innovation, then perhaps our findings could be seen as corroborating the claim of Schilddt et al. that CVC is less effective in promoting corporate innovation compared to the alternatives (Schilddt, Maula, & Keil, 2005). More research effort is needed to further explore this important finding.

Two implications of our research are particularly important for academics. First, this study clearly demonstrates that open innovation is not a universal cure for improving corporate patenting. Our results support the notion that contingencies shape the effectiveness of such practices to an extent where open innovation may inhibit corporate patenting. As such, future open innovation research should acknowledge possible contingencies and recognize the risks of proposing models that are too universal in character. Second, this study introduces an information exchange paradox inherent in syndicated CVC investment decisions. The essence of this paradox is that information exchanges within CVC networks must be both open and closed at the same time. Unlike prior CVC research, we demonstrate that knowledge sharing in open innovation forums may have a counterproductive side.

Clearly, our study has limitations. Despite the fact that we have a rather large sample, it is somewhat dated, and the question remains if that sample is representative of all corporations engaged in open innovation practices and if the relationships between the variables of interest might have changed after the sharp drop in CVC investments in 2002. While we would have liked to explore the issue in more details, data requirements make this goal very hard to reach: one of the sources of information on CVC (Corporate venturing directory and yearbook) has been discontinued after 2002 and it is thus impossible to generate the data set of comparable quality. As always, there remains a possibility that some important variable have been omitted that could have modified our results. We simply tried our best to provide a meaningful set of controls to concentrate on the relationship between the variables of interest. It may also be argued that corporate investors are not the only ones syndicating their deals, and that any new venture may have a group of investors representing both corporate and independent venture capital (Lerner, 1994). While this is undoubtedly true, independent venture capitalists only invest for financial reasons and do not seek strategic benefits such as innovation. For that reason, we believe it was safe to leave them out for the purpose of this study.

CONTACT: Sergey Anokhin; sanokhin@kent.edu; (T): 330-672-1150; Graduate School of Management, Kent State University, Kent, OH, 44242-0001 USA.

REFERENCES


Ernst, & Young. 2002. Corporate venture capital report. 


Figure 1: Interaction effects

a

Low Patenting

Low CVC High CVC

Low centrality High centrality

b

Low Patenting

Low Concentration High Concentration

(1) High centrality, High CVC
(2) High centrality, Low CVC
(3) Low centrality, High CVC
(4) Low centrality, Low CVC
### Table 1: Regression Results

<table>
<thead>
<tr>
<th>Predictor variables</th>
<th>Criterion variable: patent applications</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Model 1</td>
</tr>
<tr>
<td><strong>Step 1: Controls</strong></td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>4.26*** (.13)</td>
</tr>
<tr>
<td>Preferred investment stage</td>
<td>0.04 (.13)</td>
</tr>
<tr>
<td>Firm size</td>
<td>0.25* (.10)</td>
</tr>
<tr>
<td>Organizational slack</td>
<td>-0.19*** (.04)</td>
</tr>
<tr>
<td>Internal R&amp;D</td>
<td>0.79*** (.12)</td>
</tr>
<tr>
<td>Industry patenting propensity</td>
<td>1.47*** (.13)</td>
</tr>
<tr>
<td><strong>Step 2: Testing Hypothesis 1</strong></td>
<td></td>
</tr>
<tr>
<td>CVC intensity</td>
<td>0.36*** (.08)</td>
</tr>
<tr>
<td>Syndicate network centrality</td>
<td>-0.06 (.17)</td>
</tr>
<tr>
<td>Syndicate network centrality x CVC intensity</td>
<td>-0.61*** (.13)</td>
</tr>
<tr>
<td><strong>Step 3: Testing Hypothesis 2</strong></td>
<td></td>
</tr>
<tr>
<td>Industry concentration</td>
<td>-0.53*** (.12)</td>
</tr>
</tbody>
</table>
| Syndicate network centrality x
| Concentration                        | -0.13 (.18) |
| CVC intensity x Concentration        | 0.34 (.18) |
| CVC intensity x Syndicate network centrality x Concentration | -0.68* (.30) |
| χ²                                  | 326.39 | 410.05 | 571.05 |
| d.f.                                | 5      | 8      | 12      |
| p                                   | <.001  | <.001  | <.001  |

*p<0.05; **p<0.01; ***p<0.001; two-tailed significance test; semi-robust standard errors in parentheses.