APPENDIX 3: CORPORATE VENTURING MODES AND THEIR IMPACT ON CORPORATE LEARNING[4]

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THE STEVENS INSTITUTE OF TECHNOLOGY WESLEY J. HOWE AWARD FOR EXCELLENCE IN RESEARCH ON THE TOPIC OF CORPORATE ENTREPRENEURSHIP

CORPORATE VENTURING MODES AND THEIR IMPACT ON CORPORATE LEARNING

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ABSTRACT

Learning and increased innovation are often mentioned as some of the key benefits from corporate venturing for corporations. However, little research exists that would analyze whether there are systematic differences in learning outcomes across different governance modes. In this paper, we systematically analyze how the governance choice between different external corporate venturing modes (i.e. corporate venture capital investments, alliances, joint ventures and acquisitions) influences the learning outcomes from corporate venturing. Based on learning theory, we develop hypotheses predicting how the characteristics of these governance modes affect learning outcomes in the corporation.

INTRODUCTION

Studies of corporate venturing frequently cite organizational learning and innovation among the key benefits from corporate venturing activity (e.g., Chesbrough, 2002; Keil, 2002; McGrath, 2001; Zahra, Nielsen, & Bogner, 1999). These learning and innovation benefits have been attributed to internal corporate venturing activities (McGrath, 2001) and external corporate venturing activities such as corporate venture capital (CVC) investments (Dushnitsky & Lenox, 2002), alliances (Khanna, Gulati, & Nohria, 1998), joint ventures (Shenkar & Li, 1999), and acquisitions (Ahuja & Katila, 2001; Vermeulen & Barkema, 2001).

Despite a large body of literature that has analyzed learning in each of these governance modes, little empirical research exists that would systematically compare the learning and innovation impact of different governance modes. The question largely goes unanswered whether some governance modes are superior to others in terms of supporting corporate learning and innovation.

In this paper, we aim to systematically analyze whether the governance choice between different *external* corporate venturing modes (i.e. CVC investments, alliances, joint ventures, and acquisitions) have similar positive effects on innovative performance as suggested in prior literature focusing on single governance modes. In addition, we analyze the effects of relatedness as a contingency for the effects of ventures on innovative performance. To test our predictions we employ a longitudinal data set of leading corporations operating in four sectors in information and communications technology industries. Our data set tracks these companies between 1990–2000 covering all their CVC investments, alliances, joint ventures and acquisitions within that period. To measure learning effects, we connect the venturing activities to the patenting of the corporations. The scope of the study is thus limited to learning outcomes that are related to technological innovations.

Our study makes important contributions to at least three areas of research. First our study contributes to research on governance mode choices of corporations. Research on governance choice has predominantly employed arguments derived from transaction cost economics (Vanhaverbeke, Duysters, & Noorderhaven, 2002) and to a lesser extent from the resource-based view of strategy. Our study is among the first steps towards a learning perspective of governance choices. Second our research contributes to organizational learning theory. To our knowledge, our study is the first study to simultaneously test the learning and innovation effects of different venturing governance modes. Third, our research contributes to the emerging literature on corporate venturing by adding further detail to the benefits of corporate venturing, in particular, by extending research that has focused on learning within single modes of corporate venturing.

Our paper is organized as follows. Next, we develop predictions of the learning effects of different external corporate venturing modes. In the following section, we discuss our sample and methods. Next we present results of our empirical analyses. The paper closes with discussion and conclusions.

Hypotheses

Creation of successful new businesses areas or more broadly innovation in established firms is often based on the integration and combination of pre-existing knowledge in a new context (e.g. Fleming & Sorenson, 2001; Hargadon & Sutton, 1997). In many technology intensive industries, this process is becoming increasingly complex due to an raising number of technologies to be mastered by a firm (Granstrand, Bohlin, Oskarsson, & Sjöberg, 1992; Patel & Pavitt, 1997). This makes it more likely that the knowledge necessary to create new businesses or innovations is likely to reside outside the boundaries of the firm (Cohen & Levinthal, 1990). To access this knowledge and to cope with the increasing technological complexity, firms often engage in inter-organizational relationships. Goal of these relationships can be to learn about new opportunities that reach beyond the familiar business areas the firm competes in (Katila, 2002; Rosenkopf & Nerkar, 2001), to acquire lacking knowledge to exploit such an opportunity, or to leverage existing knowledge and resources with the help of an external partner (Keil, 2002).

