



## Configuring a corporate venturing portfolio to create growth value: Within-portfolio diversity and strategic linkage

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### ABSTRACT

This study attempted an empirical investigation of whether and how a corporate investor can enhance future growth opportunities through corporate venturing investments (CVIs). Different from previous studies, we assessed the firm-level performance impact of a CVI portfolio with a focus on two configuration features: within-portfolio diversity and strategic linkage. Based on a longitudinal dataset of CVIs made by Taiwanese technology-based companies, we found that increasing CVI portfolio diversity and maintaining strategic linkages, particularly vertical ones, between the portfolio companies and the investing firm's core business will add value to the investing firm's future growth. Implications for CVI strategy and opportunities for future research are also discussed.

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### 1. Executive summary

The strategic benefits of employing corporate venturing investments (CVIs) to support corporate growth have received a great deal of attention in both academia and business. Unlike investments for financial purposes, CVIs can serve as antennae attuned to emerging technologies, organizational learning facilitators, and innovation enhancers, which in turn help the investing firm to grasp future growth opportunities. Because future growth opportunities are embedded with different degrees of uncertainty, the investing firm has to allocate resources strategically to selected investment targets so that the growth value of the whole investment portfolio can be maximized. In other words, the heterogeneous resource configuration of a CVI portfolio will determine the differential value of growth opportunities that an investing firm can obtain.

Guided by the extant literature, we suggest that higher growth benefits will be positively associated with the growth potential and uncertainty level of the target industries selected. In addition, following the notion of the portfolio effect proposed by growth options perspective and alliance portfolio studies, we further suggest that a diversified CVI portfolio, coupled with the maintenance of a strategic linkage between portfolio companies and the investing firm, will be beneficial for an investing firm's future growth. In brief, we endeavored to analyze the configuration features of a firm's corporate venturing portfolio and their impact on future growth value.

Based on econometric analyses, we found that the magnitude of a firm's investment in external ventures is not positively associated with its growth options value. In contrast, increasing the diversity within a CVI portfolio and enhancing a strategic linkage between the portfolio and the focal firm's core business do exert significant positive influences on the growth value. Specifically, diversifying CVIs across differential industry groups and pursuing multiple investments in a narrow product arena can enhance growth opportunities because these arrangements help the investing firms increase the possibility of identifying the best

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opportunities. Furthermore, strategically investing in ventures that are vertically linked with the investing firm's core business has a greater impact on the growth value than does investing in horizontally linked ones.

These results imply that although firms make strategic investments to cope with environmental uncertainties, these investments do not ensure an increase in the investing firms' growth value. Instead, the configuration characteristics of a CVI portfolio affect the growth opportunities and value that the investing firm can achieve. Our results both support and extend the significance of portfolio effects among CVIs. Overall, the present study extends the existing literature from an individual venture perspective to one with a more holistic view of the configuration of corporate venturing initiatives. Our research into the structural features of CVI portfolios provides useful implications for the pursuit of more effective CVI strategy.

## 2. Introduction

Activities involving the strategic use of corporate slack resources and investments in entrepreneurial start-ups outside a firm's existing organizational boundaries are commonly known as corporate venturing investments (CVIs). Previous research has suggested that the benefits gained from CVIs should be evaluated from a strategic angle that looks beyond the financial returns of the investing firm. The strategic benefits highlighted in the literature include gaining a window into the navigation of emerging technologies (e.g., Chesbrough, 2003), facilitating organizational learning (e.g., Schildt et al., 2005), enhancing innovative capabilities (e.g., Dushnitsky and Lenox, 2005b), and building an ecosystem in the industry landscape in which the investing firm is involved (e.g., Campbell et al., 2003; Chesbrough, 2003). As Chesbrough (2002) postulated, "While corporate VC investments have generated decidedly uneven financial returns, they should not be judged primarily on that basis. They should be thought of as important ways for a company to fuel the growth of its business." In other words, the strategic benefits mentioned above are not well acknowledged when merely evaluating the performance specific to each individual venture. Rather, an adequate assessment of the strategic effects of CVIs should be based on a firm-level analysis.

Along this line of inquiry, only a few studies have empirically explored various corporate-level strategic benefits of CVIs. For instance, Wadhwa and Kotha (2006) found an inverted U-shaped relationship between the number of CVIs and the focal investing firm's knowledge creation rate. Dushnitsky and Lenox (2006) documented that CVIs would increase the investing firm's value as measured by Tobin's  $q$ . While these pioneering studies offered important insights, they are subject to some limitations. One of the key limitations is their treatment of a CVI portfolio as a "black box". In these studies, an investing firm's external venturing was merely portrayed by its magnitude, such as the number of corporate venture projects invested in (Wadhwa and Kotha, 2006) or the amount of total investments (Dushnitsky and Lenox, 2006). Such an approach does not address many important strategic issues regarding *how* to enhance the strategic benefits of CVIs. In this paper, we attempt to open up the black box, with a focus on probing the configuration features of a CVI portfolio. Configuration features here refer to the structural characteristics of a portfolio with a particular focus on the product relatedness among CVIs and the investing firm's core business. We suggest that there are at least two reasons for this emphasis.

First, by considering the heterogeneous patterns of resource deployment across investment targets, we can scrutinize the strategies for constructing a performance-enhancing portfolio. Given that CVIs usually carry corporate-level strategic purposes (Dushnitsky and Lenox, 2006; Gompers and Lerner, 1998; Shrader and Simon, 1997; Thornhill and Amit, 2001; Zahra and Covin, 1995), what really matters is not the success or failure of a single venture but whether the investing firm will reach its strategic goals with the bundle of CVIs. Therefore, investigating how to configure a CVI portfolio to secure a better position for future development enables us to shed light on CVI strategy, which is a matter of significant interest for both academia and practitioners.

Second, analyzing the association between configuration features and business outcomes also allows us to tackle an important issue regarding portfolio interactions. Prior studies have implicitly assumed each new venture to be isolated from other investments because they used magnitude to characterize a firm's CVI activities. However, recent research in various streams, including alliance portfolios (Powell et al., 1996; Hoffmann, 2007) and real options (Vassolo et al., 2004), has proposed that an entire collection of inter-organizational relationships performs qualitatively and quantitatively differently from the sum of each alone. The entrepreneurship literature also calls for research to scrutinize the interdependency among venturing portfolio companies (Li, 2008). In light of this, this paper seeks to bridge the literature gap by identifying key configuration features that drive the potential interactions among CVI projects. Furthermore, it takes an important step forward in examining subsequent performance implications, an analysis that is largely lacking in prior studies.

Specifically, we suggest the empirical scrutiny of two critical but rarely examined structural features of a CVI portfolio that may cause complementary or substitutive interactions among CVIs. They are the degree of industry diversity among CVIs (i.e., *within-portfolio diversity*) and the product relatedness between the venture and the investing firm's core business (i.e., *strategic linkage*). The former measure assesses the extent to which a focal investing firm's venture investments are targeted at dispersed opportunity areas, a scenario that may enhance the overall value of a portfolio. The latter measure gauges the degree of vertical or horizontal closeness of the investment portfolio with regard to the focal investing firm's existing business, which may enhance growth opportunities due to resource leverage (e.g., Zahra, 1991). By including these variables of portfolio configuration, we are able to take an initial step in describing the configuration features of a CVI portfolio and therefore prescribe their performance implications in terms of the strategic benefits to the investing firm.

To pursue our research goals, we compiled a longitudinal database of CVIs undertaken by investing firms from technology-intensive industry sectors based in Taiwan, a major emerging market in Asia. Ranked 12th, 11th, and 8th for company operations, strategy, and innovation, respectively, in the *Global Competitiveness Report* (World Economic Forum, 2004), Taiwan provides a rich but less well-explored context for research on the corporate entrepreneurship strategy undertaken by established firms to sustain their growth and global competitiveness. As discussed in a subsequent section, we chose growth value to measure the various

strategic benefits derived from CVIs. Based on econometric analyses and robustness checks, our findings confirmed our expectation that portfolio configurations play an indispensable role in determining the growth value of the investing firm, while the magnitude of investments is less important, if at all. Specifically, our results showed that increasing a CVI portfolio's diversity and enhancing strategic linkages between the portfolio and the investing firm's core business both add significant value to the investing firm.

