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Real Options and Investment Mode: Evidence from Corporate Venture Capital and Acquisition

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Existing research has used real options theory to study corporate venture capital (CVC) investment, yet little work has empirically examined such investment in a comparative setting. In this paper, we begin to address this gap by investigating firms' investment mode choice between CVC and acquisition, which are alternative modes for pursuing external business development and corporate growth. We propose that when exogenous uncertainty elevates the value of real options, firms are more likely to undertake CVC investments rather than acquisitions. Furthermore, we suggest that the value of real options under uncertainty is contingent upon several factors, which may also shape firms' choice between CVC and acquisition. The results indicate that market uncertainty is positively related to firms' choice of CVC versus acquisition. In addition, investment irreversibility strengthens the effect of uncertainty, whereas growth opportunities surrounding the investment weaken the effect. Our empirical findings and the comparative approach we adopt to studying CVC investments and acquisitions have important implications for theory and research.

Key words: real options; investment mode; corporate venture capital; acquisition
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Introduction

Strategic management scholars have long been interested in how firms can achieve growth, and a large amount of research exists on the various means that firms can employ to pursue corporate growth and development (Penrose 1959, Gulati 2004, McGrath and MacMillan 2005). One external means for business development and corporate growth is acquisition. Acquisition involves a firm buying a target company, and it has been the focus of a large body of strategy research (Haspeslagh and Jemison 1991). Recently, corporate venture capital (CVC) has emerged as another important means for achieving strategic growth and expansion. CVC involves an investing firm taking a minority equity stake in a private entrepreneurial company (Gompers and Lerner 1998). Prior research has analyzed why firms make acquisitions and when acquisitions are value creating (see Haspeslagh and Jemison 1991, Capron and Pistre 2002). Similarly, research has also examined why firms undertake CVC investments and when such investments create value for the investing firms (see Chesbrough 2002; Dushnitsky and Lenox 2005, 2006; Wadhwa and Kotha 2006; Benson and Ziedonis 2009).

By contrast, much less work has been done to examine firms' CVC investments in comparison with acquisitions. However, both CVC investments and acquisitions are important tools that firms can employ to further their external business development and corporate growth initiatives (Keil 2002), and they represent alternative modes for governing collaborative relationships for organizational growth and renewal (Schildt et al. 2005, van de Vrande et al. 2006, Keil et al. 2008). Practitioners share a similar view. For instance, a recent article on the electronics industry reported, "Intel and others [electronics firms] typically view venture capital investing as one of the three pillars of innovation, along with internal R&D and acquisitions" (Roberts 2006, p. 2). A technical report by the National Institute of Standards and Technology, the U.S. Department of Commerce indicates that while firms still use traditional investment approaches such as acquisitions or alliances, they have also increasingly "looked to the [CVC] mode as yet another approach" to seeking strategic growth, which can offer "real options" on new markets and technologies (MacMillan et al. 2008, p. 1).

In this paper, we aim to partially fill this gap by empirically comparing CVC and acquisition as two investment modes and by investigating when firms prefer to undertake CVC investments versus acquisitions. We draw from real options theory to develop hypotheses on the determinants of the choice between CVC and acquisition. Real options theory has been used in extant research to analyze firms' investment under uncertainty, such as alliances (Kogut 1991, Chi 2000, Kumar 2005, Tong et al. 2008), market entry (Campa 1993, Folta and O'Brien 2004, Folta et al. 2006, Chi and Seth 2009),

and entrepreneurial initiatives and technology investment (Hurry et al. 1992, McGrath 1997, McGrath and Nerkar 2004). Real options theory is fitting for our study: firms making CVC investments often confront substantial uncertainty; in addition, CVC investments are embedded with several real options, whose value is enhanced under uncertainty (Hurry et al. 1992, Trigeorgis 1993, Triantis 2001, Cossin et al. 2002, Li 2008). Our study considers real options theory's boundary by investigating the contingent effect of uncertainty on the choice between CVC and acquisition under conditions of irreversibility, growth opportunities, and competition. Following extant research in organization and management (e.g., Gulati and Gargiulo 1999, Argyres et al. 2007), we also supplement quantitative analyses with insights obtained from field interviews of managers involved in firms' CVC investments and acquisitions. The interviews enable us to ground our comparison of CVC and acquisition as alternative investment strategies and help us better understand some of the conditions under which firms choose to use one investment mode rather than the other.

Our study makes three contributions to research on CVC investments and acquisitions. First, prior research has compared different modes of external business development with regard to their impact on interorganizational learning and has shown that different modes such as CVC and acquisition have differential effects on performance outcomes (e.g., Schildt et al. 2005, Keil et al. 2008). Our paper complements this research by focusing on the antecedents of the choice between CVC and acquisition, which are two major modes for external business development and corporate growth (e.g., Keil 2002, van de Vrande et al. 2006). Second, a growing stream of research takes a comparative approach to examining firms' investment mode choice, such as the choice between acquisitions and alliances (e.g., Hennart and Reddy 1997, Folta 1998, Hagedoorn and Duysters 2002, Vanhaverbeke et al. 2002, Dyer et al. 2004, Villalonga and McGahan 2005, Wang and Zajac 2007). Our study contributes to this research by highlighting CVC as another important investment mode, which has been neglected in previous research comparing acquisitions with other corporate investment strategies. Third, emerging research has studied the conditions under which firms invest in private ventures through corporate venture capital (e.g., Dushnitsky and Lenox 2005, Dushnitsky and Shaver 2009), as well as the conditions under which firms acquire private companies (e.g., Capron and Shen 2007, Reuer and Ragozzino 2008). Our study complements the two streams of research by using a comparative lens to examine the conditions affecting firms' choice between CVC investments and acquisitions.

Theory and Hypotheses

The choice between CVC and acquisition can be linked to the literature on different modes that firms can employ for external business development. Such business activities involve going outside of the firm and collaborating with external partners through various modes such as CVC, alliances, and acquisitions (Robert and Berry 1985, Keil 2002). Several studies have compared different modes used for external business development and viewed them as alternative vehicles for accessing external market and technological opportunities for strategic growth. For example, Schildt et al. (2005) and Keil et al. (2008) suggest that CVC investments and acquisitions, among others, can be viewed as alternative governance modes for external business development activities, and they find that the two investment modes have differential impact on firms' learning and innovative performance. Whereas these studies compare different investment modes with regard to their performance outcomes, van de Vrande et al. (2006) specifically focuses on the choice of different governance modes for accessing external market knowledge. Their conceptual framework emphasizes CVC as an alternative to other traditional modes such as acquisitions and suggests that researchers empirically examine CVC as a governance alternative to acquisitions given the growing importance of CVC investments.

Viewing CVC and acquisition as alternative modes for external corporate growth and development resonates with practitioner reports and industry practice, as in the case of Intel (Roberts 2006). The president of the corporate venture program of a leading electronics company that we interviewed shared this view. As the manager put it, "While we certainly make a lot of acquisitions, CVC has become such an important means for strategic growth that no companies in our industry can now neglect it. We are proud to be the industry leader, but we are also humble enough to know that we can't develop all the new products and technologies by ourselves. In fact, we have expanded our venture capital investment in the past several years, and we will maintain this strategy in the future." A number of firms have institutionalized an equity investment board to oversee direct equity investment decisions such as CVC investments and acquisitions. As one example, Motorola's equity investment board directors include the head of Motorola Ventures, corporate acquisition executives, and other corporate and business unit executives, and the board signs off on venture capital investments as well as acquisitions (Roberts 2006). In some firms such as Intel, the strategic investment arm oversees CVC investments, as well as other forms of investment such as acquisitions, alliances, and licensing. In other firms, the head of the venture capital unit is actively involved in corporate strategy decisions (see Grover 2008, about Disney's Steamboat Ventures). For instance, the managing director of the venture capital group of a leading computing technology company that we interviewed is also the vice president of corporate strategy of the company. According to this manager, "This [strategy] facilitates information sharing. For

example, we [the VC group] would refer ventures to our corporate development group for acquisition, if initial screenings suggest that they would be better candidates for acquisitions." Just as alliances and acquisitions are alternative investment strategies suitable for different situations (e.g., Dyer et al. 2004), the managers we interviewed also indicated that CVC and acquisitions are different forms of collaboration that are appropriate under different circumstances. We elaborate on the differences between CVC investments and acquisitions using a real options perspective below.