Companies can utilize several governance modes in their attempt to build new businesses and to generate innovations with the help of external partners. Governance modes include corporate venture capital investments in which a company takes small equity stakes in start-ups, alliances or joint ventures, in which a company pools resources with another company to form a new business, and acquisitions in which a company acquires the majority of the assets of another company. Even though these governance modes exhibit significant differences, different bodies of literature have argued that each governance mode provides learning mechanisms enhancing innovation in the focal firm.

Learning and Innovation from CVC Investments

In common with traditional venture capital firms, many large corporations have initiated programs in which they provide funding and related services to entrepreneurial firms in return for an equity stake. The objectives to engage in CVC programs are often both financial and strategic, however, strategic objectives often prevail (Chesbrough, 2002; Gompers & Lerner, 1998; Siegel, Siegel, & MacMillan, 1988) with learning and innovation being among the most prevalent. Recently first empirical studies have started to show an empirical linkage between CVC investment activity and innovative performance (Dushnitsky & Lenox, 2002; Maula, Keil, & Zahra, 2003).

Several mechanisms exist through which CVC investments might lead to learning and innovation. By investing in start-ups that develop new technologies or business models, the corporation might create a window on these technologies or business models. A firm's ability to absorb external knowledge has been argued to depend on its ability to acquire, assimilate, transform, and exploit this knowledge (Cohen & Levinthal, 1990; Lane & Lubatkin, 1998; Zahra & George, 2002). To acquire and assimilate external knowledge requires early exposure to new knowledge. CVC investments might allow the corporation to build up such an absorptive capacity to internalize knowledge. CVC investments might also help to redirect internal research and development efforts and so support the creation of internal breakthroughs since experimentation with new technologies and business models has been found to be positively correlated with later breakthrough innovations (Ahuja & Lampert, 2001). Aside from building absorptive capacity and redirecting knowledge search, CVC investments might allow the firm as well to internalize some of the technology of its portfolio companies. In many instances, relationships with portfolio companies extend beyond the investor-investee relationship (Maula, 2001) and the corporation might license technologies from the start-up or might source components from it. Thus the CVC investment might give way to a more tangible knowledge transfer between the start-up and the corporation. Taken together we hypothesize:

Hypothesis 1: The number of corporate venture capital investments is positively correlated with the future number of successful patent applications

Learning and Innovation from Alliances and Joint Ventures

A relatively broad literature supports that alliances and joint ventures can be mechanisms for corporate learning (Kogut, 1988; Shenkar & Li, 1999). Repeatedly, studies have found that alliances (Ahuja, 2000; Hagedoorn & Duysters, 2002b; Khanna et al., 1998; Stuart, 2000) and joint ventures (Shenkar & Li, 1999) are related to increase innovative performance. Studies of inter-organizational networks have suggested that firms can effectively access knowledge from a network of alliances in a form of quasi-internalization (Powell, Koput, & SmithDoerr, 1996). Such a network of alliances might allow the firm to receive information about new technology and so improve its ability to absorb it or refocus its internal research and development activities.

On the dyadic level of analysis, alliance literature suggests that alliances can provide the firm access to the knowledge and skills of its alliance partners. In many instances, a firm might try to internalize the knowledge of its partner for instance by imitating its partner. Alliances and joint ventures seem ideally suited to knowledge transfer since they allow for sufficiently intense interaction to transfer both articulated and tacit knowledge.

Some authors have argued that the ability of participating firms to learn from their partner or discover new knowledge, might vary between non-equity alliances and joint ventures (Hagedoorn & Narula, 1996; Mowery, Oxley, & Silverman, 1996; Osborn & Baughn, 1990). Joint ventures might be more appropriate when firms seek to learn and transfer tacit knowledge back to the parent firm (Osborn & Hagedoorn, 1997) since they allow for more interaction (Osborn & Baughn, 1990). On the other hand, non-equity arrangements might provide a more effective environment for discovery of new knowledge due to the greater flexibility they offer (Osborn & Hagedoorn, 1997).

Hypothesis 2: The number of alliances is positively correlated with the future number of successful patent applications

Hypothesis 3: The number of joint ventures is positively correlated with the future number of successful patent applications

Learning and Innovation from Acquisitions

Previous results concerning the relationship between acquisitions and learning and innovation are mixed. Several studies have found that acquisitions lead to reduced investments in research and development, lead to a focus on financial as opposed to strategic control and so reduce the innovative performance of corporations (Hitt, Hoskisson, Ireland, & Harrison, 1991; Hitt, Hoskisson, Johnson, & Moesel, 1996). Acquisitions might further reduce the productivity of both the acquirer and the target by disrupting the established routines of both firms (Jemison & Sitkin, 1986).