This paper contributes to the corporate entrepreneurship literature by redirecting CVI research away from individual-project-based assessments and toward the whole portfolio as the unit of investigation. Furthermore, we highlight the research imperative that the construct of portfolio configuration should be included in a comprehensive assessment of the CVI strategy-performance link. We have built an empirical approach to this research challenge and suggested portfolio configuration features relevant to the investing firm's growth value. Overall, our study not only finds support from empirical evidence but also extends the CVI literature to embrace a more holistic view of the association between CVIs and the growth value of a corporate investor. Such a view should elucidate better strategies for corporate venturing activities.

In the following sections, we discuss the current literature on CVIs, particularly with regard to relationships between CVIs and an investing firm's consequent growth value. We then develop the hypotheses and elaborate on our empirical approaches. In the final section, we discuss our research contributions and limitations, and we explore the practical implications of our findings.

### 3. Theory and hypotheses

This study selected future growth opportunity as a central strategic benefit of CVIs because many strategic benefits, including technology navigation (Chesbrough, 2003), knowledge accumulation (Wadhwa and Kotha, 2006), organizational renewal, and acquisition candidate access (Siegel et al., 1988) all ultimately contribute to firm growth. These growth opportunities can be realized either externally or internally by an investing firm. Externally, a new start-up can be developed and become a direct growth vehicle, leading to the development of a "new leg strategy" (Campbell et al., 2003). Once developed, this new venture then becomes affiliated with the business group of the investing firm, a phenomenon that is commonly observed in Asian countries, such as Japan, Korea or Taiwan. This external venture can also be acquired and later developed within an investing firm's boundaries when market conditions become favorable (Hurry et al., 1992; Siegel et al., 1988). Internally, CVIs facilitate the growth of the core business of the investing firm. They help an investing firm build an "ecosystem" consisting of suppliers, customers and complement providers, thus stimulating demand for its core products. For instance, Intel successfully employed this strategy by investing in new start-ups that in turn increased the demand for Intel microprocessors (Campbell et al., 2003). Another way that CVIs improve the internal growth prospects of an investing firm is through learning benefits, such as the acquisition of proprietary knowledge and the enhancement of innovative capabilities (Dushnitsky and Lenox, 2005a; Wadhwa and Kotha, 2006), which are critical for current and future competition.

With specified growth value (i.e., the value) as a central performance indicator, we began to identify several important industrial characteristics and configuration features of a CVI portfolio and examined their association with performance. Within the first set of factors, the industrial characteristics of individual CVIs have been highlighted in the CVI literature, while these characteristics for the whole investment portfolio are rarely examined. The second and third factors, within-portfolio diversity and *parent-venture strategic linkage*, deal with the configuration features of a CVI portfolio that are overlooked in the extant literature on CVI. We then proceeded to delineate the theoretical basis for these factors and their relationship with the growth value of the investing firms.

#### 3.1. Magnitude and industrial characteristics of CVIs

The magnitude of a firm's engagement in CVI activities is considered an important factor in determining consequent strategic benefits, such as learning (Dushnitsky and Lenox, 2005a,b; Wadhwa and Kotha, 2006). Magnitude is also positively associated with a firm's Tobin's  $q$  (Dushnitsky and Lenox, 2006). As mentioned earlier, CVIs can be vehicles for both explorative and exploitative growth. Exploitative growth relies on the investing firm's existing resources and capabilities. In the case of exploitative growth, new ventures can act as conduits for leveraging the investing firm's proprietary capabilities or as supplements to it. However, CVIs can also generate exploratory growth by allowing a firm to develop a new growth direction in a domain distant from the firm's core business. Both exploitative and explorative growth can be realized through the development of new ventures, the development of an investing firm's core business, or both. Therefore, a firm's investment in external new ventures reflects an emphasis on new growth opportunities that will enhance its future prospects. As such, we suggest the following hypothesis:

**Hypothesis 1a.** The magnitude of corporate venturing investments is positively associated with the investing firm's growth value.

Recognizing that not every CVI provides equivalent growth value, we need to take venture-specific attributes into consideration. The growth potential of the targeted industrial segment is an important determinant of each CVI's growth value. Although both firm-specific and industry-specific factors (Klevorick et al., 1995) can affect the growth potential of the new venture, in this paper, we focus only on the influence of industry factors. Because new ventures are generally small, they usually have not built a position that is sufficient to directly affect growth scenarios. Factors influencing industry-specific growth potential may include the pace of technology changes, market deregulation, or demand evolution. Based on both internal knowledge and external insights from the investment community (e.g., venture capitalists), the investing firm selects new ventures in industrial segments characterized by high growth potential. For instance, Dushnitsky and Lenox (2005a) found that a large percentage of CVI

activities in North America were directed at industrial sectors that are associated with relatively promising technological opportunities. Therefore, we expect to see a positive link between the overall industrial growth potential of the investment portfolio and the investing firm's growth value.

**Hypothesis 1b.** The overall growth potential of the industrial segments with which the corporate venturing portfolio is involved is positively associated with the investing firm's growth value.

In addition to an industry's growth potential, the uncertainty surrounding an investment's payoff affects the investing firm's growth opportunities as well. Some economists, including Knight (1921) and Kirzner (1979), have proposed that market dynamics give rise to a state of disequilibrium and thus create market opportunity available to economic actors. In these turbulent markets, the expected variation of return rates on investments can be significant. Although prior studies have suggested ways to reduce uncertainty (Shepherd et al., 2000), these control techniques are hardly useful for controlling exogenous uncertainties. The real options perspective provides a different lens through which to view these uncertainties. It posits that environmental uncertainties can be exploited by delaying full investment until external conditions are favorable. In other words, so-called "toehold" investments enable firms to enjoy an asymmetric payoff structure, combining a limited downside loss with unlimited upside potential (McGrath, 1997). Prior studies identified that a CVI project was usually initiated with a small investment or minority equity so as to reserve the managerial flexibility necessary for appropriate reaction to uncertain contingencies. For instance, Li (2008) confirmed that staging decisions were associated with market uncertainty. Hurry et al. (1992) also delineated how Japanese firms conducted two-stage investment decisions in making CVIs. Owing to the rich growth opportunities embedded in an uncertain environment and the common practice of staging, we suggest that CVIs can be a valid way to exploit these uncertainties. In other words, uncertainties embedded in a CVI portfolio are beneficial to a firm's future growth prospects.

**Hypothesis 1c.** The average level of uncertainty embedded in a corporate venturing portfolio is positively associated with the investing firm's growth value.

Having identified a number of industrial characteristics of CVI portfolios that impact an investing firm's growth value, we now turn our attention to two configuration features of a firm's CVI portfolio. Given the fact that a firm usually invests in multiple CVIs,<sup>2</sup> and that each new venture is not isolated from other existing investments, the potential interactions will consequently influence the overall performance of the CVI portfolio. Thus, it is important to investigate how to configure a portfolio to gain better overall growth value. In the following sections, we will identify within-portfolio diversity and strategic linkage as two relevant configuration features, and then elaborate on their impact on the investing firm's growth opportunities.

### 3.2. Within-portfolio diversity

To take into account potential interactions among the ventures of an investment portfolio, we rely on previous research insights to guide our hypotheses. There are two somewhat complementary arguments in the extant literature. Specifically, some studies have suggested that allocating investment projects among a diverse set of growth opportunities enhances the likelihood of capitalizing on growth opportunities, while other research suggests that multiple investments made within a narrow domain may be detrimental to the aggregate growth value of all ventures in a portfolio.