A Real Options View of CVC Investments and Acquisitions

To start with, prior research has suggested that venture capital investments entail valuable real options that are particularly important under uncertainty because of the flexibility they afford to the investors (e.g., Hurry et al. 1992, Trigeorgis 1993, Amram and Kulatilaka 1999, Triantis 2001, Cossin et al. 2002, Li, 2008). Venture capital investment is often fraught with uncertainty, especially that concerning the viability of the business model or market demand, and ultimately the return of the investment (Ruhnka and Young 1991, Cochrane 2005). In practice, managers also intuitively talk about CVC investments as providing real options on new markets and opportunities (e.g., MacMillan et al. 2008). In the words of one of the managers we interviewed, "Most of our [venture capital] investments are made in new and uncertain markets, especially those that might be of strategic importance to us in the future. It is like buying an option for the future."

CVC investors often stage their financing, which according to real options theory can offer several types of real options to deal with uncertainty (Sahlman 1990, Trigeorgis 1993). Specifically, upon the initial investment, the CVC investing firm has the flexibility to do one of the following in the postinvestment stage. First, the CVC firm has the right but not the obligation to make a subsequent investment and increase the level of resource commitment. The preferential right to expand, or the option to grow, is critical for the CVC firm to obtain positive returns from their investment projects. The value of a venture capital project is derived primarily from future discretionary investment opportunities or growth options, rather than from immediate cash flows (Amram and Kulatilaka 1999, Triantis 2001). This holds true particularly for CVC, where an initial investment often serves as the first link in a chain of subsequent investments aimed at unlocking future growth opportunities in a new business or market (Hurry et al. 1992, Chesbrough 2002). The option to grow is obtained through the initial equity stake, and the firm can exercise this option if uncertainty unfolds to its advantage subsequently. Second, the CVC firm also has an abandonment option to liquidate its investment (Sahlman 1990, Trigeorgis 1996, Kaplan and Stromberg 2003). The firm can exercise this option if uncertainty unfolds to its disadvantage. The possibility to abandon a "bad" project is key to the flexibility advantage underlying a staged venture capital project, because downside risk can be contained and resources can be redirected to other, more promising projects (Sahlman 1990). Third, if uncertainty remains about the prospect of the project subsequent to the initial investment, the CVC firm has an option to defer making any definitive decision concerning whether to expand or abandon. Such deferral options are particularly salient in "time-to-build" projects such as venture capital investments (Trigeorgis 1996).

In summary, through the initial investment, the CVC firm obtains the option to expand, the option to abandon, and the option to defer. Whereas these option rights may be implicit in venture capital projects, they can also be explicitly specified in venture capital contracts, and therefore are supported and reinforced by explicit option clauses (Kaplan and Stromberg 2003). For example, venture capital contracts often specify cash flow rights in the form of convertible securities, whereby CVC investors have the right to exercise the conversion option and become owners of a substantial fraction of their investment projects, thus effectively capturing their projects' upside in the case of favorable developments (Cornelli and Yosha 2003). Concerning the abandonment option, CVC investors can use staged financing, whether specified ex ante or implemented ex post, to monitor the development of their projects over time (Gompers 1995). In the case of negative developments, CVC investors can abandon their projects that do not meet the milestones and thus are "out of the money." This abandonment option is usually reinforced by the liquidation rights and redemption rights that are specified in venture capital contracts (Kaplan and Stromberg 2003). Because venture capital contracts can help investors enhance upside gains in the good state of the world and limit downside losses in the bad state of the world (Sahlman 1990, Kaplan and Stromberg 2003), existing research has suggested that a venture capital investment can be valued as a basket of options consisting of the conversion, liquidation, and other rights (Cossin et al. 2002).

Compared to CVC investments, acquisitions have limited real options and provide less flexibility in general. First, acquisitions represent high commitment rather than flexibility, and they provide little deferral option (Folta 1998, Dyer et al. 2004). Second, acquisitions are typically one-time deals and provide few sequential investment possibilities; by contrast, because of the staged financing structure, through an initial minority investment in a company, the CVC investing firm has the option to expand its equity subsequently. Finally, it is much more difficult to (acquire and then) divest a company than to liquidate a minority equity stake in

a CVC investment project. Therefore, although acquisitions can offer an abandonment option, to the extent that the option is more difficult or less likely to exercise, the option's value is significantly decreased (see Berger et al. 1996). These differences suggest that CVC investments are embedded with greater real options and offer more flexibility than acquisitions. Although some of these characteristics have been noted separately for CVC investments and acquisitions in prior research, little work has taken a comparative approach to study the firm's choice between the two investment modes. In the following, we aim to partially fill this gap by developing a set of hypotheses linking several real options value drivers to the choice between CVC and acquisition.

Uncertainty and the Choice Between CVC and Acquisition

Firms making CVC investments or acquisitions usually confront various uncertainties. For example, the firm may not be sure how well the invested company's business model will be accepted. Substantial uncertainty also exists about the market demand for the product offerings and ultimately the return of the investment (Ruhnka and Young 1991, Cochrane 2005, Capron and Shen 2007). These sources of uncertainty are largely exogenous and beyond the control of individual firms.[1] Because exogenous uncertainty enhances the value of real options, it highlights the importance of maintaining flexibility to adjust investment decisions over time as information is revealed and uncertainties are resolved (Dixit and Pindyck 1994, Trigeorgis 1996).

Although CVC and acquisition represent alternative investment modes, real options become more salient in CVC investments compared to acquisitions under conditions of uncertainty. As discussed earlier, through the initial investment, the CVC investor obtains the options to grow, abandon, and defer. Because of the presence of these real options, a CVC investment cannot only help the firm reduce downside risk, but it can also position the firm to capitalize on the upside should the environment develop favorably. Unlike staged CVC investments involving sequential resource commitments, acquisitions are most often one-shot transactions requiring large upfront investments. Thus, compared to CVC investments, acquisitions give the firm less flexibility to adjust or reverse its actions. Because the value of all types of real options increases with uncertainty (Dixit and Pindyck 1994, Trigeorgis 1996), the various real options embedded in the initial CVC investment will enhance the total value of a CVC project vis-à-vis an acquisition under uncertainty, leading to the firm's preference of CVC over acquisition. Moreover, acquisitions lead to internalization of an exchange (Villalonga and McGahan 2005), whereas a CVC investment can be viewed as a transitional governance structure providing the firm with an option to defer internalization. By deferring internalization, the firm can limit its exposure to market uncertainty, in the case of adverse developments ex post (Balakrishnan and Wernerfelt 1986, Folta 1998).

In summary, uncertainty creates a disincentive for firms to make one-time and hard-to-reverse commitment that is often required in acquisitions. By contrast, the various real options obtained from initial CVC investments will become more valuable under conditions of uncertainty. Consequently, we expect that under exogenous market uncertainty, firms will prefer CVC over acquisition, which forms the baseline prediction from real options theory.

HYPOTHESIS 1 (H1). *The greater the level of uncertainty, the more CVC is preferred over acquisition.*

The Contingent Effects of Uncertainty

Although the value of real options embedded in CVC investments will become more salient under uncertainty, several factors can either increase or decrease this value, thus accentuating or attenuating the effect of uncertainty on the choice of CVC versus acquisition. Below, we consider the contingent effects of three such factors that extant theoretical research suggests will particularly shape the value of real options under uncertainty (e.g., Dixit 1989, Pindyck 1991, Dixit and Pindyck 1994, Trigeorgis 1996, Kulatilaka and Perotti 1998, Smit and Trigeorgis 2004).