A second stream of authors has emphasized the potential benefits from acquisitions. In an acquisition the focal firm might be able to absorb the knowledge base of the target firm. The so expanded knowledge base might allow the firm to reap economies of scale or might allow for novel combination and integration of knowledge (Ahuja & Katila, 2001). Acquisitions might thus allow two firms to combine their strength and so might allow creating innovations that would have been beyond the reach of each firm on its own (Gerpott, 1995). By integrating new knowledge into the knowledge base of the firm, acquisitions might allow the firm develop a knowledge base with sufficient complexity and flexibility to allow it to adapt to changes in the environment but also to create innovation (Vermeulen & Barkema, 2001).

Acquisitions can act as knowledge transfer channels. Acquisitions might be particularly well suited for the transfer or combination of tacit knowledge (Bresman, Birkinshaw, & Nobel, 1999). Acquisitions allow for the intense interaction and help to control the transaction cost that result from the transfer of tacit knowledge. To achieve these innovation and learning benefits might require careful management of the integration process (Haspeslagh & Jemison, 1991).

Taken together we expect the positive effects of acquisitions to outweigh the negative effects. We therefore expect an overall positive effect:

Hypothesis 4: The number of acquisitions is positively correlated with the future number of successful patent applications

Relatedness of Ventures

Aside from the governance mode, we focus in this paper on a second contingency—relatedness of the venture—that may be critical for the learning and innovation impact of corporate ventures. Previous research on corporate venturing has studied relatedness mainly for internal ventures and focused on the impact of relatedness on financial performance. The results of these studies have been mixed (Thornhill & Amit, 2001). Some authors found a positive relationship between relatedness and performance (e.g., Dougherty, 1995) while others found a negative relationship (e.g., Ginsberg & Hay, 1994) or no relationship at all (e.g., Sorrentino & Williams, 1995).

The impact of external corporate ventures on learning and innovation has been less well studied but arguments can be derived from the literature on alliances, joint ventures, and acquisitions. Arguments derived from these literatures center around two sets of arguments. Some authors (e.g., Gerpott, 1995) argue that in related ventures, the corporation is able to exploit scale and scope advantages. For instance, in a related acquisition, the corporation might be able to combine research and development resources (Hagedoorn & Duysters, 2002a) and so generate new technologies. A second set of authors has focused on underlying characteristics of knowledge and learning. For instance, Cohen and Levinthal (1990) argue that absorption of external knowledge is easier when knowledge is related to the knowledge base of the firm. Elements of similar knowledge facilitate the integration of the partners' knowledge bases (Kogut & Zander, 1992). Common skills, shared languages, and similar cognitive structures enable the partners to communicate and learn from each other (Lane & Lubatkin, 1998; Nahapiet & Ghoshal, 1998). Furthermore, similar prior technological knowledge has been shown to increase learning in alliances (Mowery et al., 1996).

The above arguments would suggest a linear positive relationship between relatedness and learning and innovation. However, if the knowledge of the venture and the corporation are too closely related, little learning might take place and therefore little innovation might result (Ahuja & Katila, 2001). Some degree of dissimilarity of knowledge might be necessary. To maximize learning and innovation firms might try to engage in ventures with complementary partners that is partners that have a moderate relatedness of knowledge (Ahuja & Katila, 2001; Dussauge, Garrette, & Mitchell, 2000; Shenkar & Li, 1999).

Hypothesis 5: The relatedness of external corporate ventures (corporate venture capital investments, alliances, joint ventures, and acquisitions) exhibits an inverted-U shaped relationship with the future number of successful patent applications

Sample and Methods

Data

Information and Communications Technology Corporations. To test the hypotheses, we studied four information and communications technology industries which covered three-digit standard industrial classification (SIC) codes 357 (computer & office equipment), 366 (communications equipment), 367 (electronic components & accessories), and 737 (computer programming, data processing, & other computer related services). We chose to use panel data to analyze longitudinal changes to the patenting rate of the companies resulting from external corporate venturing activities. The panel data covers the period from 1993 to 2000. Within each of these four sectors, we initially selected all publicly traded companies with revenues above 200 million U.S. dollars in 1989. We limited the data to the companies that had at least four years of financial data available. We excluded all subsidiaries of foreign companies, as well as those companies that had no venturing activities or successful patent applications during the period. Finally, we required that companies had at least two firm years with complete data. The final dataset includes 67 companies, with from two to eight observations per company. Altogether, the data contains 456 firm-year observations.