The first contention addresses the role of CVIs in exploring new opportunities (Roberts and Berry, 1985). Related concepts involve experiments (e.g., Block and Ian, 1993; Chesbrough, 2000; Keil, 2004) and real options (e.g., Hurry et al., 1992; Li, 2008). The idea behind this line of reasoning is that variance-generating learning (McGrath, 2001) is important to a firm's growth potential and can be better achieved through external corporate venturing (Roberts and Berry 1985). By exposing themselves to diverse industrial segments rather than narrowly defined ones, firms can expand their knowledge and capabilities, particularly regarding novel technologies (Siegel et al., 1988; Hurry et al., 1992), new markets (McGrath, 1995), and proprietary intelligence related to the new venture (Rind, 1981). These diverse streams of information are valuable as a firm identifies, evaluates and further realizes growth opportunities. Thus, a firm's capacity to capture growth opportunities should be greater if its investment ventures are themselves diverse and are located in diverse industrial segments.

In contrast to a diverse portfolio, investments within proximate industrial segments or technological domains are usually subjected to stronger internal selection because of duplicate opportunities. A recent development of real options perspective sheds light on this issue. In the context of alliance portfolios, Vassolo et al. (2004) found that the likelihood of divestiture of an alliance was positively associated with technological adjacency between a focal alliance and the portfolio of other alliances; they referred to such an effect due to competition and duplication among portfolio companies as sub-additivity. In the study of DuPont's entrepreneurial search, Bhardwaj et al. (2006) demonstrated a similar phenomenon. DuPont rapidly but selectively increased corporate venturing projects. It increased its number of corporate venturing projects in order to quickly explore the growth opportunities within a specific domain, but later, only a small number of these projects were selected for a deeper search. To put it simply, when a firm invests in multiple new ventures within a narrowly defined industrial domain, the aggregate growth value of the investments is less than the sum of each venture's individual growth value (Vassolo et al., 2004, 2005). The intensity of internal

<sup>2</sup> Dushnitsky and Lenox (2005b) collected data on CVIs from 20 of the largest venturing firms in the United States. They reported that these firms invested in an annual maximum of 5 to 179 ventures.

selection can be alleviated by distributing ventures across different industrial domains. In DuPont's case (Bhardwaj et al., 2006), a technological domain or an industrial segment was less likely to be abandoned than an individual investment venture. In fact, a venture in a distinct domain was abandoned only when "information strongly suggests that the search is being conducted in the wrong space or if the strategic context changes" (Bhardwaj et al., 2006, p. 252).

Integrating these two lines of reasoning, we contend that diverse CVIs can serve as an effective way to facilitate variance-generating learning and can prevent the sub-additivity effect by diversifying investments. This leads to the following hypothesis:

**Hypothesis 2.** The degree of within-portfolio diversity of a corporate venturing portfolio is positively associated with the investing firm's growth value.

### 3.3. Parent-venture strategic linkage

In addition to within-portfolio diversity, correlations between the portfolio and the investing firm's existing businesses also warrant exploration. Prior literature has addressed that the relatedness between the investment target and the investing firm is critical to CVI success (Zahra, 1991). We believe that product relatedness is beneficial not only to CVIs but also to the investing firm. We suggest that allocating new ventures in product market related to the investing firm's core business directly reflects the investor's strategic focus on pursuing CVIs. Additionally, strategic linkage can enhance synergy by facilitating the sharing of critical resources or the cross-leveraging of business opportunities and operation know-how. Therefore, when there is a strong strategic linkage between an investing firm and the new venture, the growth value of the investing firm may be further enhanced.

We examine two types of strategic linkages: vertical and horizontal. In this study, vertical linkages exist when new ventures pertain to the upstream or downstream value chain stages of the investing firm's core business. Alternatively, horizontal linkages exist when the new venture and the investing firm's core business belong to the same industrial segment. Note that the three most-cited growth benefits of CVIs are exposure to new technology, access to acquisition targets and the creation of new businesses (Siegel et al., 1988; Winters and Murfin, 1988). We found that these benefits can be better realized when the portfolio has either vertical or horizontal linkages with the investing firm's core business.

When investing in a new venture aimed at acquiring new technology, an investing firm can better absorb the newly acquired knowledge (Cohen and Levinthal, 1990) if there is an appropriate overlap between the investing firm and the portfolio firms, particularly in terms of operational and domain-specific knowledge. In this situation, the firm's learned knowledge should be better leveraged to fully realize its growth value. Even if the new ventures eventually fail, learning benefits can enhance the investing firm's growth potential (Dushnitsky and Lenox, 2005a; McGrath et al., 2006), or at the very least, the firm can "get a valuable early warning about which pitfalls to avoid" (Chesbrough, 2002, p.94) in the target investment domain. Additionally, investing in new downstream ventures can stimulate demand for the investing firm, while investing in new upstream ventures can lower the cost of components and subsequently increase the value of the core product. This strategy strengthens the firm's competitive position and thus enhances its future growth value.

Access to acquisition candidates is another important strategic goal for investing firms (Siegel et al., 1988). Strategic linkages can create synergies due to common utilization of fungible resources among different investments. As such, when an investing firm decides to acquire a portfolio company, it can enjoy either lower investment costs or lower expansion costs. Additionally, when the investing firm shares some common knowledge with CVIs, it will be able to better time future acquisitions and show a superior capacity for post-merger integration and development (Campbell et al., 2003; Chesbrough, 2003).

We also consider the case in which an investing firm pursues the development of a new business as a growth avenue. In this case, parent-venture strategic linkages enhance leveraging the investing firm's strategic resources, such as proprietary knowledge or managerial experience, to alleviate "the liability of newness" of a new venture (Zahra, 1996). This, in turn, can increase the likelihood of survival of new ventures and enhance the realization of the investing firm's growth value.

In sum, an investing firm can realize higher growth potential if there are strategic linkages between the firm's CVI portfolio and its core business. This relationship should be valid regardless of whether the investing firm pursues explorative growth or exploitative growth. We therefore expect that the greater and more related the strategic linkages are between the core business and the CVI portfolio, the higher the investing firm's growth value will be.

**Hypothesis 3.** The degree of relatedness between the CVI portfolio and the investing firm's core business is positively associated with the investing firm's growth value.

## 4. Methods

### 4.1. Empirical context

Our empirical investigation was based on the corporate venturing activities for companies listed on the Taiwan Stock Exchange (TSE) in information technology and electronics (IT&E) sector. The chosen sector, IT&E, has been the largest category in the TSE market since 1998 in terms of the number of firms, market capitalization and volatility. At the end of 2000, it accounted for 54% of market value, and its trade volume shares were 73% of the total volume.

Positioned as global electronics manufacturers, our sample firms mainly provide contractual design and manufacturing services to worldwide industrial buyers (Sturgeon and Lee, 2005). With the increasing intensity of global competition in the end-

product market, contract electronics manufacturers have to manage their business growth against a short product life cycle and declining profitability due to product commoditization. To ensure competitiveness and future growth, these companies increasingly utilize various corporate investment mechanisms to grasp growth opportunities. Their investment targets range from key component suppliers, which can strengthen the investing firm's competitiveness in terms of cost position or responsiveness, to those technology-based start-ups that may broaden the focal firm's business scope in the future. According to their financial reports, by the end of 2004, total domestic CVIs amounted to approximately 6% of total assets. Such vigorous CVI activities engaged by Taiwanese electronics manufacturers provide a rich context for examining the heterogeneity of CVI decisions and their implications for a firm's growth value.

Bringing these electronics manufacturers into a broader context, we note that Taiwan as a whole has been identified as technologically and entrepreneurially intensive country (Phan and Foo, 2004), with firms eagerly sourcing external knowledge and growth opportunities (Tsai and Wang, 2008). In our sample, 86% of listed companies in the IT&E sector have committed to various types of domestic venturing investments. With global competitiveness in IT&E (Ding and Abetti, 2003) and vigorous CVI activities, our research context is adequate for demonstrating how firms capitalize on entrepreneurial new ventures in the pursuit of strategic benefits. Accordingly, empirical findings from this context would extend the knowledge boundary of the extant literature on technological entrepreneurship in general and on corporate venturing strategies in particular.