The first contingency factor is the irreversibility of investments. Investments are irreversible when their resale value is less than their cost. With fully reversible investments, firms can invest and disinvest at their will regardless of uncertainty, because the downside loss is sufficiently contained (Dixit and Pindyck 1994). However, most investments in the real world are at least partially irreversible. As irreversibility increases, the resale value decreases, and investment decisions will become more sensitive to conditions of uncertainty (Dixit 1989, Pindyck 1991). Extant studies have demonstrated the positive interaction effect between uncertainty and irreversibility on firms' investment decisions, albeit not on firms' investment mode choice. For example, Campa (1993) finds that the greater the irreversibility, the larger the negative effect of exchange rate uncertainty on foreign direct investment in the United States. Folta and colleagues (Folta and O'Brien 2004, Folta et al. 2006) show that the negative effect of market uncertainty on investment in new markets is more pronounced when the investment entails greater irreversibility.

We suggest that investment irreversibility can also interact with uncertainty to affect firms' investment mode choice, such as the choice between CVC and acquisition. Investment irreversibility can be partially addressed through structural flexibility embedded in investment vehicles (Kogut 1991, Bowman and Hurry 1993). Compared to acquisitions that are one-time transactions, CVC

involves multistage investments and allows sequential resource commitments to future uncertain initiatives. On the other hand, acquisitions typically involve substantial resource commitments, which, combined with the one-shot investment approach, afford less operating flexibility and are harder to reverse. Existing real options models suggest that increases in irreversibility increase the value of real options under uncertainty (Pindyck 1991, Dixit and Pindyck 1994). As a result, the value of the real options embedded in CVC investments will be enhanced by irreversibility and uncertainty jointly. These arguments suggest that when an investment project involves high levels of irreversibility and uncertainty, CVC will be a more appropriate investment vehicle than acquisition. Consequently, we expect that firms will have a stronger incentive to choose CVC rather than acquisition under those conditions.

HYPOTHESIS 2 (H2). *The greater the level of irreversibility, the stronger the positive relationship between uncertainty and the preference for CVC over acquisition.*

Whereas irreversibility strengthens the positive impact of uncertainty on the preference for CVC over acquisition, other factors can weaken this impact. The real options literature suggests that one such factor is the growth opportunities surrounding the firm's investment. In particular, delaying or staging investments in the presence of growth opportunities may incur opportunity costs of waiting. First, firms expect higher payoffs from investments with higher growth opportunities, and indecision can lead to loss of profit streams in the present or future periods (Kulatilaka and Perotti 1998). Second, although delaying commitment can protect firms from downside losses, such downside loss protection is less valuable when there is significant upside potential and as firms make investments to capitalize on growth opportunities (Dixit and Pindyck 1994). Therefore, we expect that the value of real options embedded in CVC investments will be partially offset by the growth opportunities that are present. Whereas CVC investments allow the firm to defer commitments and adopt a wait-and-see strategy, acquisitions enable the firm to commit resources in a speedy way to capitalize on the growth opportunities. The argument that growth opportunities can discourage deferment and induce investment despite uncertainty is consistent with the findings of previous research on firms' investment decisions concerning entry into new markets and knowledge areas that present significant growth opportunities (e.g., Folta and O'Brien 2004, McGrath and Nerkar 2004). We extend this line of logic to firms' investment mode choice, and we suggest that with growth opportunities, firms' preference for CVC over acquisition will be weaker under conditions of uncertainty, namely,

HYPOTHESIS 3 (H3). *The greater the level of growth opportunities, the weaker the positive relationship between uncertainty and the preference for CVC over acquisition.*

Another contingency factor that can attenuate the impact of uncertainty on firms' preference for CVC over acquisition is competition. Growth opportunities typically are not proprietary, or exclusively owned by a firm, but rather are shared and accessible by industry competitors (Trigeorgis 1996, Smit and Trigeorgis 2004). To the extent that growth opportunities are shared, speedy investment can help the firm avoid missing out the opportunities, and timely commitment can also gain the firm strategic advantages, such as preempting the market by shaping consumers' preferences or reducing operating costs with cumulative learning (e.g., Kulatilaka and Perotti 1998, Smit and Trigeorgis 2004). When competitors have access to nonproprietary opportunities, the strategic value of the firm's commitment may outweigh the flexibility value of deferring or staging investment (e.g., Kulatilaka and Perotti 1998). Thus, while it is generally beneficial to maintain flexibility by postponing or sequencing commitments under uncertainty, such strategies may lead to a loss in the expected value of the project in the presence of competitive investment (Smit and Ankum 1993).

Although CVC provides the firm with the flexibility to defer or sequence investments, acquisitions signal commitment to potential rivals. The strategic value of commitment in acquisitions under competition may diminish the value of flexibility under uncertainty offered by CVC investments. Therefore, we expect that the flexibility advantage in CVC investments will likely be less salient in a competitive environment, and we propose that firms' preference for CVC over acquisition under uncertainty will be weaker when the industry environment is more competitive. Thus,

HYPOTHESIS 4 (H4). *The greater the level of competition, the weaker the positive relationship between uncertainty and the preference for CVC over acquisition.*

Data and Methods

Sample

We obtained data on CVC investments and acquisitions from Thomson Financial's Securities Data Company (SDC) database. For both types of investments, we restricted the investing firms to public firms included in the Compustat database, which provides financial, accounting, and other information for our empirical analysis. Public firms were not required to report acquisitions of private targets; however, the situation has improved since the signing of the Sarbanes–Oxley Act in July 2002. Under Section 404 of the act, a public acquirer needs to report whether a private target company has adequate internal controls and financial reporting procedures, and consequently, the act must be investigated by the transacting parties in the process of the acquisition. It is expected that coverage of private

acquisitions would become more accurate and extensive since 2003, and therefore, we chose to focus on the time window during 2003–2005.

Using this time window, we first obtained data on all CVC investments from Venture Economics' VentureXpert database, which is included as a separate module in the SDC. CVC investors are nonfinancial corporate subsidiaries or affiliates. To identify the status of CVC investors and their corporate parents, we performed an extensive search using several sources, including Lexis-Nexis' Directory of Corporate Affiliations, Hoovers Online, and Standard and Poor's Corporate Descriptions. We excluded financial services firms (i.e., Standard Industrial Classification (SIC) codes 6000–6999), corporate pension fund investors, and independent venture capitalists. We also dropped investments in the government-sponsored Small Business Investment Company (SBIC) program (22 first-round investments), but our results are robust to inclusion of SBIC investments. All of the investing firms are traded on the U.S. stock market, and the investees are private companies based in the United States. We limited our analysis to first-round CVC investments, because these initial investments provide the firm with several valuable real options, as we discussed in the theory section. Focusing on first-round investments also places CVC investments on a similar footing with acquisitions. Finally, we identified the SIC codes of the investee ventures based on the business descriptions of these ventures, the Venture Economics Industry Classification (VEIC) codes, and the SIC definitions provided by the U.S. Department of Labor. Specifically, we developed a concordance between VEIC codes and SIC codes, and three research assistants helped us for the cases where one VEIC code corresponds to more than one SIC code. Upon performing these procedures and eliminating observations with missing values, we had a CVC subsample that consisted of 546 investment deals made by 99 investing firms.

We used the same time window to obtain data on all domestic acquisitions of private companies by U.S. public acquirers from the mergers and acquisitions (M&A) module in the SDC database. We focused on acquisition of private targets because CVC investments are directed to private companies, and such a focus makes the two investment choices comparable. We also limited targets to independent companies that are not a subsidiary of a corporate parent, and we dropped financial acquirers (i.e., SICs 6000–6999). We further excluded acquisitions that were coded as buyouts, divestitures, restructurings, recapitalizations, carveouts, and liquidations. For the large majority of the transactions, the database reports information about the industry of the target and the acquirer, the state of the target and the acquirer, the percentage of the ownership acquired, etc. However, because of our focus on private acquisitions, information on target size or performance, transaction value, etc., is not available for over 90% of the transactions. This remains a limitation of using the database despite many of its merits such as the broad coverage of transactions. After going through each of these steps and accounting for missing observations, we had an acquisition subsample that consisted of 2,237 investment deals made by 1,193 acquirers.