External Corporate Venturing. For each company included in the sample, venturing data was recorded from the *SDC Platinum database.* The data include corporate venture capital investments, alliances, joint ventures, and acquisitions. The SIC code of each partner and target company was recorded. For corporate venture capital investments, the SIC code was derived using a conformance table of Venture Economics industry classification. When multiple subsequent venturing activities with the same partner were conducted within three years, only the first venturing activity was taken into account. The data on venturing activities is recorded from the beginning of year 1990 to the end of year 1999. The final data included several thousands of ventures.

Patenting. All successfully granted patents from the companies included in the data set were recorded from Derwent patent database in November 2002. Patent data was gathered from year 1988 to the end of year 2000. Because of the considerable time lag between the filing of a patent application to time the patent is granted, we were unable to use more recent patents. The patenting data concerning the last years of the study period is partial, due to time lag between patent application and filing (Hall, Jaffe, & Trajtenberg, 2001). Year dummies are used to take yearly differences into account.

Financial Data. The financial data for the companies was gathered from *Compustat.* Because companies' fiscal years did not always follow calendar years, we followed the approach of *Compustat* and used the ending month of each company's accounting year to match the fiscal year based data with calendar year based data. We treated fiscal years ending January 1 through May 31 as ending in the prior calendar year. For example, data for a fiscal year beginning on June 1, 1998, and ending on May 31, 1999 was attributed to 1998. Data for a fiscal year beginning on July 1, 1998 and ending on June 30, 1999, was attributed to 1999 (COMPUSTAT, 2001).

Dependent Variable

The dependent variable is the yearly innovative performance of a company. We model the innovative performance of companies as the number of successful patent applications filed during each year. Although the use of patents as a measure of innovativeness has been debated, it is widely used, and is highly correlated with other measures of innovative performance (Hagedoorn & Cloodt, 2003). The suitability of patenting as a measure of innovative output was corroborated by Hagedoorn and Cloodt (2003), who showed that the correlations between the number of patents with patent citations, new product introductions, or R&D expenditures were very high ranging between 0.793-0.973 in computers and office machinery and electronics and communications industries.

Independent Variables

CVC Investments, Alliances, Joint Ventures, and *Acquisitions.* The number of CVC investments, alliances, joint ventures, and acquisitions carried out during the previous three-year period relative to the dependent variable are represented by separate variables.

Relatedness. There are various sophisticated ways to measure industry relatedness utilizing the full range of SIC codes the companies have (Palepu, 1985). However, because we are observing the rate of venturing activities, yearly mean relatedness of deals would then need to be utilized. These measures could prove to be difficult to interpret and relate to practice. The lack of ventures during some period would create missing values. Therefore, we opted to a different operationalization. In order to test the effects of relatedness, the ventures were divided in three groups *Intra-industry, Related,* and *Unrelated* on the basis of the match of the SIC code between the focal company and the venture. Ventures with three or four first digits matching were classifies as *Intra-industry.* Those with one or two first digits matching were classified as *Related.* Those with no different first digit were classified as *Unrelated.*

Control Variables

R&D Intensity. R&D expenditure has been show to be positively related to patenting (Ahuja & Katila, 2001; Hagedoorn & Cloodt, 2003; Hall & Ziedonis, 2001). To separate R&D effects from size effects (Hall & Ziedonis, 2001), we used R&D intensity (the firm's R&D expenditure divided by its annual sales) instead of using the R&D expenditure directly.

Size. Prior research has show that size is related to patenting rate. In line with prior research, we include size, measured as the logarithm of annual sales, as a control variable.

Previous Patents. Following earlier research (Stuart, 2000), we included a measure of earlier patents to control for firm-specific factors that do not remain constant over time. The variable *Previous Patents* indicates the cumulative amount of successful patent applications by the company during three previous years (Ahuja & Katila, 2001).