However, there is no dedicated database available for use in research on CVIs by these sampled firms. To implement our empirical analysis, we built a proprietary CVI dataset based mainly on the annual reports of these listed companies. Unlike other industrialized countries, the Taiwanese government has required publicly listed companies to disclose information concerning their equity investments in their annual reports since 1999 in order to enhance corporate transparency. Because of this regulation, we were able to collect detailed information on CVIs, including even those indirectly made by the legally independent venturing arms of the investing companies.<sup>3</sup>

#### 4.2. Data sources and sample set

Within the IT&E sector, the year 2000 is considered the base year for sample selection. We thus included ventures established fewer than six years prior to the base year<sup>4</sup> that nevertheless underwent IPO before 2000. We then focused on the observation window between 2000 and 2003, and those investing firms that suffered a financial crisis during this time were excluded. The result is a final sample of 779 new ventures invested in by 111 investing firms during a four-year timeframe (2000–2003). In other words, this panel contains 444 firm-year observations.

In this sample set, the top five four-digit SIC segments to which these CVIs pertained were software (10.72%), semiconductor manufacturing (8.02%), photonics materials and components manufacturing (7.21%), IC design services (6.58%) and other electronic components manufacturing (6.17%). Based on investment amounts, the top five segments for investment were photonics materials and components manufacturing (45.30%), battery manufacturing (21.13%), semiconductor manufacturing (8.34%), wholesale electrical and electronics equipment (6.94%), and telecommunications equipment and apparatus manufacturing (5.75%). Eighty-seven of the total CVIs were in existence by the year 2003.

#### 4.3. Dependent variables

We adopted two measures of a firm's growth value, Tobin's  $q$  and the growth options value (GOV hereafter). In the literature, a firm's future growth value is usually measured by Tobin's  $q$  (Bharadwaj et al., 1999; Dushnitsky and Lenox, 2006). Because Tobin's  $q$  is commonly used as a market-based performance measure without specifically addressing growth prospects, we additionally adopt a new measure of GOV to ensure that a firm's growth potential is appropriately evaluated.

We adopted Tobin's  $q$ , which is a firm's market value divided by its total assets, as one of our dependent measures of growth value. In order to compare this measure with our alternative measure of growth opportunity, we subtracted 1 from Tobin's  $q$ , which is expressed in the following formula:

$$(V_{\text{mkt}} / V_{\text{ta}}) - 1 = (V_{\text{mkt}} - V_{\text{ta}}) / V_{\text{ta}} \quad (1)$$

where  $V_{\text{mkt}}$  refers to the market value of a firm, and  $V_{\text{ta}}$  denotes the value of total assets.

We also employed the GOV measure developed by proponents of real options research. Despite variations in the GOV formulas presented in the literature (e.g., Andrés et al., 2005; Chung et al., 2005; Tong et al., 2008), researchers generally agree that a firm's GOV can be calculated by subtracting a firm's assets-in-place value from its market value:

$$V_{\text{gov}} = V_{\text{mkt}} - V_{\text{aip}} \quad (2)$$

<sup>3</sup> Although prior research has highlighted concerns about the integrity of financial information in emerging markets, in our institutional context, the quality of the financial reports is considered to be reliable and satisfactory because the majority of listed companies are audited by the US Big Five (now the Big Four) accounting affiliates, while Taiwan's GAAP (Generally Accepted Accounting Principles) are exactly the same as those used in the US. Specifically, 81% of all listed companies and 88% of IT&E firms in the TSE market are audited by the Big Five.

<sup>4</sup> Ventures that were 6 years old or younger are commonly defined as 'new ventures' (c.f., Brush and Vanderwerf, 1992; Robinson, 1999; Zahra et al., 2000).

where  $V_{gov}$  denotes the GOV and  $V_{aip}$  refers to the assets-in-place value. In the present study,  $V_{aip}$  is estimated using the discounted cash flow (DCF) technique expressed by the following formula:

$$V_{aip} = \sum_{t=1}^N \frac{CF_t}{(1+r)^t} \quad (3)$$

where  $CF_t$  denotes the estimated cash flow at year  $t$  and  $r$  is the discount rate.

Researchers have proposed different measures of  $V_{aip}$  based on the estimates of future cash flows (i.e.,  $CF_t$ ) and the discount rate that they adopt. Of those, the one we have basically followed is that of [Andrés et al. \(2005\)](#), used to calculate the assets-in-place value with one minor adjustment. We use the weighted average cost of capital (WACC) ([Miles and Ezzell, 1980](#)) of each firm as a discount rate instead of the industry average beta or the risk-free rate of return. Thus, we can improve the estimation of the GOV by considering firm-specific risks. Our formula also takes into account the firm's cash flow from the previous year as an estimate of future annual cash flow rather than the income reported in that year, which is consistent with the original DCF formula.<sup>5</sup> To control for any potential contamination due to a size effect,  $V_{gov}$  is divided by the total assets (i.e.,  $V_{ta}$ ) of the investing firm, denoted as:

$$V_{gov} / V_{ta} = (V_{mkt} - V_{aip}) / V_{ta} \quad (4)$$

and serves as the dependent variable for various regression analyses.

The major difference between Eqs. (1) and (4) lies in the minuend of the equations; the former employs the value of the asset-in-place, while the latter adopts book value of the asset. For high-tech companies such as those in our sample, the most valuable assets are human capital and other intangibles that are not adequately reflected in the firm's book value. The difference between the market value and book value of assets may contaminate factors beyond future growth. Therefore, we would expect that the GOV is a better measure than Tobin's  $q$  for capturing the value of growth opportunities.

#### 4.4. Independent variables

##### 4.4.1. CVI magnitude

This variable measures the magnitude of CVIs made by an investing firm. We divided the total costs of the CVI portfolio by the investing a firm's total assets to reflect the intensity of corporate venturing activities.

##### 4.4.2. CVI portfolio growth potential

To measure the average growth potential of a CVI portfolio, we performed a weighted average of the expected return of that portfolio, taking the ratio of each investment cost to total CVI costs as a weighting factor. The expected return of each new venture is indicated by the growth rate of the stock indices of the four-digit SIC segment in which the venture operates. We followed [Folta \(1998\)](#) for the construction of the stock indices<sup>6</sup> for each four-digit SIC segment based on the weekly stock prices of all publicly-traded companies in the TSE and the over-the-counter (OTC) market. We then calculated the average annual returns of each industrial segment as the growth potential<sup>7</sup> of a CVI portfolio.

To implement the measures described above, we needed information about the SIC code for each new venture. However, this information is not readily available in Taiwan; therefore, we needed to assign a SIC code to each new venture and listed firm. To accomplish this and to ensure the internal consistency of our data, we crosschecked several information sources, including the Taxation Agency, the Ministry of Finance, the Department of Statistics of the Ministry of Economic Affairs, and the annual reports of the sampled companies. These code assignments were later double-checked by an independent security analyst.

##### 4.4.3. CVI portfolio uncertainty

This variable is calculated by summing the uncertainty of individual new ventures in a CVI portfolio weighted by the ratio of each investment cost to the total CVI costs. To calculate uncertainty, we followed [Folta's \(1998\)](#) measure of uncertainty by taking the 26-week standard deviation of stock returns of each four-digit SIC segment. The volatility of the stock returns represents the exogenous uncertainty of the market payoff specific to each four-digit SIC segment. Other potential measures of uncertainty

<sup>5</sup> In [Kester's \(1984\)](#) model,  $N$  is taken as infinity. However, in the context of developing countries after the bubble economy of the early 2000s, growth options value is calculated negative if  $N$  is set to infinity. In order to avoid large  $N$ , we adopt two different settings:  $N=7$  and  $N=10$ . The results represented little difference in terms of the sign and significance of the coefficients.