We further investigated whether some acquisitions in this sample started as CVC investments. Such acquisitions are considered *exercise* of the options that are embedded in the initial CVC investment; by contrast, our study focuses on the *purchase* of options through the initial CVC investment. First, we examined whether the names of the portfolio companies and CVC investors in the 546 CVC deals matched the names of the targets and acquirers in the 2,237 acquisition deals, and we found that in none of the acquisition deals was the acquirer also the CVC investor that funded the target earlier. Second, when we compared the names of the targets and acquirers from our acquisitions subsample with the names of the portfolio companies and CVC investors in the VentureXpert universe, we found eight matches, indicating that in 8 out of the 2,237 instances (i.e., 0.36%) the acquirer was the original CVC investor. None of the targets in these eight acquisitions appeared as a portfolio company in our CVC subsample, however. In constructing the final sample, we dropped these eight acquisition deals; though none of the targets in the eight deals appeared as a portfolio company in our CVC subsample, it is possible that these acquirers adopt a different approach to managing acquisitions than the rest of the acquirers in our study. This procedure reduced the subsample of acquisitions to 2,229 deals, whereas CVC deals remained the same at 546. We merged the two subsamples (a total of 2,775 deals) and then matched them with financial, accounting, and other information obtained from Compustat.

Variables and Measures

CVC vs. Acquisition. The dependent variable used to test the hypotheses is a dichotomous measure indicating whether an investing firm used CVC or acquisition as the investment mode; the variable *CVC* takes the value one if an investment is structured as a CVC investment, and zero if structured as an acquisition.

Prior research has tended to focus on either investment decision (market entry) or investment mode choice (entry mode choice), implicitly viewing the two as separate decisions. However, one can argue that the empirical relationship between particular transactional or firm attributes and firms' governance or entry mode choice might reflect the possibility that only certain types of firms or transactions are actually observed. In our context, we can only observe the investment mode choice for firms that actually undertook CVC investments *or* acquisitions, but the choice for firms undertaking neither

is not observable. To address this issue, we estimated probit models with sample selection to safeguard against the possibility of sample selection bias (Heckman 1979). Using such a modeling strategy also allows us to study firms' investment decisions and investment mode choice simultaneously, which has not been attempted in existing research. The two-stage model is constructed as follows (e.g., Van de Ven and Pragg 1981). The first-stage probit model is a sample selection model that distinguishes firms that undertook CVC investments *or* acquisitions from firms that undertook *neither* investment. To construct the sample for the first-stage model, we obtained all public firms in Compustat during the period. We dropped inactive firms whose financials are not provided in Compustat and firms for which Compustat does not update the data. We identified the "actual investors," i.e., firms that undertook CVC investments or acquisitions, and we considered the rest "noninvestors." We incorporated the following five variables in the sample selection model to address firms' likelihood of undertaking CVC investments *or* acquisitions in the first place: (1) the natural log of the firm's total assets in million dollars (i.e., *size*), (2) the firm's return on sales (i.e., *profitability*), (3) the firm's research and development (R&D) intensity, measured as the amount of R&D expenditures as a percentage of sales (i.e., *R&D intensity*), (4) the firm's capital intensity, measured as the amount of capital expenditures as a percentage of sales (i.e., *capital intensity*), and (5) the firm's financial leverage, measured as the ratio of a firm's long-term debt to its total capital (i.e., *financial leverage*). All variables were lagged by one year; the first three variables were also used in the second-stage model on the choice of CVC versus acquisition.

Explanatory Variables. The first theoretical variable used in the second-stage probit model for the chosen investment mode (i.e., CVC versus acquisition) is the uncertainty that surrounds a firm's investment. Following previous research on real options and investment under uncertainty, we focused on exogenous uncertainty (e.g., Dixit and Pindyck 1994), and measured it as the volatility of industry stock market indices (Carruth et al. 2000). We performed the following procedures to calculate stock market volatility (e.g., Folta and O'Brien 2004). First, we computed the monthly value-weighted market returns for each industry using data from the Center for Research in Security Prices. Second, we specified a Fama and French (1993) three-factor model to forecast monthly industry returns recursively from 1950 to 2005. We further specified a generalized autoregressive conditional heteroskedasticity (GARCH) (1, 1) process to model the variance of the error term (e.g., Bollerslev et al. 1992); likelihood ratio tests showed that the GARCH (1, 1) model outperformed alternative GARCH and other ARCH models. Fama and French (1993) classified the economy into 49 industries that reflect the fundamentals of each industry, and we recorded industries at the three-digit SIC level (e.g., Davis and Duhaime 1992). Third, for each estimated monthly return, we obtained the conditional variance from the GARCH model. We then annualized the variance measure by averaging the conditional variance for the past 12 months for an investment that occurred in the current year, and took the log of the average variance.

In Hypotheses 2–4, we proposed three contingency factors that would interact with uncertainty to affect firms' investment mode choice between CVC and acquisition. In Hypothesis 2, we were interested in whether the interaction between uncertainty and irreversibility would affect the firm's investment mode choice. While irreversibility is a theoretically appealing concept, measuring irreversibility presents a challenge for empirical research in general, especially for a large number of firms and investments. In this paper, we followed existing empirical studies on real options and used asset intangibility as a measure of irreversibility (e.g., Folta and O'Brien 2004). Irreversibility occurs when the invested assets are difficult to resell or the trading market is subject to imperfections (Dixit and Pindyck 1994). Intangible assets are likely to suffer from market failure, making their trading much more difficult compared to tangible and physical assets (Long and Malitz 1985, Williamson 1988). We calculated the intangibility measure of *irreversibility* as the median value of the ratio of intangible assets to total assets for all firms in the industry in the previous year, using data from Compustat. In robustness checks to be reported below, we also tested other measures of irreversibility.

Another contingency factor is the level of growth opportunities in the industry. Growth opportunities can increase the value of the underlying asset of an investment and thus may also have a direct effect on firms' investment mode choice. One measure that has been used as a proxy for growth opportunities is the market-to-book ratio. Because firms with a higher market-to-book ratio tend to possess a higher level of growth opportunities, industries in which firms have a higher average market-to-book ratio should present a higher level of growth opportunities in general. We used the median market-to-book ratio of the investee's industry (at the three-digit SIC level) in the previous year to measure the variable *growth opportunities*, using data from Compustat.

The third interaction variable is the level of competition. Competition can lead to earlier expiration of a real option as in the Black–Scholes model, negatively affecting the option's valuation (Trigeorgis 1996). We followed research in industrial organization economics and used one-minus-industry concentration ratio to measure the variable *competition*. The rationale for this measure is that more (less) concentrated industries will

exhibit lower (higher) levels of competition. We calculated industry concentration ratio as the Herfindahl–Hirschman Index (HHI) of the investee's industry (at the three-digit SIC level), which is the sum of the squares of the market shares of all of the companies in the industry in the previous year using data from Compustat. We subtracted the HHI from one, so that the higher the value of this measure, the higher the level of competition in the industry. In supplementary analyses, we also used the four-firm concentration ratio to replace the HHI and obtained the same results as those presented below.

Control Variables. The first set of control variables relate to the investing firm. First, *size* was measured as the natural log of the firm's total assets in million dollars. Larger firms tend to possess greater resources and provide more slack for pursuing external growth strategies such as CVC investments and acquisitions. Second, *R&D intensity* was measured as the amount of R&D expenditures as a percentage of sales. Including this variable allowed us to examine whether internal investment in R&D will affect firms' decision concerning the choice between CVC and acquisition, both of which have been viewed as tools for acquiring external technology (e.g., Roberts 2006). Third, we controlled for the firm's *profitability*. Firm performance can influence CVC investments (Dushnitsky and Lenox 2005) and motivate acquisitions (Haspeslagh and Jemison 1991), and we were interested in whether it might also affect the firm's decision to undertake CVC versus acquisition. Profitability was measured as return on sales, which is income before extraordinary items as a percentage to sales. Data for these three variables were obtained from Compustat. Finally, we also included a variable controlling for the firm's experience in CVC versus acquisition. Prior research suggests that firms with significant acquisition experience are more likely to have developed acquisition capabilities or possess unobservable characteristics that may lead them to prefer acquisitions (e.g., Dyer et al. 2004, Arikan and McGahan 2010). We used the SDC database to track a firm's CVC investments and acquisitions, and we then counted the numbers of CVC investments and acquisitions that the firm had during the five years preceding the focal investment. To measure the variable *CVC to acquisition experience*, we logged the ratio of one plus the number of CVC investments to one plus the number of acquisitions, because some firms had zero CVC investments or acquisitions, and the log of zero is undefined.