Technology Concentration. Those companies that are concentrated in a very few technologies could be less likely to increase their innovation rate than those with diverse technological capabilities (Fleming, 2002). In addition, these differences could correlate with the extent of venturing activities. We followed Fleming, and calculated the *Herfindahl index* to describe the heterogeneity of the company's knowledge stock based on patent classes. The index is calculated as the sum of squares of the relative shares of patents for each patent subclass as an average of the three previous years.

$$H = \left(\sum \frac{Patents_{Class}}{Patents_{All}} \right)^2$$

The Herfindahl index is used to measure industry concentration, and receives a value between 0 and 1. Value of 1 indicates that all innovations are filed in the same patent class, where as the numbers close to 0 indicate that the patents are spread across a very large number of different patent classes. We used international patent classification (IPC) system to construct the measure, aggregating the data to subclass level (i.e. 1 alphabet section code + 2-digit class code + 1 alphabet subclass code). All patent class entries in the patents were recorded instead of just the main class, therefore a single patent can belong to multiple patent classes.

Analytical Method

Our dependent variable, patenting rate, is a count variable as it can only receive positive integer values. Poisson regression model is often used to model count variables, but negative binomial model is preferable when the assumption of the equality of the conditional mean and variance functions is violated (Greene, 2000). A Likelihood Ratio test showed that our data violates Poisson regression model assumptions, so the negative binomial model was used. Negative binomial model has also been common in recent studies that utilize patenting rate as the dependent variable.

In the panel model we use fixed effects to control constant firm-specific heterogeneity, and yearly effects to control macroeconomic effects that are constant across companies. Because of fixed effects, industry dummies do not need to be explicitly entered in the model. The models were also tested using GEE regression with industry dummies. The results were qualitatively similar. In order to take into account the time it takes for ventures to influence patent rate, the variables measuring ventures and previous patents were lagged by summing the numbers for the previous three years, and the technology concentration index by averaging the previous three years relative to the dependent variable.

Results

Table 1 provides descriptive statistics and correlations. Even though the sample involves the largest firms in the industry sectors, there is considerable variance on all the key variables. The variables reflecting the hypothesized effects are not highly correlated among themselves or with the control variables suggesting that multicollinearity of variables should not be a problem in the analysis.

Table 2 provides results for all models using fixed effects negative binomial estimators. Model 1 presents the base model with firm- and year- related control variables. Model 2 includes *Number of corporate venture capital investments*, *Number of Alliances*, *Number of joint ventures*, and *Number of acquisitions* corresponding to Hypotheses 1–4 as aggregated measures. In model 3, the variables reflecting venturing activities are entered split in three groups on the basis of relatedness (*Intra-industry*, *Related* and *Unrelated* ventures).

Hypotheses 1–4 predicted positive relationships between the four types of venturing activities and innovative performance. For alliances and joint ventures (Hypotheses 2 and 3) the aggregated measures (Model 2) gave strong support. Contrary to hypotheses 1 and 4, for corporate venture capital investments and acquisitions, the effects were nonsignificant or weakly negative when using aggregated measures.

Hypothesis 5 predicted a curvilinear inverted-U shaped relationship between the relatedness of the ventures and the innovative output. In Model 3, this hypothesis was tested by separating the ventures in *Intra-industry*, *Related*, and *Unrelated* ventures. The hypothesis would receive support, if for all venturing modes, the middle groups were significantly positive and if the closest and the most distant groups were negative, nonsignificant, or significantly weaker compared to the middle groups. Figure 1 illustrates the results of this analysis by giving the percentage changes in the annual patenting rate for an incremental deal in the cumulative number of ventures for the previous three years as estimated in Model 3.

Using the relatedness-based grouping of deals in *Intra-industry*, *Related*, and *Unrelated* ventures, CVC investments appear to follow the prediction of Hypothesis 5. Whereas intra-industry (closest) and unrelated (most distant) ventures have a nonsignificant, weakly negative relationship, the middle group has a significant positive relationship. Model 3 predicts an 11% increase in the number of patents for an incremental CVC investment during three previous years. Also for alliances and joint ventures, the middle group is positive and significant. For an incremental alliance, the predicted increase in patents is 3%. For an incremental JV, the figure is also 3%. However, the closest and the most distant groups do not behave as predicted. For alliances, although the intra-industry alliances were negative (-1% effect), the most distant group was highly positive (+2% effect). For joint ventures, the closest group was negative (-1% effect) but the intra-industry group was highly positive (+2% effect). Although the relatedness in CVC investments, and to some extent also in alliances and joint ventures followed the predicted inverted U-curve, the behavior of relatedness in acquisitions was totally different. In acquisitions, intra-industry deals were positive and significant (+6% effect). However, for the middle group and for the most distant group, the relationships were significantly negative (the effects were –8% and –5% respectively)