<sup>6</sup>  $I_t = B_0 \frac{A_t}{n_t} \sum_{i=1}^{n_t} \left( \frac{P_{it}}{P_{i0}} \right)$ , where  $I_t$  denotes the price level of the index at time  $t$ ;  $B_0$  is a base value of the index at  $t=0$  (year 1999 in this paper), set at 100;  $A_t$  indicates an adjustment factor that allows for changes in the membership of the index and capitalization changes in companies comprising the index;  $n_t$  is the number of existing listed companies in each segment;  $P_{it}$  is the value of stock  $i$  at time  $t$ ; and  $P_{i0}$  is the price of stock  $i$  at  $t=0$ .

<sup>7</sup> [Folta \(1998\)](#) used the stock index as a proxy for growth potential. However, this measure is inappropriate for our study. Because we study CVIs, which involve many emerging segments that prevent us from tracing the stock index from a reasonable base year, we suggest the index growth rate instead of the value of the stock index per se.

specific to a new venture, such as the variance in revenues, are not applicable because most of the information on new venture revenues is lacking or not disclosed.

#### 4.4.4. Within-portfolio diversity

Within-portfolio diversity measures the diversity of new ventures within a portfolio in terms of its industrial segment. As our conceptualization is guided by two complementary arguments concerning the performance consequences of investment diversity and overlap, we submit two complementary measures, namely *Investment Dispersion* and *Investment Overlap*, as indicators of within-portfolio diversity. Both of the measures are based on an entropy measure of product diversity (Jacquemin and Berry, 1979; Palepu, 1985); however, they employ different analytical units.

Investment Dispersion captures how CVIs are scattered across four-digit SIC segments. This measure can be calculated using the following formula:

$$\sum_{j=1}^M P^j \ln(1/P^j)$$

where  $P^j$  is the percentage of the cost of all investment targets in the  $j$ th segment over the total cost of the whole CVI portfolio, and where  $M$  is the number of four-digit SICs in which investments are made. According to the formula, the greater the number of four-digit SIC segments in which a company invests and the more evenly these investments are distributed across segments, the higher the value of Investment Dispersion will be. Based on Hypothesis 2, we expected a positive association between Investment Dispersion and the investing firm's growth value.

The second variable, Investment Overlap, reflects the extent to which multiple ventures occupy the same four-digit SIC segment. This measure is calculated using the following formula:

$$\sum_{j=1}^M \left[ \sum_{i \in j} P_i^j \ln(1/P_i^j) \right] P^j$$

where  $P_i^j$  is the cost of the  $i$ th new venture over the total cost of the  $j$ th four-digit SIC segment, expressed as a percentage. Essentially, the greater the number of new ventures and the tighter their size distribution, the higher the Investment Overlap will be. Based on Hypothesis 2, Investment Overlap will be negatively associated with the growth value of the investing firm. In some sense, these two measures serve as necessary and sufficient conditions for evaluating within-portfolio diversity.

#### 4.4.5. Parent-venture strategic linkage

This variable is designed to capture the structural relationship between a CVI portfolio and the investing firm's core business. Distinct from previous empirical studies in which strategic linkages were mostly captured by self-reported measures (e.g., Sorrentino and Williams, 1995; Thornhill and Amit, 2001) or announcements in the media (e.g., Dushnitsky and Lenox, 2006), our study analyzes product relatedness between the focal investing firm and entrepreneurial ventures. We consider two types of linkages in this study: vertical and horizontal linkages. We labeled them *Parent-venture Vertical Linkage* and *Parent-venture Horizontal Linkage*, respectively. A venture is vertically linked with the investing firm if it is related to segments upstream or downstream of the investing firm's core business. A horizontal linkage refers to a new venture operating in the same SIC segment as the investing firm's core business. Segment identification follows the same four-digit SIC code system we used earlier; likewise, our choices were reconfirmed by a senior security analyst. After identifying the ventures that were strategically linked both vertically and horizontally, we calculated the ratio of the cost of these CVIs to the total cost of the overall CVI portfolio to construct our measure of parent-venture strategic linkage.

#### 4.5. Control variables

Recognizing that growth value can come from CVIs as well as from the core business of the investing company, it is necessary to control for growth value arising from the prospects of the investing firm's core business. Accordingly, we included both industry-specific and firm-specific factors that could influence the growth value of the investing firm. In particular, we considered the growth potential and uncertainty specific to the segment to which a firm's core business pertains. These measures were calculated using the same formula for measuring the growth potential and uncertainty of the CVI portfolio. In terms of firm-specific factors, three variables relevant to the future growth of the investing firm are included. They are the investing firm's core business operating capabilities, R&D investment and resource deployment. We used the average ratio of operating income to sales of the core business over the prior three years as a proxy for a firm's operating capability (*Core Business Profitability*). If a firm is adept at running its core business, then it may be able to create growth opportunities through its core business even without CVIs. Next, we used the in-house R&D intensity (*Core Business R&D Intensity*), measured as the ratio of R&D expenditure to a firm's sales, to control for the intensity of the investing firm's efforts in seeking future growth opportunities internally (Garner et al., 2002; Ho et al., 2006). Moreover, we control for the investing firm's resource deployment outside of CVIs. Of the four components of a firm's total assets (i.e., current assets, long-term investments, fixed assets, and intangible assets), we exclude intangible assets because they are difficult to capture using the investing firm's financial reports. That is, we divide the investing firm's long-term

investments excluding CVIs and total fixed assets by its total assets to obtain the long-term investment ratio (*Core Business Long-term Investment Ratio*) and fixed assets ratio ( $z$ ), respectively, to control for a firm's resource deployment.

## 5. Analytical results

Descriptive statistics and correlations are shown in Table 1. Our two dependent variables measuring the investing firm's future growth opportunities, the GOV and Tobin's  $q$ , are highly correlated with each other ( $\rho = 0.78$ ,  $p < 0.01$ ). In other words, there is a high degree of correlation between the estimated assets-in-place and the book value of the assets. Consequently, these two measures revealed very similar correlations with other explanatory variables. However, this is not to say that the GOV and Tobin's  $q$  are equivalent in capturing future growth opportunities, but rather that within the IT&E sector, the risk-adjusted net present value created by each unit of an asset is not very different among the sampled investing firms.

Our dataset contains 111 investing firms, and each investor was tracked for 4 years (2000 through 2003), yielding a total of 444 data entries. Repeated observations of the same firms may lead to temporal correlation among these entries. Other corporate characteristics that may influence an investing firm's growth opportunities are not included as explanatory variables; these include the firm's culture, experience, or learning capability. To control for these organizational factors, which may not be observable or measurable, we adopt the Cross Section Time Series (CSTS) model, or the so-called "panel data analysis". We performed the Hausman tests (Hausman, 1978) to choose between the fixed and random effects models under the CSTS setting. The results showed  $p$ -values greater than 0.05, which suggests that a random effects model is appropriate. Therefore, we used the random effects model across all CSTS analyses.

The first set of empirical analyses involves investigating the impact of the magnitude of CVIs on the investing firm's growth value. To ensure a rigorous evaluation, we conducted various tests. First, we tested Hypothesis 1a with two dependent variables, the GOV and Tobin's  $q$ , by using the pooled CSTS model. We found that the coefficient of *CVI magnitude* is negative in model 2-1 but positive in model 2-2, although neither is statistically significant. Among the control variables, *Core Business Growth Potential*, *Core Business Uncertainty*, *Core Business Profitability* and *Core Business R&D Intensity* are significantly positive, and thus, we considered them as sources of growth generated from the core business. However, as expected, the *Core Business Fixed Asset Ratio* has a significantly negative impact on future growth due to the low degree of managerial flexibility inherent in this type of asset.