We used three control variables related to the investee's industry to account for industry-level heterogeneity and other factors that might affect firms' investment mode choice. We first controlled for *industry profitability*, which might influence the attractiveness of an investment by affecting the immediate cash flow generated from the investment. We measured industry profitability as the sum of the income before extraordinary items for all of the firms in the industry in which the investee resides as a percentage of industry sales. Second, we created the variable *industry R&D intensity* to proxy for information asymmetry and opacity surrounding the investee (Gompers 1995, Vicente-Lorente 2001), which may affect the investing firm's preference for CVC versus acquisition. We followed Gompers (1995) and measured industry R&D intensity by the amount of R&D expenditures for all of the businesses in the industry as a percentage of industry sales. The data for calculating the two variables were obtained from Compustat. The third control variable is the appropriability regime of the industry. Following existing research suggesting that intellectual property (IP) protection can affect firms' decision to invest in CVC (Dushnitsky and Lenox 2005, Dushnitsky and Shaver 2009), we used the variable *IP regime* to study the effect of IP protection on firms' investment mode choice between CVC and acquisition. Including IP regime also helps address potential transaction cost issues lying at the heart of organizational governance decision. According to transaction cost economics, when the IP regime is weak and it is difficult to delineate and enforce intellectual property rights, firms will want to adopt a more hierarchical governance structure that offers more protection (Teece 1986), such as acquisitions in our study. We derived the IP regime measure from the Carnegie Mellon Survey of Research and Development (Cohen et al. 2000).

We controlled for two other factors at the investor–investee dyadic level, which proxy for the degree of information asymmetry experienced by the investing firm in relation to the investee company. The first control variable, *interindustry investment*, is a dummy variable that equals one when the investor and the investee operate in two different three-digit SIC industries, and zero otherwise. Prior research suggests that interindustry investment presents greater information asymmetry (e.g., Balakrishnan and Koza 1993, Coff 1999), and therefore, it is expected to take the form of CVC rather than acquisition. The second control variable relates to the geographic location of the investor and the investee, following the argument that greater geographic dispersion in investments is associated with greater information asymmetry (e.g., Sorenon and Stuart 2001). The dummy variable *different state* equals one when the investor and the investee are located in two different states, and zero otherwise.

We also sought to control for characteristics of the investee. The SDC database provides limited data on private companies' characteristics, however. Our research assistants therefore searched a number of data sources (i.e., the Dun & Bradstreet Directory, Hoover's Online, ReferenceUSA, and the Business & Company Source Center), and they were able to identify the founding year information for 2,323 observations in our sample, the employment size information for 2,197 observations,

and both types of information for 2,120 observations. We calculated two variables and included them in the regressions: *investee age* was calculated by subtracting the founding year from the current year and then taking the log of the subtracted value; *investee size* was calculated by taking the log of the number of employees. Given that the two variables have a number of missing values, we conducted two sets of analyses and reported the results in two separate tables (i.e., Tables 2 and 3) in the section below. Finally, we included two year dummy variables by treating the year 2005 as the base year.

Results

Table 1 presents descriptive statistics of the variables used in the analyses and the correlations between the variables. The table indicates that about 20% of the deals in our sample are CVC investments. The average investing firm has about $820 million in assets and a 4% return on assets, and its investment in internal R&D is roughly 8% of its sales revenue. Seventy-six percent of the investments involve an investor and an investee from different states, and 59% are interindustry deals. Whereas some of the variables exhibit significant correlations with one another, we found that the maximum variance inflation factor for any model that we ran was 2.5, suggesting that multicollinearity is not a concern.

Table 2 presents the multivariate results from the probit models with sample selection for the full sample. Results from the choice model comparing CVC investments and acquisitions appear in the top panel, and estimates from the selection model appear in the bottom panel. In the top panel, a positive parameter estimate indicates that an increase in a variable increases the likelihood of a CVC investment *versus* an acquisition. In the bottom panel, a positive parameter estimate indicates that an increase in a variable increases the likelihood of a CVC investment *or* an acquisition versus no transaction. Column I is the baseline model that incorporates all the control variables. Column II adds uncertainty and the three moderators: irreversibility, growth opportunities, and competition. Columns III to V introduce each of the three interaction terms successively, and Column VI is the full model. All of the six models are highly significant ($p < 0.001$).

Hypothesis 1 tests a core prediction from real options theory that under conditions of market uncertainty, firms will prefer to undertake CVC investments rather than acquisitions. The coefficient estimate of the variable *uncertainty* is positive and significant ($p < 0.05$ in Column VI; $p < 0.01$ in other models), supporting H1. We also sought to interpret the coefficient of the variables to understand the variables' economic significance for firms' investment mode choice (e.g., Hoetker 2007, Zelner 2009) by using the results reported in the full model (i.e., Column VI). We found that when uncertainty increases from its 50th percentile to 75th percentile value and the values of all the other variables are held at their median level, the probability that an investment will be in the form of CVC vis-à-vis acquisition increases by about 37%.

Hypotheses 2–4 propose three contingencies that will moderate the relationship between uncertainty and the preference for CVC over acquisition. Hypothesis 2 posits

Table 1 Descriptive Statistics and Correlation Matrix

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
(1) *CVC*	—															
(2) *uncertainty*	0.06	—														
(3) *irreversibility*	0.19	−0.18	—													
(4) *growth opportunities*	0.18	−0.09	0.27	—												
(5) *competition*	0.21	0.07	0.20	0.32	—											
(6) *investee age*[a]	−0.07	−0.03	−0.11	−0.08	−0.11	—										
(7) *investee size*[a]	−0.49	0.02	−0.13	−0.14	−0.13	0.27	—									
(8) *interindustry investment*	0.17	−0.04	−0.07	−0.12	−0.11	0.00	−0.09	—								
(9) *different state*	0.00	−0.08	−0.05	−0.03	−0.10	0.06	0.03	0.05	—							
(10) *size*[a]	0.60	0.04	0.11	0.09	0.10	0.06	−0.22	0.13	0.08	—						
(11) *profitability*	0.20	−0.01	0.02	0.04	−0.00	0.02	−0.10	0.02	0.01	0.37	—					
(12) *R&D intensity*	0.08	0.03	0.18	0.22	0.18	−0.08	−0.09	−0.11	−0.10	−0.04	−0.09	—				
(13) *CVC to acquisition experience*[a]	0.66	0.02	0.19	0.20	0.24	−0.10	−0.34	0.09	−0.07	0.28	0.09	0.16	—			
(14) *industry profitability*	0.06	0.03	0.23	0.34	0.24	−0.10	−0.08	−0.13	−0.04	0.07	0.10	0.10	0.09	—		
(15) *industry R&D intensity*	0.39	0.06	0.56	0.61	0.47	−0.14	−0.22	−0.14	−0.05	0.23	0.04	0.33	0.35	0.32	—	
(16) *IP regime*	0.09	0.17	−0.10	0.37	0.08	−0.02	−0.04	−0.08	0.07	0.04	0.07	0.11	0.05	0.21	0.29	—
Mean	0.20	2.51	0.04	3.36	0.85	10.18	4.74	0.59	0.76	6.73	0.04	0.08	−0.79	0.05	0.07	29.40
SD	0.40	0.60	0.08	1.10	0.15	9.53	0.87	0.49	0.43	2.90	0.16	0.17	1.46	0.05	0.05	6.47
Minimum	0.00	1.30	0.02	0.65	0.02	3.00	1.10	0.00	0.00	−5.30	−0.98	0.00	−4.19	0.00	−0.58	23.66
Maximum	1.00	4.44	0.56	7.14	0.98	43.00	7.76	1.00	1.00	13.38	0.94	0.93	4.07	0.20	0.50	43.77
N	2,775	2,775	2,775	2,775	2,775	2,323	2,197	2,775	2,775	2,775	2,775	2,775	2,775	2,775	2,775	2,775

Note. Correlations with an absolute value of 0.03 or greater are significant at $p < 0.05$.
[a]Logged.