Regarding control effects, the size of the company and the R&D intensity were not significantly related to patenting. Although unexpected, these results are in line with several other studies using R&D intensity instead of absolute or logged R&D (Hagedoorn & Duysters, 2002b). As predicted, the prior patents are positively related to new patents. Also in line with expectations, technology concentration was negatively related to patenting. Year dummies suggest higher patenting rates for years 1995-1998 compared to the base year 1993. The negative coefficient for the year 2000 suggests that some of the applications filed in 2000 may not have been accepted at the time of the data collection in November 2002. To test the robustness of the results, the analyses were rerun (not reported here) without year 2000 with qualitatively similar results.

Discussion and Conclusions

In this study, we set out to study how the governance choice between different external corporate venturing modes (i.e. CVC investments, alliances, joint ventures, and acquisitions) influences the learning outcomes from external corporate venturing. We found significant differences in the effects of different external venturing modes on innovative performance.

Our finding that in a simultaneous model only joint ventures and alliances show an aggregate positive relationship with patenting, might on a first glance suggest that at least some governance modes are ineffective mechanisms to stimulate innovation. This finding is interesting in the light of prior studies that have typically found positive effects for all the tested governance modes when analyzing the impacts of a single governance mode without controlling for other transactions occurring at the same time. Controlling for other governance modes is important, because companies strategically choose what governance modes they use in building their portfolio of inter-organisational ventures to support innovation. Focusing on one mode may lead to an omitted variable bias, which cannot be treated by using a fixed effects model because use of different governance modes is not time-invariant.

Our analysis of intra-industry, related, and unrelated governance modes provides a more differentiated picture of the relationship between external corporate venturing governance modes and innovative performance. For each governance mode at least one relatedness-based group of ventures exhibits a positive relationship with patenting. This suggests that only some of the venture groups stimulate learning and innovation, and more importantly, that these effective relatedness groups differ across governance modes.

Taken together our findings show that the link between external corporate venturing modes and innovative performance is much more complex than organizational learning theory currently would predict and that more fine-grained research is needed to understand in detail how different governance modes for corporate ventures affect learning and innovation.

Our results contribute to at least three areas of research. Our study contributes to research on organizational learning and governance mode choices by integrating these two streams of literature. In addition our study contributes to the emerging literature on corporate venturing by adding further detail to the benefits of corporate venturing. Future research should build on these contributions, for instance by utilizing more fine-grained measures for relatedness. This might add further detail to our findings. Future studies might also explore the relationship between governance modes and other dimensions of learning, such as the effects of venturing on the direction of technological evolution in the firm. There may also be a trade-off between learning and other financial benefits in the choice of governance mode that depend on venture relatedness.

A practical implication of our findings is that different corporate venturing modes provide the corporation with distinct learning and innovation benefits. Different governance modes of corporate venturing would seem complementary rather than replacements of one another. This implies that firms should include learning goals in their decision-making concerning their corporate venturing tools and portfolio.

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Table 1
Descriptive Statistics (n = 456)