Next, we examined the influence that CVI magnitude has on growth opportunities once an investing firm has decided to allocate resources to CVIs. We used only observations with a positive CVI amount to perform regressions for models 2-3 and 2-4. It is worth noting that a corporate venturing decision can be the result of self-selection such that only investing firms with abundant financial resources and superior external corporate venturing capabilities will engage in CVIs. This creates an endogeneity problem that would make a regular regression overestimate the effects of a firm's CVIs (Shaver, 1998). To cope with this estimation bias, we used a sample selection model with a Tobit selection equation and endogenous explanatory variable (Wooldridge, 2002). This is a model that extends Heckman model (Heckman, 1979) with two modifications. First, a Probit selection equation in Heckman model is replaced by a Tobit selection equation because the selection criteria (i.e.,  $CVI\ magnitude > 0$ ) are based on a continuous variable rather than a discrete one. Second, the endogeneity of the explanatory variable (CVI magnitude) is also considered. We adopted a two-step procedure<sup>8</sup> to implement this model. In the first step, we ran a Tobit model regressing CVI magnitude on all control variables and two additional variables, *IPO Number* and *Liquidity*, to capture the firm-level factors influencing an investing firm's propensity to engage CVIs. *IPO Number* refers to the total number of prior external CVIs that underwent IPOs before the observation year. This variable indicates the investing firm's external corporate venturing capability. *Liquidity* is calculated by looking at a firm's working capital at the end of the previous year ( $t - 1$ ) to capture its financial slack. In the second step, the residuals obtained from the first procedure were introduced into models 2-1 and 2-2 with a selected subsample. The corresponding results using the GOV and Tobin's  $q$  as dependent variables are shown in models 2-3 and 2-4, respectively. After controlling for the aforementioned estimation biases, CVI magnitude still revealed an insignificant relationship with the GOV, but it became negatively associated with Tobin's  $q$  ( $p < 0.05$ ).

For a further robustness test, we dichotomized the amount of CVI and created a dummy variable (i.e., *CVI dummy*), coded 1 for samples with a positive CVI value and 0 otherwise. We then implemented a treatment model with a two-stage regression procedure by adopting this dummy variable instead of CVI magnitude. Like our endogenous explanatory variable model, *IPO Number*, *Liquidity* and other control variables are included in the first-stage selection equation. The corresponding regression results are reported in the last column of Table 2 and show that a firm's *IPO number* is positively associated with its propensity to engage in CVIs. After controlling for self-selection, the results of models 2-5 and 2-6 show that, despite the signs of the coefficient, a firm's involvement in CVIs reveals only an insignificant association with that firm's growth opportunities. Overall, none of the above-mentioned empirical results shows support for H1a. Instead, they indicate that merely increasing the amount of CVIs will not positively affect the investing firm's future growth.

Subsequently, we examined the remaining hypotheses that address the attributes of a CVI portfolio as critical determinants of a firm's growth value. The empirical results are shown in Table 3.

Knowing that the endogeneity problem is insignificant, we directly conducted the CSTS analyses without taking two-stage regressions. To choose between the random effects model and the fixed effects model, we performed the Hausman tests on each regression model as previously described. The results indicated that the random effect model is appropriate. The  $p$ -value of each

<sup>8</sup> Please see Wooldridge, 2002 section 17.5.2 for detail.

**Table 1**  
Descriptive statistics and correlations.

	Mean	S.D.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1 GOV	0.69	0.76															
2 Tobin's <i>q</i>	0.10	0.80	0.78*														
3 CVI magnitude	0.06	0.08	0.05	0.03													
4 CVI portfolio uncertainty	0.09	0.08	0.10	0.09	0.23*												
5 CVI portfolio growth potential	0.05	0.03	0.26*	0.25*	0.17*	0.13*											
6 Investment overlap	0.10	0.18	0.21*	0.27*	0.19*	0.11	0.15*										
7 Investment dispersion	0.71	0.58	0.24*	0.18*	0.29*	0.10	0.35*	0.34*									
8 Parent-venture strategic linkage	0.26	0.31	0.13*	0.17*	0.04	0.00	0.16*	0.17*	0.09								
9 Parent-venture vertical linkage	0.15	0.26	0.16	0.20*	0.06	0.07	0.21*	0.19*	0.24*	0.50*							
10 Parent-venture horizontal linkage	0.11	0.72	0.10	0.15*	-0.06	0.05	0.04	0.10	-0.04	0.51*	-0.10						
11 Core Business growth potential	0.07	0.57	0.05	0.14*	-0.05	-0.13*	0.01	-0.03	0.02	-0.03	-0.02	-0.01					
12 Core business uncertainty	0.06	0.02	0.08	0.06	0.03	-0.04	0.38*	0.00	0.07	0.04	0.07	0.00	-0.05				
13 Core business profitability	7.69	9.31	0.28*	0.52*	-0.01	0.01	0.11	0.27*	0.07	0.09	0.18*	-0.01	-0.13*	0.11			
14 Core Business R&D intensity	0.03	0.04	0.21*	0.29*	-0.02	-0.06	0.07	0.26*	0.19*	0.13*	0.11	0.06	0.02	0.02	0.18*		
15 Core bus. l-term investment ratio	0.20	0.13	0.08	0.07	0.00	0.04	0.07	-0.03	0.21*	0.01	0.02	0.06	0.04	-0.01	-0.05	-0.06	
16 Core bus. fixed asset ratio	0.23	0.18	-0.24	-0.14*	-0.26*	-0.17*	-0.13*	-0.02	-0.20*	0.07	0.02	0.06	-0.07	0.08	0.12*	0.16	-0.49*

*N* = 444.

\*  $p < 0.01$ .

**Table 2**  
Regressions examining the impacts of CVI magnitude on growth opportunities.

Model	2-1	2-2	2-3	2-4	2-5	2-6	
Specification	CSTS <sup>a</sup>	CSTS <sup>a</sup>	Sample selection <sup>b</sup>	Sample selection <sup>b</sup>	Treatment <sup>c</sup>	Treatment <sup>c</sup>	Probit selection Equation <sup>d</sup>
Dependent variable	GOV	Tobin's q	GOV	Tobin's q	GOV	Tobin's q	CVI dummy
Independent variable							
CVI magnitude (H1a)	−0.17	0.40	−1.00	−3.18*	−0.02	0.05	
Control variables							
Core business growth potential	0.10*	0.30***	0.03	0.25***	0.08	0.27***	−0.08
Core business uncertainty	2.92*	2.46**	1.89	1.16	2.10	0.81	−2.33
Core business profitability	0.02***	0.04***	0.03***	0.05***	0.02***	0.04***	0.00
Core business R&D intensity	3.74**	2.01*	2.95**	3.74***	4.02***	4.83***	3.03
Core bus. L-term investment ratio	−0.44	−0.21	−0.69*	−0.74*	−0.33	−0.12	−1.11
Core bus. fixed asset ratio	−1.35***	−0.89**	−1.78***	−1.64***	−1.46***	−1.05***	−2.46***
IPO number							0.70***
Liquidity							−0.02
Instrument variable			−0.12	−0.34			
Intercept	0.62***	0.78	0.91***	1.33***	0.65	−0.25	1.74**
Firms	111	111	105	105	111	111	105
N (firm-year entries)	444	444	382	382	444	444	444
χ <sup>2</sup> test	65.25	171.44					91.47
F test			13.7***	31.03***	16.11***	41.21***	
R <sup>2</sup>	0.20	0.37	0.21	0.35	0.19	0.39	
Hausman test: p value <sup>a</sup>	0.9	0.19					

<sup>a</sup> Based on the result of Hausman test, we adopted the random effect model to perform the cross-sectional time series analysis.

<sup>b</sup> In this model, we adopted a sample selection model with Tobit selection equation for the section criteria of positive CVI magnitude and with instruments to deal with the endogeneity of CVI magnitude.

<sup>c</sup> In this treatment effects model, we adopted a binary selection variable, CVI dummy, where value of 1 represents a positive CVI investment and 0 for non investment.

<sup>d</sup> This column represented the corresponding Probit selection equation for model 2-3 and 2-4.

\*  $p < 0.05$ .

\*\*  $p < 0.01$ .

\*\*\*  $p < 0.001$ .