Table 2 Heckman Regression Results for CVC vs. Acquisition

	I	II	III	IV	V	VI
CVC vs. acquisition choice model variables ($N = 2{,}775$)						
intercept	−6.93*** (0.60)	−9.01*** (1.62)	−9.87*** (1.41)	−8.88*** (1.65)	−9.76*** (1.74)	−10.11*** (1.67)
year 2003	0.89** (0.31)	0.72* (0.29)	0.73* (0.30)	0.74* (0.30)	0.76* (0.31)	0.69* (0.29)
year 2004	0.11 (0.21)	0.01 (0.23)	0.01 (0.24)	−0.03 (0.23)	0.01 (0.23)	−0.01 (0.22)
interindustry investment	0.37** (0.12)	0.27** (0.11)	0.24** (0.10)	0.26* (0.12)	0.25* (0.11)	0.25** (0.09)
different state	−0.03 (0.20)	−0.02 (0.15)	0.02 (0.18)	−0.02 (0.16)	−0.05 (0.17)	−0.01 (0.16)
size	0.45*** (0.05)	0.37*** (0.06)	0.38*** (0.06)	0.37*** (0.06)	0.39*** (0.06)	0.38*** (0.06)
profitability	0.47 (0.59)	0.29 (0.60)	0.24 (0.60)	0.31 (0.59)	0.26 (0.61)	0.22 (0.60)
R&D intensity	0.15 (0.34)	0.11 (0.25)	0.11 (0.28)	0.10 (0.25)	0.07 (0.25)	0.03 (0.28)
CVC to acquisition experience	0.59*** (0.09)	0.49*** (0.10)	0.48*** (0.10)	0.47*** (0.11)	0.46*** (0.09)	0.47*** (0.09)
industry profitability	−3.36* (1.61)	−2.60** (0.94)	−1.82* (0.81)	−2.59*** (0.98)	−1.99* (0.93)	−2.25* (0.96)
industry R&D intensity	6.01*** (2.01)	3.90* (1.92)	3.99† (2.08)	4.19* (2.10)	4.22* (2.08)	4.06† (2.23)
IP regime	0.02* (0.01)	0.04* (0.02)	0.05** (0.02)	0.04* (0.02)	0.05** (0.02)	0.05** (0.02)
irreversibility	—	3.39* (1.63)	4.31** (1.50)	3.45* (1.63)	3.34* (1.55)	4.71** (1.52)
growth opportunities	—	0.05 (0.08)	0.07 (0.10)	0.06 (0.09)	0.06 (0.09)	0.09 (0.10)
competition	—	0.39† (0.22)	0.49† (0.26)	0.41* (0.20)	0.38* (0.19)	0.36† (0.20)
uncertainty	—	0.29** (0.11)	0.25** (0.10)	0.26** (0.10)	0.28** (0.09)	0.23* (0.09)
uncertainty ∗ *irreversibility*	—	—	5.77** (2.01)	—	—	5.57** (1.92)
uncertainty ∗ *growth opportunities*	—	—	—	−0.26* (0.11)	—	−0.27* (0.12)
uncertainty ∗ *competition*	—	—	—	—	2.97 (2.06)	1.77 (1.90)
Selection model variables ($N = 9{,}956$)						
intercept	−1.74*** (0.08)	−1.46*** (0.03)	−1.45*** (0.03)	−1.43*** (0.04)	−1.43*** (0.04)	−1.42*** (0.03)
size	0.08*** (0.02)	0.07*** (0.01)	0.05*** (0.01)	0.06*** (0.01)	0.05*** (0.01)	0.05*** (0.01)
profitability	0.76*** (0.11)	0.70*** (0.10)	0.66*** (0.10)	0.65*** (0.10)	0.65*** (0.09)	0.64*** (0.10)
R&D intensity	0.24*** (0.05)	0.25*** (0.04)	0.24*** (0.05)	0.24*** (0.05)	0.23*** (0.04)	0.24*** (0.05)
capital intensity	0.10 (0.07)	0.07 (0.08)	0.07 (0.09)	0.06 (0.09)	0.06 (0.08)	0.06 (0.08)
financial leverage	−0.21* (0.08)	−0.19* (0.09)	−0.20* (0.09)	−0.18* (0.08)	−0.19* (0.09)	−0.19* (0.09)
χ^2	47.44***	59.88***	64.28***	64.60***	61.11***	69.33***
Wald test of indep. equations ($\rho = 0$)	2.01	8.60**	8.89**	8.87**	8.50**	9.75**

Notes. Robust standard errors appear in parentheses. In the top panel, positive coefficients indicate that increases in a variable increase the likelihood of a CVC versus an acquisition. In the bottom panel, positive coefficients indicate that increases in a variable increase the likelihood of either a CVC or an acquisition vis-à-vis neither.

†$p < 0.10$; *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

that under greater uncertainty, investment of greater irreversibility will be more likely in the form of CVC rather than acquisition. The interaction between uncertainty and irreversibility is positive and significant in Columns III and VI ($p < 0.01$), providing strong support for H2. When uncertainty increases from its 50th percentile to 75th percentile value, the probability of a CVC investment versus an acquisition increases by about 96% if the value of irreversibility increases to its 75th percentile. By comparison, as reported above, if the value of irreversibility is held at its median level (and the values of the other variables are also held at their median level), the probability increases by just 37% with a similar increase in uncertainty. The comparison indicates that the interaction effect is a 59% increase in the probability of a CVC investment rather than an acquisition.

Hypothesis 3 proposes that the positive effect of uncertainty on the preference for CVC over acquisition will be attenuated for investments made in the presence of significant growth opportunities. The negative and significant interaction of uncertainty and growth opportunities in Columns IV and VI provide support for H3 ($p < 0.05$). In this case, when uncertainty increases from its 50th percentile to 75th percentile value, the probability of a CVC investment versus an acquisition increases by about 18% if the value of growth opportunities increases to its 75th percentile. However, if the value of growth opportunities (as well as the values of the other variables) is held at the median level, the probability increases by 37% with a similar increase in uncertainty, suggesting that the interaction effect is a 19% decrease in the probability of a CVC investment rather than an acquisition.

Finally, Hypothesis 4 predicts that the level of competition will weaken the positive relationship between uncertainty and the preference for CVC over acquisition. In neither Column V nor VI is the interaction effect of uncertainty and competition significant. Therefore, there is no support for H4. The nonsignificant interactive effect might reflect the countervailing effect that firms invest in concentrated industries through acquisitions to avoid adding excess capacity to the industry (e.g., Kogut 1991, Hennart and Reddy 1997). Our finding might also reveal some issues worthy of future theoretical and empirical research. Prior research on real options, for example, has largely focused on the role of

competition in the context of investment decision, rather than in the setting of investment mode choice in our study (e.g., Smit and Ankum 1993, Kulatilaka and Perotti 1998, Smit and Trigeorgis 2004). These considerations suggest that more work is required to reveal and tease out the specific mechanisms through which competition may affect firms' investment mode choice under uncertainty in the real options framework (e.g., Pacheco-de-Almeida et al. 2008).

Turning to the results for the selection models in the bottom panel, we find that larger firms and firms with better performance, greater R&D intensity, and lower leverage are more likely to undertake a CVC investment or acquisition ($p < 0.001$ for the first three variables, and $p < 0.05$ for financial leverage). The other variable, *capital intensity*, does not seem to affect firms' propensity to engage in CVC investments *or* acquisitions.