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1 Patents	1.00																				
2 CVC investments	.12	1.00																			
3 ", intraindustry	.05	.55	1.00																		
4 ", related	.25	.87	.27	1.00																	
5 ", unrelated	.10	.99	.41	.87	1.00																
6 Alliances	.48	.26	.35	.23	.21	1.00															
7 ", intraindustry	.28	.19	.44	.07	.12	.88	1.00														
8 ", related	.63	.27	.07	.39	.26	.66	.31	1.00													
9 ", unrelated	.43	.24	.32	.21	.20	.97	.80	.57	1.00												
10 Joint ventures	.51	.24	.18	.27	.22	.69	.51	.65	.66	1.00											
11 ", intraindustry	.37	.12	.10	.17	.10	.46	.34	.45	.43	.86	1.00										
12 ", related	.55	.10	.01	.20	.10	.49	.23	.65	.47	.85	.68	1.00									
13 ", unrelated	.36	.34	.32	.29	.31	.75	.67	.52	.71	.86	.64	.49	1.00								
14 Acquisitions	.25	.65	.47	.51	.63	.58	.55	.31	.56	.48	.34	.26	.58	1.00							
15 ", intraindustry	.10	.31	.46	.12	.25	.55	.72	.06	.50	.33	.24	.06	.49	.79	1.00						
16 ", related	.21	.48	.21	.44	.48	.19	.06	.30	.18	.27	.16	.28	.23	.56	.17	1.00					
17 ", unrelated	.27	.72	.34	.65	.72	.45	.29	.41	.47	.46	.34	.31	.50	.85	.40	.49	1.00				
18 Sales (log)	.58	.24	.15	.34	.22	.61	.43	.57	.58	.55	.45	.48	.48	.45	.29	.29	.43	1.00			
19 R&D intensity	.07	.06	.17	.01	.04	.15	.20	.03	.12	.12	.11	.04	.16	.07	.14	-.05	.01	-.07	1.00		
20 Previous patents	.85	.27	.12	.38	.26	.50	.26	.64	.47	.49	.35	.51	.37	.40	.15	.34	.47	.61	.07	1.00	
21 Tech. concentration	-.35	-.08	.03	-.15	-.09	-.18	-.05	-.34	-.15	-.23	-.19	-.26	-.15	-.06	.06	-.13	-.12	-.34	-.06	-.35	1.00
Mean	118.63	1.34	.29	.18	.87	17.10	5.19	3.68	8.23	3.28	.81	1.09	1.38	3.04	1.34	.51	1.18	7.49	.09	330.46	.41
S.D.	207.72	8.48	1.55	.84	7.00	26.37	9.84	6.28	14.09	6.00	1.54	2.62	2.87	5.21	2.80	1.09	2.79	1.37	.07	587.30	.29
Min	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4.08	.00	0	.05
Max	1 079	156	22	14	132	213	97	37	107	37	8	21	19	55	26	10	35	10.80	.62	3 019	1.00

Table 2
Negative Binomial Regression Analysis of Number of Annual Patents (n=456)

	Model 1			Model 2			Model 3		
CVC investments, 3-year cumulative total number				.995		(.005)			
", intra-industry							.981		(.024)
", related							1.112	**	(.051)
", unrelated							.997		(.006)
Alliances, 3-year cumulative total number				1.006	***	(.002)			
", intra-industry							.987	**	(.005)
", related							1.029	***	(.008)
", unrelated							1.015	***	(.004)
Joint ventures, 3-year cumulative total number				1.014	**	(.005)			
", intra-industry							1.010		(.018)
", related							1.027	**	(.011)
", unrelated							.988		(.014)
Acquisitions, 3-year cumulative total number				.984	+	(.010)			
", intra-industry							1.060	***	(.016)
", related							.921	**	(.031)
", unrelated							.948	***	(.014)
Sales (log)	1.378	***	(.097)	1.321	***	(.100)	1.260	**	(.097)
R&D per sales	.900		(.618)	.887		(.615)	1.067		(.722)
Patents, three-year cumulative total number	1.000	*	(.000)	1.000	*	(.000)	1.000	*	(.000)
Technology concentration (Herfindahl index)	.519	***	(.096)	.507	***	(.094)	.513	***	(.094)
Year is 1994	1.052		(.100)	1.013		(.091)	1.035		(.089)
Year is 1995	1.256	*	(.118)	1.217	*	(.109)	1.240	*	(.107)
Year is 1996	1.395	***	(.132)	1.338	***	(.122)	1.395	***	(.123)
Year is 1997	1.519	***	(.147)	1.494	***	(.143)	1.556	***	(.144)
Year is 1998	1.405	***	(.144)	1.448	***	(.148)	1.517	***	(.154)
Year is 1999	.983		(.119)	1.029		(.121)	1.078		(.127)
Year is 2000	.594	***	(.080)	.687	**	(.092)	.732	*	(.100)
Log likelihood	-1562.309			-1550.303			-1530.333		
Degrees of freedom	11			15			23		
Wald χ^2	189.74	***		259.09	***		349.37	***	
Number of observations	456			456			456		
Number of companies	67			67			67		

Dependent variable: patents. Model specification: negative binomial with fixed effects. The coefficients are exponentiated betas. Standard errors are reported in parentheses. *** p<.001, ** p<.01, * p<.05, + p<.10, one sided tests for hypothesized variables, two sided tests for control variables.

Figure 1
Estimated Effects of Ventures on Patenting Rate (dotted lines represent 95% confidence intervals)