**Table 3**  
Regressions examining the impacts of CVI configuration on growth opportunities.

Model	3-1	3-2	3-3	3-4	3-5	3-6
Specification	Random effect <sup>a</sup>					
Dependent variable	GOV	Tobin's q	GOV	Tobin's q	GOV	Tobin's q
Independent variable						
CVI magnitude (H1a)	−0.30	0.46	−0.58	0.31	−0.52	0.37
CVI portfolio uncertainty (H1b)	0.89*	0.99*	1.16*	1.20**	0.97*	0.96*
CVI portfolio growth potential (H1c)	6.02***	5.95***	6.16***	6.16***	5.84***	5.74***
Investment overlap (H2)			0.03	0.19	0.01	0.15
Investment dispersion (H2)			0.28***	0.19**	0.26***	0.16**
Parent-venture strategic linkage (H3)			0.32**	0.36***		
Parent-venture vertical linkage (H3)					0.33*	0.48***
Parent-venture horizontal linkage (H3)					0.10*	0.14***
Control variables						
Core business growth potential	e06	0.30***	0.06	0.31***	0.06	0.30***
Core business uncertainty	−1.00	−1.00	−1.42	−1.28	−1.34	−1.24
Core business profitability	0.02***	0.04***	0.02***	0.04***	0.02***	0.04***
Core business R&D intensity	3.20**	1.87	2.28*	1.06	2.43*	1.29
Core business long-term investment ratio	−0.51	−0.21	−0.75*	−0.37	−0.77*	−0.39
Core business fixed asset ratio	−1.52***	−0.95**	−1.55***	−1.00***	−1.57***	−1.05***
Intercept	0.49**	−0.46**	0.30	−0.63***	0.35*	−0.57***
N	382	382	382	382	382	382
Firms	105	105	105	105	105	105
χ <sup>2</sup> test	83.11	184.36	104.61	211.59	107.77	230.79
R <sup>2</sup>	0.2618	0.4304	0.2890	0.4438	0.2951	0.4595
Hausman test: p value <sup>a</sup>	0.64	0.18	0.11	0.15	0.22	0.08

<sup>a</sup> According to the Hausman test, a random effect model rather than a fixed effect model is selected to perform our panel data analysis.

\*  $p < 0.05$ .

\*\*  $p < 0.01$ .

\*\*\*  $p < 0.001$ .

Hausman test is reported at the bottom of each column. The regression model 3-1 included only three explanatory variables, CVI magnitude, *CVI Portfolio Uncertainty* and *CVI Portfolio Growth Potential*, along with a series of control variables and the dependent variable GOV. While CVI magnitude still had no significant relationship with the GOV, both the aggregate uncertainty and the growth potential of the CVI portfolio showed a significant and positive association with the GOV ( $p < 0.05$  and  $p < 0.001$ , respectively). The regression results are similar when we use Tobin's  $q$  as our dependent variable (model 3-2). These findings clearly indicate that a portfolio composed of ventures in industrial segments characterized by either high growth potential or high growth volatility will be significantly associated with a higher level of future growth. This evidence supports both **H1b** and **H1c**. These results indicate that the industrial characteristics of CVIs are critical to the determination of firm growth value, which is consistent with findings in the corporate entrepreneurship literature (Shane, 2001). In particular, investing in industrial segments with high uncertainty can generate greater growth value. Despite the fact that established firms are usually less able to respond to emerging opportunities because of organizational inertia (Hannan and Freeman 1977, 1984), our finding clearly indicates that investing in new ventures is an effective way to help them overcome organizational constraints so as to exploit these uncertain market opportunities.

In models 3-3 through 3-6, we tested the performance implications of various configuration features of a CVI portfolio. The first set of results, focusing on within-portfolio interactions, is shown in models 3-3 and 3-4. As mentioned earlier, we included two measures of within-portfolio diversity: Investment Dispersion and Investment Overlap. The empirical results show a positive but insignificant influence of Investment Overlap on both performance variables, while the coefficients of Investment Dispersion with respect to both the GOV and Tobin's  $q$  are significantly positive ( $p < 0.01$  to  $0.001$ ). This implies that exploring opportunities in diverse and distant areas should enhance the investing firm's growth value. However, pursuing multiple investment projects within a narrowly defined segment should not decrease a firm's growth opportunities; this result seems to deviate from our argument regarding the substitution effects of investments. The present regression analysis therefore indicates that dispersing venturing investments across different domains of opportunity is more likely to positively affect growth value than is engaging in multiple investment projects in a selected domain. Hence, our analytical results generally support **H2**.

Regarding the influence of parent-venture strategic linkage on the investing firm's growth opportunities, there is a significant, positive association between parent-venture strategic linkage and the focal firm's growth value, as shown in models 3-3 and 3-4 ( $p < 0.05$  to  $0.01$ ). This positive relationship also holds for the tests that use alternative dependent variables. To further investigate the impact of differing types of strategic linkages, we decomposed this measure into vertical and horizontal linkages, the results of which are presented in models 3-5 and 3-6. Our findings show that both Parent-venture Vertical Linkage and Parent-venture Horizontal Linkage exert positive impacts on GOV ( $p < 0.05$ ) and on Tobin's  $q$  ( $p < 0.001$ ). Overall, these results directly support **H3**, which argues that synergistic effects between the investing firm and the venture targets positively affect an investing firm's growth value.

As far as the control variables are concerned, we found that some firm-level characteristics do affect the investing firm's growth value. For example, the investing firm's previous profitability level consistently revealed a positive effect on the firm's growth opportunities ( $p < 0.001$ ). As expected, the investing firm's Core Business Growth Potential shows a positive correlation with Tobin's  $q$ , rather than with the GOV. In addition, those focal firms characterized by a high level of fixed investments are associated with a low level of growth opportunities, which reflects the relatively important role that intangible assets play in firm growth potential in the high-tech sectors.

## 6. Discussion

The major objective of this research was to conceptually explore and empirically examine whether different configurations of CVI portfolio affect the investing firm's growth opportunities. Based on a longitudinal database of CVIs, our empirical results elucidate that the growth potential, uncertainty level, and configuration features of a CVI portfolio significantly affect the growth value of the investing firm. In particular, two structural features of an investment portfolio, within-portfolio diversity and strategic linkage, were found to be salient determinants of the growth value of the corporate investor. In contrast, after various robustness checks, we found no direct linkage between the total investment amount of a portfolio and the firm's growth value. These empirical findings jointly affirm that the configuration feature of a CVI portfolio is a critical dimension for understanding CVI strategy and its performance impact.

Corporate entrepreneurship research has long been concerned with how to capture external opportunities for corporate growth (e.g., Shane, 2001; Kester, 1984; Dushnitsky and Lenox, 2006). Along this line of inquiry, our research findings corroborate previous evidence that making venturing investments would affect a firm's growth value (e.g., Dushnitsky and Lenox, 2006). However, our results deviate from those previously presented in the literature (e.g., Dushnitsky and Lenox, 2006) by showing that portfolio configuration, rather than magnitude, is vital to successfully achieving growth opportunities from CVIs. This major finding advances the extant literature by highlighting a need to expand the existing analytical angle on evaluating CVIs. Specifically, an analysis of individual ventures cannot encompass the full strategic benefits of CVIs for investing firms. Neither is an examination of portfolio magnitude sufficient to indicate the heterogeneous values of strategic benefits. We propose that beyond these two approaches, investigating the configuration features of a portfolio is a promising direction for future research.