The results for several control variables are worth noting as they shed light on other theories of organizational governance and investment mode choice. First, we find that the variables *irreversibility* and *competition* both have a positive and significant main effect on the choice of CVC versus acquisition, whereas the variable *growth opportunities* only has an interaction effect. It seems that growth opportunities per se, in the absence of uncertainty, may not be sufficient to increase firms' preference for CVC vis-à-vis acquisition. Second, we find that the coefficient of the variable *interindustry investment* is positive and significant, indicating that CVC is preferred to acquisition for cross-industry deals. Because interindustry investment involves greater information asymmetry compared to intraindustry investment (e.g., Balakrishnan and Koza 1993), this finding shows that greater information asymmetry between the investor and investee encourages CVC investments and discourages acquisitions. Third, the coefficient of the variable *industry R&D intensity* is positive and significant. Given that greater R&D intensity in the investee industry presents greater information asymmetry to the investor (e.g., Gompers 1995), this finding suggests that information asymmetry has a positive and significant influence on the preference for CVC over acquisition. Fourth, we find a positive and significant coefficient for the variable *IP regime*: when the IP regime is strong, firms will be more willing to undertake CVC investments rather than acquisitions; conversely, when the IP regime is weak, firms will prefer internalization via acquisitions. This result is consistent with predictions from transaction cost economics (Teece 1986), and it also indicates that real options theory and transaction cost theory can complement each other in studying organizational governance and investment mode choice (Leiblein 2003, Leiblein and Miller 2003). Fifth, the coefficient of the variable *CVC to acquisition experience* shows the expected, positive sign. The finding might reflect firms' development of CVC capabilities or the proclivity to use particular modes to structure investments (e.g., Dyer et al. 2004). Finally, there is evidence that larger firms are more likely to make CVC investments and that acquisitions are more commonly undertaken in profitable industries.

Table 3 reports the multivariate results for the sample that controls for the two investee characteristics variables: *investee age* and *investee size*. All the other variables in this table are the same as those in Table 2. Column I includes the variable *investee age*, Column II includes the variable *investee size*, and Column III includes both variables and has a smaller sample size than that in the first two columns. Controlling for the investee's characteristics, results for the explanatory variables across the three columns are qualitatively similar to those reported in Table 2: these results provide

Table 3 Results for Choice Models Including *Investee Age* and *Investee Size*

	I		II		III	
CVC vs. acquisition choice model variables						
intercept	−9.80***	(1.48)	−9.11***	(2.78)	−8.88**	(2.96)
year 2003	0.65*	(0.31)	0.85*	(0.41)	0.88*	(0.42)
year 2004	−0.03	(0.26)	0.03	(0.31)	0.02	(0.31)
investee age	−0.18†	(0.10)	—		−0.18†	(0.11)
investee size	—		−0.68**	(0.22)	−0.71*	(0.28)
interindustry investment	0.29**	(0.11)	0.32**	(0.10)	0.27**	(0.10)
different state	−0.04	(0.16)	0.02	(0.21)	−0.03	(0.22)
size	0.36***	(0.07)	0.36***	(0.08)	0.37***	(0.08)
profitability	0.17	(0.60)	0.20	(0.71)	0.13	(0.70)
R&D intensity	0.04	(0.28)	0.06	(0.31)	0.06	(0.32)
CVC to acquisition experience	0.47***	(0.09)	0.57***	(0.12)	0.59***	(0.13)
industry profitability	−2.01*	(0.90)	−1.94*	(1.00)	−1.82†	(1.03)
industry R&D intensity	3.79*	(1.80)	3.60†	(1.90)	3.51	(1.92)
IP regime	0.05**	(0.02)	0.07**	(0.03)	0.06**	(0.03)
irreversibility	4.01**	(1.70)	7.86**	(2.80)	6.94**	(2.35)
growth opportunities	0.09	(0.11)	0.20	(0.13)	0.23	(0.14)
competition	0.30	(0.34)	0.48†	(0.28)	0.41	(0.28)
uncertainty	0.22*	(0.10)	0.22*	(0.11)	0.21*	(0.10)
uncertainty ∗ *irreversibility*	5.51**	(2.22)	6.55*	(3.00)	6.43*	(2.80)
uncertainty ∗ *growth opportunities*	−0.31*	(0.13)	−0.28†	(0.15)	−0.32*	(0.14)
uncertainty ∗ *competition*	1.84	(1.90)	2.99	(1.98)	2.87	(1.94)
N (CVC vs. acquisition choice model)	2,323		2,197		2,120	
Selection model variables						
intercept	−1.35***	(0.04)	−1.41***	(0.04)	−1.45***	(0.04)
size	0.05***	(0.01)	0.05***	(0.01)	0.04***	(0.01)
profitability	0.70***	(0.11)	0.65***	(0.09)	0.65***	(0.10)
R&D intensity	0.24***	(0.06)	0.23***	(0.05)	0.22***	(0.06)
capital intensity	0.06	(0.09)	0.07	(0.10)	0.06	(0.10)
financial leverage	−0.26*	(0.11)	−0.25*	(0.12)	−0.26*	(0.11)
N (selection model)	9,504		9,378		9,301	
χ^2	73.17***		71.93***		72.52***	
Wald test of indep. equations ($\rho = 0$)	4.78*		2.05		2.10	

Notes. Robust standard errors appear in parentheses. In the top panel, positive coefficients indicate that increases in a variable increase the likelihood of a CVC versus an acquisition. In the bottom panel, positive coefficients indicate that increases in a variable increase the likelihood of either a CVC or an acquisition vis-à-vis neither.

†$p < 0.10$; ∗$p < 0.05$; ∗∗$p < 0.01$; ∗∗∗$p < 0.001$.

support for Hypotheses 1–3, but not for Hypothesis 4. Concerning the two investee-level variables, we find that the coefficient of investee age is negative and marginally significant in Columns I and III ($p < 0.10$ for both models); the coefficient of investee size is negative and significant in Columns II and III ($p < 0.01$ and $p < 0.05$, respectively). Thus, there is some evidence that older and larger companies are more likely to be targets for acquisition rather than CVC investment.

We performed several additional tests to examine the robustness of the results to alternative measures and other models. First, we calculated another measure for uncertainty that has been used in earlier management research (Dess and Beard 1984, Keats and Hitt 1988). Specifically, we regressed industry sales over five years against time and then used the standard error of the regression coefficient divided by the mean of industry sales to develop a standardized proxy of uncertainty for each industry and year. When we used this new uncertainty measure in the analyses, we found that the results had similar interpretations to those reported in Table 2: the main effect of uncertainty and its interaction effect with irreversibility are positive and significant ($p < 0.05$ and $p < 0.01$, respectively), the interaction between uncertainty and growth opportunities is negative and moderately significant (i.e., $p < 0.10$), whereas the interaction between uncertainty and competition remains nonsignificant.

Second, we tested alternative measures of irreversibility. We followed existing real options studies and used the industry inverse leverage as a measure of irreversibility, under the assumption that investments in high-leverage industries should be more reversible than investments in low-leverage industries (Long and Malitz 1985, Titman and Wessels 1988, Williamson 1988). Industry inverse leverage is calculated as one minus the median leverage ratio of the investee's industry. We found that the coefficient of this measure and the coefficient of its interaction term with uncertainty were significant at $p < 0.05$, whereas the results for the other theoretical variables had the same interpretation as before. We also sought to develop a proxy of irreversibility based on the M&A deal flow in the industry.[2] Specifically, we followed prior studies to create a liquidity index that measures the intensity of M&A activities in the investee's industry at the two-digit SIC level in the year before investment (e.g., Schlingemann et al. 2002). With the data aggregated to the two-digit SIC level, the liquidity index measure becomes quite broad; in addition, using the liquidity index measure reduced the sample size by about 5%, because this index could not be calculated for a certain number of industry–year combinations (Schlingemann et al. 2002). When we ran regressions using the liquidity index measure, we found that its interaction term with uncertainty was correctly signed but was just close to marginal significance.

We also explored the sensitivity of the findings to alternative models. First, in certain high-tech industries, exogenous shocks such as technological innovations may increase uncertainty as well as the presence of CVC candidates. To address this possibility, we ran models by focusing on companies outside of the high-tech realm where shocks are less likely to apply; the results are qualitatively similar to those for the full sample, though the statistical significance is weaker for several control variables. Second, given that minority acquisitions have been studied in prior real options research, we also conducted multinomial analyses to compare acquisitions with CVC investments and with 62 minority acquisitions obtained using the sampling procedures described earlier. We found that the results for the variable *uncertainty* and its interactions with *irreversibility* and with *growth opportunities* were similar across the two comparison models. These results indicate that under these conditions, CVC investments, as well as minority acquisitions, are preferred to acquisitions.[3]

Discussion

In this paper, we use real options theory to investigate firms' investment mode choice between CVC and acquisition, and our findings broadly corroborate real options theory's predictions. When an investment is surrounded by high levels of market uncertainty, maintaining flexibility becomes more important, and firms attach greater value to the real options embedded in initial CVC investments vis-à-vis acquisitions. As a result, firms prefer to stage commitments and defer internalization by undertaking CVC investments rather than acquisitions. Furthermore, the value of real options under uncertainty is contingent upon several factors that may either increase or decrease such value and therefore may shape firms' choice between CVC and acquisition. The findings show that investment irreversibility will further increase firms' propensity toward CVC, whereas growth opportunities facing the investment will weaken the preference for CVC under uncertainty.

Our study offers several important implications for theory and research. First, prior research has used real options theory to investigate firms' investment decisions such as capacity expansion, diversification, and foreign market entry (e.g., Pindyck 1991, Campa 1993, Dixit and Pindyck 1994, Folta and O'Brien 2004, McGrath and Nerkar 2004). Our study extends this stream of research by examining how real options theory may also inform firms' investment mode choice (e.g., Chi and McGuire 1996, Folta 1998). We also move beyond prior studies by using real options theory as a unifying framework to integrate the effects of three contingencies that may affect the value of options under uncertainty and therefore shape firms' investment mode choice. To our best knowledge, we are the first empirical real options study to use such a

contingent approach to examine firms' investment mode choice, and using this approach is valuable by helping bound the theory's application in strategic management (Tong and Reuer 2007). To the extent that different investment modes represent different ways to govern economic exchanges, our study also points to the value of the real options approach to examining firm boundaries. In particular, our findings reaffirm prior research suggesting that real options theory can complement transaction cost economics, as well as other theories of organizational governance, in explaining firms' boundary choice (e.g., Balakrishnan and Wernerfelt 1986, Argyres 1996, Chi and McGuire 1996, Folta 1998, Leiblein 2003, Leiblein and Miller 2003).

Second, our study contributes to extant research on CVC investments and acquisitions in several ways. Prior research has compared CVC with acquisition as two governance modes by investigating their differential effects on performance outcomes (e.g., Schildt et al. 2005, Keil et al. 2008). Our study complements this research by empirically examining the antecedents of the choice between CVC and acquisition (e.g., van de Vrande et al. 2006). Emerging research has studied the conditions under which firms make CVC investments (e.g., Dushnitsky and Lenox 2005, Dushnitsky and Shaver 2009) and acquire private targets (e.g., Capron and Shen 2007, Reuer and Ragozzino 2008). Our study complements the two streams of research by adopting a comparative lens to examine CVC investments and acquisitions together. Our study also contributes to the fast-growing literature on firms' investment mode choice between acquisitions and alliances (e.g., Hennart and Reddy 1997, Folta 1998, Hagedoorn and Duysters 2002, Vanhaverbeke et al. 2002, Dyer et al. 2004, Villalonga and McGahan 2005, Wang and Zajac 2007) by highlighting CVC as another important investment mode that can be incorporated into future research. Finally, prior empirical research has tended to examine firms' investment decisions and investment mode choice separately. By contrast, we consider and model these two important and interconnected aspects of corporate investment simultaneously. This broader framing recognizes that firms' investment decision and investment mode choice are interdependent and can contribute to a more general understanding of corporate investment (see Kogut and Singh 1988).

Third, our study also has several implications for research on entrepreneurship and corporate strategy. We respond to recent calls to use additional theories such as real options theory in conducting corporate entrepreneurship research (e.g., Ahuja and Lampert 2001, Hoskisson and Busenitz 2002, Dess et al. 2003). Previous research suggests that real options theory can shed new light on entrepreneurial activities (e.g., Hurry et al. 1992, McGrath 1997), and our study indicates that CVC provides an attractive investment vehicle for firms to commit resources to future initiatives under uncertainty. Our study adds to the emerging research on external corporate venturing by bringing CVC investments and acquisitions together rather than treating them separately, and our results confirm that the two investments provide alternative modes of business development and corporate growth (e.g., Schildt et al. 2005, van de Vrande et al. 2006, Keil et al. 2008). Finally, we also join recent corporate strategy research on acquisitions of private companies (e.g., Capron and Shen 2007, Reuer and Ragozzino 2008), and we examine how firms choose between undertaking private acquisitions and making CVC investments.

We would like to note several areas for future research, which can also help address some of the limitations of this paper given the scope of our study. In this paper, we focus on comparing firms' CVC investments and acquisitions. Future research can go beyond this focus to consider other activities, such as alliances and joint ventures, which can also be used to further firms' external corporate development initiatives (e.g., Schildt et al. 2005, van de Vrande et al. 2006, Keil et al. 2008). However, researchers must also attend to additional challenges presented to theory and empirical analysis due to the enlarged scope of investment choices. As one example, the large heterogeneity often seen in different types of alliances might explain why researchers treat alliances as a separate category and investigate the choice of one type of alliances versus another (e.g., Oxley 1997, Gulati and Singh 1998).

Like previous studies, we take the investing firm's perspective to examine investment mode choice (e.g., Kogut and Singh 1988, Hennart and Reddy 1997, Folta 1998, Dyer et al. 2004, Villalonga and McGahan 2005). Future research would find it especially useful to investigate investment mode choice from the perspectives of both the investor and the investee (e.g., Wang and Zajac 2007). Such work would benefit from a research design that gives more attention to the needs and motivations of the investee. For instance, research can focus on selected industries by collecting specific information on the investee's technologies and characteristics at different stages of its development to examine more explicitly the specific sources of uncertainty in its industry and the link between uncertainty and the investment mode chosen to exploit the opportunity. Further research in this direction can also compare the use of different investment modes across different industries (e.g., Auster 1992).

Our study focuses on the creation of options by studying firms' decision to undertake initial CVC investments versus acquisitions. Future research can extend our focus on option creation at the initial investment stage to option implementation at the postinvestment stage. For example, it would be interesting to examine the conditions under which CVC investors subsequently decide to acquire their portfolio companies or abandon their investments.

We also follow existing real options research on alliances to focus on the implicit options embedded in CVC investments. An opportunity therefore lies in studying explicit option clauses in venture capital contracts (e.g., Triantis 2001, Kaplan and Stromberg 2003), such as how they might affect firms' initial investment decision or mode choice, and how firms use these option rights as the investment unfolds and environmental conditions change. Such research can shed important light on the management and organizational processes in applying real options analysis for strategic investment decisions that are currently understudied. We believe that research in directions such as these will prove useful in enhancing the value of real options theory for understanding firms' investment decision and other strategic choices.

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Endnotes

[1]Both real options theory and transaction cost economics emphasize the importance of uncertainty in investment decisions and entry mode choice, but their focuses differ. Real options theory focuses primarily on the source of uncertainty that is exogenous and resides in firms' external environment, whereas transaction cost economics focuses primarily on behavioral uncertainty that can arise when exchange partners behave opportunistically in the presence of asset specificity and small numbers bargaining (Williamson 1985). Our study follows the classical research on real options theory (Dixit and Pindyck 1994) by examining the effect of exogenous market uncertainty (e.g., Folta and O'Brien 2004).

[2]We thank an anonymous reviewer for this suggestion.

[3]Details on this and other robustness tests are available from the authors.

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