Our exploration of configuration effects also has important implications regarding CVI portfolio strategies in the pursuit of growth opportunities. Specifically, researchers and practitioners are interested in resources distribution across new ventures and industries, raising questions such as "how many venture projects should be invested?" and "is diversification a better strategy than specialization?" As far as the resource distribution over new ventures is concerned, Biggadike's seminal study (1979) suggested

that firms should concentrate their resources on a few ventures rather than spreading them over many projects. Our findings do not concur with such a notion; we show that Investment Overlap (i.e., the degree to which resources are spread over multiple ventures within a narrowly defined segment) is *not* detrimental to future growth opportunities after controlling for the total amount of the portfolio. Such a discrepancy may stem from the different goals presumed: Biggadike (1979) emphasized market share and financial returns, while we propose that learning and future growth are major goals for CVIs. Furthermore, studies in project management (Loch et al., 2001; Sommer and Loch, 2004) have also provided an explanation for why overlapping investments may not have a negative effect. Some researchers have argued that in a complex environment (i.e., a rugged landscape) where many factors interact in a nonlinear way, merely performing a single search in a specific domain could lead to a local superior solution (i.e., local peak) rather than a global one. Pursuing simultaneous multiple searches increases the possibility of identifying global peaks. Accordingly, within an opportunity area with a vague technology trajectory and incomplete information, investing in multiple new ventures with competing technologies could expand sources of information. It thus enhances the likelihood of discovering a final successful technology, and these benefits could offset the possible substitution effect arising from having to weed out inferior ventures in the future.

This study sheds light on another dimension of portfolio strategy: the choice between diversification and specialization (i.e., resources allocation across industries). Our results also concur with other recent research findings indicating that diversification strategy for CVI portfolios is superior because it conveys potential learning benefits for investing firms. Yang et al. (2009) suggested that accumulating CVI experiences across diverse industries is beneficial to the investing firm's selection and evaluation of portfolio companies. Our results extend their study by further confirming that increasing within-portfolio diversity can enhance the investing firm's growth value. We do not ignore the potential downsides of undertaking a diversification portfolio strategy. The deficiencies of such an approach include unfruitful investments and constrained learning due to limited organizational attention and absorptive capability (Dushnitsky and Lenox, 2005a; Wadhwa and Kotha, 2006). We contend that despite potential project-based inefficiency in the short run, managing a CVI portfolio with a main goal of learning (Dushnitsky and Lenox, 2005a; Roberts and Berry, 1985; McGrath, 1995) from both successful and failed projects generates long-term firm-level strategic benefits in return.

Although our evidence supports a diversification portfolio strategy, the selection of diverse industrial segments should not be a random decision, but should instead maintain strategic links with the core business of the investing firm. The association between performance and parent-venture relatedness has long been a major concern and has produced mixed results at best in the corporate entrepreneurship literature (Knight, 1989; Thornhill and Amit, 2001; Sorrentino and Williams, 1995). Our study shifts the research focus from benefits for individual ventures to benefits for the investing firm and reveals that strategic linkages are beneficial to the investing firms' growth value. We further found that the performance impact of a vertical linkage is more critical than that of a horizontal linkage within our empirical context. We propose two explanations for this result. First, in addition to providing access to growth opportunities in the targeted industrial segment, investing in upstream or downstream start-ups may obtain more diverse sources of information that are beneficial to the core business. Vertical linkages can help investing firms obtain information from customers, suppliers or other stakeholders and thus enlarge recognized opportunity sets or enhance the assessment of these opportunity sets. In contrast, horizontal investments usually suffer from redundant information inflow. Secondly, investing vertically can lead to the formation of an ecosystem or a coordinated network (e.g., Campbell et al., 2003; Chesbrough, 2002) favorable to the investing firm; such benefits are not usually available for within-segment investments. Specifically, investing in downstream ventures can stimulate the demand for the investing firms' core products (Nambisan, 2002). A well known example is Intel's investment in manufacturers to promote its microprocessors (Chesbrough, 2002). Investing in upstream ventures can stimulate innovation or product improvements from the supply side. Pharmaceuticals commonly invest in biotechnological ventures for sourcing new drugs or other emerging technologies; at the same time, they block competitors once the valuable products or technologies are developed. In our sample, system integrators prevalently invest in IC designers dedicated to key IC chips for their systems. In contrast, horizontal investments in a defined four-digit SIC segment cannot provide as many complementary benefits as vertical investments.

### 6.1. Implications for real options research

Although we do not explicitly explore our inquiry through the real option lens (e.g., Li and Mahoney, 2006; Li, 2008), our findings provide implications for applying real options theory to CVI research. First, our finding regarding a positive association between the uncertainty of a CVI portfolio and the growth value of the investing firm implies that investments via corporate venturing mechanisms allow a firm to exploit external uncertainties while maintaining limited downside losses (Andrés, et al., 2005; Kulatilaka and Perotti, 1998; Hurry, et al., 1992; Tong, et al., 2008), as if the investor holds growth options. Recent research (e.g., Li and Mahoney, 2006; Li, 2008) has indicated that the nature of initial investment and subsequent staging decisions regarding new venture investments follows real options logics. Complementary with Li and Mahoney's research on the CVI decision process, our empirical investigation of performance impact provides outcome justification. Furthermore, the evidence from the CVI decision process and outcome together implies that the options value considered in making CVIs is achievable despite concerns regarding options traps due to organizational and psychological deterrents to options abandonment (Adner and Levinthel, 2004).

Second, the present study expands on recent research interest in options interactions (e.g., Vassolo et al., 2004, 2005) by testing the performance impact of sub-additive effects (Vassolo et al., 2004) in an investment portfolio. With measures of Investment Overlap and Investment Dispersion, our empirical findings show a positive gain from Investment Dispersion across different industrial segments, but we fail to find statistical support for the existence of a sub-additivity effect due to Investment Overlap in

the same segment. When only growth options are considered, investing in multiple ventures in a specific segment may cause sub-additivity. However, in a segment without a dominant technology, investing in competing technologies might confer options to switch to another technology (i.e., switch options). If the conferred switch options value outweighs the growth value discount, then the sub-additivity effect disappears; therefore, such parallel investments can be justified. Therefore, our empirical analyses suggest a need to untangle multiple options (e.g., growth options, abandonment options, switch options and deferral options) potentially embedded in a single CVI.

## 6.2. Limitations and future research

Our study has inherent limitations, opening the door for future research above and beyond what we have already suggested. First, we included only domestic corporate ventures due to the limited availability of venture data. This leaves open an avenue for future research into the strategic benefits of international ventures. In particular, in the IT&E industry, the sourcing of global knowledge and global opportunities is prevalent. Because portfolio interactions are suggested as a promising research direction, the complementary or substitutive interactions among domestic ventures, international ventures, internal R&D and other forms of strategic investments are worthwhile to investigate. Second, we only incorporated two configuration attributes relevant to portfolio interactions. Future research can investigate other attributes, such as product complementarity, linkage strength or technological proximity. Thirdly, this study addresses the importance of portfolio diversity in enhancing growth values. However, we suspect that this positive effect of diversity is not without limits. Managers' cognitive capabilities, parent firms' absorptive capabilities, and corporate investors' financial slack for further venture development are all potential constraints. Future research could examine contingencies that may cause portfolio diversity to have a diminishing or even a negative impact. Further, we limited the analyses of our prescriptions to the IT&E industry in Taiwan, and some caution is warranted in extending these results to other contexts. Future research work is needed to explore the portfolio configuration and its impact on the investing firm's growth value in other industrial and cultural settings.

## 7. Conclusions

This study investigates how to effectively utilize corporate investment vehicles to enhance growth opportunities. We redirect CVI research from individual-project-based assessments toward an evaluation of the whole investment portfolio. This is a critical but less explored angle, especially for the discovery of the role that the configuration features of a CVI portfolio play in the determination of the growth value of the investing firm. Taking the investment portfolio as a unit of analysis, our research suggests two configuration features of the CVI portfolio, within-portfolio diversity and strategic linkage, for empirical investigation. This attempt deepens our understanding of CVI strategy by highlighting the importance of managing the networked relationships beyond the dyad ones. Our findings indicated that the magnitude of a portfolio per se is insufficient to generate growth value. Rather, arranging a diversified investment portfolio, coupled with maintaining a strategic linkage, particularly a vertical linkage, between portfolio companies and the investing firm would be beneficial to the investing firm's capture of future growth opportunities. Our results not only confirm the need to consider possible interactive effects between individual venture investments in making CVI decisions but also depict critical configuration features for practical usage and future research exploration. Overall, the present research highlights the need for a holistic view of CVI decision-making that embraces interrelated investment portfolios in the pursuit of sustainable growth.

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